# APPENDIX 6-4

***BIODIVERISTY MANAGEMENT AND ENHANCEMENT PLAN***

# 1. INTRODUCTION

## 1.1 Background

This Biodiversity Management and Enhancement Plan (BMEP) has been prepared in support of the Environmental Impact Assessment Report (EIAR) produced for the proposed Borrisbeg Renewable Energy Development.

This Biodiversity Management and Enhancement Plan (BMEP) has been prepared in order to outline the proposed biodiversity enhancement measures associated with the Proposed Project. This Biodiversity Management and Enhancement Plan also outlines how the proposed project has been designed to offset any loss of habitat or loss of faunal supporting habitat.

Biodiversity enhancement measures outlined in this BMEP include the following:

- River restoration of a portion of the Eastwood River within the Site,
- Planting of 1.8ha of native Woodland species associated with the above-mentioned river restoration as well as to offset the loss of 0.78ha of (Mixed) broadleaved woodland (WD1) associated with the Proposed Project,
- Planting of 5.17km of linear vegetation within the Site in order to increase hedgerow and treeline habitat, bolster wildlife corridors and offset the loss of 1.8km of hedgerow and treeline habitat associated with the Proposed Project.,
- Installation of pine marten den boxes in order to increase the amount of potential habitat for pine marten within the Site,
- Installation of bat boxes in order to provide suitable habitat for roosting bats within the Site as well as offset any potential loss of bat roosting habitat associated with the Proposed Project,
- Grassland management measures. Grassland management measures are also described within Appendix 7-7 of this EIAR and will also result in a positive effect on local biodiversity.

(Mixed) broadleaved woodland and linear vegetation losses associated with construction of the Proposed Project infrastructure and turbine bat buffers (as per NatureScot guidelines) are shown on Figure 1-1.

The proposed river restoration area associated woodland planting area and linear vegetation replanting areas are shown on Figure 1-2.

## 1.2 Statement of Authority

This report has been prepared by Aran von der Geest Moroney (B.Sc.) and Thomas Blackwell (B.Sc., M.Sc., PWS).

Aran von der Geest Moroney is an ecologist with MKO having over 3 years' experience in professional ecological consultancy. Aran holds a first-class honours BSc (Hons) in Ecology and Environmental Biology from University College Cork. Aran has also completed a Level 8 Special Purpose Award in Digital Mapping and GIS. Aran's areas of expertise are wintering bird surveying and identification, freshwater macroinvertebrate identification and sampling, freshwater pearl mussel surveying, white-clawed crayfish surveying, electric fishing, bat surveys, GIS, habitat mapping, preparation of Stage 1 and Stage 2 Appropriate Assessment reports and Ecological Impact Assessment. Aran has been involved in a range of mixed use, residential, industrial, restoration, public services, wind energy and forestry projects. Aran has conducted a wide range ecological field surveys in accordance with NRA Guidelines, bat surveys, bird surveys, recording vegetation relevés and freshwater quality analysis using bioindicators. Aran has provided supervision as an ecological clerk of works in residential and wastewater infrastructure projects. Aran is trained in conducting bat surveys, non-volant mammal surveys, bird surveys, freshwater pearl mussel surveys, white-clawed crayfish surveys, electric fishing surveys, river condition assessment surveys and in taking vegetation relevés of vascular plants and has experience in habitat identification and habitat mapping. Aran is responsible for independently conducting and planning a range of ecological field surveys in accordance with NRA Guidelines and conducting Appropriate Assessment screenings, Natura Impact Statements, Ecological Impact Assessments, Biodiversity chapters for EIARs, Invasive Species Management Plans and Aquatic

reports as part of the ecology team. Aran is a member of CIEEM, holds a current Bat Roost Disturbance licence and holds an IFM Certificate in Electric Fishing.

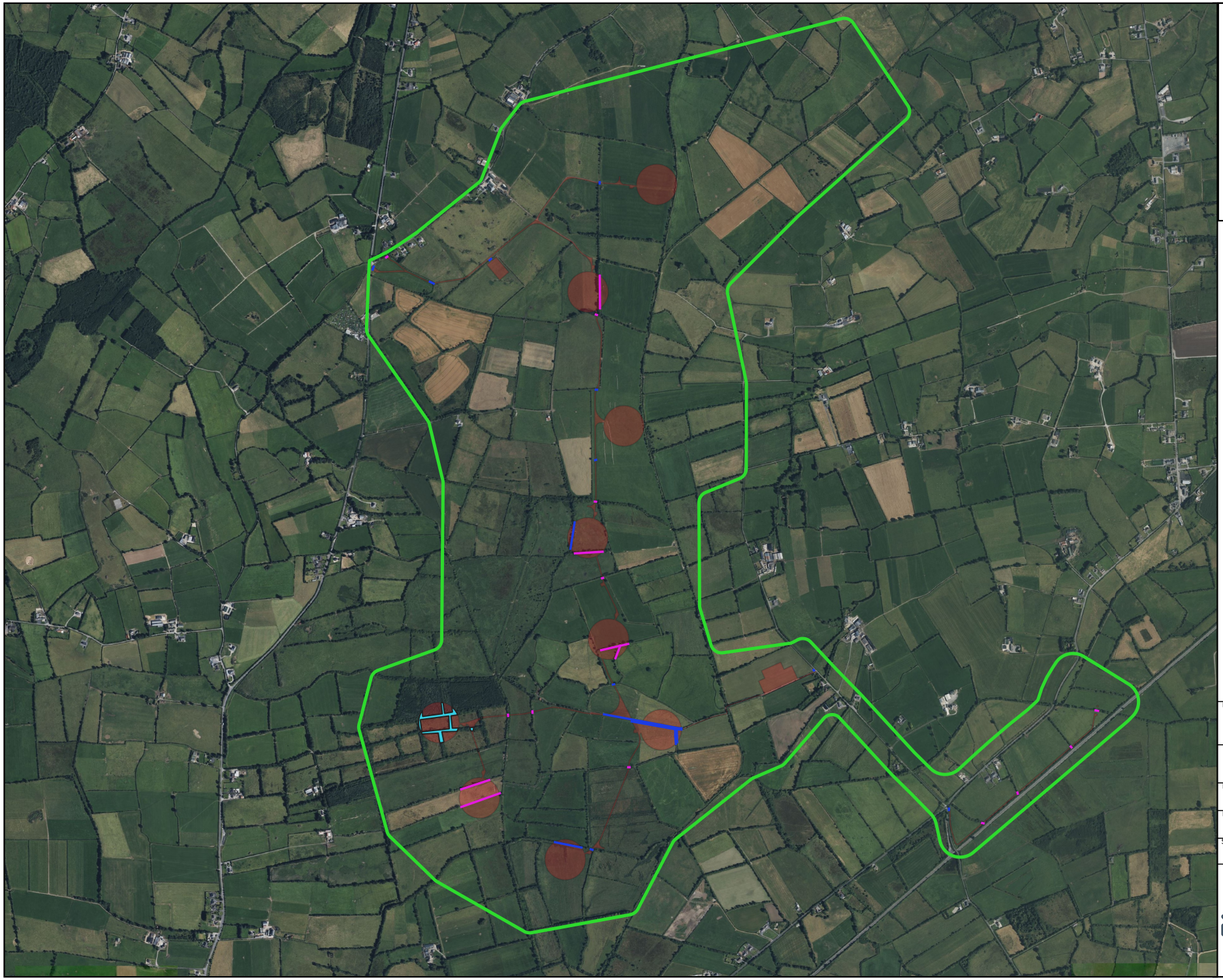
Thomas is a Senior Environmental Consultant with over 18 years of progressive experience in environmental consulting. Thomas' professional experience includes managing Environmental Impact Assessments, environmental permitting, environmental due diligence and compliance, and general environmental assessment on behalf of clients in the renewable energy, mining, solid waste management, residential and commercial development, and public sectors. Thomas also has extensive experience in environmental and ecosystem restoration design, project management, and construction oversight. In particular, Thomas has experience in the design and implementation of stream and river restoration project for the purposes of water quality, fisheries habitat, and riparian and wetland habitat restoration. Thomas' multi-sector experience working on projects in multiple jurisdictions has allowed him to develop a wealth of knowledge and understanding of the challenges involved in guiding complex project through the regulatory and planning process.

This report has been reviewed by John Hynes (BSc., MSc., MCIEEM) who has over 10 years' experience in ecological assessment and ecological management.

## 1.3 Structure of this Report

This report will follow the below layout:

- **Section 1** is the introduction which discusses briefly the core areas of Biodiversity management and Enhancement associated with the Proposed Project
- **Section 2** discusses the Stream Geomorphic Assessment and Restoration Plan (Also referred to as the 'Proposed River Restoration') associated with the Proposed Project,
- **Section 3** discusses the measures put in place to create a net gain in woodland habitat within the Site and offset any loss of (Mixed) Broadleaved Woodland (WD1) associated with the Proposed Project,
- **Section 4** discusses measures put in place to create a net gain in linear vegetation within the Site and offset any loss of Hedgerow and Treeline Loss associated with the Proposed Project,
- **Section 5** discusses the Installation of Pine Marten Den Boxes.
- **Section 6** discusses Installation of Bat Boxes
- **Section 7** discusses the Grass Growing management within the Site as per Appendix 7-7.
- **Section 8** provides a conclusion for all Biodiversity and Enhancement Measures presented within this report.



## Map Legend

- EIAR Study Boundary
- Infrastructure Footprint and Bat Felling Buffers
- Hedgerow (WL1) to be Felled
- Treeline (WL2) to be Felled
- (Mixed) Broadleaved Woodland (WD1) to be Felled

N



Drawing Title
(Mixed) Broadleaved Woodland Loss and Linear Vegetation Loss

Project Title
Borrisbeg Renewable Energy Development

| Drawn By | Checked By |
|---|---|
| AvdGM | JH |
| Project No. | Drawing No. |
| 220310 | Figure 1-1 |
| Scale | Date |
| 1:22,500 | 12.12.2023 |

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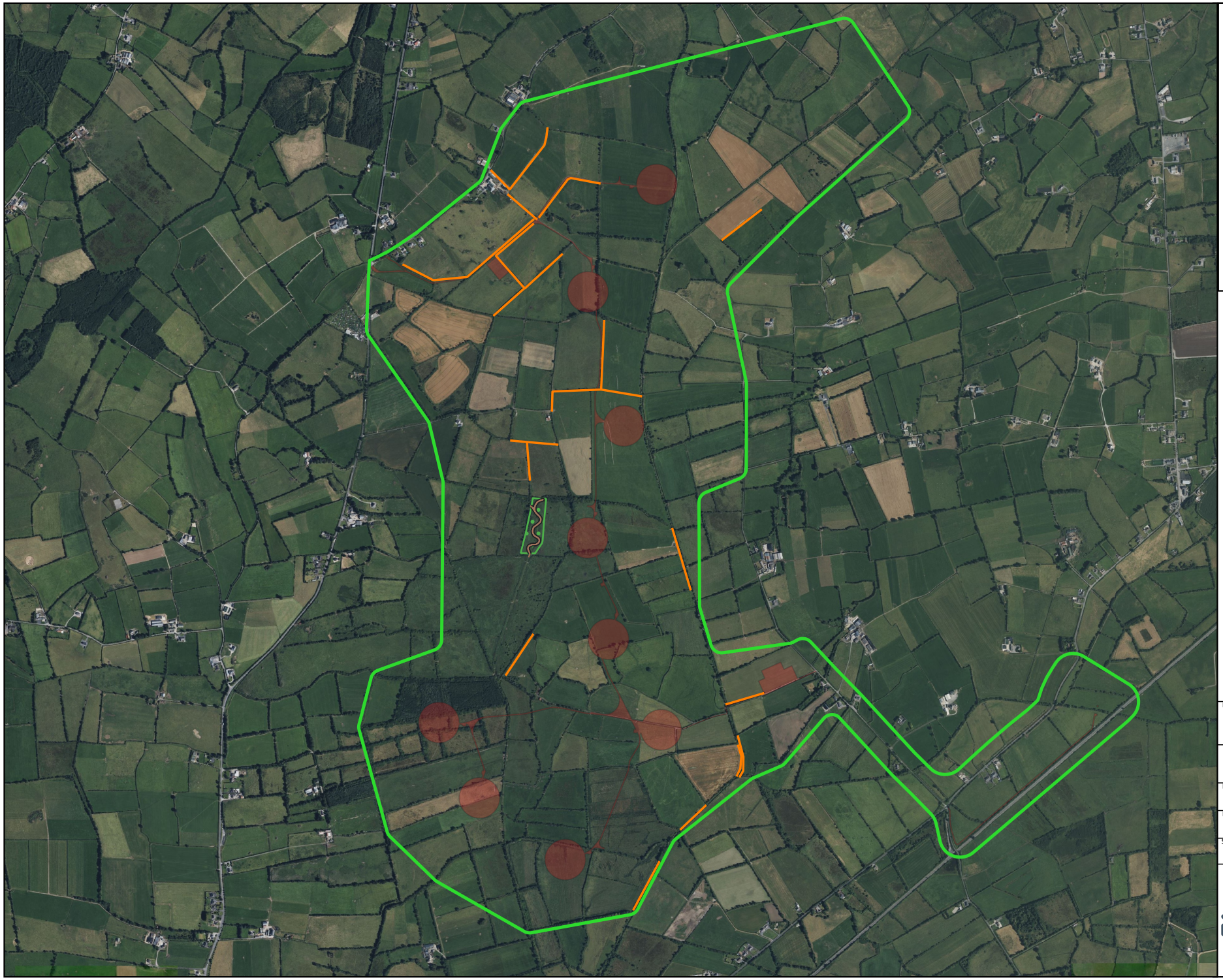

## Map Legend

- EIAR Study Boundary
- Infrastructure Footprint and Bat Felling Buffers
- Linear Vegetation Replanting
- River Enhancement Stream Concept
- River Enhancement 5m Riparian Buffer
- River Enhancement 1.8ha Natural Woodland

N



Drawing Title
Proposed River Restoration Area, Associated Native Broadleaved Woodland Planting and Linear Vegetation Planting

Project Title
Borrisbeg Renewable Energy Development

| Drawn By | Checked By |
|---|---|
| AvdGM | JH |
| Project No. | Drawing No. |
| 220310 | Figure 1-2 |
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# 2. STREAM GEOMORPHIC ASSESSMENT AND RESTORATION PLAN

## 2.1 Introduction

While no loss of depositing/ lowland river (FW2) or any other natural watercourse will occur as a result of the proposed project a river restoration plan has been proposed in order to create a net gain in depositing/ lowland river (FW2) within the site as well as an associated increase in the quality of the watercourse for local aquatic fauna. Section 2 of this report 'Stream Geomorphic Assessment and Restoration Plan' details the baseline environmental conditions and methodologies of the proposed river restoration on a portion of the Eastwood River within the Site. The portion of the Eastwood subject to River Restoration currently measures approximately 240m and after restoration works will measure approximately 300m. This will result in a net gain of watercourse length as well as a functional uplift within the Eastwood River.

## 2.2 Existing Geomorphic Conditions

A geomorphic survey of a segment of the Eastwood River within the EIAR Study Boundary of the proposed Borrisbeg Renewable Energy Development (the reach study area) was performed by MKO on October 21, 2023. The survey included detailed cross sections, substrate sampling (Wolman reach-wide pebble count) and photographic documentation of the segment of the Eastwood River for which restoration is proposed. Longitudinal profile data was derived from a previous survey of the Eastwood River. These data were used to classify the restoration reach using the Rosgen Level II system (Rosgen 1996). The locations of the stream cross-sections are shown in Figure 2-1.

## 2.3 Bankfull Verification

Indicators of bankfull levels were identified in the field and included scour lines, and floodplain benches. Depositional bars were not apparent in the reach study area due to the heavily modified character of the channel. The observed bankfull indicators were verified by HEC-RAS modelling conducted by R&D Fluvio Ltd. Locations of cross sections were chosen at areas that represent the overall character the reach study area. Cross sectional measurements were not taken within two bankfull widths of bridges or culverts or other in-stream structures or obstructions for consistency with current methodology. Instream structures alter the flow and velocity of the channel resulting in the presence of nonrepresentative bankfull indicators.

*Table 2-1 Field Measured and Modelled Bankfull Area*

| Cross Section No. | Reach Catchment Area (km²) | Field Measured Bankfull Area (m²) | Average Bankfull Area (m²) |
|---|---|---|---|
| CS1 | 11.23 | 1.23 | 1.30 |
| CS2 | | 1.33 | |
| CS3 | | 1.34 | |

## 2.4 Geomorphic Assessment

The assessed reach of the Eastwood River flows south through the EIAR Study Boundary (the "Site") and is approximately 240m in length. MKO conducted a limited geomorphic assessment of the reach study area with a view to classifying the channel according to the Rosgen stream classification methodology.

The reach study area is shown in Figure 2-1. The Level II classification for this reach was identified as G5c /B5c (Table 2-2). This reach exhibits substrate consisting of very fine sand (D50 = 0.062mm) based on a Wolman Reach-Wide Pebble Count.

The average drainage area for this reach equals approximately 11.23 $km^2$, channel slope averages 0.0032 m/m, and sinuosity averages 1.06 m/m. Mean bankfull width and depth for this reach are 2.78m and 0.4m, respectively. The average floodprone width for this reach is approximately 7.47m. This reach displays bank height ratios of between 1.75 and 2.34, and entrenchment ratios of between 2.06 and 2.65.

The existing reach of the Eastwood River is heavily modified due to historic relocation, straightening, and dredging. The channel does not fit neatly into a single stream type but rather displays elements of both a G type channel and a very low slope B type channel. The river has a very low width to depth ratio (average 5.98) and an average bank heigh ratio of 2.04 indicating a high degree of incision. However, partially due to the low bankfull width of the channel, the average entrenchment ratio is 2.43, indicating the presence of bankfull benches.

The riparian area is dominated by wet grassland with small areas of scrub. In general, there are few woody plants within the riparian zone and little channel shading. Photographs of the proposed restoration reach are included in Appendix 1: Plates 1 to 6. Cross-section and pebble count data are included in Appendix 2.

*Table 2-2. Summary of Existing Conditions*

| Parameter | Existing Condition |
|---|---|
| Reach | Reach 1 |
| Length of Reach (m.) | 240 |
| **Channel Dimension** | |
| Average Bankfull Width (m.) | 2.78 |
| Mean Bankfull Depth (m.) | 0.47 |
| Average Width/Depth Ratio | 5.98 |
| Average Bankfull Area (sq. m.) | 1.30 |
| Average Bankfull Maximum Depth (m.) | 0.75 |
| Average Width Floodprone Area (m.) | 7.47 |
| Average Entrenchment Ratio | 2.43 |
| Bank Height Ratio | 2.04 |
| **Channel Pattern** | |
| Sinuosity | 1.06 |
| **Channel Profile** | |
| Valley Slope (m./m.) | 0.0035 |
| Channel Slope (m./m.) | 0.0032 |
| **Channel Materials** | |
| Bed Material Distribution | Material Size (mm) |
| d16 | <0.062 |
| d35 | 0.062 |
| d50 | 0.062 (very fine sand) |
| d84 | 0.5 |
| d95 | 2 |
| **Rosgen Stream Type** | **G5c/B5c** |


Map Legend

- EIAR Study Area
- Cross section Location
- Existing Rivers



Drawing Title
Existing Eastwood River

Project Title
Borrisbeg Renewable Energy Development

| Drawn By | Checked By |
|---|---|
| TB | KM |
| Project No. | Drawing No. |
| 220310 | Figure 2-1 |
| Scale | Date |
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# 2.5 Discussion of Restoration Options

## 2.5.1 Restoration Options

Incision of stream channels is caused by straightening of channels, loss of riparian buffers, changes in watershed land-use, or changes in sediment supply. An incised stream has a bank height ratio greater than 1.0 m/m, meaning that the bankfull stage is at a lower elevation than the top of either streambank. Severely incised streams with bank height ratios greater than 1.8 m/m are usually classified as Rosgen stream types G or F. Shear stress at high flows in these streams may become very high, increasing the potential for streambank erosion and/or streambed downcutting. Moderately incised streams with bank height ratios between 1.4 and 1.8 m/m may be classified as Rosgen stream types E, C or B, but they are at increased risk of instability. Slightly incised streams with bank height ratios between 1.1 and 1.3 m/m are often stable; however, they may become unstable if land use in the watershed changes or riparian buffers disappear.

Because incised streams typically are unstable and function poorly, they are good candidates for restoration projects. Rosgen (1997) presents four priority options for restoring incised channels. The following sections describe the four main restoration approaches. In general, in selecting a restoration approach, the highest priority option practical should be selected, taking into account the constraints that may exist. In general, a Priority 1 restoration offers the highest level of functional uplift, while Priority 4 offers the lowest level of uplift.

### 2.5.1.1 Priority 1: Establish Bankfull Stage at the Historical Floodplain Elevation

The objective of a Priority 1 project is to replace the incised channel with a new, stable stream at a higher elevation. This is accomplished by excavating a new channel with the appropriate dimension, pattern and profile (based on reference-reach data) to fit the watershed and valley type. The new channel is typically an E or C stream with bankfull stage located at the ground surface of the original floodplain.

The increase in streambed elevation also will raise the water table, in many cases restoring or enhancing wetland conditions in the floodplain.

If designed and constructed properly, a Priority 1 project produces the most long-term stable stream system. It may also be the least expensive and simplest to construct depending on surrounding land-use constraints. Priority 1 projects usually can be constructed in dry conditions while stream flow continues in its original incised channel. The new channel can be stabilized with structures and bank vegetation before water is directed into the new stream. A special consideration with Priority 1 projects is the unbalanced cut/fill requirements. Typically, the amount of soil excavated in constructing the new channel will be much less than that required to completely fill the existing incised channel. The designer has the option of bringing additional fill to the site or creating floodplain ponds and/or wetlands to support habitat and recreation.

Surrounding land uses can limit the use of a Priority 1 approach if there are concerns about increased flooding or widening of the stream corridor. Most Priority 1 projects will result in higher flood stages above bankfull discharge in the immediate vicinity of the project and possibly downstream. The Priority 1 approach also requires sufficient land area on one or both sides of the existing incised stream to construct the new meandering channel on the floodplain. It also may be necessary to raise the existing channel at the beginning of the project reach and/or lower the new channel at the end of the project reach to connect with the existing channel.

### 2.5.1.2 Priority 2: Create a New Floodplain and Stream Pattern with the Stream Bed Remaining at the Present Elevation.

The objective of a Priority 2 project is to create a new, stable stream and floodplain at the existing channel-bed elevation. This is accomplished by excavating a new floodplain and stream channel at the elevation of the existing incised. The new channel is designed with the appropriate dimension, pattern and profile (based on reference-reach data) to fit the watershed. The new channel is typically an E or C stream with bankfull stage located at the elevation of the newly excavated floodplain.

A Priority 2 project can produce a stream system with long-term stability if designed and constructed properly. It may be more expensive and complex to construct than a Priority 1 project, depending on valley conditions. Priority 2 projects usually can be constructed in dry conditions while stream flow continues in its original channel or is diverted around the construction site. Typically, water is diverted into the new channel as soon as all or part of it is constructed and stabilized with structures and temporary bank-protection measures. Because the new floodplain is excavated at a lower elevation, Priority 2 projects do not increase, and may decrease, the potential for flooding. Also, the stream corridor created by the excavated floodplain may enhance riparian wetlands.

Unlike Priority 1 projects, which are normally short on material to fill the old channel, Priority 2 projects typically produce a surplus of cut material. Designers must consider the expense and logistics of managing extra soil material excavated from the floodplain. The designer may elect to raise the bed of the stream slightly in an attempt to balance cut and fill. Further, surrounding land uses can limit the use of a Priority 2 approach if there are concerns about widening of the stream corridor. This approach requires sufficient land area on one or both sides of the existing incised stream to construct the new floodplain and meandering channel.

#### 2.5.1.3 Priority 3: Widen the Floodplain at the Existing Bankfull Elevation.

Priority 3 is similar to Priority 2 in its objective to widen the floodplain at the existing channel elevation to reduce shear stress. This is accomplished by excavating a floodplain bench on one or both sides of the existing stream channel at the elevation of the existing bankfull stage. The existing channel may be modified to enhance its dimension and profile based on reference-reach data. The resulting channel is typically a B or Bc (low slope) stream with bankfull stage located at the elevation of the newly widened floodplain. Priority 3 projects typically do not increase sinuosity to a large extent because of land constraints.

A Priority 3 project can produce a stream system with long-term stability if it is designed and constructed properly. But it may require more structural measures and maintenance than Priority 1 or 2 projects. It may be more expensive and complex to construct, depending on valley conditions and structure requirements. Priority 3 projects are constructed in wet conditions unless stream flow is diverted around the construction site. These projects typically have little impact on flooding potential unless there are large changes in channel dimension. Priority 3 projects typically do not produce large quantities of extra cut material or require extensive changes to surrounding land uses. They also do not typically affect riparian wetlands or elevation of the water table.

In-stream structures are important to the success of Priority 3 projects. In many projects, a channelized stream must remain in its current location because of surrounding land uses or utilities. The resulting stream may be classified as a B or Bc channel even though the valley conditions support a more meandering E or C channel. In this case, boulder cross-vane structures should be used to protect streambanks, provide grade control and support scour pools for habitat.

#### 2.5.1.4 Priority 4: Stabilize Existing Streambanks in Place.

Priority 4 projects use various stabilization techniques to armour the bank in place. These projects do not attempt to correct problems with dimension, pattern or profile. Priority 4 projects often use typical engineering practices to harden (armour) one or more streambanks. Projects may use riprap, concrete, gabions, bioengineering or combinations of structures to protect streambanks. Both the upstream and downstream impacts of the project should be carefully evaluated. Because these projects do not correct dimension, pattern and profile, they are likely to continue being susceptible to extreme shear stress, which can erode streambanks despite armouring.

A Priority 4 project can stabilize streambanks if designed and constructed properly, but inspection and maintenance may be necessary to ensure long-term success. For these reasons, the long-term cost may be more. Priority 4 projects are constructed in wet conditions unless stream flow is diverted around the construction site. These projects typically have no impact on flooding potential and do not require changes to surrounding land uses. They also do not typically affect riparian wetlands or elevation of the water table.

## 2.5.2 Option Selection

Based on the Existing Conditions Survey, Eastwood River provides good opportunities for restoration. The channel is straight and exhibits steep banks that are heavily poached by livestock. There is little habitat diversity in the channel and no evidence of riffles or pools. The channel substrate is dominated by silt and fine sand. There is little in the way of woody vegetation within the riparian area and very little shading of the channel.

MKO has identified several design constraints potentially limiting the restoration options for the channel. These constraints include the following:

- Requirement to tie into the existing channel elevation above and below the restoration reach.
- Requirement to limit potential flooding outside of the restoration area and to ensure that the drainage function of the channel is maintained.

In selecting a restoration approach for the Eastwood River, the restoration options discussed above were considered in priority order. Taking the identified constraints into account it was determined that a Priority 1 restoration approach was not feasible as it would not be possible to raise the elevation of the channel bed and still tie into in the existing channel elevation above and below the restoration reach. Therefore, a "Priority 1" restoration approach was discounted.

A Priority 2 approach was then considered and was determined to be feasible. This approach allows for the reestablishment of an appropriate stream pattern, dimension, and profile, and will not result in any increase in flood levels beyond the immediate restoration area.

Priority 3 and 4 restoration approaches were considered; however, these approaches would not provide the same level of functional uplift as a Priority 2 approach. It was therefore determined that a Priority 2 restoration approach would be the most appropriate for the segment of Eastwood River within the reach study area, given the existing constraint of the site.

# 2.6 Stream Restoration Plan

## 2.6.1 Project Approach

Based on the existing condition of the stream and the space available, Priority 2 Stream Restoration is proposed. Approximately 240m of the existing degraded Eastwood River be restored. The existing channel will be relocated, and a new stable channel constructed at the same elevation as the existing channel. The new stream channel has been designed based on the data gathered during the stream geomorphic survey, and modelled data. The new channel will be approximately 300m in length and will provide improvement to channel dimension, pattern and profile. The new channel will have a broad floodplain excavated at bankfull elevation. Riffles will be constructed within the channel to provide improved habitat diversity. Bioengineering techniques such as livestaking and use of brush mattresses will used to promote bank stability on the outside of meander bends. Cross-vanes will be used, as necessary to provide vertical channel stability.

The restored stream section will have improved channel stability as a result of increased floodplain accessibility, and improved channel dimensions. The channel dimensions have been designed to improve water depths during low flow conditions and to provide improved habitat diversity within the channel. In addition, the entire riparian corridor (approximately 1.8 hectares) will be fenced to prevent access by livestock and will be planted with native woody vegetation.

## 2.6.2 Conceptual Stream Design

A stream design was developed for the relocated restored portion of the Eastwood River within the reach study area, based on the existing conditions of the stream, in combination with the reference reach data. Figures 2-2 and 2-3 (below) show typical cross-sections for riffle and pool sections of the proposed stream relocation. The dimensions of the proposed new channel are given in Table 2-3. The proposed channel profile is shown in Figures 2-4 and the proposed channel pattern is provided in Figure 2-5. Table 2-4 summarizes the proposed stream reach data for the restored channel.

*Table 2-3: Proposed Channel Dimensions*

| Feature | Rosgen Stream Type | Width of Floodprone Area (M) | Bankfull Width (m) | Mean Bankfull Depth (m) | Width/Depth Ratio | Bankfull Area (M”) | Max Depth (m) | Entrenchment Ratio |
|---|---|---|---|---|---|---|---|---|
| Riffle | C | 25 | 4 | 0.3 | 12.8 | 1.3 | 0.5 | 6.3 |
| Pool | C | 25 | 5 | 0.47 | 10.7 | 2.3 | 1 | 5 |

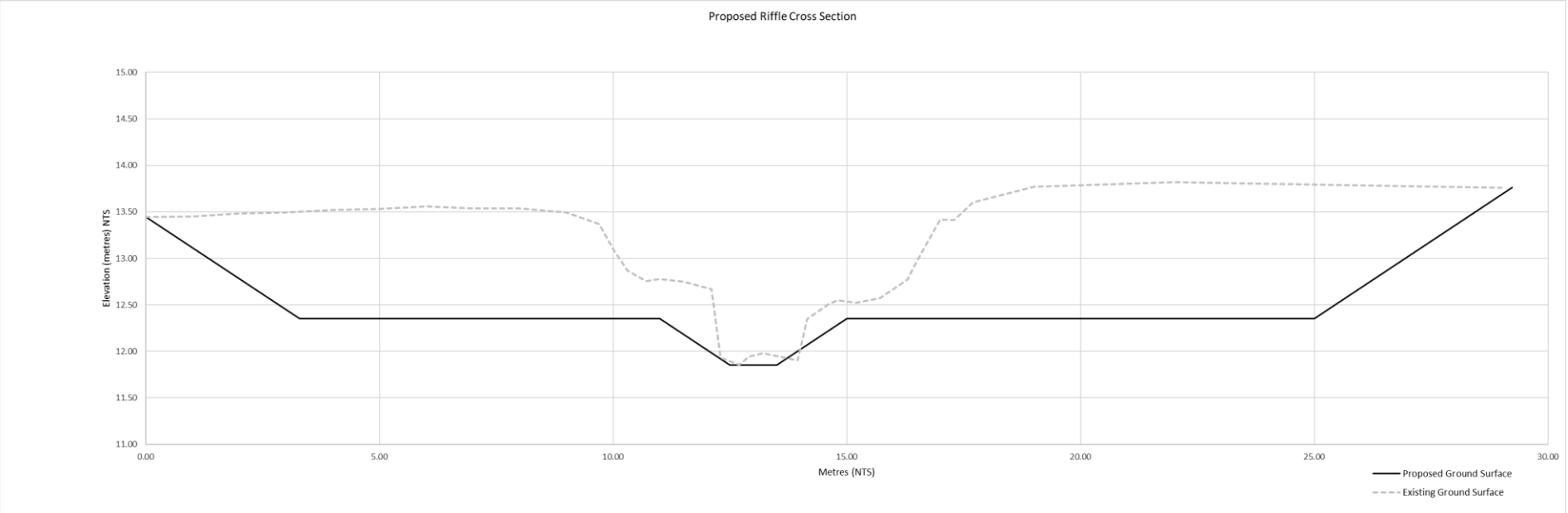


*Figure 2-2 Standard Proposed Riffle Cross Section*

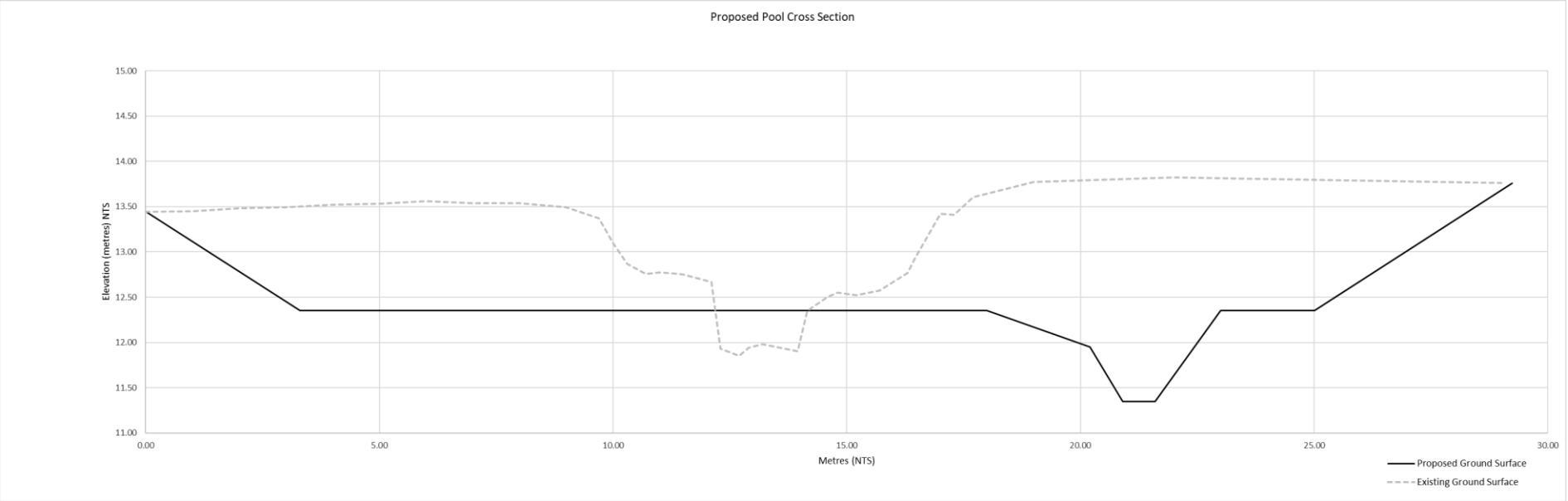


*Figure 2-3 Standard Proposed Pool Cross Section*

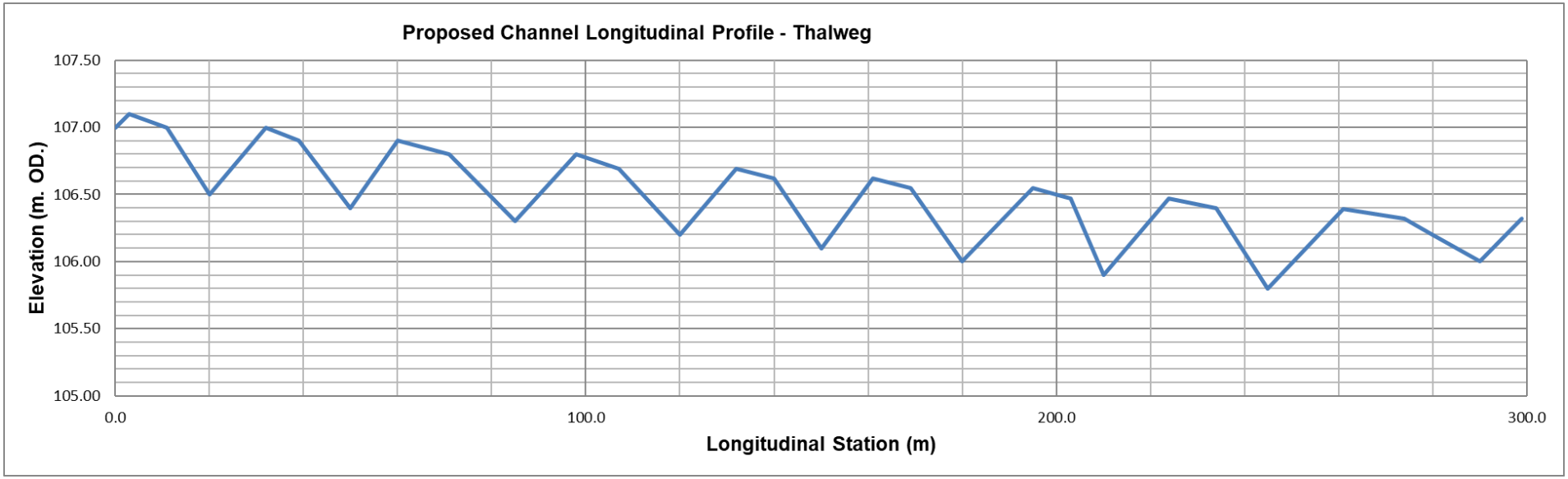


*Figure 2-4 Proposed Channel Profile*

*Table 2-4. Proposed Stream Reach Data Summary*

| Parameter | Proposed Dimensions |
|---|---|
| Reach | Relocated Channel |
| New Length of Reach (m.) | 300 |
| **Channel Dimension** | |
| Average Bankfull Width (m.) | 4.0 |
| Mean Bankfull Depth (m.) | 0.3 |
| Average Width/Depth Ratio | 12.8 |
| Average Bankfull Area (sq. m.) | 1.3 |
| Average Bankfull Maximum Depth (m.) | 0.5 |
| Average Width Floodprone Area (m.) | 25 |
| Average Entrenchment Ratio | 6.3 |
| Max Pool Depth (m.) | 1.0 |
| Ratio Max Pool Depth to Bankfull Depth | 2 |
| Ratio Pool Width/Bankfull Width | 1.2 – 1.7 |
| Pool to Pool Spacing (m.) | 28 - 40 |
| Ratio Pool to Pool Spacing to Bankfull Width | 7 – 10 |
| Bank Height Ratio | 1.0 |
| **Channel Pattern** | |
| Meander Length (m.) | 40 - 52 |
| Meander Length Ratio | 10 - 13 |
| Radius of Curvature (m.) | 10 - 14 |
| Radius of Curvature Ratio | 2.5 – 3.5 |
| Meander Belt Width (m.) | 18-23 |
| Meander Width Ratio | 4.5 – 5.5 |
| Sinuosity | 1.32 |
| **Channel Profile** | |
| Valley Slope (m./m.) | 0.0035 |
| Channel Slope (m./m.) | 0.0026 |
| Riffle Slope (m./m.) | 0.007 – 0.014 |
| Pool Slope (m./m.) | 0.0000 |
| **Channel Materials** | |
| Bed Material Distribution | Material Size (mm) |
| d50 (riffle) | 16 |
| Rosgen Stream Type | C4 |

Tributary Chainage: 0.0m

Chainage: 0.0m
Thalweg Elevation: 107m OD

Tributary Chainage: 87.00m

Chainage: 299m
Thalweg Elevation: 106.32m OD

Map Legend

- EIAR Study Area
- Proposed Conservation Area

Proposed Stream Design

- Proposed Centreline of River
- Proposed Bankfull
- Edge of Floodplain Bench
- Proposed Constructed Riffles



Drawing Title
Stream Restoration Design (Plan View)

Project Title
Borrisbeg Renewable Energy Development

| Drawn By | Checked By |
|---|---|
| TB | KM |
| Project No. | Drawing No. |
| 220310 | Figure 2-5 |
| Scale | Date |
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## 2.7 Monitoring Plan

The proposed stream restoration will be monitored for a period of five years from the completion of the work. The purpose of this monitoring is to ensure the success of the proposed restoration and to enable remedial action to be undertaken in a timely fashion if necessary. The proposed monitoring includes vegetation survival monitoring, photo documentation, and channel stability analysis annually for five years.

Upon completion of the project, an as-built channel survey will be conducted. The survey will document the dimension, pattern and profile of the relocated channel. Permanent cross sections will be established at an approximate frequency of one per 20 bankfull-width lengths (approximately one for every 80 metres of channel). The locations will be selected to represent approximately 50% pools and 50% riffle areas. The selection of locations will include areas that may be predisposed for potential problems. The as-built survey will also include photo documentation at all cross-sections and structures, a plan view diagram, a longitudinal profile, vegetation information and a pebble count for all cross sections. The longitudinal profile will include the entire length of the restored stream channel.

### 2.7.1 Required Monitoring

The required monitoring will be performed each year for the 5-year monitoring period. A minimum of two bankfull flow events will be documented during the 5-year monitoring period. If less than two bankfull events occur during the first 5 years, annual monitoring will continue until the second bankfull event is documented. The bankfull events must occur during separate monitoring years.

Monitoring data collected will include the following:

- reference photos (twice yearly – summer and winter)
- plant survival analysis
- channel stability analysis

Photo documentation will occur twice a year, once in the summer and again in the winter. Annual monitoring of plant survival and channel stability will be conducted at the same time of year during mid-growing season.

Photographs will be taken from no fewer than five established monitoring positions. The exact locations will be determined, marked with a stake, and recorded with a GPS receiver in the field during the first monitoring event and used in each of the following monitoring events.

Vegetation survival counts will be collected from established plots within each monitored area. The plot locations will be randomly determined in the office using GIS. The plots for stream restoration sites extend from the toe of bank to the furthest edge of the outside planting zone. The total area of plots is equal to 10% of the specific restoration site. The vegetation monitoring plots for each monitoring event will total 1,800 square metres, with 900 square metres on the left bank and 900 square metres on the right bank. Within these vegetation plots, all planted vegetation will be counted, identified to the species level, and survival rate will be calculated.

The results of each monitoring event will be collated into an annual monitoring report that will include photographs, vegetation survival counts, stream stability documentation, and a narrative describing current site conditions. The annual monitoring reports will be used to document the condition of the restored stream and will provide recommendations for remedial actions to be undertaken if success criteria are not being met.

### 2.7.2 Success Criteria

As described above, three forms of monitoring will be conducted to evaluate the success of the channel restoration within the reach study area: photo documentation, ecological function, and channel stability measurements. These criteria will be used to evaluate success by considering the following data:

#### 2.7.2.1 Photo documentation

A minimum of 5 permanent photo points will be established throughout the restored stream reach. These photo documentation points will be used to record the following at each monitoring event.

- Channel aggradation or degradation
- Bank erosion
- Success of riparian vegetation
- Effectiveness of erosion control measures

#### 2.7.2.2 Ecological Function

Health and survival of vegetation (80% survival of planted species required after 5 years)

#### 2.7.2.3 Channel Stability

There should be insignificant change from the as-built dimensions to those measured in the field during monitoring. If changes are present the changes should be minor and represent an increase in stability (e.g. decreased width to depth ratio without a decrease in entrenchment ratio). The following criteria will be used to assess channel stability.

- There should be little change from the as-built longitudinal profile.
- Pool/riffle spacing should remain constant.
- Pools should not be filling in (aggradation) or riffles starting to change to pools (degradation).
- Pebble count should show a change in the size of bed material toward the desired composition (as specified in Table 2-4).

### 2.7.3 Remedial Action

If the success criteria are not met remedial action will be taken to ensure that any channel instability is corrected. If plant survival rates are not met, then supplemental planting may be required. Required remedial actions (if any) for the following year will be set out in the annual monitoring report.

## 2.8 Discussion

The proposed river restoration as outlined in the preceding sections will results in the creation of approximately, additional river habitat within the Site as well as improving the habitat diversity and quality in the Eastwood River within the Site. The success of the proposed river restoration will be monitored as outlined in section 2.7. This bespoke river restoration is expected to create a slight long-term uplift in water quality within this segment of the Eastwood River and provide enhanced habitat for a variety of aquatic species. In addition, Section 3 of this report describes the planting of 1.8ha of native woodland species which has been designed to integrate with the proposed river restoration and create high quality riparian habitat along this segment of the Eastwood River.

# 3. WOODLAND LOSS AND PLANTING

## 3.1 (Mixed) Broadleaved Woodland (WD1) Loss

Turbine 6 hardstand footprint is in close proximity to and overlaps with an area of linear woodland classified as (mixed) broadleaved woodland (WD1). This woodland originated as hedgerows/ treelines established on both sides of drains which merged and expanded outwards into neighbouring fields. This has resulted in thin layers of woodland forming between the areas of wet grassland (GS4). In addition, areas of plantation Ash (*Fraxinus excelsior*) are to be felled to accommodate the bat felling buffer associated with Turbine 6. In total approximately 0.78ha of broadleaved woodland (WD1) will be lost to accommodate the footprint and Bat Buffer associated with Turbine 6. It is proposed to replace the 0.78ha of (mixed) broadleaved woodland to be felled with approximately 1.8ha of native trees resulting in a net gain of approximately 1.02ha of woodland habitat within the Site.

(Mixed) broadleaved woodland losses associated with construction of the Proposed Project infrastructure and turbine bat buffers (as per NatureScot guidelines) are shown on Figure 1-1.

## 3.2 Proposed Woodland Replanting

As part of the proposed plan to restore a segment of the Eastwood River, it is proposed to plant by hand, approximately 1.8 hectares of native tree species within the Site along this segment of the Eastwood River that has been designated for river restoration work (please see Section 2 for further details). Tree species and plant community to be planted will include those which have the potential to develop a habitat in-keeping with the riparian planting strategy and wet-woodland influence. Tree planting spacing has been calculated using a triangular grid with spacing, species and number of each tree species presented below in Table 3-1. In total 5,252 trees are proposed to be planted based on a density of 2,887 trees/ hectare.

*Table 3-1. Summary of Existing Conditions*

| Species | Size | % of plants in mix | No. of Stems/ Plants |
|---|---|---|---|
| **Species Mix to be planted at 2.0m o.c. Spacing** | | | |
| Pedunculate Oak (*Quercus robur*) | Bare root (2-3ft) | 35% | 1817 |
| Hazel (*Corylus avellana*) | Bare root (2-3ft) | 10% | 519 |
| Hawthorn (*Crataegus monogyna*) | Bare root (2-3ft) | 10% | 519 |
| Holly *(Ilex aquifolium*), | Bare root (2-3ft) | 10% | 519 |
| willows (*Salix spp.*) | Bare root (2-3ft) | 15% | 779 |
| Alder (*Alnus glutinosa*) | Bare root (2-3ft) | 20% | 1038 |
| **Species Mix to be planted at 20.0m o.c. Spacing** | | | |
| Pedunculate Oak (*Quercus robur*) | Containerised (10L Pot) | 60% | 37 |
| Alder (*Alnus glutinosa*) | Containerised (10L Pot) | 40% | 24 |

In areas of bare soil post construction of the new river channel the below herb layer mix will be spread in order to recolonise any bare ground. Wildflowers.ie species list of 'Code EC03 Woodland Wildflower Mixture' includes the following:

- Bluebell
- Burdock
- Dog Violet
- Cowslip
- Devils Bit Scabious
- Foxglove
- Hedge Garlic Mustard
- Lesser Knapweed
- Meadowsweet
- Ramson
- Red Campion*
- Ribwort Plantain
- Sorrel
- Upright Hedge Parsley
- Wild Angelica
- Wood Avens
- Hemp Agrimony
- Hoary Plantain
- Primrose
- Sweet Violet
- Wood Sage

The above tree and herb species have been chosen to align with species commonly found and characteristic of a Wet pedunculate oak-ash woodland (WN4) (Fossitt, 2000).

The planting of 1.8ha of native tree species will result in an increase of approx. 1.02ha of woodland within the Site, when the potential habitat loss around the proposed turbine T6 area is accounted for. While this habitat will develop into a habitat of minimum local importance (higher value) it has the potential to form a habitat of greater significance. Monitoring of the planted area will allow for the assessment of this habitats value to be made.

The new woodland habitat will need to be protected from browsing by livestock and wildlife (i.e. deer), through the erection of new stockproof and deer proof fencing where required, which should be at least 5m away as required.

### 3.2.1 Maintenance of Newly Planted Woodland Habitat

Maintenance of the proposed woodland planting will be followed out as per the *Native Woodland Establishment GPC9 & GPC10 Silvicultural Standards* (Department of Agriculture, Food and the Marine, 2015).

## 3.3 Monitoring

To confirm that habitat creation and enhancement has been successful the above outlined woodland replanting scheme will be monitored by a qualified ecologist at the following intervals:

- 6 Months,
- 1 Year,
- 2 Years.
- 3 Years,
- 4 Years,
- 5 Years.

At the end of the 5-year monitoring plan as outlined above, the Project Ecologist will assess the need for and frequency of further monitoring of the woodland replanting area in agreement with the wind farm

operator. In order to carry out monitoring, a qualified ecologist will conduct inspections and relevés of the planting area at the above outlined temporal intervals following the main growing season (i.e. in September). These inspections and relevés will be recorded and entered into a monitoring report. The collected information will inform the success of the proposal allow for adaptive intervention if it is deemed necessary e.g. if any shrubs are dead or damaged these will be replaced using the same species within the next planting season. Monitoring will be undertaken in partnership between the developer, the Project Ecologist, and the Landowner. The proposed management actions will be conveyed to the developer and the relevant landowner, and management alterations implemented as required to achieve the targets of the management plan.

## 3.4 Reporting

Monitoring results will be reported by a suitably experienced ecologist within an Environmental and Ecological Report with any criteria failures identified and corrective actions implemented. Monitoring results will be reported after each monitoring year as outlined in section 3.3. Reports detailing the monitoring works carried out, the results obtained and a review of their success, along with any suggestions for amendments to the plan will be prepared at the temporal intervals outlined in Section 3.3 following commencement of the plan's implementation.

## 3.5 Discussion

The proposed planting of 1.8ha of native woodland around the proposed river restoration as outlined in the preceding sections will result in the creation of a diverse habitat which compliments the proposed river restoration. This woodland habitat will offset the loss of woodland associated with the Proposed Project and provide a net gain of approx. 1.02ha of woodland habitat. The planting of 1.8ha of woodland habitat will also provide potential foraging, commuting and resting habitat for a range of faunal species. The Trees which are planted in close proximity to the restored river channel will provide shading and help with thermo-regulation of fish species present within the watercourse and provide detritus in the form of fallen leaves for macroinvertebrates to utilise within the watercourse.

# 4. LINEAR HABITAT LOSS AND REPLANTING

## 4.1 Hedgerow and Treeline loss

The majority of hedgerow/tree habitat loss is associated with habitat buffering measures required to avoid impact on bats as per NatureScot recommendations. The proposed vegetation removal to prevent impacts on bats is summarised in Table 4-1 below. Linear vegetation loss associated with construction of the Proposed Project infrastructure measures 1.8km in total and is shown on Figure 1-1.

*Table 4-1 Assessment of Linear Habitat Features within Turbine Buffers*

| Turbine No. | Length of Proposed Removal |
|---|---|
| Turbine 1 | None |
| Turbine 2 | 155m Treeline (WL2) |
| Turbine 3 | None |
| Turbine 4 | 120m Hedgerow (WL1)<br>125m Treeline (WL2) |
| Turbine 5 | 184m Treeline (WL2) |
| Turbine 6 | None (Woodland felling and replanting associated with Turbine 6 has been addressed in Section 3 of this report) |
| Turbine 7 | 320m Hedgerow (WL1) |
| Turbine 8 | 343m Hedgerow (WL1) |
| Turbine 9 | 123m Hedgerow (WL1) |

The remainder (430m) of hedgerow/tree habitat loss is to facilitate road new access roads and construction works associated with the Proposed Project.

It is proposed to create new hedgerows and treelines and the bolstering of existing linear vegetation features within the Site. A total of 5.17km of linear hedgerow and treeline habitat is proposed to be created within the Site. This habitat creation will offset the 1.8km loss of this habitat and also provide a significant habitat net gain, once the planting has established. Overall, the proposed replanting will result in a net gain of approximately 3.37km in the linear landscape features within the Site. Planting will be of semi-mature specimens to ensure connectivity gains are immediate and will be indigenous to the local area.

## 4.2 Proposed Linear Habitat Replanting

The locations in which the proposed replanting of hedgerow and treeline will take place is presented in Figure 1-2. There is an extensive network of existing linear landscape features in the wider area that will be retained, and the proposed replanting will enhance connectivity across the Site and wider landscape. Planting will be of semi-mature specimens to ensure connectivity gains are immediate and will be indigenous to the local area. Such species include hawthorn (*Crataegus monogyna)* which should make up approx. 75% of the hedgerow mix. The ideal native hedge is made up of 75% Whitethorn and 25% of at least four other species[1]. Other species which will be included are:

- Spindle (*Euonymus europaeus*)
- Dog rose (*Rosa canina*)
- Hazel (*Corylus avellana*)
- Elder (*Sambucus nigra*)

[1] *NBDC – Pollinator-friendly Management of Wind Farms – National Biodiversity Data Series No. 25*

- Blackthorn (*Prunus spinosa*)

When planting new hedgerow, plants will be closely spaced (a maximum of 50cm apart) and planted in a staggered row. The new hedgerow will need to be protected from browsing by livestock, through the erection of new stockproof fencing where required, which should be at least 1m away from the hedge, and on each side if required.

### 4.2.1 Maintenance of Newly Planted Hedgerow

In order to facilitate the successful establishment of the new hedgerow and trees to be planted within the site, and to promote biodiversity value of the new hedgerow the following measures are proposed:

- New hedgerow shrub planting will be kept weed and litter free until the new plants are established, particularly from ruderal weeds. Healthy growth will be maintained by allowing the plant to occupy as much of the planting areas as possible to allow them to achieve as close their natural form as possible.
- During spring and autumn maintenance periods all trees and plants will be checked and adjusted/replaced as required, soil firmed, and any dead wood present removed back to healthy tissue and mulch added if required. Where tree stakes and ties are no longer required these will be removed to avoid damage to the tree.
- During the first growing season, all standard trees/ semi-mature trees will be watered regularly during any prolonged dry periods during the growing season (i.e. in April, May, June, July and August). During the second growing season the trees will be kept well-watered as often as required, particularly during June, July and August.
- New hedgerows should be cut annually, with the cutting height raised by 10-15cm each year. This will allow the plants to flower and produce berries whilst preventing the height of the hedgerow from increasing too rapidly.
- Any tree, hedge or shrub that is removed, uprooted, destroyed or that becomes seriously damaged, defective diseased or dead shall be replaced in the same location with another plant of the same species and size as that originally planted. All such replacements shall be carried out within the first planting season following the loss.

## 4.3 Monitoring

Hedgerows and replanted trees will be inspected following the main growing season (i.e. in September) for the first five years of growth, where the requirement for replacement planting will be assessed. If any shrubs are dead or damaged these will be replaced using the same species within the next planting season. Recommendations for ongoing or remedial management required will be specified within an Environmental and Ecological Report.

## 4.4 Reporting

Monitoring results will be reported by a suitably experienced ecologist within an Environmental and Ecological Report with any criteria failures identified and corrective actions implemented Monitoring results will be reported after each monitoring instance as outlined in section 3.3. Reports detailing the monitoring works carried out, the results obtained and a review of their success, along with any suggestions for amendments to the plan will be prepared at the temporal intervals outlined in Section 3.3 following commencement of the plan's implementation.

## 4.5 Discussion

The proposed planting of 5.17km of hedgerow habitat as outlined in the preceding sections will result in the creation of an additional 3.37km of linear vegetation habitat within the Site. The planting of additional hedgerow/ treeline will serve to enhance the linear habitats within the site due to increased species diversity

compared to that to be lost, will benefit wildlife and due to the increase of 3.37 linear kilometres over that to be lost, will result in a net gain in this habitat within the Site.

Improving hedgerow and treeline availability will increase the commuting route bats use to connect roosting sources with foraging availability. Linear features allow bats to navigate across a landscape while providing protection from predators like Owls and Hawks. Predators rely on hunting bats where gaps or open space exist. Bolstering hedgerow and treelines reduce and remove gaps to provide more consistently safe commuting routes for bats. Bat have been shown to avoid crossing a linear feature gap with a distance of 3m. Increasing the treeline and hedgerow linear habitat by 3.37 km improves the commuting and foraging habitat availability, and offers better predator protection, resulting in a positive net gain for bats. Improving the diversity of the hedgerow and treelines will allow a more diverse and abundant habitat for insect species. Inspect species that breed and exist within the tree habitat are an important food source for bats.

# 5. PINE MARTIN DEN BOXES

While no significant loss of pine martin habitat or significant effects on pine martin are expected as a result of the proposed project pine martin were recorded utilising the Site. Therefore, enhancement measures are proposed in order to create new suitable habitat for pine martin. Pine Martin Boxes will be erected within the Site during construction. The number and location of these Pine Martin Boxes will be agreed upon in partnership between the developer, the Project Ecologist and the Landowner and will be informed by the following documents:

- Protocol and risk assessment for installation of artificial pine marten den boxes (Tosh and Twining, 2018),
- Constructing, erecting and monitoring Pine Marten Den Boxes (The Vincent Wildlife Trust).

## 5.1 Proposed Pine Marten Box Installations

Table 5-1 (found in Constructing, erecting and monitoring Pine Marten Den Boxes (The Vincent Wildlife Trust)) below states the recommended density of pine marten boxes relating to varying woodland types. These boxes should be spaced evenly throughout a woodland, with the aim of providing a minimum of four boxes within the home range of a female pine marten (which varies in relation to woodland type).

*Table 5-1 Recommended Density of Pine Marten Boxes per woodland type (Source: The Vincent Wildlife Trust)*

| Woodland Type | Minimum density of marten boxes (no. per square kilometre) |
|---|---|
| Lowland, species-rich, broadleaved or mixed | 4 |
| Lowland, coniferous, commercial, mixed coniferous | 2 |
| Upland, commercial, coniferous | 1 |

As outlined above Pine Marten boxes will be constructed in line with *Constructing, erecting and monitoring Pine Marten Den Boxes* (The Vincent Wildlife Trust).

Installation of the Pine Marten Den Boxes will be carried out as follows:

Tree Selection

Selection of a suitable tree will require the installer to seek out a tree that they deem to be fit for the purpose. The following guidelines will aid the installer in selecting a tree that is suitable for installation:

- Ensure the den box is installed on a tree a suitable distance from human roadways and paths, and away from areas targeted for woodland management or harvesting in the near future, to avoid disturbance of the box.
- Locating the box near pre-existing animal trails may increase the likelihood and speed with which the box is discovered by pine martens.
- The boxes are likely to produce the greatest benefits if they are installed in large, undisturbed, prey-rich woodlands where natural den sites such as tree cavities are scarce or absent.
- The tree itself must be a living tree with a straight trunk and a minimum DBH (diameter at breast height) of 20cm. Additionally, the tree should not show any obvious signs of disease.
- Ensure there are branches at a height of 3 to 4m that will allow the box to be hung at a suitable height. Additionally, ensure that branches are present above this to facilitate an anchor point for the installer who will be working at height, as well as for the pulley system that will be used during the installation to be attached to.

- Typical trees within conifer plantations that pine marten boxes are usually hung on include the following species: Sitka spruce (*Picea sitchensis*), Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), lodgepole pine (*Pinus contorta*) or Larch (*Larix sp.*).
- Finally, when choosing a site for a box, bear in mind the future requirement to view the lid of the box through binoculars to check for signs of marten scats.

Erecting the box

The following text regarding the erecting of pine marten boxes is taken directly from the document titled 'Protocol and risk assessment for installation of artificial pine marten den boxes' (Tosh and Twining, 2018) (consult the aforementioned document for images that illustrate the steps mentioned below):

Once at a suitable location and a tree has been selected the following should be undertaken **(NOTE: PPE should be worn by person on ladder and ground during above procedure):**

1. Clear area around base of the tree to ensure a clear working space and remove trip hazards as much as possible. Use hand saw to remove any low branches that may impede say use of ladder.
2. Erect the ladder against trunk of tree.
3. Secure base of ladder to the tree trunk using 1 ratchet strap.
4. Climb ladder to proposed working height and attach sling around tree at an anchor point ABOVE working position and attach to climbing harness with carabiner. Do this BEFORE attempting step 5 and always ensure a 2nd person is holding the ladder during this process.
5. Attach top of ladder to tree trunk with 2nd ratchet strap.
6. Whilst on the ground, attach two additional batons to the rear of the box. These will act to provide more stability for the box against the tree.
7. Prepare two lengths of the blue nylon rope for attaching the den box to the tree and loop them through batons. Tie a bowline knot on one end of each rope. Do this on the ground and not at height for an easier installation.

Once the ladder is safely in position and you have an attachment point for the person working at height, the following should be undertaken to attach the box to the tree. NOTE: prior to commencing work at height, determine the direction of prevailing wind for the area and ensure the entrances to the box face the opposite direction.

1. Climb the ladder, with the pulley, and attach to the tree using a climbing sling in combination with a carabiner. The sling should be wrapped round the tree and the ends secured with a carabiner. The pulley should then be attached to the carabiner. Ensure that the sling to which the pulley is attached, is secured point is on the tree trunk ABOVE the height at which the den box will be positioned. This is important otherwise disconnecting the pulley and rope once box is in position will be difficult. NOTE it is advisable that the anchor point for the pulley is above a branch to ensure that if it slips it does not fall far.
2. Once the pulley is securely attached the rope should be connected to the pulley with a bowline at one end to which a carabiner will be attached. This will be lowered to the ground to pull up the den box.
3. On the ground, a single sling should have both ends looped through the two entrances of the den box (this will allow the box to be attached to the rope used to lift it into the tree using a carabiner).
4. The person on the ground should then attach the end of the rope with the carabiner (see step 2 above) to the sling inside the den box.
5. When the person on the ladder is safely in position, the person on the ground should raise the den box (by pulling on the rope attached to the pulley) to a suitable working height.
6. Once at a suitable working height the person on the ladder should secure the first piece of nylon rope around the trunk ensuring it is hooked above a branch. To secure the rope, tie a bowline in one end and loop the other end through it before tying another knot to secure. This can be repeated a number of times to ensure if one knot fails another will be in position to act as a fail-safe.
7. Repeat Step 6 for the 2nd blue nylon rope but note there is less of a need to ensure 2nd rope is secured above a branch as weight will be carried by first rope (ensuring it is attached above a branch).

8. Once secure, detach pulley system from tree and lower it and rope to ground and then secure lid to box. NOTE: Ensure sawdust or local bedding material e.g. moss is used to line the bottom of the nesting chamber.

### 5.1.1 Maintenance of Proposed Pine Marten Boxes

The box should require only basic maintenance, with the condition to be checked on an annual basis.

- The condition of the attaching line should be checked to ensure it is not damaged or that the tree is not growing into it. If either of these is the case the attaching line should be replaced/loosened to ensure it does not break or cause damage to the tree.
- The box will require repainting approximately every three years to enhance its lifespan. A low odour coating should be used. As there may not be a time of the year when pine martens can be guaranteed to not be in residence, September and October are likely the most suitable months to repaint.
- The condition of the lid should also be checked, as martens may mark the lid with urine and scats, resulting in a faster deterioration compared to the rest of the box and it may need to be replaced. When checking if a box is occupied, knock the side of the box before removing the lid and wait a few moments. This will give any occupants time to get out of the way.
- Finally, the general condition of the box itself should be checked. Although marine timber is used to construct the box, it will deteriorate over time, and it will need to be replaced eventually.

Prior to any maintenance works on the box, it should be checked for occupants. As disturbance can result in abandonment of denning sites, this should be minimised as much as possible.

The maintenance of the pine marten boxes will be carried out by the wind farm operator.

## 5.2 Monitoring

Resting sites of pine marten are protected by law in the Ireland under the Wildlife Act (1976 to 2023). Therefore, if a pine marten is using a den box, then it is illegal to check the den box without a license. A licensed Ecologist will carry out all monitoring of Pine Marten Den Boxes.

Monitoring will take place yearly after installation of the Pine Marten Den Boxes for the first three years of the operational Proposed Wind Farm. The results of the first three years of monitoring will inform the need for and frequency of further monitoring and maintenance of the Pine Marten Den Boxes, to be reviewed by the Project Ecologist and agreed with the wind farm operator.

As previously mentioned, disturbance can result in the abandonment of denning sites. Therefore, monitoring should be carried out using non-invasive methods where possible.

- If den boxes are used by pine martens, scats can accumulate on the roof. Therefore, if you can locate an elevated position nearby, use of box can be confirmed by using binoculars. This should obviate the need for a licence and, done quietly and infrequently (maximum twice per year), should avoid disturbance that might lead a pine marten to desert the box.
- Camera traps can be situated opposite den box entrances in adjacent trees or at ground level facing the base of a tree with den box, if viewing with binoculars is not possible.

Typical signs indicating that the box is in use include scratches on the tree bark and the box, bark on the ground at the base of the tree, scats on top of the box or at the base of the tree, and food items in the nesting chamber.

## 5.3 Reporting

Monitoring results will be reported by a suitably experienced ecologist within an Environmental and Ecological Report with any criteria failures identified and corrective actions implemented. Monitoring results will be reported after each monitoring instance. Reports detailing the monitoring works carried out, the results obtained and a review of their success, along with any suggestions for amendments to the plan will be prepared.

## 5.4 Discussion

Den boxes are installed in areas where there is an absence of natural tree cavities that would ordinarily provide natural breeding sites for pine marten. These boxes act to provide artificial breeding sites facilitating the raising young during the spring and summer, in addition to providing martens with shelter from environmental conditions and predators. As the absence of suitable breeding sites can be a critical constraint on pine marten populations in an area, the provision of elevated dens that can afford protection to local marten populations are crucial to increasing fecundity.

These boxes have proved to be a very successful conservation tool in Scotland, with many boxes being occupied continuously over a number of years and were used by breeding females to raise their young (Croose et al., 2016)

Therefore, these den boxes are an excellent conservation/habitat enhancement tool, which are of particular importance in commercial forestry sites. Additionally, they can also be used to facilitate the monitoring of martens breeding success and populations.

Installing boxes will lead to a net gain in pine marten habitat within the Site and result in a positive effect on pine martens within the local area.

# 6. BAT BOXES

As outlined in Section 6.1.4 of Appendix 6-2 of the EIAR, a number of mature trees presenting potential roosting features were identified within turbine felling buffers. Bats comprise mobile species that can move regularly between tree roosts. As such, the trees with potential roosting features have been considered as a "roost resource" and therefore to cover for the potential loss of the resource, the installation of Bat Boxes is proposed.

## 6.1 Proposed Bat Box Installations

The following procedures are proposed prior to felling trees with PRFs:

- A pre-commencement survey will be carried out by a suitably qualified ecologist on trees with PRFs proposed for felling.
- A bat derogation licence will be obtained from the NPWS for the loss of any confirmed roost resource, prior to felling, and the felling activity will be supervised by a qualified ecologist.
- Tree-felling of mature deciduous trees will be carried out according to the following standard mitigating procedures:
    - Trees with suitable potential roost features proposed for felling will be checked for bats by a suitably qualified arborist at the time of felling.
    - Trees will be nudged two or three times prior to limb removal, with a pause of 30 seconds in between, to allow bats to wake and move.
    - Rigged felling shall be used to lower the limbs and trunk carefully to ground level and cavities searched by a qualified ecologist.
    - Felled trees will be left in-situ for a minimum of 24 hours prior to sawing or mulching, to allow any bats present to escape (National Roads Authority, 2006).
    - Any tree felling will be undertaken outside the bat maternity season (May- August) and the hibernation period (December-February) (Marnell, Kelleher and Mullen, 2022).

Alternative potential roosting features will be implemented on a like-for-like basis, through veteranisation of retained trees or the provision of bat boxes. Schwegler 1FF and one 2FN woodcrete bat boxes are recommended. 2FN bat boxes are equipped with a floor and can be used for the relocation of bats by a licenced ecologist if any are found during the demolition and felling processes. Bat boxes will have a southerly orientation and be positioned at least 2m from the ground, away from artificial lighting. Bat boxes should be installed in dark areas within the Site along a suitable linear feature. A licenced ecologist will confirm a suitable location for the bat boxes. Bat boxes will be placed adjacent to vegetation features such as treelines and hedgerows to ensure they are close to existing flight paths and can avoid wide open spaces (Collins, 2016). Existing buildings, trees and walls to be retained within the Site and can be used for the installation of bat boxes.

- A count of all potential roosting features lost will be required to ensure all features are accounted for by the alternative roosting features.
- Veteranisation (i.e. artificially ageing trees by producing non-lethal damage) will be undertaken by professionally trained arborists.
- Bat-boxes produced with woodcrete materials (i.e. Schwegler) will be utilised where veteranisation of existing broadleaves is not possible.

- Bat boxes will be installed on the retained treelines to provide new roosting opportunities within the site. A minimum of five bat boxes are recommended for installation prior to any works commencing. Two Schwegler 1FF and three 2FN woodcrete bat boxes are recommended. 2FN bat boxes are equipped with a floor and can be used for the relocation of bats by a licenced ecologist if any are found during the felling processes. Bat boxes will have a southerly orientation and be positioned at least 3m from the ground, away from existing or proposed artificial lighting and other potential disturbance, as per best practice guidelines.

- Monitoring and maintenance of the Bat boxes will take place yearly for the first three years of the operational Wind Farm. The results of the first three years of monitoring will inform the need for and frequency of further monitoring and maintenance of the Bat Boxes, to be reviewed by the Project Ecologist and agreed with the wind farm operator.

### 6.1.1 Maintenance of Proposed Bat Boxes

2FN bat boxes contain a base, as a result, the box may need to be checked outside the Maternity Season to remove excess bat droppings and remove bird nests outside the bird nesting season.

## 6.2 Monitoring

A Licenced Ecologist will carry out a yearly Bat Box Monitoring protocol for the first three years of the operational life of the Proposed Wind Farm. The ecologist will confirm and flag Bat boxes in use by bats, evidence of bats, droppings, urine splashing, bat fur oil stains and/or dead bats. Monitoring will be carried out a suitable time of year to ensure no disturbance to any roosting bats, particularly in the case of a Maternity Roost. The best time of year for a Bat Box Monitoring protocol to be carried out is September/ October.

Evidence or presence of nesting birds will be flagged and removed outside the bird nesting season. 2FN Bat boxes must be checked to remove excess bat droppings and flag any bird nests being constructed within a bat box. If a bird nest is found, a secondary bat roosting source must be erected to replace the bat roosting source lost.

The results of the first three years of monitoring will inform the need for and frequency of further monitoring and maintenance of the Bat Boxes, to be reviewed by the Project Ecologist and agreed with the wind farm operator.

## 6.3 Reporting

Monitoring results will be reported by a suitably experienced ecologist within an Environmental and Ecological Report with any criteria failures identified and corrective actions implemented Monitoring results will be reported after each monitoring instance. Reports detailing the monitoring works carried out, the results obtained and a review of their success, along with any suggestions for amendments to the plan will be prepared.

## 6.4 Discussion

The installation of Bat boxes within the Site will prevent any net loss of potential bat roosting habitat due to the proposed felling and will provide suitable roosting habitats for bats within the local area. Maintenance and monitoring of the bat boxes installed will allow for further detail on bats within the site to be recorded and will allow the success of the bat boxes to be evaluated.

# 7. GRASSLAND MANAGEMENT

## 7.1 Discussion

Appendix 7-7 'Bird Mitigation Plan' of the EIAR includes mitigations for Golden Plover (*Pluvialis apricaria*) and Lapwing (*Vanellus vanellus*) which details the alteration of winter sward height around certain selected fields within the Site. These measures are being undertaken in order to dissuade Golden Plover and Lapwing from landing in fields close to Turbines where they have been recorded during bird surveys of the Proposed Project.

Further details on the implementation of the above outlined measures, the monitoring of same and the annual assessment of same can be found within Appendix 7-7 of the EIAR.

This alteration in sward height over the wintering season (1st October – 31st March Inclusive) has the potential to have a number of additional benefits for biodiversity within the Site including the provision of cover habitat for small mammals and benefits to pollinators emerging at the beginning of spring as the areas of grassland will not be interfered with until the end of March.

# 8. CONCLUSION

Sections 2, 3, 4, 5, 6 and 7 describe the list of Biodiversity Management and Enhancement Measures proposed for the Proposed Project. The measures described in this BMEP will serve to offset the loss of linear vegetation (treeline and hedgerow) and woodland habitat associated with the Proposed Project and provide a net gain for both linear habitat and woodland habitat within the Site. In addition, the measures described in this BMEP serve to create a functional uplift in the geomorphology and water quality of a segment of the Eastwood River. A total net gain of 3.37km of linear hedgerow and treeline habitat is proposed and a net gain of approximately 1.02ha in woodland habitat will be established within the Site. The installation of an artificial Pine Marten Den Boxes and Bat Boxes will result in an increase in the suitable habitat for these species within the site. The planting of linear vegetation and woodland within the Site also provides additional habitat for these species and other faunal species. Management of grass heights in select fields within the Site, while primarily a mitigation feature as described in Chapter 7 of this EIAR, will offer additional benefits to biodiversity including the creation of areas of cover for small mammals and provision of pollinating opportunities for early emerging pollinators at the start of spring.

The success of these measures will be evaluated through a detailed monitoring and reporting programme.

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# APPENDIX 1

## PHOTOGRAPHS

*Plate 1. View of Eastwood River, facing upstream towards CS-1*

*Plate 2. View of livestock access on Eastwood River, facing downstream.*

*Plate 3. View of Eastwood River, facing downstream towards CS-2*

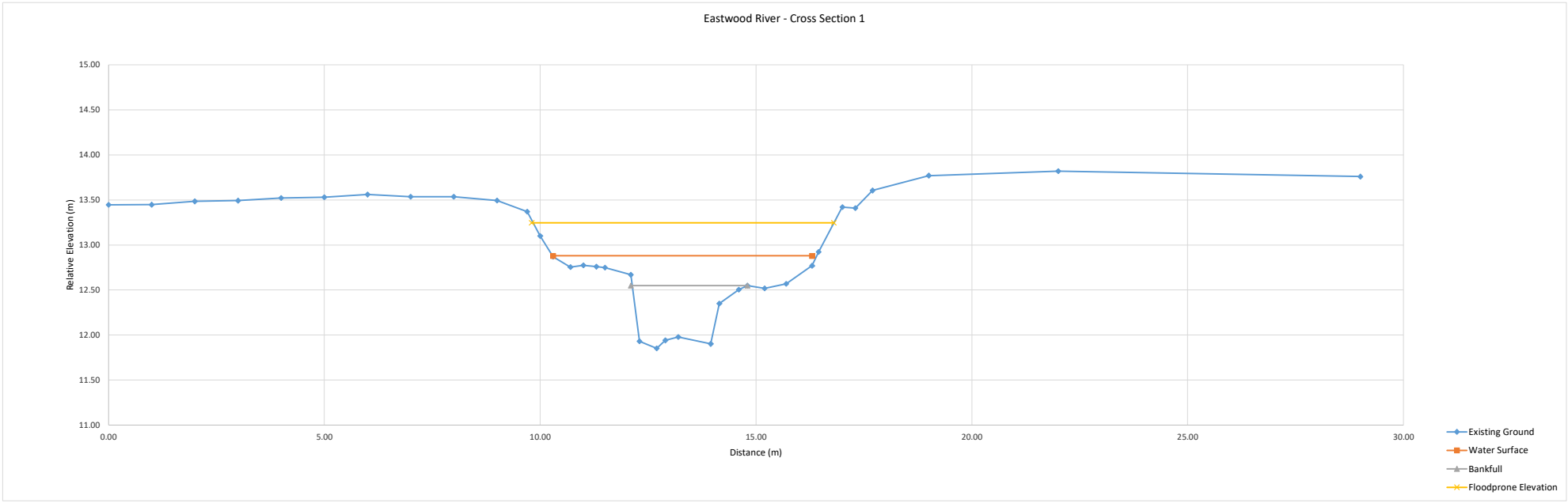
*Plate 4. View of Eastwood River, facing upstream towards CS-3*

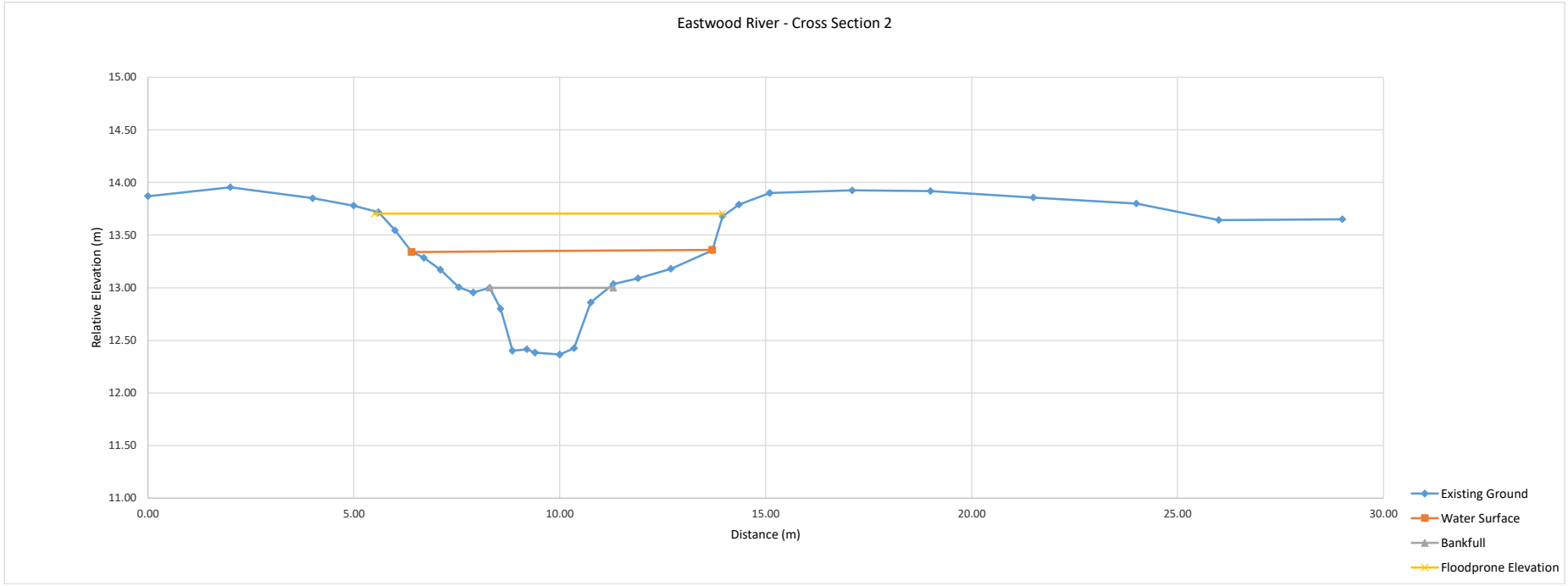
*Plate 5. View of Eastwood River, facing upstream at upstream end of proposed restoration reach*

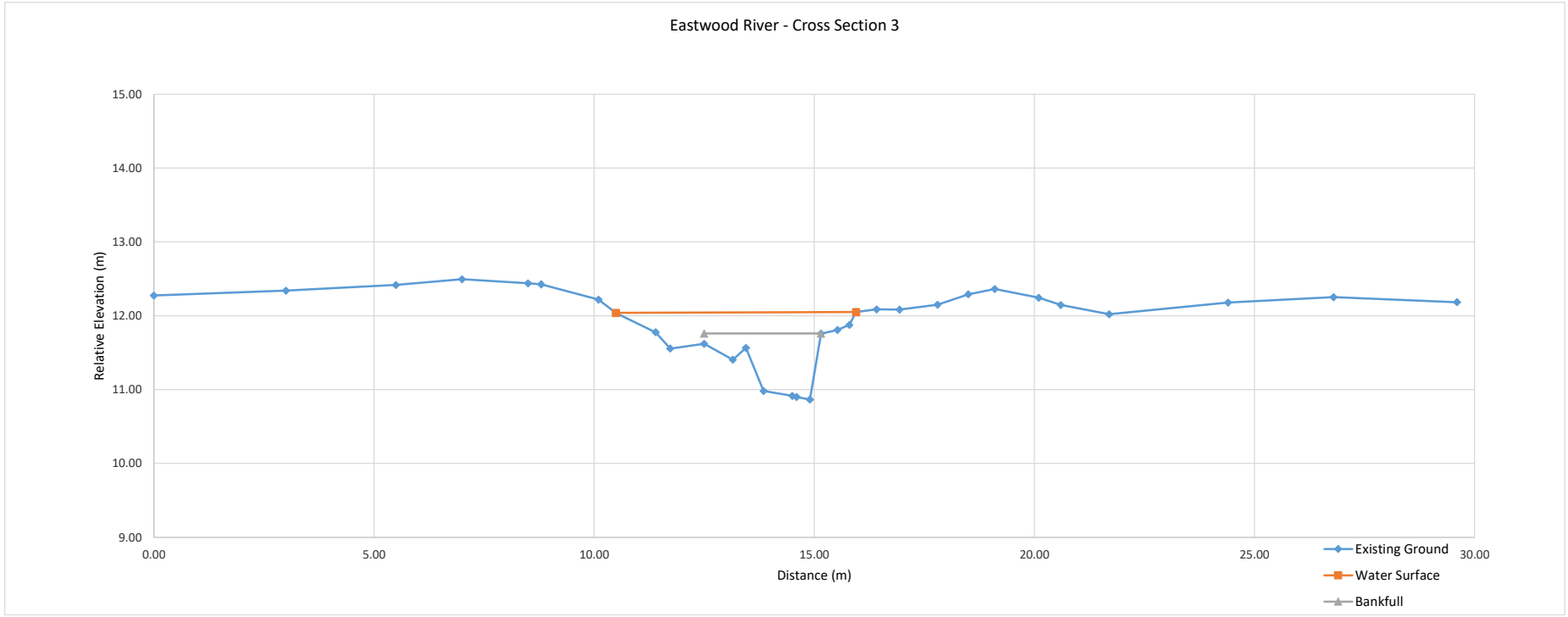
*Plate 6. View of Eastwood River, facing upstream from downstream end of proposed restoration reach*

# APPENDIX 2

## EXISTING CHANNEL CROSS SECTION AND PEBBLE COUNT DATA


Eastwood River - Cross Section 1
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
Relative Elevation (m)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Distance (m)
Existing Ground
Water Surface
Bankfull
Floodprone Elevation


Eastwood River - Cross Section 2
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
Relative Elevation (m)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Distance (m)
Existing Ground
Water Surface
Bankfull
Floodprone Elevation


Eastwood River - Cross Section 3
15.00
14.00
13.00
12.00
11.00
10.00
9.00
Relative Elevation (m)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Distance (m)
Existing Ground
Water Surface
Bankfull

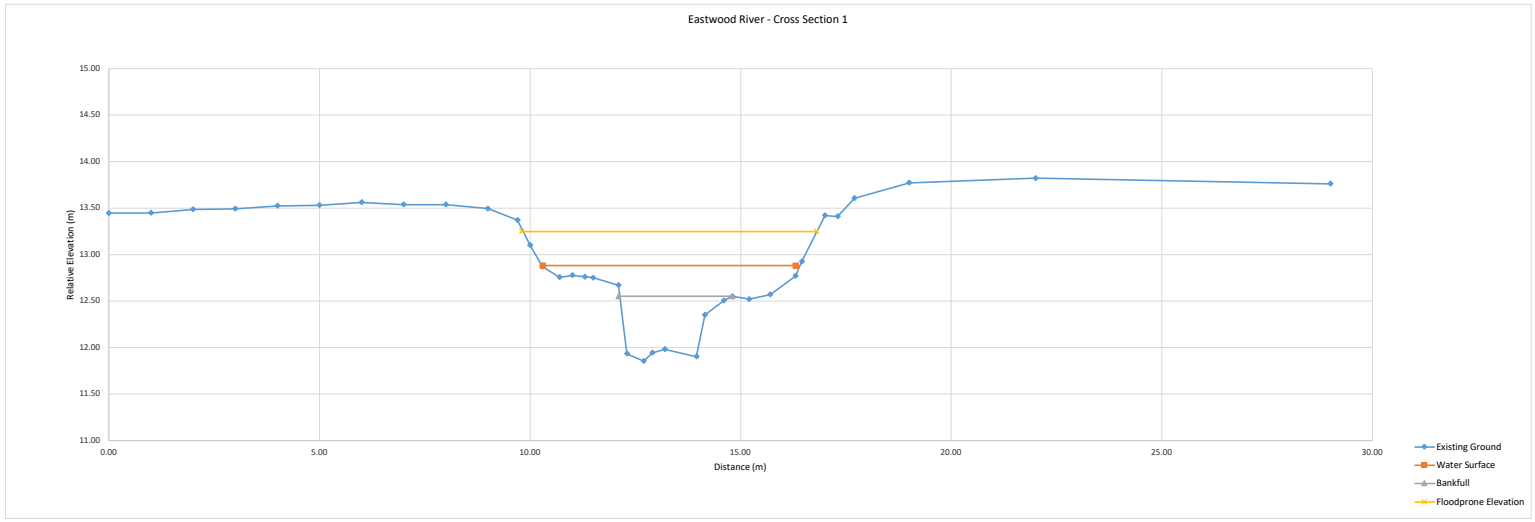
**CROSS-SECTION: CS1**
**Project Name:** Borrisbeg
**Project Location:** Templemore, Tipperary
**Date:** 21.09.23

BM= 15 Longitudinal Station 0

| Distance; Point | Back-Sight | Height of Instrument | Fore-Sight | Height Depth | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **STATION** | **B.S.** | **H.I.** | **F.S.** | **Elevation** | **Corrected Elevation** | **Comment** | **Width** | **Bkf depth** | **AVG DEPTH** | **BKF Area** |
| BM#1 - Pin&Cap #110 | 0.00 | 15.00 | | 9.99 | | | | | | |
| 0.00 | | 15.00 | 1.554 | 13.45 | | | | | | |
| 1.00 | | 15.00 | 1.552 | 13.45 | | | | | | |
| 2.00 | | 15.00 | 1.515 | 13.49 | | | | | | |
| 3.00 | | 15.00 | 1.507 | 13.49 | | | | | | |
| 4.00 | | 15.00 | 1.477 | 13.52 | | | | | | |
| 5.00 | | 15.00 | 1.470 | 13.53 | | | | | | |
| 6.00 | | 15.00 | 1.440 | 13.56 | | | | | | |
| 7.00 | | 15.00 | 1.464 | 13.54 | | | | | | |
| 8.00 | | 15.00 | 1.464 | 13.54 | | | | | | |
| 9.00 | | 15.00 | 1.506 | 13.49 | | LTOB | | | | |
| 9.70 | | 15.00 | 1.630 | 13.37 | | | | | | |
| 10.00 | | 15.00 | 1.900 | 13.10 | | | | | | |
| 10.30 | | 15.00 | 2.130 | 12.87 | | LEW | | | | |
| 10.70 | | 15.00 | 2.245 | 12.76 | | | | | | |
| 11.00 | | 15.00 | 2.225 | 12.78 | | | | | | |
| 11.30 | | 15.00 | 2.240 | 12.76 | | | | | | |
| 11.50 | | 15.00 | 2.250 | 12.75 | | | | | | |
| 12.10 | | 15.00 | 2.330 | 12.67 | | LBKF | 0 | 0 | | |
| 12.30 | | 15.00 | 3.067 | 11.93 | | LTOS | 0.20 | 0.62 | 0.3085 | 0.062 |
| 12.70 | | 15.00 | 3.147 | 11.85 | | TW | 0.40 | 0.70 | 0.657 | 0.263 |
| 12.90 | | 15.00 | 3.058 | 11.94 | | | 0.20 | 0.61 | 0.6525 | 0.131 |
| 13.20 | | 15.00 | 3.020 | 11.98 | | | 0.30 | 0.57 | 0.589 | 0.177 |
| 13.95 | | 15.00 | 3.098 | 11.90 | | RTOS | 0.75 | 0.65 | 0.609 | 0.457 |
| 14.15 | | 15.00 | 2.649 | 12.35 | | | 0.20 | 0.20 | 0.4235 | 0.085 |
| 14.60 | | 15.00 | 2.495 | 12.51 | | | 0.45 | 0.05 | 0.122 | 0.055 |
| 14.80 | | 15.00 | 2.450 | 12.55 | | RBKF | 0.20 | 0.00 | 0.0225 | 0.005 |
| 15.20 | | 15.00 | 2.480 | 12.52 | | | | | | |
| 15.70 | | 15.00 | 2.430 | 12.57 | | | | | | |
| 16.30 | | 15.00 | 2.230 | 12.77 | | REW | | | | |
| 16.45 | | 15.00 | 2.075 | 12.93 | | | | | | |
| 17.00 | | 15.00 | 1.580 | 13.42 | | | | | | |
| 17.30 | | 15.00 | 1.590 | 13.41 | | | | | | |
| 17.70 | | 15.00 | 1.395 | 13.61 | | RTOB | | | | |
| 19.00 | | 15.00 | 1.230 | 13.77 | | | | | | |
| 22.00 | | 15.00 | 1.180 | 13.82 | | | | | | |
| 29.00 | | 15.00 | 1.240 | 13.76 | | | | | | |
| | | 15.00 | 2.120 | 12.88 | | Water surface | | | | |

SUMMARY

| | | |
|---|---|---|
| **low bank height** | 1.64 | m. |
| **Sinuosity** | 1.06 | m. |
| **LBKF** | 12.10 | m. |
| **RBKF** | 14.80 | m. |
| **Bankfull WIDTH (Wbkf)** | 2.70 | m. |
| **Mean DEPTH (dbkf)** | 0.46 | m. |
| **Bnkfl. X-Section AREA (Abkf)** | 1.23 | Sq. Ft. |
| **W/D RATIO (Wbkf/dbkf)** | 5.91 | m/m |
| **Max DEPTH (dmbkf)** | 0.70 | m. |
| **WIDTH of Flood Prone Area (** | 7.00 | m. |
| **Entrenchment Ratio (ER)** | 2.59 | m/m |
| **Slope** | 0.0052 | m/m |
| **Channel Substrate** | 1.00 | (D50) |
| **Rosgen Classification** | **G/B** | |
| **Bank Height Ratio** | 2.34 | |



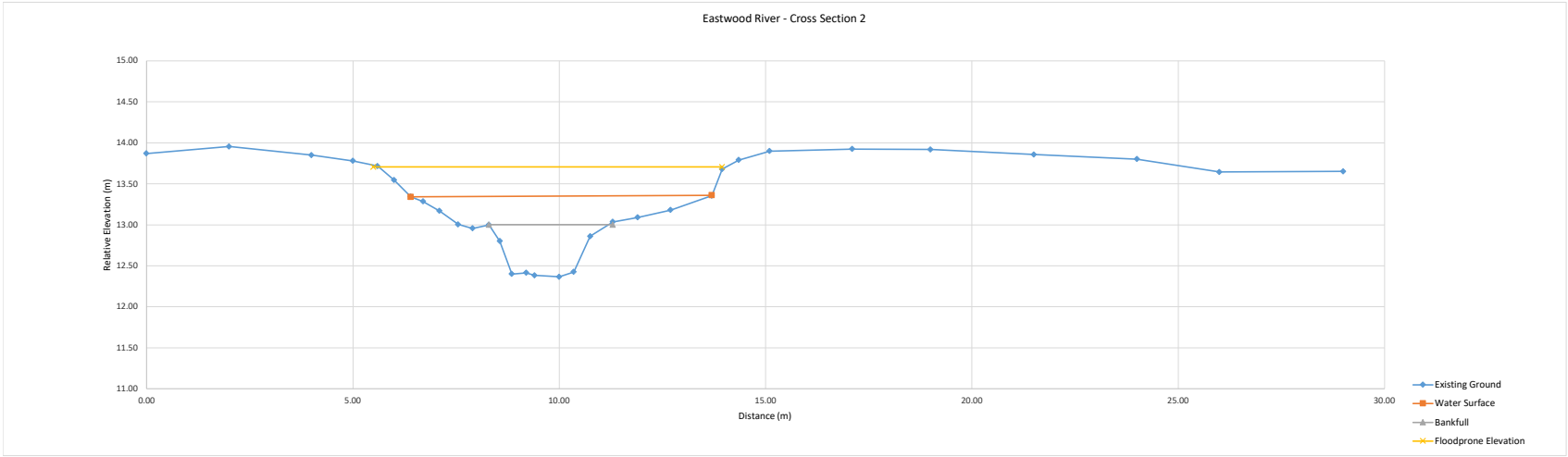
**CROSS-SECTION: CS2**
**Project Name:** Borrisbeg
**Project Location:** Templemore, Tipperary
**Date:** 21.09.23

BM= 9.99 Longitudinal Station 40

| Distance; Point | Back-Sight | Height of Instrument | Fore-Sight | Height Depth | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **STATION** | **B.S.** | **H.I.** | **F.S.** | **Elevation** | **Corrected Elevation** | **Comment** | **Width** | **Bkf depth** | **AVG DEPTH** | **BKF Area** |
| BM#1 - Pin&Cap #110 | 5.60 | 15.59 | | 9.99 | | | | | | |
| 0.00 | | 15.59 | 1.720 | 13.87 | | | | | | |
| 2.00 | | 15.59 | 1.635 | 13.96 | | | | | | |
| 4.00 | | 15.59 | 1.740 | 13.85 | | | | | | |
| 5.00 | | 15.59 | 1.810 | 13.78 | | | | | | |
| 5.60 | | 15.59 | 1.874 | 13.72 | | LTOB | | | | |
| 6.00 | | 15.59 | 2.045 | 13.55 | | | | | | |
| 6.40 | | 15.59 | 2.248 | 13.34 | | LEW | | | | |
| 6.70 | | 15.59 | 2.305 | 13.29 | | | | | | |
| 7.10 | | 15.59 | 2.420 | 13.17 | | | | | | |
| 7.55 | | 15.59 | 2.585 | 13.01 | | | | | | |
| 7.90 | | 15.59 | 2.635 | 12.96 | | | | | | |
| 8.30 | | 15.59 | 2.590 | 13.00 | | LBKF | 0.00 | 0.00 | | |
| 8.56 | | 15.59 | 2.790 | 12.80 | | | 0.26 | 0.23 | 0.1175 | 0.031 |
| 8.85 | | 15.59 | 3.190 | 12.40 | | | 0.29 | 0.64 | 0.435 | 0.126 |
| 9.20 | | 15.59 | 3.175 | 12.42 | | | 0.35 | 0.62 | 0.6275 | 0.220 |
| 9.40 | | 15.59 | 3.207 | 12.38 | | | 0.20 | 0.65 | 0.636 | 0.127 |
| 10.00 | | 15.59 | 3.225 | 12.37 | | TW | 0.60 | 0.67 | 0.661 | 0.397 |
| 10.35 | | 15.59 | 3.165 | 12.43 | | | 0.35 | 0.61 | 0.64 | 0.224 |
| 10.75 | | 15.59 | 2.730 | 12.86 | | | 0.40 | 0.18 | 0.3925 | 0.157 |
| 11.30 | | 15.59 | 2.555 | 13.04 | | RBKF | 0.55 | 0.00 | 0.0875 | 0.048 |
| 11.90 | | 15.59 | 2.500 | 13.09 | | | | | | |
| 12.70 | | 15.59 | 2.410 | 13.18 | | | | | | |
| 13.70 | | 15.59 | 2.235 | 13.36 | | REW | | | | |
| 13.95 | | 15.59 | 1.910 | 13.68 | | | | | | |
| 14.35 | | 15.59 | 1.800 | 13.79 | | | | | | |
| 15.10 | | 15.59 | 1.690 | 13.90 | | RTOB | | | | |
| 17.10 | | 15.59 | 1.665 | 13.93 | | | | | | |
| 19.00 | | 15.59 | 1.671 | 13.92 | | | | | | |
| 21.50 | | 15.59 | 1.733 | 13.86 | | | | | | |
| 24.00 | | 15.59 | 1.789 | 13.80 | | | | | | |
| 26.00 | | 15.59 | 1.946 | 13.64 | | | | | | |
| 29.00 | | 15.59 | 1.939 | 13.65 | | | | | | |
| | | 15.59 | 2.210 | 13.38 | | water Surface | | | | |

SUMMARY

| | | |
|---|---|---|
| **low bank height** | 1.35 | m. |
| **Sinuosity** | 1.06 | m. |
| **LBKF** | 8.30 | m. |
| **RBKF** | 11.30 | m. |
| **Bankfull WIDTH (Wbkf)** | 3.00 | m. |
| **Mean DEPTH (dbkf)** | 0.44 | m. |
| **Bnkfl. X-Section AREA (Abkf)** | 1.33 | Sq. Ft. |
| **W/D RATIO (Wbkf/dbkf)** | 6.77 | m/m |
| **Max DEPTH (dmbkf)** | 0.67 | m. |
| **WIDTH of Flood Prone Area (Wfpa)** | 7.95 | m. |
| **Entrenchment Ratio (ER)** | 2.65 | m/m |
| **Slope** | 0.0052 | m/m |
| **Channel Substrate** | 1.00 | (D50) |
| **Rosgen Classification** | | |
| **Bank Height Ratio** | 2.02 | |



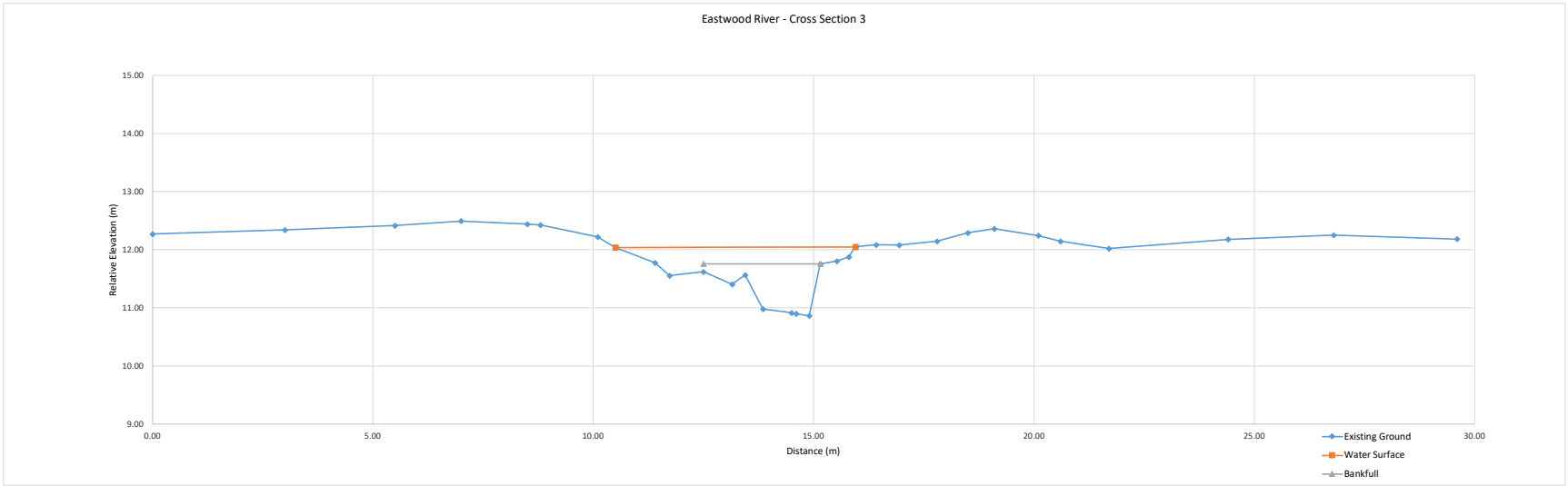
**CROSS-SECTION: CS3**
**Project Name:** Borrisbeg
**Project Location:** Templemore, Tipperary
**Date:** 21.09.23

BM= 15 Longitudinal Station 81

| Distance; Point | Back-Sight | Height of Instrument | Fore-Sight | Height Depth | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **STATION** | **B.S.** | **H.I.** | **F.S.** | **Elevation** | **Corrected Elevation** | **Comment** | **Width** | **Bkf depth** | **AVG DEPTH** | **BKF Area** |
| BM#1 - Pin&Cap #110 | 0.00 | 15.00 | | 9.99 | | | | | | |
| 0.00 | | 15.00 | 2.727 | 12.27 | | | | | | |
| 3.00 | | 15.00 | 2.660 | 12.34 | | | | | | |
| 5.50 | | 15.00 | 2.583 | 12.42 | | | | | | |
| 7.00 | | 15.00 | 2.505 | 12.50 | | | | | | |
| 8.50 | | 15.00 | 2.560 | 12.44 | | | | | | |
| 8.80 | | 15.00 | 2.575 | 12.43 | | LTOB | 0.30 | | | |
| 10.10 | | 15.00 | 2.780 | 12.22 | | | 1.30 | | | |
| 10.50 | | 15.00 | 2.964 | 12.04 | | LEW | 0.40 | | | |
| 11.40 | | 15.00 | 3.223 | 11.78 | | | 0.90 | | | |
| 11.73 | | 15.00 | 3.444 | 11.56 | | | 0.33 | | | |
| 12.50 | | 15.00 | 3.380 | 11.62 | | | 0.77 | 0.14 | | |
| 13.15 | | 15.00 | 3.595 | 11.41 | | | 0.65 | 0.35 | 0.2445 | 0.16 |
| 13.45 | | 15.00 | 3.435 | 11.57 | | LBKF | 0.00 | 0.19 | 0.272 | 0.00 |
| 13.85 | | 15.00 | 4.020 | 10.98 | | | 0.40 | 0.78 | 0.4845 | 0.19 |
| 14.50 | | 15.00 | 4.085 | 10.92 | | | 0.65 | 0.84 | 0.8095 | 0.53 |
| 14.60 | | 15.00 | 4.100 | 10.90 | | | 0.10 | 0.86 | 0.8495 | 0.08 |
| 14.90 | | 15.00 | 4.135 | 10.87 | | TW | 0.30 | 0.89 | 0.8745 | 0.26 |
| 15.15 | | 15.00 | 3.243 | 11.76 | | RBKF | 0.25 | 0.00 | 0.446 | 0.11 |
| 15.53 | | 15.00 | 3.193 | 11.81 | | | | | | |
| 15.80 | | 15.00 | 3.125 | 11.88 | | | | | | |
| 15.95 | | 15.00 | 2.949 | 12.05 | | REW | | | | |
| 16.42 | | 15.00 | 2.913 | 12.09 | | | | | | |
| 16.94 | | 15.00 | 2.918 | 12.08 | | | | | | |
| 17.80 | | 15.00 | 2.852 | 12.15 | | | | | | |
| 18.50 | | 15.00 | 2.709 | 12.29 | | | | | | |
| 19.10 | | 15.00 | 2.638 | 12.36 | | | | | | |
| 20.10 | | 15.00 | 2.756 | 12.24 | | | | | | |
| 20.60 | | 15.00 | 2.853 | 12.15 | | | | | | |
| 21.70 | | 15.00 | 2.980 | 12.02 | | | | | | |
| 24.40 | | 15.00 | 2.821 | 12.18 | | | | | | |
| 26.80 | | 15.00 | 2.748 | 12.25 | | | | | | |
| 29.60 | | 15.00 | 2.816 | 12.18 | | | | | | |
| | | 15.00 | 2.934 | 12.07 | | Water Surface | | | | |

SUMMARY

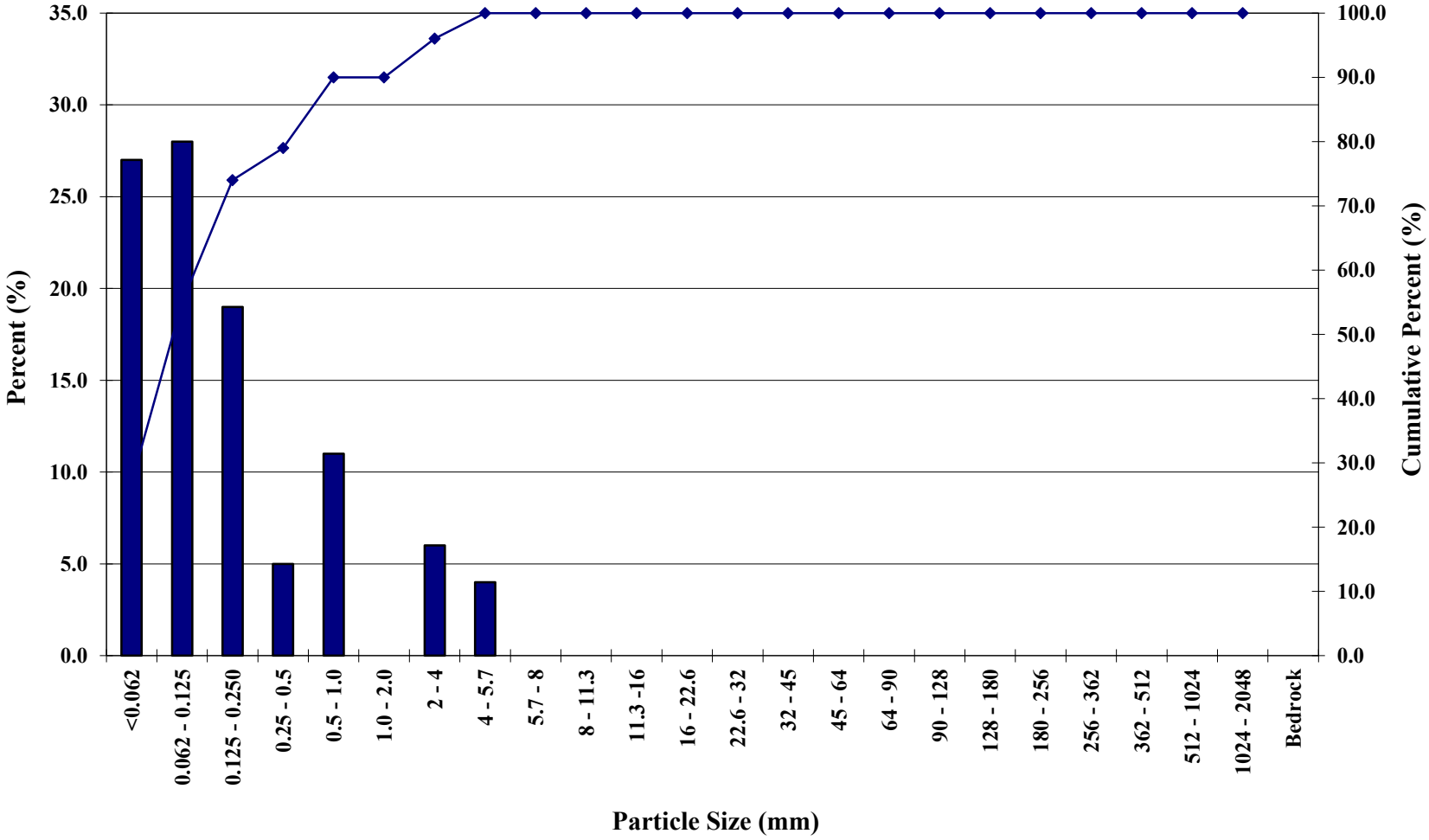
| | | |
|---|---|---|
| **low bank height** | 1.56 | m. |
| **Sinuosity** | 1.06 | m. |
| **LBKF** | 12.50 | m. |
| **RBKF** | 15.15 | m. |
| **Bankfull WIDTH (Wbkf)** | 2.65 | m. |
| **Mean DEPTH (dbkf)** | 0.50 | m. |
| **Bnkfl. X-Section AREA (Abkf)** | 1.34 | Sq. Ft. |
| **W/D RATIO (Wbkf/dbkf)** | 5.25 | m/m |
| **Max DEPTH (dmbkf)** | 0.89 | m. |
| **WIDTH of Flood Prone Area (Wl** | 5.45 | m. |
| **Entrenchment Ratio (ER)** | 2.06 | m/m |
| **Slope** | 0.0052 | m/m |
| **Channel Substrate** | 1.00 | (D50) |
| **Rosgen Classification** | | |
| **Bank Height Ratio** | 1.75 | |

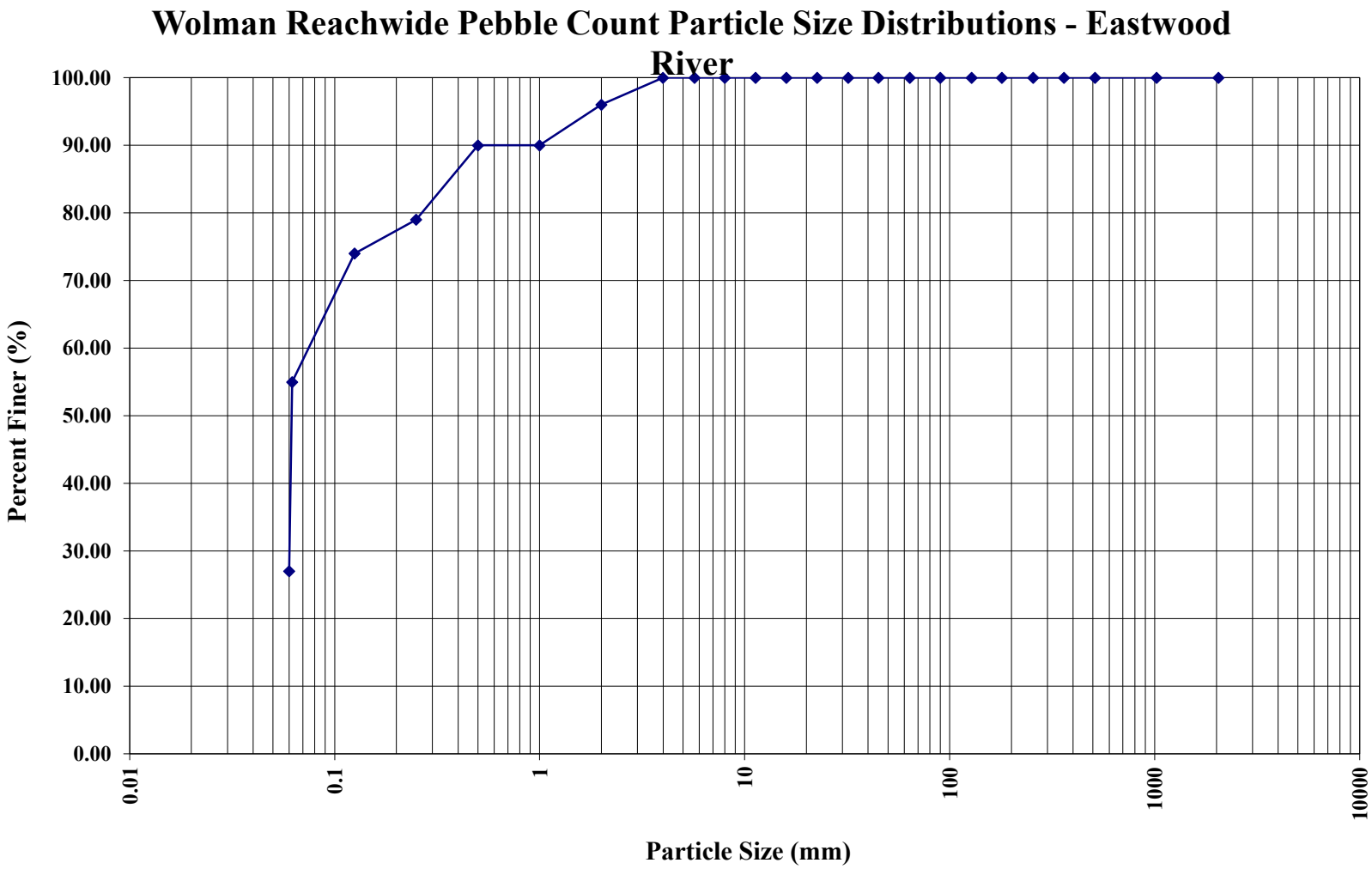


# Pebble Count - Eastwood River

| Metric (mm) | Particle | | Count | Tot # | % Tot | % Cum |
|---|---|---|---|---|---|---|
| <0.062 | Silt/Clay | SAND | 27 | 100.0 | 27.0 | 27.00 |
| 0.062 - 0.125 | Very Fine Sand | | 28 | 100.0 | 28.0 | 55.00 |
| 0.125 - 0.250 | Fine Sand | | 19 | 100.0 | 19.0 | 74.00 |
| 0.25 - 0.5 | Med. Sand | | 5 | 100.0 | 5.0 | 79.00 |
| 0.5 - 1.0 | Coarse Sand | | 11 | 100.0 | 11.0 | 90.00 |
| 1.0 - 2.0 | Very Coarse Sand | | 0 | 100.0 | 0.0 | 90.00 |
| 2 - 4 | Very Fine Gravel | GRAVEL | 6 | 100.0 | 6.0 | 96.00 |
| 4 - 5.7 | Fine Gravel | | 4 | 100.0 | 4.0 | 100.00 |
| 5.7 - 8 | Fine Gravel | | 0 | 100.0 | 0.0 | 100.00 |
| 8 - 11.3 | Medium | | 0 | 100.0 | 0.0 | 100.00 |
| 11.3 -16 | Medium | | 0 | 100.0 | 0.0 | 100.00 |
| 16 - 22.6 | Coarse | | 0 | 100.0 | 0.0 | 100.00 |
| 22.6 - 32 | Coarse | | 0 | 100.0 | 0.0 | 100.00 |
| 32 - 45 | Very Coarse | | 0 | 100.0 | 0.0 | 100.00 |
| 45 - 64 | Very Coarse | | 0 | 100.0 | 0.0 | 100.00 |
| 64 - 90 | Small | Cobble | 0 | 100.0 | 0.0 | 100.00 |
| 90 - 128 | Small | | 0 | 100.0 | 0.0 | 100.00 |
| 128 - 180 | Large | | 0 | 100.0 | 0.0 | 100.00 |
| 180 - 256 | Large | | 0 | 100.0 | 0.0 | 100.00 |
| 256 - 362 | Small | Boulder | 0 | 100.0 | 0.0 | 100.00 |
| 362 - 512 | Small | | 0 | 100.0 | 0.0 | 100.00 |
| 512 - 1024 | Medium | | 0 | 100.0 | 0.0 | 100.00 |
| 1024 - 2048 | Large - Very Large | | 0 | 100.0 | 0.0 | 100.00 |
| Bedrock | Bedrock | | 0 | 100.0 | 0.0 | 100.00 |

# Wolman Reachwide Pebble Count Analysis - Eastwood River




Wolman Reachwide Pebble Count Particle Size Distributions - Eastwood River
Percent Finer (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

# Wolman Reachwide Pebble Count Analysis - Eastwood River