FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

Response to An Bord Pleanála Submissions

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1. INTRODUCTION

In June 2022, Cork County Council submitted an application to An Bord Pleanála in relation to Section 177AE of the Planning & Development Act 2000 (as amended) and the Planning and Development Regulations 2001 (as amended), in respect of the proposed Fermoy Weir Remediation and Fish Bypass Works at Fermoy, Co Cork.

On the 26th October 2022, An Bord Pleanála wrote to Cork Co Co stating that it considers it appropriate to invite them to make submissions on the observations received in relation to the application. An Bord Pleanála received six submissions in respect of this application, and these were circulated to the applicant.

An Bord Pleanála set a deadline for receipt of submissions from Cork Co Co as the 23rd November 2022. In a subsequent letter dated 17th November 2022, An Bord Pleanála provided a time extension, setting a revised date for receipt of submissions from Cork Co Co of the 21st December 2022. At the request of the applicant, An Bord Pleanála provided a further time extension for receipt of submissions from Cork Co Co with a revised date of the 3rd March 2023.

1.1. Submissions Received by An Bord Pleanála

The submissions received by An Bord Pleanála were as follows:

1. Tii submission dated 5th July 2022;
2. Simon Beckett letter dated 24th July 2022;
3. IFI Submission by email and letter dated 28th July 2022;
4. An Taisce Submission by letter dated 28th July 2022
5. OPW Submission by email dated 29th July 2022.
6. Development Application Unit submission by letter dated 29th July 2022

Submissions in the form of responses to the observations made in relation to the application are set out in section 2 to 7 below in respect of each of the submissions received.

2. TII SUBMISSION DATED 5TH JULY 2022

Consultations have taken place with Tii's Structures Section in respect of the matters raised by TII in their submission. A Level 2 Scour Assessment report was prepared in accordance with BD97/12 "The assessment of scour and other hydraulic actions at bridges" and submitted to Tii. A copy of this report is included at Appendix A. The scour assessment concludes that the velocities at the bridge in the design event (1 in 200year plus climate change allowance) does not exceed the threshold velocity for bed erosion based on the material observed to be present in the riverbed at the bridge.

Tii have accepted the findings of this assessment in an Email dated 17th October 2022 and formally in a letter from the Tii Land Use Planning Section dated 15th November 2022. Copies of this correspondence is reproduced at Appendix B.

2.1. Responses to Tii Submission

We provide responses and comments on individual issues raised in the Tii submission below. The relevant text from the Tii submission is shown in italics before the response.

1. The designer will be required to arrange for a structural investigations company to undertake structural investigations at the structure to evaluate the foundation level.

Based on the Scour assessment as completed in response to Item 2 below the Bridge is assessed as Priority Rating 5 in respect of which no action is recommended in BD97/12. Therefore, in this case, there is no compelling requirement for the applicant to undertake structural investigations of the bridge pier and abutment foundations to evaluate the foundation level.

Tii have confirmed by email dated 17th October 2022 that the scour assessment produced by TJ O'Connor and Associates Consulting Engineers has followed BD 97 correctly and that the outcome satisfies Tii concerns regarding the effect of the completed works on the bridge.

2. The implications for the bridge of a new embankment and fish passage adjacent to the structure needs to be investigated, to identify the future hydraulic effects of changing riverbed levels and river flows at the bridge substructure. The designer is advised to refer and implement UK Standard BD 97/12 "The assessment of scour and other hydraulic actions at bridges", and other relevant standards to identify how the proposals will affect the bridge structure.

There is no new embankment proposed for this development. The existing and proposed scenarios have been assessed in accordance with the level one and level two assessment procedures as set out in BD 97/12 "The assessment of scour and other hydraulic actions at bridges". The assessment (reproduced at Appendix A) concludes that the velocities at the bridge in the design event (1 in 200year plus climate change allowance) does not exceed the threshold velocity for bed erosion based on the material observed to be present in the riverbed at the bridge. The Level Two assessment concludes that the bridge has a Priority Risk Rating of 5 and no further action is recommended. See reference to Tii response to the receipt of the scour assessment report under Item 1 above.

3. The designer shall investigate alternative mitigation treatments such as piling or underpinning the bridge, to secure it against the effects of scour, which the works are likely to cause. The effects of changing river flows and changing riverbed levels proposed by the works shall be modelled and calculated to ensure that mitigating bridge works are sufficient to prevent future bridge damage to scour.

The Level Two scour assessment concludes that the Priority Risk Rating for the bridge is 5 and no further action is recommended other than routine inspections, there is no requirement for mitigation treatment to secure the bridge against the effects of scour.

Any potential temporary works upstream of the bridge required for the construction of the proposed development will be submerged in a flood event resulting in flows passing through the entire bridge structure. Therefore, the conclusions of the scour assessment are valid for the temporary works scenario as well as for the post construction operational scenario. Tii will be consulted with and kept informed during detailed design development and contractor's construction method statements in order to ensure that these are subject to Tii agreement and approvals.

4. TII advise that these treatments would involve significant works to the Fermoy Bridge and a geotechnical investigation of the substrata beneath the bridge would be required in order to design the piling or underpinning solution.

Based on the Priority Risk Rating as determined by the Level Two Scour Assessment, completed in accordance with BD97/12, there is no recommendation for action other than routine inspections. However, prior to procurement and construction of the development, a detailed site investigation will be commissioned to inform the detailed design of the works. The scope and extent of this site investigation will be informed by historic site investigation data previously gathered in the area for the Fermoy North and Fermoy South Flood Defence Scheme contracts.

2.2. Responses to Additional Concerns

T.J. O'Connor & Associates, acting on behalf of Cork Co Co, submitted the Scour Assessment report to Tii in an email dated 14th September 2022 (reproduced at Appendix B). Tii responded to receipt of the Scour Assessment Report in an email dated 17th October 2022 (copy attached at Appendix B). This response raised two additional concerns which are addressed below.

1. The intention to dredge the river upstream of Span 3 and 4 (1 being north, 7 being south), this would have an effect on the piers, with the potential to cause scour and undermine the piers given we don't know the as built details. There is no scour protection, or other such measure proposed to mitigate this risk and nothing is proposed, I would like to see further consideration given to this. There was an area of scour (2.8m L x 2.0m W x 0.4m D) picked up at pier 3 in the 2017 underwater inspection. Dredging will exacerbate this, consideration should be given to remediating this. Since 2017 further scour could have occurred this should also be considered and remediated where necessary.

The proposal to dredge the riverbed upstream of the bridge is intended to provide a resting pool for fish prior to entry to the fish bypass channel. The extent of the resting pool has been reduced to ensure that there is no reduction in riverbed levels within 10m of the

upstream face of the bridge piers and arches. The extent of the reduced resting pool is shown on revised Proposed Fish Bypass Plan Drawing 19011-TJOC-XX-XX-DR-C-0053 rev C02 (See Appendix C). A detail has been added to this drawing showing the transition slopes from existing bed level to the reduced bed level. It should be noted that a survey of the weir undertaken in 2018 by Murphy Surveys Ltd (Drg MSL27232_Fermoy Weir_V0 as included with the Planning application and included herewith at Appendix D) showed an existing pool in the riverbed downstream of the weir in the area of the proposed resting pool. The lowest bed level identified in the survey was 17.55mOD Malin which is lower than the bed level now proposed for the resting pool of 18.5mOD.

The area of scour identified at Pier 3 in the 2017 underwater investigation was no longer present during the survey undertaken for the Scour assessment report in August 2022. Any localised depressions in the riverbed identified at the bridge piers during the course of the construction works will be infilled with natural riverbed material, in accordance with a method statement to be approved by Tii, IFI and NPWS prior to the commencement of these works, and in accordance with the mitigation measures identified in the Construction Stage Environmental Management Plan.

2. The construction of the embankment itself. There are a few issues here, the removal of the existing embankment and weir, this is directly adjacent to pier 5 and could cause damage during removal. The excavation required to construct the embankment is likely to affect pier 5. There are no details about how deep the excavation is or a cross section showing the intention in and around the pier. Given we don't know the as built details of the bridge this work could cause an issue at this pier in the temporary phase. The other problem is again the lack of details around the pier, how will the embankment be constructed, what effect will that have on the pier, will it be tied into the pier at all?

It is not proposed to remove the existing embankment which forms the weir structure upstream and immediately downstream of the bridge and which wraps around pier No 5 of Kent Bridge. The methodology for refurbishment is based on conservation of the protected structure, with minimal interventions into the structure. It is described in the Conservation Engineer's report at Appendix B of the Engineering Technical Report which was included with the Planning Submission. Where the weir structure envelopes Pier No 5 of the Bridge as per Figure 2-1 below, it is proposed to remove concrete screed from the surface of the weir, replace missing stones, grout inject and point the masonry with Prompt natural cement.

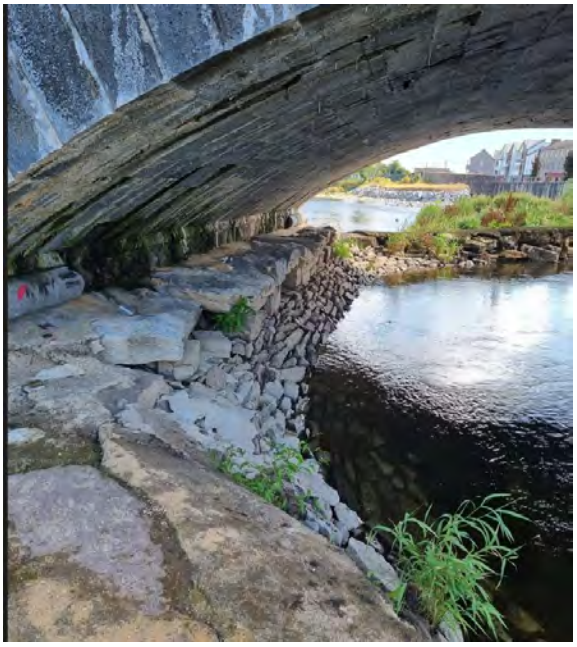

Figure 2-1: Upstream face of Weir alongside south side of Pier 5

On the downstream face of the weir structure at Pier 5, the weir does not extend alongside the north side of the pier (See Figure 2-2 below). The existing concrete screed will be removed from the weir at either end of the pier, the cobbles and stone reinstated to create a uniform surface profile and joints will be pointed with Prompt natural cement. The rock armour filled trench proposed for the toe of the embankment will be reduced in depth as it approaches the vicinity of the bridge pier.

Figure 2-2: Downstream face of weir at north side of Pier 5

In addition to the methodology described in the Conservation Engineer's report, Section 4 of the Outline Construction Management Plan, as included with the planning submission, describes the works proposals and the sequence of construction. Detailed construction method statements will be developed and submitted to Tii for agreement prior to commencement of construction of works in this area.

2.3. Concluding Comments

Cork Co Co and their design team will engage and consult with Tii during detailed design (including in respect of any site investigation and bathymetric surveys) prior to finalising the contract documents for the procurement stage. The Employer's Requirements which will be included with the Contract Documents will require that the Contractor undertaking the works obtain prior approval from Tii for any method statements relating to works with the potential to impact on assets managed by Tii.

Cork Co Co acknowledges that Tii might still require a TAR in accordance with 'Technical Approval of Road Structures on Motorways and Other National Roads for structures' DN-STR-03001. It is acknowledged that Technical Acceptance is required for the assessment, alteration, modification, strengthening and repair of all road structures.

3. SIMON BECKETT, KILWORTH, LETTER DATED 24TH JULY 2022

Mr Beckett, in his submission, links the breach in the weir to a reduction in flood risk stating that "since the weir was breached the river has not come near to breaking its banks like it used to."

This is not borne out by the evidence of flood records and level gauges maintained by the Office of Public Works at Fermoy. There are four (4) gauges within the vicinity of the proposed works that There are three gauges within the model that were cross-referenced:

1. 18124 Fermoy Rowing club – depth only gauge;
2. 18106 U/S Fermoy Bridge – depth only gauge;
3. 18107 D/S Fermoy Bridge – depth and flow gauge; and
4. 18117 Fermoy Mill – depth only gauge.

A maximum flow of 606.014m^3/s was recorded for the flood event of Dec 2015 at 20:00 on 30 December 2015 with a corresponding max flood level of 26.756m OD Malin at Gauge 18106 upstream of Fermoy Bridge. This flood event predated the breach in the weir...

The flood of February 2021, which occurred after the breach in the weir, had a maximum flow of 506m^3/s at 05:45 on 24th February with a corresponding max flood level of 26.530m OD Malin at Gauge 18106 upstream of Fermoy Bridge.

In both these events, the flood defence scheme demountable barriers were deployed.

Mr Beckett states that *"…the weir should be left to nature, and let the river sort itself out… The Blackwater would return to its natural state. It wouldn't flood ever."*

Extreme flood events can occur irrespective of the presence of a weir or not. The weir is drowned in flood events and has a minimal impact on the flood levels as experienced in the Dec 2015 and Feb 2021 events.

The weir at Fermoy has been designated a protected structure by Cork Co Co since 2009, imposing an obligation on the Council to protect and maintain the structure. Leisure and recreational activities have developed in the town of Fermoy as a result of the presence of the weir which in its present construction dates from the early 1800's.

4. IFI SUBMISSION BY EMAIL AND LETTER DATED 28TH JULY 2022

In its submission of the 28th July 2022, *Inland Fisheries Ireland (IFI) welcomes the opportunity to comment on Cork County Council's application with respect to the proposed re-instatement of Fermoy weir and construction of a bypass channel on the north bank of the river*.

As a general comment, in their submission, IFI have ignored the heritage aspects of the project and referred to fisheries considerations only. The applicant has consulted extensively with IFI, including a meeting between the applicant and IFI and their respective technical advisors held on the 10th Feb 2020, and the scheme as submitted for planning approval reflects the outcome of these discussions.

4.1. Responses to IFI Submission

IFI notes that within the Natura impact statement the options available include 4.2.1 do nothing and 4.2.2 stabilise remaining section of the weir. These options were ruled out in the report due to the water velocity being 'too fast to facilitate upstream movement of qualifying interest fish species...' however no data is presented on water velocity readings within and downstream of this section of the river to support this analysis. IFI velocity readings taken in 2019 indicate that water velocities would not be a barrier to the migration of salmon (velocity range 0.35 -1.62m^{-1}) while water velocities in locations were above thresholds for lamprey it is possible to achieve passage using bottom and edge effects. IFI would recommend that the first two options be investigated further and fully considered.

Following the occurrence of the breach in the weir, bed and bank erosion in the vicinity of the breach was significant until OPW undertook emergency works in Autumn 2020 to stabilise the riverbed. These emergency works were necessary due to the risk of excessive velocities undermining the flood defences on the south bank of the river at O'Neill Crowley Quay and Mill Island. Photos, dating from May 2020 and reproduced at Fig4-1 and 4-2 below, illustrate the extent of bed and bank erosion which had occurred in the period following the breach.

Figure 4-1: Bank Erosion at Mill Island following breach in weir

Figure 4-2: Velocities in low flow conditions are a hindrance to fish passage

IFI have provided no supporting data provided in respect of dates or locations of velocity reading or associated flow conditions.

T.J. O'Connor & Associates developed a HEC-RAS model along the Mill Race at Fermoy based on the cross-sections on drawing No.2961- 730 as reproduced at Appendix E. Additional cross-sections were also interpolated from these and included in the model.

The flows used in the model were the percentile flows at the downstream gauge in the river. The water levels for the corresponding percentiles at the upstream gauge were also used as the upstream boundary conditions in the model. 10, 25, 50 and 95-percentile flows and water levels were considered, based on data which were available from the OPW's gauge data. Additional values were interpolated for the 15, 20, 30 and 40 percentiles so that the likely velocity could be assessed for the worst-case scenario, i.e., when the water level is at / near the top of the weir and before it starts spilling over the weir.

Based on the calculated water profiles for the cross-sections in HEC-RAS, for the various percentiles considered, the worst-case scenario occurs at the 15-percentile flow rate. The maximum velocity at the Mill Race (cross-section 12 on Drawing No 2961-730) is estimated to be of the order of 5.67m/s as shown on the Tabulated results at Appendix E. The velocity for the 50-percentile flow rate is estimated to be in excess of 2m/s at Chainage 22, 37 and 53. The results of this analysis are included in Appendix E. This hydraulic modelling of flow though the breach and in the channel upstream of the breach indicated sustained velocities in excess of 2m/s extending for a distance in excess of 30m upstream of the breach across a range of flow conditions from 50%ile flow (22.3m^3/s) to 10%ile flow (97m^3/s). See Drawing 2961-730 at Appendix E for the location of the cross sections in the HEC_RAS model. It is evident from this analysis that velocities across a wide range of flow conditions from the 10%ile flow down to the 95%ile flow are in excess of 2m/s and that these elevated velocities are maintained for a distance along the Mill race channel.

In the autumn of 2020, the OPW were obliged to undertake emergency works to stabilise the riverbed and banks in the vicinity of O'Neill Crowley Quay and the breach in the weir, due to the real risk of undermining of the flood defences due to bed and bank erosion which had occurred as a result of the breach. The riverbed level in front of this flood defence wall, which had only been completed in 2015, had been eroded to a depth of several metres following the breach in the weir.

This lowering of the riverbed level alongside O'Neill Crowley Quay resulted in conditions which were no longer consistent with the design assumptions for passive resistance of the retaining wall. These emergency works did not reduce velocities in front of O'Neill Crowley Quay but, by placing rock armour on the riverbed, ensured that bed and bank material in the area would not be eroded at the same rate as had been occurring.

IFI restate its view that the removal of the weir would be the most beneficial option from a fisheries perspective: returning the river to a more natural hydromorphological state, allowing for free passage of aquatic organisms (including but not limited to: Austropotamobius pallipes (White clawed crayfish) Petromyzon marinus (Sea Lamprey), Lampetra planeri (Brook Lamprey), Lampetra fluviatilis (River lamprey), Alosa fallax fallax (twaite Shad) Salmo salar (Atlantic Salmon) , sediment transport and improved continuity of the riparian zone in general. At an international level the EU Biodiversity Strategy for 2030, has recognised the need for greater efforts to restore freshwater ecosystems and the natural functions of rivers. It has identified that the removal of weirs and dams will help freshwater ecosystems thrive and facilitate the migration of endangered species, such as Atlantic salmon, Sea lamprey and the European eel. Investing in healthy rivers will also bring many benefits related to ecosystem services, such as flood protection, water purification and greater recreational opportunities.

IFI are treating the situation following the breach as a baseline and do not refer to any other considerations that might warrant the repair of the weir, i.e., its heritage status and community benefits. IFI also are selective in their reference to velocities in the breach.

The development as proposed provides for the reinstatement of the weir for its heritage value and, through the provision of the fish bypass channel, provides for better access for a wider range of fish species.

It has been noted that there are now far fewer signs of adult salmon activity in the environs of the weir, which may reflect that post-breach, salmon are no longer delayed below the structure; this was not the case pre-breach when upstream migrants, reliant on the fish pass, were held below the weir and vulnerable to various predators. Adult salmon do not accumulate or jump at the weir barrier as was the case pre breach, with fresh-run salmon being caught upstream of Fermoy even in low water conditions indicating their free passage to the upper catchment.

Similarly, the present funnelling of the river to the breach east of the bridge appears ideally suited in facilitating the downstream migration of salmon smolts. The proposed location of the fish bypass channel (option 8 in Natura Impact Statement Report) is flush with the northern bank and may not be readily located by downstream migrants resulting in fish passage being delayed or their being diverted. The development of a fish passage solution would need to be supported by an analysis to support both upstream and

downstream migration of fish. Any delay or accumulation of migrating salmon at any stage in their life cycle may lead to increased predation and mortality.

No data on fish counts either downstream or upstream of the weir at Fermoy were made available to the applicant by IFI.

The FAO DVWK guidance document "Fish Passes, Design, Dimensions and Monitoring", which is referenced in the Engineering Technical Report included with the application, notes that Fish Ramps (which includes the rough channel pool pass type proposed for Fermoy) are suitable for downstream migration of fish.

Dr Terry McDermott of Trex Ecology notes in his report Fermoy Fish Pass Operational Monitoring, which was included with the Application, that "Such a sizeable proportion of flow to the pass also suggests most fish which migrate downstream (resident fish, salmonid kelts, salmonid smolts, adult eel, juvenile lamprey, juvenile shad) will stand a good chance of moving through the pass."

Prior to the occurrence of the breach IFI had recorded a concentration of Sea Lamprey redds immediately downstream of Fermoy weir but not so since, a further indication that the barrier effect on fish passage of the weir may have been reduced significantly. Furthermore, IFI has recorded Sea Lamprey redds during the course of survey work (AMBER 202 D4.2 Report of Case Studies Demonstrating the Effects of Barrier Removal, Mitigation and Installation) upstream of the breached weir in riffle habitat newly generated at the upstream limit of the formerly impounded channel resulting from the lowering of the water level.

The AMBER report, referenced above, is referred to in the Natura Impact Statement (NIS) which accompanied the application and in the Trex Ecology Operational Monitoring review report (included at Appendix 7 of the NIS). Table 17 of the NIS referred to the AMBER report in the context of in-combination effects with the Clondulane Weir removal project.

It is noted that Section A3.1.9 of the AMBER report referenced by IFI includes a list of valid concerns which will surface in the context of any proposals to impact on a barrier. Included in this list are:

- ➢ Change in the status quo – communities are accustomed to the things they are used to and are commonly reticent in regard to changes
- ➢ The structure may have cultural significance
- ➢ It may have architectural or antique significance and may be listed on a state register as a National Monument
- ➢ There may be issues with regard to the channel starting to erode and incise into the riverbed to develop an equilibrium between the downstream bed levels and the upstream levels with concerns for bank erosion and impact on bank stability and on dwellings etc. adjacent to the channel

➢ There may be bone fide and long-established users of the impounded water upstream, such as leisure boating groups, or kayak groups who use the head differential at the barriers for their sport.

The AMBER report also notes in Section A3.1.10 that any management of the weir at Fermoy consists of requirements to

- Accommodate the upstream and downstream passage of diadromous fish species in line with the SAC status of the river and Conservation Objectives for the designated diadromous fish – Atlantic salmon, sea and river lamprey, Twaite shad- and for migratory European Eel.
- Ensure integrity of infrastructure – the existing road bridge, until recent motorway completion, was the national primary route linking the two main cities in the Republic – Dublin and Cork. The existing weir in Fermoy is constructed in a manner that takes it through the road bridge – the left-hand side of the weir is upstream of the bridge and the right-hand side is downstream
- There is a long-established rowing club on the river, and it avails of the flat, impounded waters upstream of the weir for competitions and for training. This is a valued local amenity, and its continued functioning requires a level of 'flat' water upstream of the weir.

As demonstrated in the application and supporting documentation, the proposed development of the fish Bypass channel and the remediation of the weir satisfies these requirements. Removal of the weir or the "do nothing" scenario, as advocated by IFI, does not satisfy the above requirements for reasons as outlined in this response.

The breaching of Fermoy weir exposed impounded salmon habitat 3.8km upstream at Castle Hyde House. The dewatering of the weir exposed 26,000m^2 of glide, 11,000m^2 of riffle and 7,500m^2 of side arm river habitat. Based on fish survey data this newly exposed habitat supports significant numbers of salmon fry and parr and the spawning of adult sea lamprey. This "restored" habitat would be lost in the event that repair of the weir resulted in raising the impounded water level to its prior state.

Restored glide and riffle is of no benefit if fish cannot pass through the breach due to excessive velocities in most flow conditions. The loss of areas of glide, riffle and side arm habitat alluded to by the IFI presumes that fish can access these areas through the breach. As stated previously, the velocities in the breach and in the constricted channel immediately upstream of the breach as far as Kent Bridge presents a significant obstacle to such access across a wide range of flow conditions.

5. AN TAISCE SUBMISSION BY LETTER DATED 28TH JULY 2022

Ensure all issues raised the Dept of Heritage letter of 28th Feb 2020 on potential impact to the river Blackwater SAC have been fully addressed in the NIS

Reference to obligations under Articles 4(1)(a)(i) to (iii) and Article 4(1)(c) of the Water Framework Directive and Article 5 of the Surface Water Regulations 2009

The issues raised in the Dept of Heritage letter of 28th Feb 2020 are identified in Section 2.3 of the NIS and have been addressed in the NIS.

Obligations in respect of the referenced articles in the WFD and the Surface Water Regulations have been considered in the NIS (see Section 6.8.2 of the NIS) and in the proposals for the development. Water Framework Directive data relating to the watercourses within the study area is provided in Table 11 of the NIS and shown in Figure 15 of the NIS. Obligations in respect of the Surface Water Regulations 2009 (SI 272 of 2009) are addressed in Section 6.8.1 of the NIS.

6. OPW SUBMISSION BY EMAIL DATED 29TH JULY 2022

6.1. River Blackwater (Fermoy North and South) Drainage Scheme (or Flood Relief Scheme).

The Commissioners have constructed a flood relief scheme in Fermoy, providing protection to both Fermoy North and Fermoy South. This scheme has been carried out by the Commissioners under powers given to them in the Arterial Drainage Acts of 1945 and 1995 as amended.

The project Planning Red Line Boundary indicated on the planning drawings for this project includes the locations of a number of features or elements of the flood relief scheme as follows:

1. *The River Channel itself.*
2. *The Floodplain of the river.*
3. *Flood defence embankment.*
4. *Flood defence walls.*
5. *A Pumping Station.*
6. *Demountable barrier threshold structures*
7. *Emergency bed stabilisation works.*
8. *Drainage outfalls.*

Any interference with any of these elements of the Flood Relief Scheme requires the consent of the Commissioners under Section 9 of the Arterial Drainage (Amendment) Act of 1995. This is an independent statutory requirement from the need to get planning permission for the project, and a grant of planning permission does not obviate the need to obtain such consent.

The Applicant is aware of its obligations to obtain consent under Section 9 of the Arterial Drainage (Amendment) Act of 1995. The Applicant has previously been advised by the OPW that this an independent statutory requirement. The Applicant will seek Section 9 consent in the event of a grant of planning permission for the scheme, having regard to any conditions and revisions included with such a grant of permission.

6.2. Other Statutory Consent.

Section 47 of the Arterial Drainage Act of 1945, as amended, stipulates that any person who proposes to build or modify a weir is required to have the consent of the Commissioners of Public Works. This consent is an independent statutory requirement from the need to get planning permission for the project, and a grant of planning permission does not obviate the need to obtain such consent. This consent may be applicable in this case.

The Applicant is aware of the possible applicability of Section 47 of the Arterial Drainage Act of 1945 in respect of repairs and modifications to the weir at Fermoy. The Applicant has previously been advised by the OPW that this an independent statutory requirement. The Applicant will seek Section 47 consent, if required by the OPW, following a grant of planning permission for the scheme, having regard to any conditions and revisions included with such a grant of permission.

6.3. Planning Drawings submitted.

In their submission the OPW commented on some of the drawings included in the application as noted below. For clarity the OPW comments are in italics and are followed directly by our response to the comment.

A. *It is noted that a number of the drawings indicate proposed planting of trees distributed over the width of the floodplain between the proposed fishpass and the flood defence embankment. This could very conceivably have the effect of reducing the flow capacity in the floodplain and thereby increasing flood levels in large floods. (further comment later).*

The construction of the fish bypass will result in the loss of some trees both on the riverbank and on the line of black poplar trees extending north towards the western flood embankment on the north side of the river. There is an obligation to provide compensatory planting for those trees removed as a mitigation for screening due to the loss of mature trees.

In a meeting held with the Applicant and their engineering advisor on the 23rd Aug 2022, the OPW expressed concerns with dense planting in the flood plain during a flood event and advised that trees with tall narrow trunks would be preferable as they would have less impact in a flood scenario. The applicant confirms that the landscaping design can be adjusted in consultation with OPW to take account of their concerns but notes that screening would also need to be provided to limit access to the side of the fish bypass channel and to provide shade to fish passing through the fish bypass channel.

The roughness coefficients used for the riverbank in the vicinity of the fish bypass in the hydraulic model of the proposed fish bypass and weir remediation reflects the proposed landscaping scheme. The Flood Risk Assessment report has been amended to include reference to the potential flood hazard from planting within the flood plain, taking account of the removal of barriers to flow by the removal of existing trees and the introduction of new planting in a more dispersed pattern.

The construction of the fish bypass channel will require the removal of 18 No black poplar and Lawson's cypress trees which are in a line at right angles to the direction of flow in the river. The removal of these trees, along with the ground cover planting which extends along their base, will result in the elimination of a barrier to flood flows on part of the north bank of the river.

B. *With regard to the proposed construction of the fish pass and its build up, we would comment that the materials should be carefully selected to remain stable in all flood conditions. Any instability of the material leading to a mobilisation of material which in turn could lead to accumulation of material downstream causing a potential reduction of flow capacity in the bridge or the channel downstream. This could have an adverse impact on flood levels in the area, and potentially increase flood risk in the town.*

There was a typo on armour stone size on the planning drawings which noted a stone size of 100m instead of 1000mm. This typo has been rectified and revised drawing 19011-TJOC-PL-XX-DR-C- 0054 Rev C02 is included with other revised drawings in Appendix C.

C. *It is welcome that gravel from downstream deposits in the river is to be used in the construction of the fish pass. This will have a positive impact on the channel capacity downstream.*

The OPW's comment on this matter is noted.

D. *The labelling of two of the cross sections on plan on drawing 19011-TJOC-PL-XX-DR-C-0060, in the area of the bed stabilisation works is not clear. Thus, arguably, it is not clear what the cross sections are showing, because the labels on plan don't match those on drawing 19011-TJOC-PL-XX-DR-C-0063.*

An inconsistency in the labelling of the cross sections on plan on drawing 19011-TJOC-PL-XX-DR-C-0060, in the area of the bed stabilisation works, has been identified and a revised copy of Drawing 19011-TJOC-PL-XX-DR-C-0060 Rev C-02 is included with other revised drawings in Appendix C.

E. *The levels indicated on drawing no. 19011-TJOC-PL-XX-DR-C-0063 appear to be up to about 350mm higher than the weir in this location (assumed) prior to collapse. This is a potentially significant matter, and could trigger the need for Section 47 consent as mentioned above.*

The proposed scheme provides for the reconstruction and remediation of the weir structure and Mill Race Weir wall with a uniform level (as opposed to it present partially collapsed and uneven profile). This will result in a slightly higher top level of the weir wall. The crest of the weir is proposed to be 21.45mOD for the section of weir upstream of the bridge, as opposed to the existing weir crest, which varies in level between 21.46 and a minimum of 21.20 in the most eroded areas. Downstream of the Bridge, the Mill Race end of the weir will be raised 100mm higher than the rest of the weir to distribute the flow over the weir more evenly. However, offsetting the impact of these changes in weir level, 43% of flow in the river at Annual Average Daily Flow (AADF) will flow through new bypass channel, the entrance of which will be at 21.200mOD along its 28meter width. The remainder of the AADF will flow over the remediated weir.

The net loss in cross-sectional area at the existing weir and Mill Race weir wall is of the order of 34.9m^2. The net addition in cross-sectional area by the construction of the fish Bypass channel is approximately 41.3m^2, Therefore, there is a net increase in cross sectional area at the weir of the order of 6.4m^2.

The hydraulic modelling undertaken in conjunction with the Flood Risk Assessment confirms that the flood levels predicted at the flood defences will be lower than the existing scenario, prior to the breach in the weir, as a result of the increased cross-sectional area of flow resulting from the introduction of the Bypass channel in the flood plain, with the exception of some localised areas in the 2year and 5year return period events.

F. *Drawings 19011-TJOC-PL-XX-DR-C-0084 and 19011-TJOC-PL-XX-DR-C-0085 both indicate potentially significant interferences with the flood plain between the*

river and the flood defence embankment, spoil heaps, and site accommodation and facilities respectively. These matters could cause significant obstruction to flow and cause an increase in flood levels. It is noted that the site facilities are stated to be above the 1% AEP flood levels. However, this flood level is about 3.5 metres above ground levels in this area. The support structure for these facilities, if placed in the location indicated, could, as said, have a significant adverse impact on flood levels and thus on flood risk.

The statement that the site facilities will be above the 1%AEP Flood level should have stated that the office accommodation element of the site facilities will be above the 10%. Site office accommodation, if provided on site, will be located at first floor level with storage facilities at ground floor level. The footprint of the site office accommodation and the extent of on-site storage will be determined by the contractor in a Construction Management Plan for the project. Therefore, these issues can be agreed with the OPW in the context of the approval process for Section 9 and Section 47 consent under the Arterial Drainage Acts.

G. *Similarly, drawing 19011-TJOC-PL-XX-DR-C-0086 indicates that the whole of the floodplain width between the river channel and the flood defence embankment is occupied by 'works'. There is no indication what these 'work' might be nor if they might or might not have an obstructive (to river flow) impact on the flood plain, and thus increase flood levels and flood risk. These issues need to be controlled (through the FRA, planning conditions, and the Section 9 consent process) so that an increase in flood risk does not arise, even on a temporary basis as a result of the proposed development.*

Drawing 19011-TJOC-PL-XX-DR-C-0086, as included with the application, shows the proposed phasing of the scheme. The shaded area on the north bank of the river indicates the extent of the temporary working area and permanent land acquisition on that side of the river. The construction of the Fish Bypass channel will require a working area outside the footprint of the channel in order to provide for access, circulation, marshalling, temporary works and for office accommodation if required on site. Roughness coefficients were used in the HEC-RAS hydraulic model of the proposed scheme to reflect the terrain and landscaping proposals.

The hydraulic flood modelling undertaken for this submission does not, at this stage, include the level of detail to consider the construction stage phasing and temporary use of lands on the north bank of the river. This level of detail can be provided within the Section 9 approval process. It was not considered necessary for the planning stage on the basis that:

- instream works will be restricted to the period of July to September only; and
- construction work will cease and all plant and loose materials and equipment will be removed from the river in the event of a warning of a significant flood event during this period.

H. *Further to comment A above, it is noted that drawing number LP-01-PP shows in plan and section a relatively dense amount of vegetation and tree planting distributed over much of the width of the floodplain between the fish pass and the flood defence embankment, labelled as 'riparian enhancement'. This could have adverse impacts on flood levels and flood risk in the town, as per previous*

comments. We would advise strongly that the floodplain between the flood defence embankment and the river channel in a town where there is a particularly high level of flood risk, and where the state has made very substantial investment in flood protection, is not a suitable location for dense planting of this nature. This should not be permitted as part of the development.

As noted in the response to comment A above, the scheme results in the removal of a number of mature trees which imposes a requirement for compensatory planting. There is also a requirement to provide shade and cover to the Fish Bypass channel.

The applicant is of the view that the landscaping scheme is considered and cognizant of the location within the flood defence scheme. The planting scheme as proposed, apart from the ground cover and shade planting along the edges of the bypass channel (where the bank is battered towards the tops of the bypass channel walls) could not be considered to be dense.

Notwithstanding this and taking account of the requirement for Section 9 approval, the applicant will consult with the OPW in respect of any amendments to the landscaping scheme with a view to addressing and resolving the concerns of the OPW, while meeting the requirements for screen planting, compensatory planting and shade cover within the fish bypass.

There is no planting or excavation proposed within the clay wedge area in front of the flood embankment to the north of the works area. The minimum length of clay wedge required in front of this section of embankment does not exceed 10m. No trees are proposed to be planted within 10m of the embankment. The modelling parameters for roughness of the riverbank reflects the presence of isolated trees within the flood plain and also local areas of denser planting along the bank of the bypass channel.

6.4. Flood Risk Assessment.

It is noted that a Flood Risk Assessment has been prepared and is included in Appendix E of the 'Engineering Technical Report to Accompany Planning Application'. A brief review of the flood risk assessment report prompts the following comments.

a. The Scope of the assessment as outlined in section 1.4 does not include an assessment of the flood relief scheme (and the documentation supporting it) which has been carried out in the town. It is noted that the scheme is referred to in a later section of the report.

The FRA Report has been amended to include a reference to a review of the Fermoy North and South Flood Relief Schemes in Section 1.4. The revised FRA is included in Appendix F.

b. Neither is there any reference to the flood relief scheme in the town in Table 3-1.

Table 3-1 of the FRA Report has been amended to include this reference. The revised FRA is included in Appendix F.

c. *It is noted that flood levels from CFRAM outputs are referred to in Section 4.2, rather than the flood relief scheme outputs. For example, the 1% AEP flood level with the scheme in place is noted in the 2007 document referred to in Section 5.1 as being 25.38 or so, rather than the 24.82 mentioned in Section 4.2.*

Section 4.2 of the FRA has been revised to refer to the design flows rates for the Fermoy Flood Scheme as per the 2014 Jacobs Babtie "*Additional comment on the Fermoy design flow calculation"* of February 2014, reproduced at Appendix G of the FRA and the OPW draft Trigger levels for the Fermoy Flood Relief Scheme. The 2007 design levels for the Fermoy Flood scheme with the barriers in place correspond to 25.25mOD at Gauge 18107 on the north bank downstream of Fermoy Bridge. A trigger level of 25.28mOD is noted for Q100 in Section 6.2 of the OPW's Fermoy Flood Alleviation Scheme Fermoy North Demountable Structures Protocol, v1.2, April 2015,with the comment "Design Flood – Plan for exceedance of defence levels". The Q100 model results predict a level of 25.02mOD for the existing scenario and 24.71mOD for the proposed scenario with a design flow of 776m^3/s corresponding to the Q100 design flow.

d. *In section 5.1 it is noted that there were discrepancies between observed and predicted flood levels in Fermoy and that updated/review work was carried out in 2011. It is also stated that a design memo prepared in 2007 is referred to, to provide flood levels for a variety of purposes in this FRA. It is not stated however, and this is a serious concern, that the flood levels in the 2007 memo were in effect the source of the discrepancies referred to earlier. It is a matter of concern that the levels in this 2007 memo are relied on in the way that they are in this FRA.*

e. *The section describing the Model calibration (Section 5.3.3) only refers to levels obtained from the 2007 memo. In principle, as these levels are generated from a computer model themselves, they are not suitable for model calibration in such important work as this FRA, which is intended to support the application for permission for this development in a location which already has a very high level of flood risk. In practice, it is a serious matter of concern that the 2007 memo is relied on in the way that it is for model calibration when it is known that the information in it was the basis of the discrepancies mentioned earlier.*

f. *Furthermore, on the matter of model calibration, there is an amount of recorded river level data from river level gauges operated by this office, in Fermoy. This data should be used to calibrate the model, not computer generated data that is known to be unreliable.*

In response to items d, e and f above, the HEC-RAS Model, as prepared for the FRA, has been calibrated against observed data for flood events in Dec 2015 and Feb 2021 which precede and follow the breach in the weir wall which was first observed in 2016. The calibrated existing model has then been used to develop the model of the proposed bypass channel and weir remediation works.

Sections 5.3.3 to 5.3.7 of the FRA describe the calibration of the HEC-RAS model against the observed peak flood data, as recorded by the OPW for the flood events of the 30th Dec 2015 and the 24th Feb 2021. Data for the level gauges, referenced 18106, 18107 and 18117, at Fermoy were used for this calibration exercise.

Gauge 18106 is located upstream of Fermoy weir and Bridge on the south bank of the river at Ashe Quay. Gauge 18107 is located on the downstream abutment of Fermoy Bridge on the north bank of the river. Gauge 18117 is located further east on the south bank of the river at Mill Island. A further gauge, 18124 located on the south bank of the river at Fermoy Rowing club, was located outside of the area covered by the HEC-RAS Model.

g. *It is not indicated in the flood risk assessment whether any of the items mentioned above under the heading "Planning Drawings submitted", which could have an adverse impact on flood levels and flood risk, have been considered in any way in the flood risk assessment. They should be considered and reported on in detail.*

Any outstanding issues relating to the comments raised under the heading "Planning Drawings submitted" will be addressed in the approval process for Section 9 and Section 47 consent, if required.

h. *In summary, as will be reasonably clear from the foregoing comments, it is felt that the adequacy of this flood risk assessment to support the application for permission for the proposed development, should be questioned. If this office were the deciding authority on this matter, further work on the flood risk assessment would be required, before a decision would be made.*

Following meetings with the OPW on the 23rd August and 15th Sept 2022, the hydraulic model has been calibrated against observed data and a revised Flood Risk Assessment has been prepared, addressing the comments raised by the OPW. The revised Flood Risk Assessment is included in Appendix F.

By agreement with the OPW, the FRA has been updated to address issues related to the permanent works and the planning permission application.

Matters relating to the Section 9 consent (and a Section 47 consent if required), including some matters that may impact on flood levels, will be addressed in a separate process of engagement with OPW with a view to obtaining such Arterial Drainage Act consents.

It is acknowledged that the OPW has advised that this agreement is on the strict understanding that any restrictions on working or whatever in the flood plain and any other relevant matters are agreed and reflected in the Works Requirements before the project goes out to tender. Furthermore, the OPW advised that there should be no anticipation of the appointed contractor being required to obtain any further Section 9 consent.

6.5. Requirements of OPW.

Section 3.4 of the FRA refers to consultation with OPW.

The requirements of the OPW might be summarised as follows, for clarification.

- *The impact on low and high flood levels as a result of this proposed development needs to be considered adequately, so that an assessment can be carried out as to whether Section 47 consent is required or not.*

The impact of low flow conditions (up to 1 AADF) have been considered in the Computational Fluid Dynamic Modelling report at Appendix D of the Engineering Technical Report included with the application. The impact of flood conditions from 1 in 2 year to 1 in 100 year has been addressed in the updated FRA appended herewith.

In addition to the assessment of lower flow conditions in the Computational Fluid Dynamic Modelling report, the HecRas model analysis has been extended to include consideration of the lower flood events comprising the 10%ile, 5%ile and 1%ile flow as recorded for Gauge 18107 on the OPW Hydrodata website. The flows and levels exceeded for the given percentage of time are summarised at Table 6-1 below.

Table 6-1. Flow and Level for Lower Flood Events

	Observed Gauge 18107		Existing Scenario	Proposed Scenario
	Flow m^3/s	Level mOD Malin		
10%ile	100.675	20.491	20.580	20.590
5%ile	146.389	20.915	21.010	21.020
1%ile	253.617	21.736	21.880	21.890

The HecRas model predicts slightly higher levels for the existing and proposed scenarios in each of these lower flow conditions at Gauge 18107. The proposed model shows a minimal increase of 10mm over the depth in the existing scenario for Gauge 18107 with these flows. However, this increase is local and is not reflected in the levels predicted for the existing and proposed scenarios at Guage 18106 upstream or gauge 18117 downstream. This demonstrates that in lower flow conditions there will be no increase in flood depths either upstream or downstream of the proposed works.

The HecRas model outputs for the existing and proposed scenarios, as presented in Sections 5.3.8 and 5.4 of the Flood Risk Assessment report, confirm that there will not be an increase in flood depths for higher flow flood events if the proposed development were to be constructed.

- *Consent under Section 9 as referred to earlier should be applied for and obtained prior to any work proceeding on site.*

This requirement is noted and an application for Section 9 consent will be submitted prior to the appointment of a contractor. Any such application will reflect the scheme as approved through the planning approval process.

- *There should be no impact on the flood levels that are used to trigger erection of demountable barriers and other actions, in response to rising floods in Fermoy, and their relationship with flow, as a result of this development. This has not been evaluated in the FRA.*

Section 5.4 of the FRA addresses the flood levels that are used to trigger erection of the demountable flood barriers and other assets as set out in the Fermoy North and Fermoy

South Flood Management Protocols. The HecRas model outputs demonstrate that there will be no increase in flood levels for higher return period events as a consequence of the development.

- *There should be no adverse impact on flood levels in the town that would reduce the effectiveness of the flood defences provided nor the standard of protection provided.*

When compared with the flood levels predicted at the flood defences for a range of flood return periods and percentile flows, there is no increase in predicted flood levels relative to the situation prior to the breach in the weir in 2016, apart from a localised impact downstream of the bridge on the north bank in a 1:2year return period flood. There are also minor increases in depth predicted at Wall 17 and 22 on the south bank in a 1 in 2year event and at Wall 8 on the North Bank in the 1 in 5year return period. These are attributable to the redirection of some flows around the Bypass channel diversion. The localised increase in flood depths has no significant impact on the trigger level for erection of the flood defence barriers or the level of protection afforded by the barriers.

- *The restrictions on the contractor to be appointed to carry out the works in terms of interference with the flood plain should be addressed and identified, by the developer and their consultants, in the FRA and specified in the works requirements. They should not be left for the contractor to address.*

The OPW has agreed that matters pertaining to the Section 9 consent (and a Section 47 consent if required), including some matters that may impact on flood levels, will be addressed in a separate process of engagement with OPW with a view to obtaining such Arterial Drainage Act consents. These maters will include Works Requirements pertaining to the contractor's operations within the flood plain.

6.6. Additional Concerns raised by the OPW

T.J. O'Connor & Associates, as the agent for the applicant, engaged with the OPW in respect of their concerns in advance of finalising this response, with discussions taking place in December 2022 and February 2023. The OPW advised that the rating curve used in the HecRas model should be reviewed taking account of the increased length of observations of depth and flow available at gauge 18107, building on information originally gathered between 2006 and 2011. A number of possible rating curve formulae were considered as presented in Table 6-2 below.

We have compared the flood depth predicted for 1 in 100year flows for the various formulae that have been used for rating curves in the past along with our estimate of a rating curve in the standard OPW format based on the 2006 to 2021 observations of flow and depths.

Table 6-2. Comparison of Rating Curve Formulae

	Source	Formula	Flow	Depth	R^2 number
A	Jacob's Fitted trendline 2014	$Q = 24.923x^2 = 16.12x + 29.676$	776m^3/s	5.158	0.9483
B	TJO'C Polynomial Equation (2006-2021 data)	$Q = 20.6697x^2 + 33.1738x + 10.8623$	776m^3/s	5.335m	0.9657
C	OPW format 2014 Rating Curve	$Q = 63.4(h+0.1)^{1.432}$	776m^3/s	5.65m	0.9863
D	TJOC Updated OPW Format Rating Curve (2006-2021 data)	$Q=57.07(h+0.075)^{1.4825}$	776m^3/s	5.741m	0.9825

The OPW advised their requirement that the rating curve be in the OPW standard rating curve formula. Therefore, the spline (Polynomial) type equations (A and B in Table 6-2 above) were excluded from further consideration. The OPW also advised that Formula C in Table 6-2 above is quite similar to that developed within the OPW. As a result of the review, it was concluded that the additional observations in the period 2012 to 2021 did not provide any basis for revising the OPW format rating curve equation as reported in Figure 2.1 of the Jacobs Babtie *"Additional comment on the Fermoy design flow calculation"* of February 2014, reproduced at Appendix G of the FRA. Equation C has a better regression analysis R^2 value (0.9862) than the revised OPW format formula which was developed from the available data (0.9825). This was also the case when compared with either of the spline type equations that were considered.

Therefore, the rating curve employed in the modelling of the existing and proposed scenarios is represented by the formula:

$$Q = 64.3(h+0.1)^{1.432}$$

where the function *h* is the stage height above gauge datum of 23.92m Poolbeg Datum (21.21mOD Malin).

The resultant levels (converted to Mailin Datum) for design flows with return periods from 1 in 2year to 1 in 100year return period are summarised at Table 6-3 below.

Table 6-3. Comparison of levels at Gauge 18107 Fermoy Bridge D/S

			Existing Scenario		Proposed Scenario	
Return Period	Flow	Level from Rating Curve	Predicted Level	Difference	Predicted Level	Difference
Years	m3/s	mOD Malin	mOD Malin	m	mOD Malin	m
1:2	376	22.543	22.700	+0.157	22.730	+0.187
1:5	475	23.151	23.370	+0.219	23.34	+0.189
1:10	542	23.541	23.770	+0.229	23.74	+0.199
1::25	633	24.048	24.320	+0.272	24.25	+0.202
1:50	701	24.413	24.650	+0.237	24.61	+0.197
1:100	776	24.803	25.02	+0.217	24.71	-0.093

The fitting of the observed data from 2006 to 2021 to the standard rating curve format is expanded upon in the revised FRA report at Appendix F.

The HecRas model has been run for a range of events – extending from 10%ile flow up to the 1:100year flood flow of 776m^3/s. Design flows for events of 1 in 2year return period and greater are as per the FSR Growth Curve column in Table 3.1 of the 2014 Jacobs Batie *Additional comment on the Fermoy design flow calculation"* of February 2014, reproduced at Appendix G of the FRA report. The lower flows are based on the percentile flows listed on https://waterlevel.ie/hydro-data/stations/18107/station.html?1661741499 for the 18107 gauge at Fermoy bridge. The HecRas Model has been run for the 1%ile, 5%ile and 10%ile flows listed at Table 6-1 above and the model outputs, as included in the FRA report, demonstrate no negative impact in low return period events.

The model results for these return periods are presented in Appendix D and at Table 5.6 of the FRA. The predicted flood levels for the return periods described above have been extracted from the model results for both existing and proposed scenarios at the upstream end of each flood defence wall and at locations along the north flood embankment.

The results confirm that the proposed development has no adverse impact on flood levels across the range of flood events apart from a couple of localised locations upstream of the weir for the Q2 and Q5 flows. These primarily occur in the vicinity of Wall 8 on the North bank and can be explained by the diversion of a greater proportion of flows towards the north bank in this area as a result of the introduction of the 28m wide Fish Bypass channel.

The impact of the development has been compared with the existing (2015) scenario to confirm the impact on freeboard to the top of the flood defences. While the model predicts that a number of locations have freeboard of less than 500mm in the existing scenario for the Q100 flow, this can be explained by the fact that this flood level and associated rating curve was not used in the original design of the flood relief scheme. The model outputs for the proposed scenario predict lower flood levels that the existing scenario at the defences in the Q100 flow and confirm that the 500mm freeboard can be achieved at all locations. The HecRas Model outputs at Table 5.6 of the FRA demonstrates that the scheme has no adverse impact and in fact has a positive impact on flood levels and available freeboard in the Q100 year event. This is supported by the information in Tables 5-10 and 5-11 of the FRA report.

The OPW have advised that none of the rating curves in question were used in the design of the scheme, as they were not available at that time. They advised that they would need to see that the modelling work for this flood risk assessment is based on the best practices available in so far as they can. They noted that if the modelling work suggests that the scheme defences are short of freeboard, then this will need to be investigated and considered further by the OPW and the flood relief scheme consultants. They noted that this would not be an issue for the proposed development. However, if the modelling shows that the effect of the proposed development is to reduce the freeboard below what is required or to reduce the freeboard further below the required level, then this will be a problem in the eyes of the OPW as far as the proposed development is concerned.

The analysis presented in Section 5.4 of the FRA and outlined above demonstrates that the proposed development does not have the effect of reducing the freeboard at the flood defences on the north and south banks of the river below the required level in the Flood Management Protocols and does not reduce the freeboard below the levels predicted for the existing scenario.

This updated analysis and findings has been incorporated in the Flood Risk Assessment report and has been provided to the OPW. The OPW requested confirmation, in an email dated 1st March 2023, if all the issues raised by the OPW during this process have been addressed in this latest submission.

T. J. O'Connor & Associates, as agent for the applicant, confirmed in their response that they have addressed all of the issues raised by the OPW, including those items as set out in their original observations to An Bord Pleanála of the 29th July 2022 and all additional items identified by the OPW in the subsequent discussions and communications with the agent for the applicant. Copies of this correspondence is included in Appendix G of this response.

7. DEVELOPMENT APPLICATION UNIT SUBMISSION BY LETTER DATED 29TH JULY 2022

7.1. Underwater Archaeology

DAU recommends conditions in respect of Underwater Archaeology that should be attached to any approval of planning permission.

The DAU require that provision shall be made to ensure that all historic structures within the proposed development are protected from all potential adverse impacts. The archaeological monitoring strategy shall include the plan for the protection of these heritage assets.

The proposed underwater archaeology conditions do not impose any excessively onerous conditions. However, it should be noted that the obligation to spread and metal detect all excavated deposits should be qualified to apply to such layers or levels of excavated material as required by the supervising archaeologist.

The weir at Fermoy has been designated a protected structure in the Fermoy Town Development plan. It is therefore a heritage asset, and the DAU are seeking the protection of this asset. The IFI in their submission have entirely ignored this aspect of the project.

7.2. Nature Conservation

DAU recommends that the Board seeks site specific advice for inland Fisheries in relation to the efficacy of the proposed fish pass for Twaite shad and other species.

The Hydraulic Design Review report was prepared by Dr Peter Brunner Fisheries specialist with RHDHV Consulting. It is included at Appendix C of the Engineering Technical Report which accompanied the planning submission. This report includes consideration of velocities for passage of Twaite shad and other Species and cross refers to the velocities identified for a range of flow conditions in the computational fluid dynamic modelling report at Appendix D of the Engineering Technical report.

Dr Tommy McDermott of Trex Ecology has addressed the requirements for the monitoring of the efficacy of the fish pass, particularly in relation to twaite shad access, in his report on Operational Monitoring for the Fermoy Fish Bypass which is appended to the Natura Impact Statement.

7.3. Natura Impact Statement

DAU suggests Board request a summary table of the advantages and disadvantages of the various alternatives assessed in the NIS.

DAU states that it is critical that the Blackwater remains free of the crayfish plagues disease.

The DAU recommends that eDNA monitoring appears as a proposal in the NIS and that this monitoring should be conditioned.

Advantages and disadvantages of the various alternatives assessed in the NIS were identified in general terms in the Options report which was prepared for the public consultation process and are also described in ecological context in Section 4.2 of the NIS.

The Natura Impact Statement (NIS) and Table 4-12 of the CEMP identify mitigations and measures to prevent spread of crayfish plague during construction works. These requirements can also be incorporated on permanent information display boards at access points in the vicinity of the development to inform river users of the requirements in the post construction stage of the development.

A condition to undertake eDNA monitoring post construction would be acceptable.

APPENDIX A

Scour Assessment Report

FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

Scour Assessment

September 2022

TJ O'CONNOR & ASSOCIATES CONSULTING ENGINEERS

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Document Verification

Client:	Cork County Council
Project Name:	Fermoy Weir Remediation & Fish Bypass Channel
Project Ref:	19011
Document Title:	Scour Assessment
File Name:	19011-TJOC-ZZ-XX-RP-C-3713_Scour_Assessment

Revision Code	Status Code	Description of Revision	Prepared By	Checked By	Approved By	Date of Issue
C01	AP	ABP Response Issue	MV	DC	EF	01.03.2023

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1.1. INTRODUCTION

1.2. Project Background

Cork County Council has identified the need to carry out remediation works to the existing weir in Fermoy and to construct a new permanent fish bypass channel on the north bank of the river Blackwater adjacent to Fermoy bridge. T.J. O'Connor & Associates (TJOC) were appointed by Cork County Council (CCC) to provide civil engineering consultancy services for the project and to develop a scheme to fulfil CCC's requirements while also complying with the relevant standards and statutory requirements.

The project requires CCC to fulfil its obligations to maintain and repair the weir at Fermoy, a Protected Structure under Section IV of the Planning & Development Act 2000, while complying with the conservation and fisheries obligations to provide for the free passage of fish along the river Blackwater Special Area of Conservation (SAC) arising under the Water Framework Directive, Habitats Directive and Inland Fisheries Act 2010 and related legislation.

1.3. Status of Scheme

An application in relation to Section 177AE(1) of the Planning and Development Act 2000 (as amended) and the Planning and Development Regulations 2001 (as amended) was submitted to An Bord Pleanála (ABP) on 9th June 2022 in respect of the proposed weir remediation and fish bypass channel works at Fermoy, Co. Cork.

The application is currently being reviewed by An Bord Pleanála.

2. TII SUBMISSION

2.1. Submission to An Bord Pleanála

A submission was made by Transport Infrastructure Ireland (TII) to ABP on the 5th July 2022 opposing the proposed scheme.

The main comments that were raised by TII on the proposed scheme in their submission are reproduced as follows;

1. The designer will be required to arrange for a structural investigations company to undertake structural investigations at the structure to evaluate the foundation level.

2. The implications for the bridge of a new embankment and fish passage adjacent to the structure needs to be investigated, to identify the future hydraulic effects of changing riverbed levels and river flows at the bridge substructure. The designer is advised to refer and implement UK Standard BD 97/12 “The assessment of scour and other hydraulic actions at bridges”, and other relevant standards to identify how the proposals will affect the bridge structure.

3. The designer shall investigate alternative mitigation treatments such as piling or underpinning the bridge, to secure it against the effects of scour, which the works are likely to cause. The effects of changing river flows and changing riverbed levels proposed by the works shall be modelled and calculated to ensure that mitigating bridge works are sufficient to prevent future bridge damage to scour.

4. TII advise that these treatments would involve significant works to the Fermoy Bridge and a geotechnical investigation of the substrata beneath the bridge would be required in order to design the piling or underpinning solution

2.2. Purpose of the Report

The purpose of this report is to review item 2 of TII’s submission, as reproduced in Section 2.1 above, in the context of undertaking a scour assessment in accordance with UK Standard BD 97/12. The conclusion of this assessment will identify the risk of scour to the bridge and will inform the extent of any mitigation treatment(s) required to be undertaken for the structure as part of the proposed development.

3. FERMOY BRIDGE

3.1. Bridge Location

The town of Fermoy is located approx. 35km north of Cork City. The bridge at Fermoy is located along the N72 and spans across the river Blackwater.

Figure 3-1 below illustrates the location of the bridge.

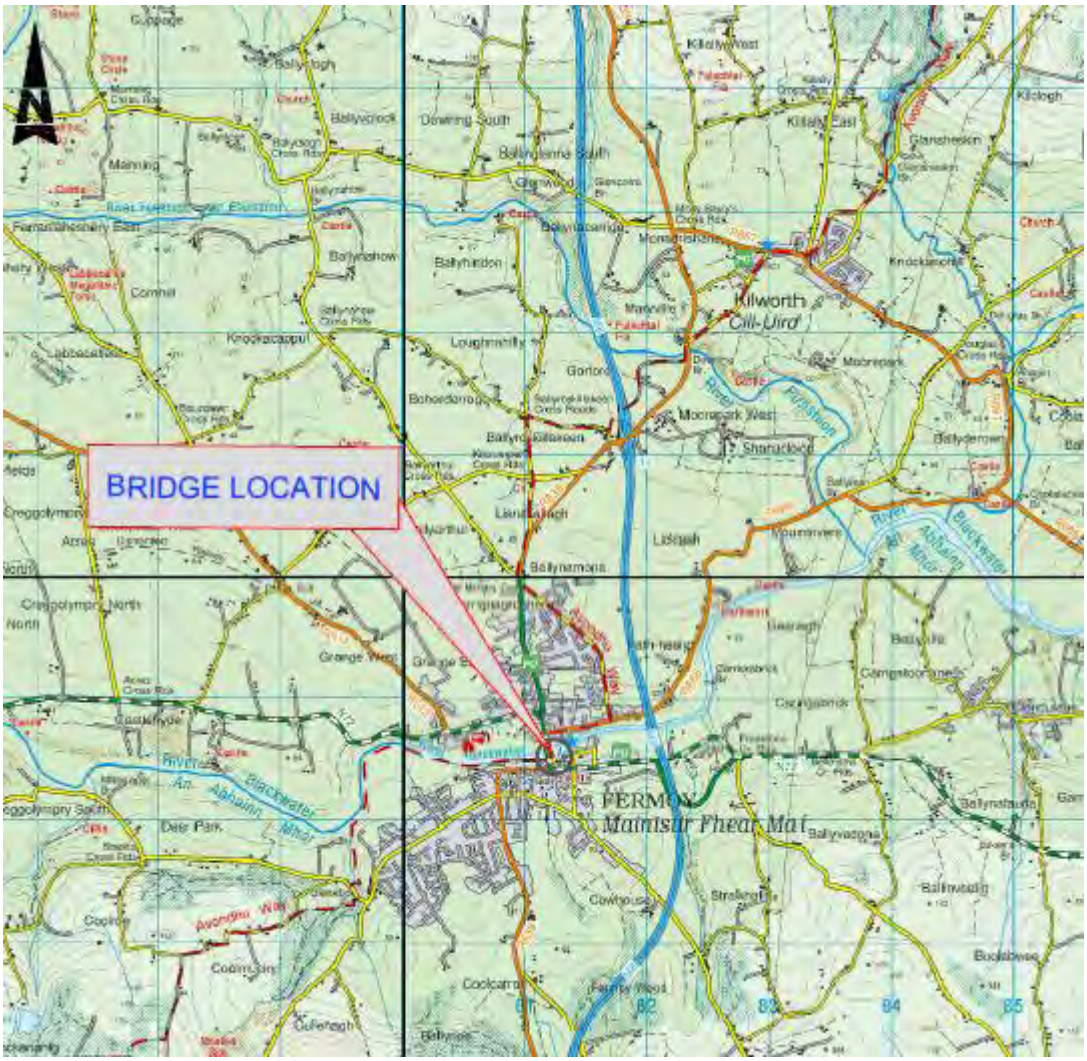


Figure 3-1: Bridge Location

3.2. Bridge Layout

Fermoy bridge is of masonry construction (dating from approximately 1864) and consists of a seven span arch structure with parapets. The 6 No. supporting piers and 2 No. abutments are also of masonry construction. The structure ID for the bridge is CC-N72-030.90.

A general arrangement plan showing the layout of the piers and abutments, as well as dimensions, is included in Appendix A.

3.3. Previous Inspections

3.3.1. Principal Inspections

Principal inspections were previously carried out on the structure in 2010, 2015 and 2020 with the associated Principal Inspection (PI) reports produced in June 2010, December 2015 and July 2020 respectively.

The 2010 report carried out an assessment on the capacity of the bridge and concluded that the structure was found to be capable of carrying 40 tonnes Assessment Live Loading (ALL).

The 2015 PI report concluded that the structure in general was in good condition throughout with minor water seepage noted on the piers. The report also concluded that the riverbed was in good condition and free from debris.

The 2020 PI report concluded that the structure was generally in good condition. Evidence of water staining and isolated sections of open joints were noted at the piers. The riverbed was noted to be in fair condition with good flow being maintained through the structure. The report also made reference to the existing weir running through span 6 (as per the span referencing in the report) which contained some damaged sections causing the flow to run in a less natural fashion.

3.3.2. Underwater Inspections

Previous underwater inspections were undertaken in 2010 and 2017.

TJOC requested a copy of the 2010 underwater inspection and scour assessment report from TII in August 2022. However, the 2010 report was not received at the time of writing this report. It is noted however that the 2017 underwater inspection report refers to the findings of the 2010 report, that was carried out in March 2010, and which found the structure to be in good condition. It also noted that the previous stage 1 scour assessment undertaken for the bridge in 2010 indicated that the structure was at a low risk to scour (priority rating of 5) and that a subsequent stage 2 scour assessment was not required to be undertaken as a result.

The final version of the 2017 underwater inspection and scour assessment report was completed in April 2018. The 2017 report concluded that the structure was in fair condition overall at the time of the inspection. Piers 1, 3, 4 and 6 (as per the pier referencing in the 2017 report) had localised areas of minor mortar loss. Two through-block fractures were also identified at pier 3. In addition, the report noted that “numerous core holes were evident at the base of the piers suggesting intrusive testing has previously been carried out to the structure”. Details of the intrusive testing undertaken (if any) is not known.

The report noted the channel bed to be in fair condition at the time of inspection. One area of localised scour was identified upstream of pier 3 which measured 2.8m x 3m x 0.4m (l x w x d).

The bed material was noted to consist mainly of 200 – 300mm dia. stone with gravel infill.

4. STAGE 1 SCOUR ASSESSMENT (BD97 FORM)

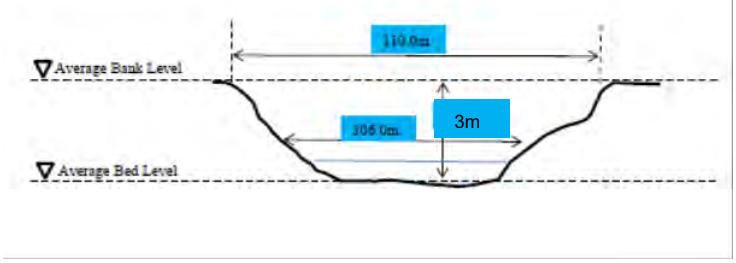
A Stage 1 scour assessment (BD97/12 form) was completed following a site visit undertaken on 16/08/22. The completed form is presented below.

Scour Inspection			
Structure Name and Number: CC-N72-030.90		OS Grid Ref:	ITM Easting: 581145 Northing: 598600
Detail of Inspection			
Inspected by:	T.J. O'Connor & Associates	Inspection date:	16/08/2022
Weather:	Dry	Flow Conditions:	Low ~ 95%ile
Details of Structure			
Record details of the following, identifying any estimated values			
Construction type:	Masonry Abutment and piers	Road over Structure:	N72
Foundation Type:	Unknown	Waterway under Structure:	River Blackwater
Construction date:	~ 1864		
Items to be included with this inspection (minimum)			
Photographs of the structure and the channel from upstream and downstream of the structure			Yes
Completed inspection form			Yes
Plan and drawings of structure			Yes
OS Plan of bridge and site			Yes

Notes	
Scour Inspection Structure name and number: CC-N72-030.90 Inspection Date: 16/08/2022	
General	
Answers must be accompanied by further details in notes section	
1) Is there a bend in the river immediately upstream or under the structure?	**No**
2) Does the river geometry agree with the OS plan?	**Yes ***
3) Are there any confluences within 1km of the structure?	**No***
4) Are there any islands or bars within the channel?	**Yes***
5) Are there any control structures in the vicinity of the structure? e.g. weirs, sluice gates	**Yes***
6) Are there evidence of ongoing scour at the bridge site (note approximate depths and locations of any scour holes)?	**Yes***
7) is there evidence of movement or settlement of the bridge structure?	**No**
8) is the structure fouled by debris or likely to become fouled in flood conditions? Action to remove fouling should be made in an urgent recommendation.	**Yes***
9) Are there signs of long-term bank stability ?	**Yes ***
10) Is there erosion at the outside of river bends? e.g. undermining of the river bank	**No***
11) Are there adjacent flood relief structures?	**Yes***
12) Is there evidence of previous flood levels?	**Yes***

Scour Inspection Form			
Structure name and number:	CC-N72-030.90	Inspection Date:	16/08/2022
Notes			
1) There is no bend directly upstream of the structure			
2) The river Geometry agrees with the OS Map but there has been a breach in the weir downstream of the structure leading to flows being funnelled between pier 5 and the south abutment in most flow conditions. The breach originally occurred in 2016 and deteriorated further in 2018. The OPW undertook emergency works in Oct 2020 to stabilise the river bank and river bed in the vicinity of the breach because of the potential to undermine the flood defence walls.			
3) There are no confluences in the vicinity of the structure. The proposed fish bypass channel will introduce a new flow direction in low flow conditions on the north bank approximately 30m upstream of the bridge.			
4) Gravels islands form in the river downstream of the weir. The location of these islands have changed since the breach in the weir originally occurred in 2016.			
5) A weir extends diagonally across the river passing through the bridge structure at pier 5. This weir is breached and all flows pass through the breach in low flow conditions. In higher flows the flows begins to spill over the remaining sections of the weir			
6) Localised scour pocket evident at the bridge on the south side of pier 4 (Depth 500mm approx). An accumulation of gravel at the upstream end of Pier 4 also had a localised depression (See photo and level survey).			
7) No movement or settlement was evident.			
8) River borne debris was evident at the upstream end of Pier 6 and also on the weir to the north of the salmon leap upstream of Piers 3 and 4. The upstream end of Pier 6 was inaccessible for the bed level survey due to the debris build up at the pier.			
9) The banks are stable with river walls on both sides of the river upstream of the bridge and with flood defence/quay walls and rock armour on the south bank downstream of the bridge. The north bank of the river downstream of the bridge is also stable. A flood embankment is set back from the north river bank with an average distance of 55m upstream of the bridge and 27m downstream of the bridge.			
10) No evidence of recent erosion on the riverbanks – OPW placed rock armour downstream of the weir at Mill Island in Oct 2020 due to significant bank erosion which occurred following the breach in the weir			
11) The Muster Blackwater Fermoy North and Fermoy South Flood Defence Scheme Structures extend upstream and downstream of the bridge comprising of flood embankments, flood walls and provisions for erection of demountable flood barriers			
12) Extensive flood records available from OPW river gauges located upstream and downstream of the bridge (www.waterlevel.ie)			

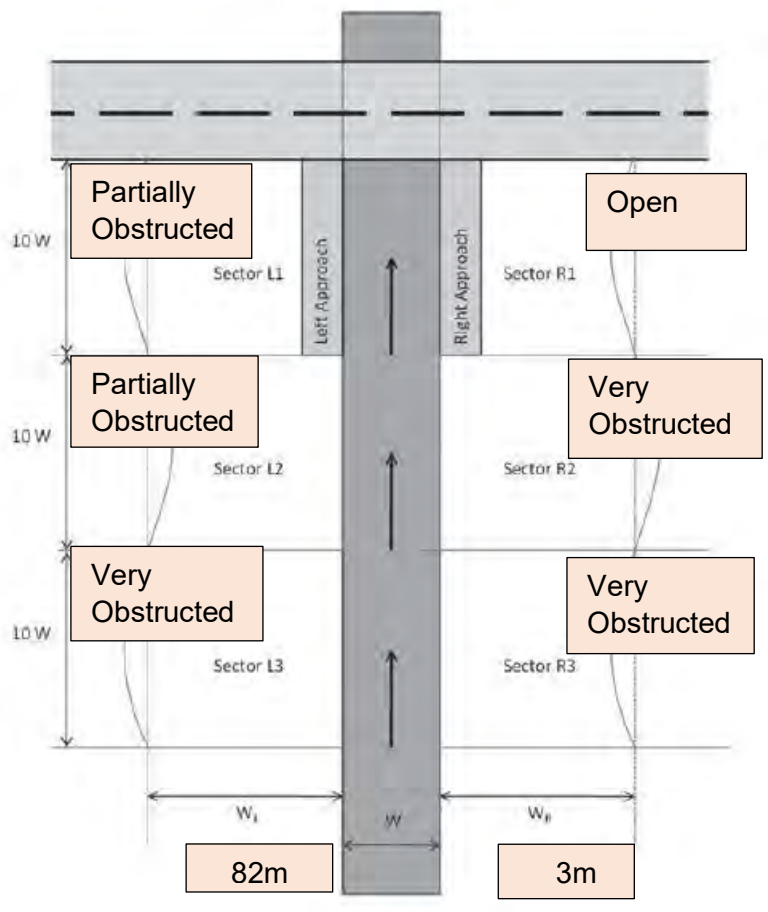
Scour Inspection Form			
Structure name and number:	CC-N72-030.90	Inspection Date:	16/08/2022
Geometry of the Structure			
Bank to Bank width of Channel			110.0m
Height of soffit (or arch crown) above average bed level			5.4
Average depth of channel (to average bank level)			3
Average width of channel			106m
Average bank height above water level during inspection			1.575m U/S of weir 3.0m D/S of weir
Average depth of water during inspection			
Max depth of water during inspection			1.24m
Sketch of structure including location of piers and abutments and approximate channel geometry			Refer to sketch in Appendix A



Pier width (if piers are not uniform, provide details of all)	2.3m
Pier length	15.5m
Pier Nose shape	Curved cutwater
Protrusion of abutments into channel (from bank)	2m on south bank
Angle of flow at Piers	0
Average bed material size	Arches 1 & 2 20-50mm; Arches 3 to 7 200-300mm or greater.

Scour Inspection Form			
Structure name and number:	CC-N72-030.90	Inspection Date:	16/08/2022
Geometry Upstream of the Structure			
Average width of Channel			55.0m
Average bank height above water level during inspection			1.575m
Width of left flood plain			82m
Width of right flood plain			3m to flood wall

Sketch of flood plain characteristics (indicate for each sector and approaches whether very obstructed, partly obstructed or open)



Scour Inspection Form			
Structure name and number:	CC-N72-030.90	Inspection Date:	16/08/2022
Notes			
No additional notes			

4.1. Site Inspection Photos

Photos were taking during the inspection carried out on the 16/08/22 and are included in Appendix B of this report. Bed levels were also recorded during this inspection and are summarised at Appendix C.

For clarity, it is noted that the pier numbers and abutments referenced in the photos relate to those as numbered / labelled in the general arrangement drawing included in Appendix A.

In the absence of definitive information on the depth of the foundations to the bridge structure, it is not possible to answer in the affirmative to the question relating to foundation depth in the Level 1 Decision Tree at Figure 3.2 of BD97/12. It is not known if the foundation depth is >3 times the max channel depth. Therefore, it is necessary to proceed to a Level 2 Scour Assessment.

5. STAGE 2 SCOUR ASSESSMENT

The primary purpose of the Level 2 Scour Assessment is to calculate the estimated scour depth corresponding to the Assessment Flow, and to compare this with the foundation level.

The existing available hydrology information was reviewed to undertake a Level 2 Scour Assessment. This was in accordance with Volume 3 Section 4 Part 21 BD 97/12 of the Design Manual for Roads and Bridges – The Assessment of Scour and Other Hydraulic Actions at Highway Structures, May 2012.

The Level 2 Scour Assessment is complimented by two detailed 2D hydraulic models built in Hec-RAS to assess the existing and proposed hydraulics in the vicinity of the Fermoy Bridge. This section summarises the findings of the assessment of the bridge within Fermoy. This assessment should be read in conjunction with the Flood Risk Assessment (FRA) report prepared by TJ O'Connor during April 2022.

A 2D HEC-RAS model was produced using the various survey information available dated from 2003 onwards and this was used to determine the water depth and velocity for the assessment process. The model was run with the 200yr plus climate change hydrograph.

There was limited foundation depth information available and, therefore, a foundation depth of 1m is assumed, based on the maximum depth of foundation exposed (alongside pier 4) relative to average bed level at the bridge on the date of survey. A sensitivity analysis was undertaken by assessing the elements between the existing and the proposed scenarios in order to reflect the effect of the development on existing conditions.

Scour calculations are reproduced at Appendix D of this report.

5.1. Assessment Limitations

Although BD 97/12 provides a robust framework in which to assess the risk of scour in structures, and to determine maintenance priorities, the analytical techniques it uses do have limitations.

For example, a key assumption is that an equilibrium in scour depth is reached at a constant extreme flood flow, which leads to very high theoretical scour depths. In reality, these scour depths will never be achieved as extreme flood flow will not remain at its peak long enough to achieve the full scour depth.

5.2. Data Gathering

A substantial amount of data has been collected in order to assess existing scour at the structure and the potential for future scour.

A walkover survey was undertaken during August 2022, as described within Section 4.

Asset Data available to TJOC was the Fermoy Bridge & Carrigabrick Viaduct, prepared by the Cork Country Council, Northern Division, dated August 1987 along with subsequent

Principal Inspection and Underwater Assessment reports, as referenced in Section 3.3 above.

5.3. Structure Description

The CC-N72-030.90 (Fermoy Bridge) is a masonry arch bridge constructed around 1864. The bridge has 6 (six) piers and 2 (two) abutments with a total clear span of 91.6m, soffit level of ranging between 26.7mAOD and 27.30mAOD. The left bank is partially/very obstructed by vegetation and the right bank is very obstructed due to the constructed masonry wall along the walkway.

5.4. Previous Analysis

No previous Level 2 Scour Assessment analysis was available for this structure. There are, however, existing hydraulic models for the site which are the OPW Flood Defence Design Model, 2003 to 2011, and the CFRAM Study Flood Model, 2016. The information within the hydraulic models has augmented the survey information gained onsite for this assessment.

5.5. Coring Information

No coring information was available for this structure.

5.6. Underwater Examination

The underwater examination report for the structure, dated 2017, indicated the channel bed to be in fair condition at the time of inspection. One area of localised scour was identified upstream of pier 3 which measured 2.8m x 3m x 0.4m (l x w x d). There was no evidence of this area of scour in the inspection completed in August 2022.

5.7. Hydraulic Model Build, Design Flood, Water Levels and Velocities

5.7.1. Hydraulic Model Build

The models were built from topographical surveyed cross sections which were collected during 2003, a detailed weir survey completed in 2018 and a river bed survey undertaken during 2020. A 5m grid size was used for optimum model run time and a more accurate representation of the channel and floodplain.

5.7.2. Design Flood

The inflow hydrology, for the 0.5%AEP return period, for the model was derived from records for the Fermoy Bridge D/S Gauge (node 18107). The Assessment Flood Q_F is taken to be 1171.41m^3/s. This corresponds to Q_{MED} of 387.37m^3/s for the Gauge with a growth factor of 2.52 plus 20% climate change allowance.

The OPW Flood Defence Scheme at Fermoy is designed for 1 In 100 return period flood plus Freeboard. The OPW design was based on a QMED of 287m^3/s and a Q100 of 843m^3/s. Applying a 20% increase for climate change produces a design flow which is lower than the Assessment Flow Q_F.

5.7.3. Water Level and Velocity

Water levels and velocity were extracted from the hydraulic model at the upstream of the Fermoy Bridge and also through the bridge to inform the Level 2 Scour Assessment. Figure 4.3 from the BD-97/12 illustrated the idealised floodplains to consider as seen within the Scour 1 Assessment Form within Section 4.

Table 5-1 below provide the associated depth and velocity from the Hec-Ras model to be utilised within the scour depth assessment.

Table 5-1 – Design Velocities

	Depth (m)	Velocity Upstream (m/s)	Velocity Downstream (m/s)	Velocity on weir (m/s)
Existing Scenario	7.2	2.01	2.09	1.8
Proposed Scenario	6.83	1.88	1.8	1.55

5.7.4. Depth of Scour

The depth of scour at a structure is the sum of the general scour (also known as constriction scour) and local scour (BD 97/12). The general scour at the bridge was estimated using water level and velocities at the upstream of the bridge and through the bridge.

Water levels and velocities at the upstream of the bridge and through the bridge were output from the detailed 2D hydraulic model and then compared to the results from the idealised outputs from Flood Modeller. The following section describes the techniques followed to calculate 'Constriction Scour' and 'Local Scour'.

Local scour has been calculated in the channel (constriction scour) as well as at the abutments. Based on the information gathered during the site investigation done during August 2022, the survey bed materials were observed to be gravels and sands. The typical grain size is tabulated within Table 5-2 below.

5.7.4.1 Constricted Scour

The average depth of constriction scour required calculation of the average velocity through the bridge opening dropping to a threshold value that would not result in further scour of the bed.

The constriction scour depth $D_{c,ave}$ as shown in Figure 3-2 (from BD-97/12) is measured as additional area ΔA.

$$\Delta A = \frac{Q_A}{v_{B,c}} - A_{By}$$

Where,

ΔA = The additional area of the flow consistent with the constriction scour

Q_A = Assessment flow

$v_{B,c}$ = the mean threshold velocity that would not cause further scouring (given in Figure 4.7 and Table 4.4 of BD 97/12)

A_{By} = Area of flow through the bridge opening without constriction scour based y_B in Figure 3-2 of BD 97/12, but not greater than the total area of the bridge.

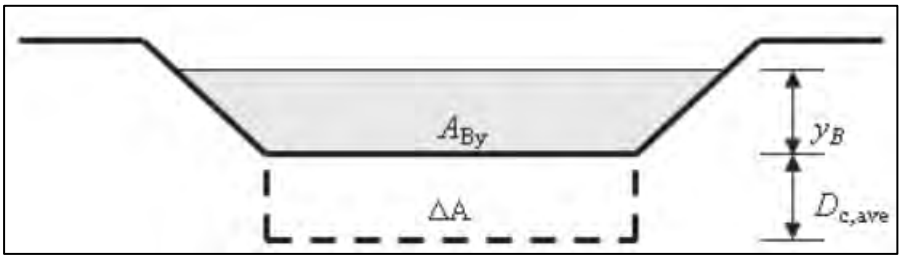


Figure 5-1: Parameters for calculating constricted scour (copied from BD 97/12)

Table 5-2 below provides the mean threshold velocity that would not cause further scouring.

Table 5-2 – Threshold Velocity for Bed Material

Arch (Refer to Annexure A)	Bed Material	$V_{B,c}$ at depth of 6.3m (m/s)
Arch 1-2	20-30mm	2.75
Arch 3-7	200-300mm	5.75

The mean threshold velocity (V_{bc}) was applied at a minimum of 2.75 m/s.

Based on the above and the actual velocity of v as indicated in Table 5-1, the velocities in the existing and the proposed scenarios are below the mean threshold, thus the average depth of constricted scour below the original bed level $D_{c,ave} = 0$.

The depth of constriction scour is taken as $D_c = F_S \times D_{c,\,ave}$

Since $D_{c,ave} = 0$, the depth of Constriction scour is also $D_c = 0$.

5.7.4.2 Local Scour

The depth of local scour adjacent to piers or abutments is determined with the following equation:

$$D_{l,pier} = 1.5\ x\ W_P\ x\ f_{PS}\ x\ f_{PA}\ x\ f_y$$

Where,

$Dl,pier =$ Depth of local scour at pier (m)

Wp = Width of pier (m)

f_{PS} = shape factor taken from Figure 4.9 of the BD 97/12 guidance

f_{PA} = is a factor depending on the angle of attack of the flow; and

f_y = the relative depth of the approach flow to the pier width

Since $D_c = 0$, $D_{l,pier} = 0$.

5.7.5. Scour Risk Rating

The scour risk rating is assessed from Figure 5-2, based on the 'Priority Factor' and the 'Relative Scour' depth. The graph shows five bands which define the risk rating (1 being the highest priority and 5 the lowest). The priority factor P_F is defined as:

$$P_F = F \times H \times M \times T_R \times V$$

Where,

F = Foundation type factor, (piled foundation or spread footing)

H = History of scour problem

M = The foundation material factor

T_R = Type of river factor (mountainous, upland, hilly or low or an estuary)

V = Importance factor (the greater the importance of the bridge and the greater the disruption caused by any interruption to its use, the higher the priority)

Relative Scour Depth

$$D_R = \frac{D_T}{D_F}$$

Where,

D_R = Relative scour depth

D_T = Total depth of scour

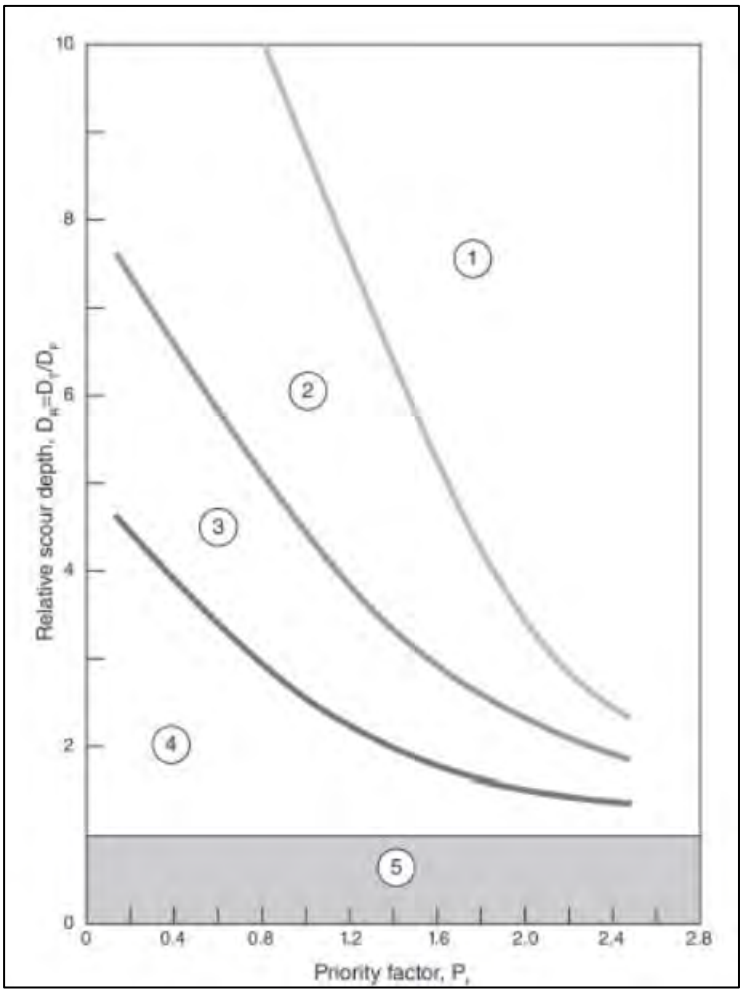


Figure 5-2: Scour risk rating (as per Figure 5.1 of BD 97/12).

Since the scour depth does not exceed the underside of the foundation for each pier and abutment (assumed as 1m from Table 3.1 within BD 97/12), the structure should be designated a Scour Risk Rating of 5.

6. CONCLUSIONS

Based on calculations from the BD 97/12 guidance and the hydraulic model outputs the calculated scour depths are as follows.

The estimated total scour depth is approximately 0m for the Fermoy Bridge in a 200 year assessment flow event Q_F of 1171.41m3/s.

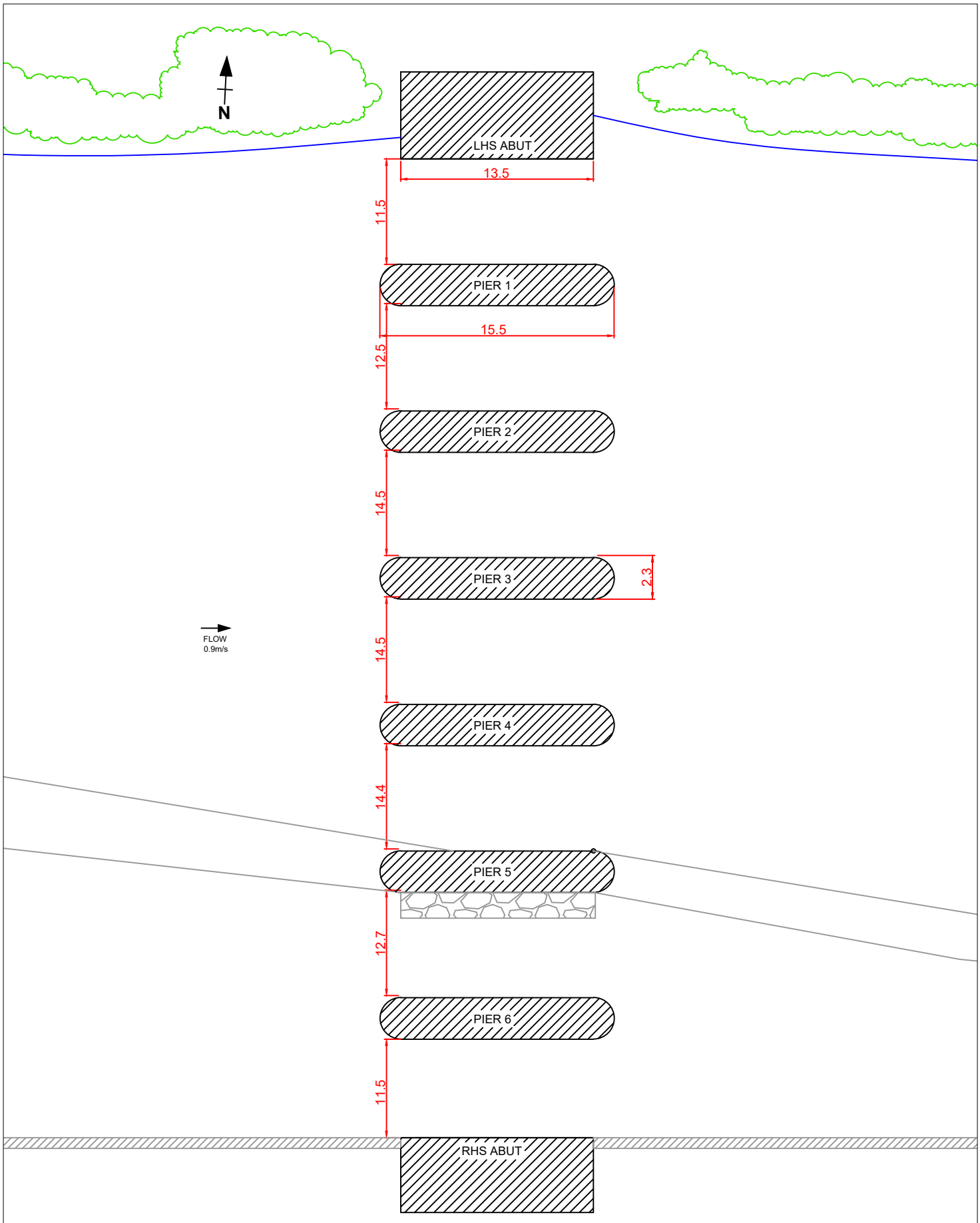
The depth of constriction scour is 0m for the same scenario.

For an assumed foundation depth of 1.0m (according to Table 3.1 from the BD 97/12) the bridge falls within a risk rating of 5. This means this is a low priority site in terms of scouring risk posed to the structure.

APPENDIX A

General Arrangement Drawing of Bridge

(Source Atkins 2017 Underwater Inspection Report)



GENERAL ARRANGEMENT PLAN
(Dimensions in 'm' - NTS)

APPENDIX B

Site Inspection Photos (16/08/22)

Photo 1 – Upstream Elevation

Photo 2 – Downstream Elevation

Photo 3 – LHS Abutment

Photo 4 – RHS Abutment

Photo 5 – LHS of Pier 1

Photo 6 – RHS of Pier 1 (facing upstream)

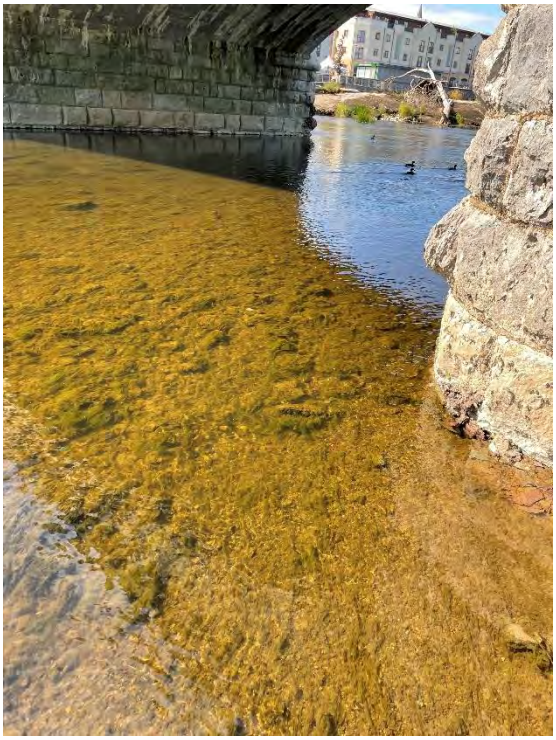


Photo 7 – Pier 2 (downstream end)

Photo 8 – LHS of Pier 3 (facing south)

Photo 9 – LHS of Pier 4 (upstream end)

Photo 10 – Gravel Deposition at upstream end of Pier 4

Photo 11 –LHS of Pier 5 (upstream end)

Photo 12 – RHS of Pier 5 (with weir)

Photo 13 – Pier 6 (upstream end)

Photo 14 – LHS of Pier 6 (facing upstream)

APPENDIX C

Site Survey Bed Levels (16/08/22)

	U/S C/L Pier	Up stream	Middle	Down stream	D/S C/L Pier	Comments
						Gauge 18107 WL =0.150m 11.00Hrs 16/08/2022 Datum 21.920 Poolbeg = 19.21 Malin WL = 19.36mOD Malin
North Abutment		19.56	19.23	19.175		
Arch 1						
Pier 1		19.095	19.205	19.165		
	18.94				19.105	
		18.91	18.75	19.16		
Arch 2		19.16		19.1		
Pier 2		19.07	19.295	19.38		Gravel alongside Pier 2 rises to 19.61midway between centre of pier and downstream end
	18.925				19.35	Exposed Gravel bank downstream of Pier 2 extends into downstream end of Arch 2
		19.025	19.07	19.155		
Arch 3		18.96		18.925		
Pier 3		19.13	18.99	19.09		
	19.15				19.1	
		18.905	19.005	19.16		
Arch 4		18.95		19.025		
Pier 4		19.23	19.115	18.99		
	19.09				19.145	Gravel Accumulation around upstream end of Pier 4 extending into Arch 4
		18.905	18.38	18.81		
Arch 5		19.02		18.97		Concrete slab extends over d/s right hand quadrant of riverbed
Pier5		19.35	19.3	19.36		Levels taken of riverbed alongside concrete plinth at base of pier
	21.02*				20.70*	Levels taken from previous survey af Weir
		19.625	19.8	*		Levels recorded at base of rock armour weir structure extending alongside Pier
Arch 6		19.615		19.575		
Pier 6		19.385	19.695	19.695		
	*				19.715	Debris Accumulation prevented access to u/s end of Pier 6
		*	19.81	19.67		
Arch 7		20.533		*		Downstream end inaccessible due to velocity of flow
South Abutment		20.275	*	*		Middle and downstream end inaccessible due to velocity of flow
						Gauge 18106 WL =-0.585m 12.30Hrs 16/08/2022 Datum 23.920 Poolbeg = 21.21 Malin WL = 20.625mOD Malin

APPENDIX D

Scour Assessment Calculations

Date: 09/09/2022.

Project Number: 19011 : Scour Assessment Page No. 1 of 5

Subject: Fermoy Weir (Cork)

Bridge Constructed ±1865.

SCOUR ASSESSMENT.

Level 1 → justify risk is tolerably low.
if adequate @ L1; then assessment is complete.

Level 2 calculations.

→ 1:200 year Q = 925m³/s (CFRAM's) ; does not include climate change.

→ Estimate upstream average depth + area of flow

→ River bed material
Arch 1-2 : 20-30 mm Ø
Arch 3-7 : 200-300 mm Ø
} cobbles with gravel infill.

1.) Default depths as per Table 3.1 of BD 97/12
D_{F_1} = 0.3m (no bend immediately upstream)
D_{F_2} = 1.0m

2) Calculate estimated scour depths to the Assessment Q (1:200 year)
↳ compare to foundation depth.

Tii Bridge Reports.

(2017 underwater inspection)

Findings 1.) local mortar loss in some piers.
2.) localised fractures to pier 2
3.) localised scour 2.8m x 2m x 0.4m deep upstream at pier 3

2020 report → no reference made.

CFRAM's 1:200 flow Q = 925m³/s (July 2016) from Fermoy Bridge Gauge (18107)
Chapter 12 → Future Scenarios
(High-end) $HEFS_{200}$ = 1235m³/s
(Mid-Range) $MRFS_{200}$ = 1139 m³/s
} Table E.1 (page 167, pdf page 313.)

OPW: Email dated 7 September 2022

Median of 20 years of data for Annual Max flow Q_{MED} = 387.37m³/s.
↳ information based on Station # : 18107
↳ dated 18 Feb 2022.

∴ use Q_{MED} = 387.37m³/s for assessment.

Subject: Fermoy Weir (Cork)

Ref: V3; S4; Part 21 BD 97/12.

RED INDICATE VALUES FROM HEC-RAS MODEL

Ref. Item.

LEVEL 2 SCOUR ASSESSMENT.

4.5 Annual Max flow $Q_{MED} = 387.37 m^3/s$.

4.7 Growth factor = 2.52

4.8 Climate Change = 1.2

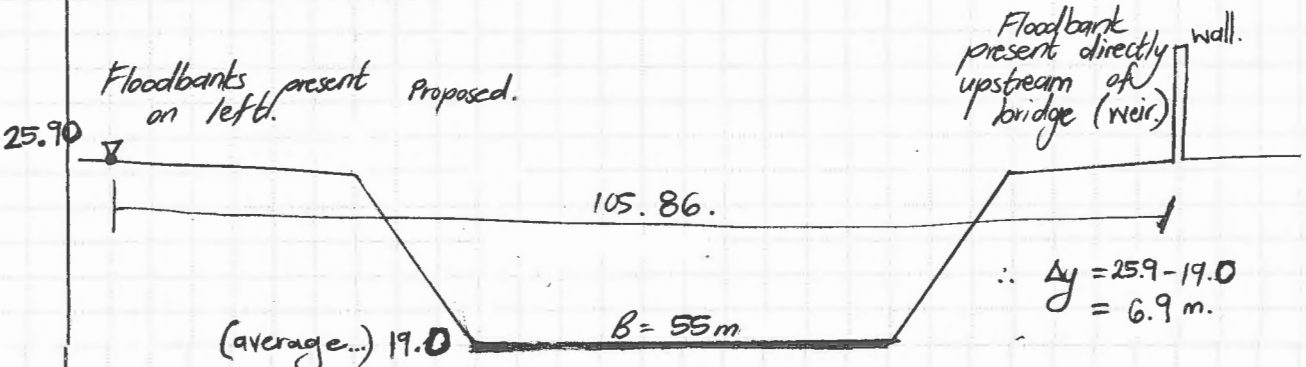
$\therefore Q_A = 1171.41 m^3/s$

4.9→4.15 N/A. No need to take into account for tidal rise (±55km from sea; Tidal applicable to Youghal)

CALC. OF FLOW DEPTH & $\bar{V}$ UPSTREAM OF BRIDGE SITE.

4.16 Hydraulic Analysis based on assessment flow & characteristics.
↳ HEC-RAS Model re-run with Q_A.

4.17 To be agreed with Tii (Technical Approval Authority)



4.18 Flood embankments

$y_u = 6.9 + 0.3m$

$y_u = 7.2 m.$

$\therefore V_u = \frac{Q_A}{B y_u} = \frac{1171.41}{105.86(7.2)}$

$V_u = 1.514 m/s.$

$B_{width} = 105.86m$

$B_{bottom} = 55m.$

$y_u = 6.83 m.$

$y_{existing} = 7.2 m.$

$\bar{V}_u = 1.88 m/s$

$\bar{V}_{u\,existing} = 2.01 m/s$

4.19 to 4.23 N/A due to flood embankments being present. N/A

4.24 $n = 0.04$ $n = 0.04$

4.25 to 4.27 N/A due to flood embankments being present.

Side note: (4.27) Floodplain factor $F_p = \frac{W_{eff,L} + W_{eff,R}}{B} = 0$ according to page 9 of flood plain characteristics.

Ref Item

CALC. OF DEPTH & V THROUGH BRIDGE

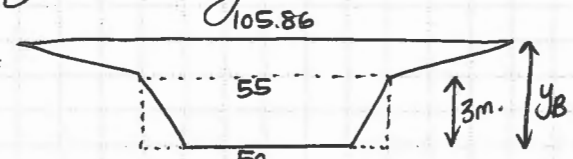
Depth $y_B = 6.83$m.

4.30

$$y_u + \frac{V_u^2}{2g} - y_B - \left(\frac{Q_A}{A_{By}}\right)^2 / 2g = 0 \quad \ldots\ (1) \times 2g.$$

$$2y_u g + V_u^2 - 2y_B g - \left(\frac{Q_A}{A_{By}}\right)^2 = 0 \quad \ldots\ (2)$$

INSERT: A_{By} (Function of y_B) =



$$A_{By} = \tfrac{1}{2}(a+b)h = \tfrac{1}{2}(55+50)(3) + \tfrac{1}{2}(105.86+55)(y_B - 3)$$

$$A_{By} = 157.5 + 80.43y_B - 241.29$$

$$= 80.43y_B - 83.79 \quad \ldots\ (3)$$

(3) into (2) → $2y_u g + V_u^2 - 2y_B g - \left(\frac{Q_A}{80.43y_B - 83.79}\right)^2 = 0$ (x equation with A_{By})

$$2y_u g(80.43y_B - 83.79)^2 + V_u^2(80.43y_B - 83.79)^2 - 2y_B g(80.43y_B - 83.79)^2 - Q_A^2 = 0$$

$$\therefore 2(7.2)(9.81)(6468.985y_B^2 - 13478.459y_B + 7020.764) + (1.54)^2(6468.985y_B^2 - 13478.459y_B + 7020.764)$$

$$- 2(y_B)(9.81)(6468.985y_B^2 - 13478.459y_B + 7020.764) - 1171.43^2 = 0.$$

$$\therefore 991781.206 - 1904027.032y_B + 913834.697y_B^2 + 16650.444 - 31965.513y_B + 15341.845y_B^2 - 137747.39y_B + 264447.366y_B^2 - 126921.486y_B^3 - 1171.43^2 = 0.$$

$$\therefore 126921.486y_B^3 - 1193623.908y_B^2 + 2073733.985y_B - 880633.038 = 0. \quad \times(-1).$$

$$\therefore y_{B1,2} = 0.9151 \pm 1.28023i \quad \text{N/A.} \qquad y_{B3} = 7.574\text{ m} \rightarrow$$

4.32(i)

$$S_c = n^2\left(\frac{B_B^2 g^{10}}{Q_A^2}\right)^{1/9}$$

$$S_c = (0.04)^2\left(\frac{91.6^2(9.81)^{10}}{1171.43^2}\right)^{1/9}$$

$$S_c = 0.0115\ \text{m/m}$$

$S_c = 0.115$ m/m.

(4.23) Estimated Slope ≈ 0.01 m/m.

4.32 (ii) $\therefore 0.9S_c = 0.01$ m/m

$\therefore S \approx 0.9S_c$

4.32 (iii)

$$y_c = \left(\frac{Q_A^2}{B_B^2 g}\right)^{1/3} = \left(\frac{1171.43^2}{91.6^2(9.81)}\right)^{1/3} = 2.555\text{m}.$$

$\therefore y_B > y_c$ $\therefore$ supercritical flow through bridge.

4.33

$$A_{By} = 80.43(7.574) - 83.79 = 525.389\ \text{m}^2$$

4.33) $A_{By} = \tfrac{1}{2}(55+105.86)(6.83-3) + \tfrac{1}{2}(55+50)(3)$

$A_{By} = 465.547\ \text{m}^2$.

Ref item. 4.33 $V_B = \frac{Q_A}{A_{By}} = \frac{1171.43}{525.389} = 2.23\ m/s.$ $V_B = \frac{1171.43}{465.547} = 2.52 m/s.$

MAX DEPTH OF WATER UPSTREAM FACE OF STRUCTURE

Soffit level = range of 26.7mAOD & 27.3mAOD.

$\therefore y_4 < Z$

4.34(ii) $y_B + \frac{V_b^2}{2g} = 7.574 + \frac{2.23^2}{2(9.81)} = 7.827m$ of water level.

$\therefore y_B + \frac{V_b^2}{2g} < Z.$ $(Z = 8.3m)$ $(27.3 - 19.0)$

4.35 N/A.

CALC. OF SCOUR DEPTH. : CONSTRICTION

4.41. $V_{B,c}$ based on Figure 4.7.
Arch 1-2 : 20-30mm ϕ
Arch 3-7 : 200-300 mm ϕ

Depth of 7.574 m (4.30) : 1.) $V_{B,c_{2S}} = 3.00\ m/s.$ 1.) $V_{Bc_{2S}} = 2.75 m/s$

2.) $V_{B,c_{250}} = 6.00\ m/s.$ 2.) $V_{B250} = 5.75 m/s$

BOTH $> V_B$.

4.39 $\therefore \Delta A_{2S} = \frac{Q_A}{V_{Bc_{2S}}} - A_{By}.$ $\Delta A_{250} = \frac{Q_A}{V_{Bc_{250}}} - A_{By}$

$\Delta A_{2S} = \frac{1171.43}{3.00} - 525.389$ $\Delta A_{250} = \frac{1171.43}{6.00} - 525.389$

$\Delta A_{2S} = 0\ m^2$ $\Delta A_{250} = 0\ m^2$

4.43 $\therefore D_{c_{2S}} = 0\ m.$ $\therefore D_{c_{250}} = 0m$

$\therefore D_{c_{2S}} = 0$

$D_{c_{250}} = 0$

CALC. OF DEPTH OF LOCAL SCOUR.

4.47. $D_{L,pier} = 1.5 W_p f_{ps} f_{\alpha A} f_y$

(4.48) $f_{ps} = 1.0$ (figure 4.9)

(4.49) $f_{\rho A} = \left(\cos\alpha + \frac{L}{W_p}\sin\alpha\right)^{0.65}$

4.50(i) pier width = 2.3m.

$y_{sp} = y_B + D_c$

$y_{sp} = 4.662 + 3.65$

$y_{sp} = 8.312$ (constricted scour)

$\therefore \frac{8.312}{2.3} = 3.614$ $\therefore f_y = 1.0$

& $\alpha = 0°$

$\therefore f_{\rho A} = 1.0$

Date: 09/09/2022

Project Number: 19011 : Scour Assessment Page No. 5. of 5.

Subject: Fermoy Weir (Cork.)

Ref item	
4.47.	$\therefore D_{pier} = 0$ due to $D_{c25} \& D_{c250} = 0$.

COMPARISON OF SCOUR DEPTH WITH FOUNDATION DEPTH.

4.54. $D_R = \frac{D_I}{D_F}$ $D_I = 0$

$D_F = 1$

$\therefore \underline{D_R = 0} \rightarrow$

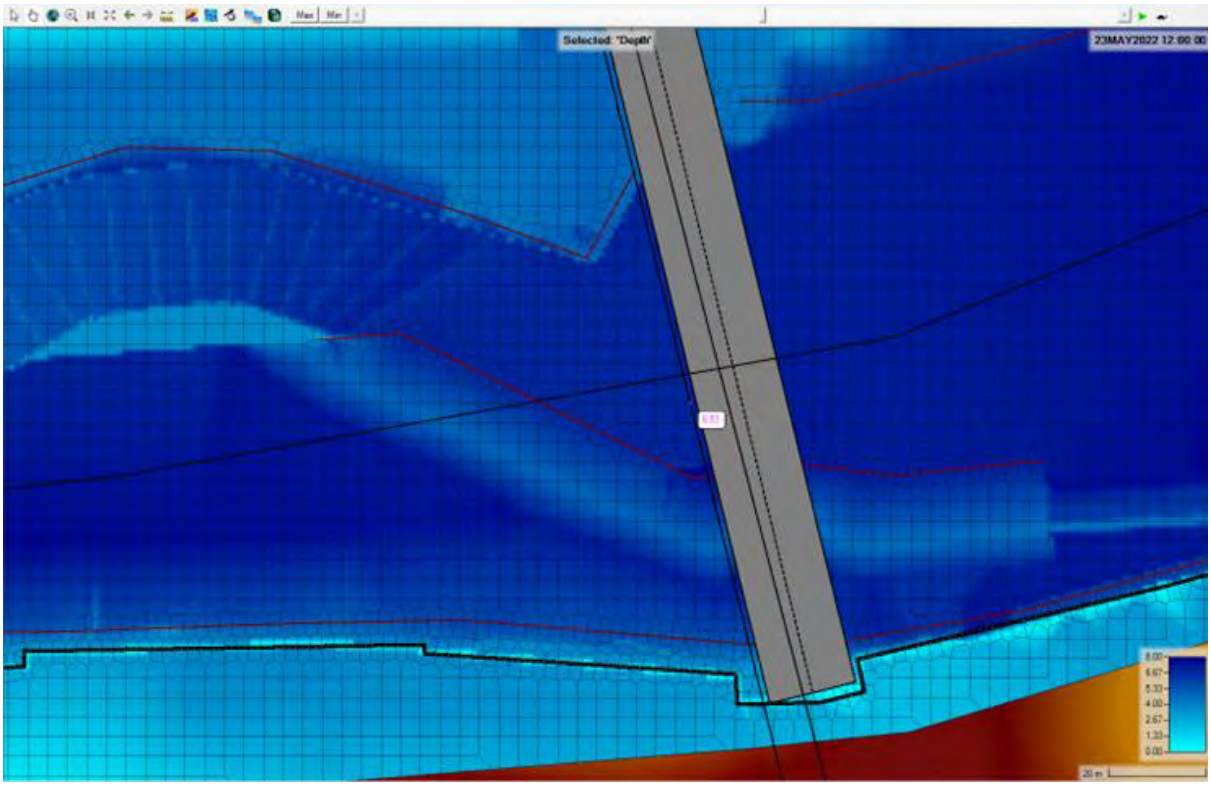
SCOUR RATING.

5.9 $P_F = F.H.M.T_R.V$

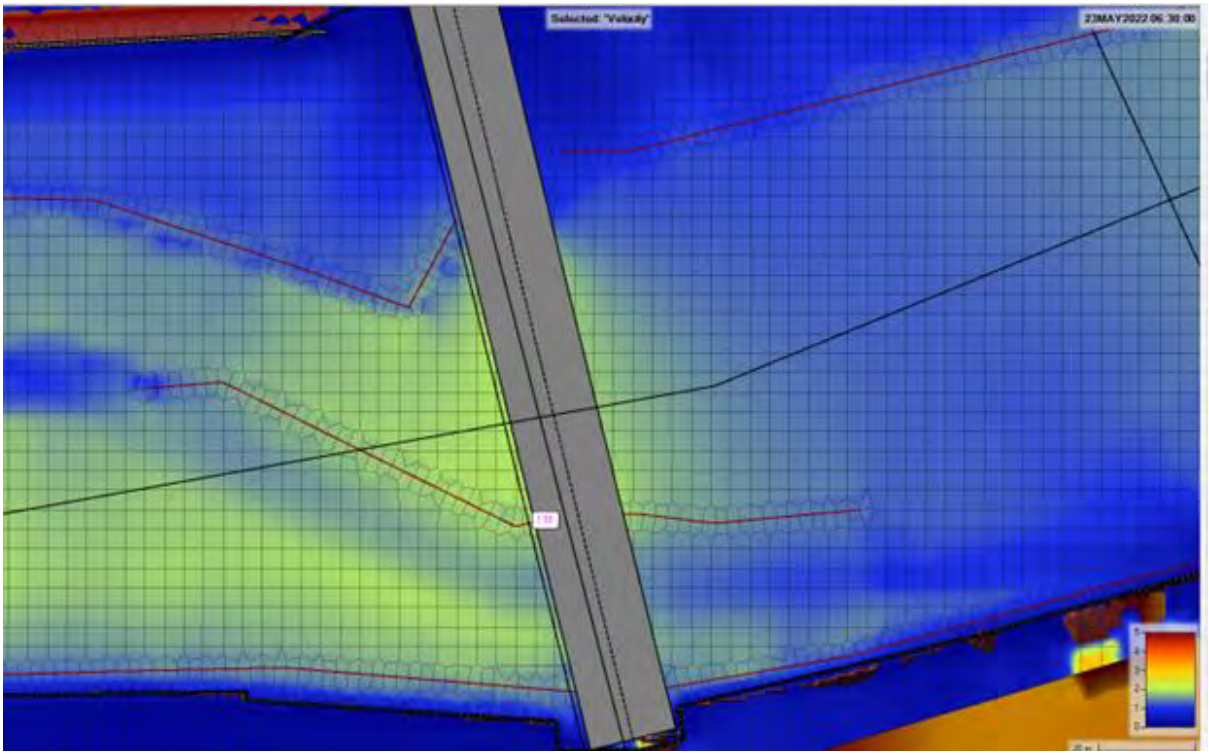
5.8. $D_R = 0$ $\therefore$ less than underside of foundation.

$\therefore$ Structure designated Scour Rating (Risk) of 5.

X end X



HecRas output - Depth in Channel at Fermoy Bridge for Assessment Flow of 1171.41m^3/s



HecRas Output – Velocity in Channel at Fermoy Bridge for Assessment Flow of 1171.41m^3/s

APPENDIX B

Correspondence with Tii

Diarmuid Cahalane

From: Diarmuid Cahalane
Sent: 09 November 2022 17:10
To: LandUsePlanning@tii.ie
Cc: Keir Wilson; Cormac Manning; Michael Vaughan
Subject: RE: ABP-313763-22 Fermoy Weir - Tii Submission
Attachments: 19011-TJOC-PL-XX-DR-C-0053_FISH_PASS_PLAN.pdf; 19011-TJOC-PL-XX-PD-C-7106 _Outline_Construction_Management_Plan.pdf; 19011-TJOC-ZZ-XX-RP-C-3713 _Scour_Assesment_Report.pdf; MSL27232_Fermoy Weir_V0.pdf; Fermoy Weir - Tii Submission

Tracking:

Recipient	Read
LandUsePlanning@tii.ie	
Keir Wilson	
Cormac Manning	
Michael Vaughan	Read: 09/11/2022 17:13

Dear Sir/Madam

We refer to Tii's submission of the 5th July 2022 to An Bord Pleanála in respect of Cork Co Co's application for permission for the proposed Fermoy Weir Remedial works and Fish Bypass on the River Blackwater (Case Number: ABP-313763-22).

We set out below our proposed response to the matters raised in Tii's original submission of the 5th July 2022 to An Bord Pleanála, followed by responses to the two further concerns raised by Tii in an email from Keir Wilson of Tii dated 17th October last.

Observation	Response
Tii Submission dated 5th July 2022	
The designer will be required to arrange for a structural investigations company to undertake structural investigations at the structure to evaluate the foundation level.	Based on the Scour assessment (19011-TJOC-ZZ-XX-RP-C-3713_Scour_Assesment_Report appended herewith), as completed in response to Item 2 below, the Bridge is assessed as Priority Rating 5 in respect of which no action is recommended in BD97/12. Therefore, in this case, there is no compelling requirement for the applicant to undertake structural investigations of the bridge pier and abutment foundations to evaluate the foundation level. Tii have confirmed by email dated 17th October 2022 that the scour assessment produced by T.J. O'Connor and Associates Consulting Engineers has followed BD 97 correctly and that the outcome can give Tii peace of mind that the completed works will not have a great effect on the bridge.
The implications for the bridge of a new embankment and fish passage adjacent to the structure needs to be investigated, to identify the future hydraulic effects of changing riverbed levels and river flows at the bridge substructure. The designer is advised to refer and implement UK Standard BD 97/12 "The assessment of scour and other hydraulic actions at bridges", and other relevant	There is no new embankment proposed for this development. The existing and proposed scenarios have been assessed in accordance with the level one and level two assessment procedures as set out in BD 97/12 "The assessment of scour and other hydraulic actions at bridges". The assessment (see 19011-TJOC-ZZ-XX-RP-C-3713_Scour_Assesment_Report appended herewith) concludes that the velocities at the bridge in the design event (1 in 200year plus climate change allowance) does not exceed the threshold velocity for bed erosion based on the material observed to be present in the river bed at the bridge. The Level Two assessment concludes that the bridge has a Priority Risk Rating of 5 and no further action is recommended. See

standards to identify how the proposals will affect the bridge structure.	reference to Tii response to the receipt of the scour assessment report under Item 1 above.
The designer shall investigate alternative mitigation treatments such as piling or underpinning the bridge, to secure it against the effects of scour, which the works are likely to cause. The effects of changing river flows and changing riverbed levels proposed by the works shall be modelled and calculated to ensure that mitigating bridge works are sufficient to prevent future bridge damage to scour.	The Level Two scour assessment concludes that the Priority Risk Rating for the bridge is 5 and no further action is recommended other than routine inspections, there is no requirement for mitigation treatment to secure the bridge against the effects of scour. Any potential temporary works upstream of the bridge required for the construction of the proposed development will be submerged in a flood event resulting in flows passing through the entire bridge structure. Therefore, the conclusions of the scour assessment are valid for the temporary works scenario as well as for the post construction operational scenario. We will keep Tii informed during detailed design development and contractor's construction method statements in order to ensure that these are subject to Tii agreement and approvals.
TII advise that these treatments would involve significant works to the Fermoy Bridge and a geotechnical investigation of the substrata beneath the bridge would be required in order to design the piling or underpinning solution.	Based on the Priority Risk Rating as determined by the Level Two Scour Assessment, completed in accordance with BD97/12, there is no recommendation for action other than routine inspections. However, prior to procurement and construction of the development, a detailed site investigation will be commissioned to inform the detailed design of the works. The scope and extent of this site investigation will be informed by historic site investigation data previously gathered in the area for the Fermoy North and Fermoy South Flood Defence Scheme contracts.
Tii email to TJO'C dated 17th October 2022	
Tii responded to receipt of the Scour Assessment Report in an email dated 17th October 2022 (copy attached herewith). This response raised two additional concerns as follows	
The intention to dredge the river upstream of Span 3 and 4 (1 being north, 7 being south), this would have an effect on the piers, with the potential to cause scour and undermine the piers given we don't know the as built details. There is no scour protection or other such measure proposed to mitigate this risk and nothing is proposed, I would like to see further consideration given to this. There was an area of scour (2.8m L x 2.0m W x 0.4m D) picked up at pier 3 in the 2017 underwater inspection. Dredging will exacerbate this, consideration should be given to remediating this. Since 2017 further scour could have occurred this should also be considered and remediated where necessary.	The proposal to dredge the riverbed upstream of the bridge is intended to provide a resting pool for fish prior to entry to the fish bypass channel. The extent of the resting pool has been reduced to ensure that there is no reduction in riverbed levels within 10m of the upstream face of the bridge piers and arches. The extent of the reduced resting pool is shown on revised Proposed Fish Bypass Plan Drawing 19011-TJOC-XX-XX-DR-C-0053 rev C02. A detail has been added to this drawing showing the transition slopes from existing bed level to the reduced bed level. It should be noted that a survey of the weir undertaken in 2018 by Murphy Surveys Ltd (Drg MSL27232_Fermoy Weir_V0 included with the Planning application and attached herewith) showed an existing pool in the river bed downstream of the weir in the area of the proposed resting pool. The lowest bed level identified in the survey was 17.55mOD Malin, which is lower than the bed level now proposed for the resting pool of 18.5mOD. The area of scour identified at Pier 3 in the 2017 underwater investigation was no longer present during the survey undertaken for the Scour assessment report in August 2022. Any localised depressions in the riverbed identified at the bridge piers during the course of the construction works will be infilled with natural riverbed material, in accordance with a method statement to be approved by Tii, IFI and NPWS prior to the commencement

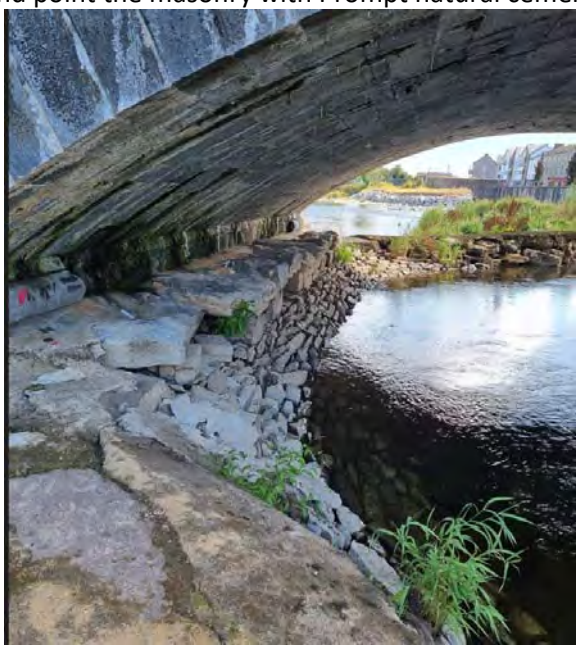
	of these works, and in accordance with the mitigation measures identified in the Construction Stage Environmental Management Plan.
The construction of the embankment itself. There are a few issues here, the removal of the existing embankment and weir, this is directly adjacent to pier 5 and could cause damage during removal. The excavation required to construct the embankment is likely to affect pier 5. There are no details about how deep the excavation is or a cross section showing the intention in and around the pier. Given we don't know the as built details of the bridge this work could cause an issue at this pier in the temporary phase. The other problem is again the lack of details around the pier, how will the embankment be constructed, what effect will that have on the pier, will it be tied into the pier at all?	It is not proposed to remove the existing embankment which forms the weir structure upstream and immediately downstream of the bridge and which wraps around pier No 5 of Kent Bridge. The methodology for refurbishment is based on conservation of the protected structure, with minimal interventions into the structure. It is described in the Conservation Engineer's report at Appendix B of the Engineering Technical Report which was included with the Planning Submission. Where the weir structure envelopes Pier No 5 of the Bridge As per Figure 1 below, it is proposed to remove concrete screed from the surface of the weir, replace missing stones, grout inject and point the masonry with Prompt natural cement.  **Figure 1. Upstream face of Weir alongside south side of Pier 5** On the downstream face of the weir structure at Pier 5, the weir does not extend alongside the north side of the pier (See Figure 2 below). The existing concrete screed will be removed from the top of the weir at either end of the pier, the cobbles and stone reinstated to create a uniform surface profile and joints will be pointed with prompt natural cement. The rock armour filled trench proposed for the toe of the embankment will be reduced in depth as it approaches the vicinity of the bridge pier.

Figure 2 Downstream face of weir at north side of Pier 5

In addition to the methodology described in the Conservation Engineer's report, Section 4 of the Outline Construction Management Plan (copy attached herewith), as included with the planning submission, describes the works proposals and the sequence of construction. Detailed construction method statements will be developed and submitted to Tii for agreement prior to commencement of construction of works in this area.

As advised to Keir Wilson in previous correspondence, we will engage with Tii during detailed design (including in respect of any site investigation and bathymetric surveys) prior to finalising the contract documents for the procurement stage. The Employer's Requirements which will be included with the Contract Documents will require that the Contractor undertaking the works obtain prior approval from Tii for any method statements relating to works with the potential to impact on assets managed by Tii.

We acknowledge Keir Wilson's previous comment that Tii might still require a TAR in accordance with 'Technical Approval of Road Structures on Motorways and Other National Roads for structures' DN-STR-03001. We understand that Technical Acceptance is required for the assessment, alteration, modification, strengthening and repair of all road structures.

Please advise if these responses are to your satisfaction.

Regards

Diarmuid Cahalane

Technical Director

+353 (0)86 8303879

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS

Dublin Office
Corrig House, Corrig Road,
Sandyford, Dublin 18,
Tel: +353 1 2952321
Fax: +353 1 2954541
Email: tjoc@tjoc.ie

Diarmuid Cahalane

From: Keir Wilson <kwilson@midwestroads.ie>
Sent: 17 October 2022 16:31
To: Diarmuid Cahalane
Cc: Liam Duffy; Cormac Manning; Joan Dineen (Joan.Dineen@CorkCoCo.ie); Kevin Morey; Michael Vaughan; Ed Fitzgerald
Subject: Fermoy Weir - Tii Submission

Diarmuid,

On review of the scour assessment produced by TJ O'Connor and Associates Consulting Engineers I am satisfied that you have followed BD 97 correctly and that the outcome can give us peace of mind that the completed works will not have a great effect on the bridge. This also mirrors the outcome of the 2010 scour assessment report so I believe we can be confident of the findings of the current assessment.

However I do still have two concerns.

1) The intention to dredge the river upstream of Span 3 and 4 (1 being north, 7 being south), this would have an effect on the piers, with the potential to cause scour and undermine the piers given we don't know the as built details. There is no scour protection or other such measure proposed to mitigate this risk and nothing is proposed, I would like to see further consideration given to this. There was an area of scour (2.8m L x 2.0m W x 0.4m D) picked up at pier 3 in the 2017 underwater inspection. Dredging will exacerbate this, consideration should be given to remediating this. Since 2017 further scour could have occurred this should also be considered and remediated where necessary.
2) The construction of the embankment itself. There are a few issues here, the removal of the existing embankment and weir, this is directly adjacent to pier 5 and could cause damage during removal. The excavation required to construct the embankment is likely to affect pier 5. There are no details about how deep the excavation is or a cross section showing the intention in and around the pier. Given we don't know the as built details of the bridge this work could cause an issue at this pier in the temporary phase. The other problem is again the lack of details around the pier, how will the embankment be constructed, what effect will that have on the pier, will it be tied into the pier at all?

And just to make you are aware we are to be consulted at every stage and kept up to date with any changes and further designs.

We might still require a TAR in accordance with 'Technical Approval of Road Structures on Motorways and Other National Roads for structures' DN-STR-03001. Technical Acceptance is required for the assessment, alteration, modification, strengthening and repair of all road structures.

Keir Wilson CEng MICE
Senior Executive Engineer – Bridge Management

Mid West National Road Design Office,
Lissanalta House, Dooradoyle.
Tel: 087 743 3621
Email: kwilson@midwestroads.ie

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Diarmuid Cahalane
Technical Director
T.J.O'Connor & Associates
Corrig House,
Corrig Road,
Sandyford, Dublin 18.
Email: dcahalane@tjoc.ie

Dáta | Date	Ár dTag | Our Ref.	Bhur dTag | Your Ref.
15/11/2022	TII22-119006	ABP Ref P04.313763

Re.: Proposed Fermoy Weir remedial works and fish bypass on the River Blackwater.

Dear Mr Calahane,

Transport Infrastructure Ireland (TII) has received referral of the material related to the above Local Authority development on the 9th of November 2022 by email. The documentation submitted includes document references :

1. Contents of the email issued by D. Calahane to TII on the 9th of November 2022.
2. 19011-TJOC-PL-XX-PD-C-7106_Outline_Construction_Management_Plan.pdf.
3. 19011-TJOC-PL-XX-DR-C-0053_FISH_PASS_PLAN .
4. 19011-TJOC-ZZ-XX-RP-C-3713_Scour_Assesment_Report.pdf.
5. MSL27232_Fermoy Weir_V0.
6. Email Fermoy Weir – TII Submission (17/10/2022) from Keir Wilson Senior Executive Engineer – Bridge Management, Mid West National Road Design Office.

For clarity, these documents have been attached to the email issued with this TII correspondence.

TII has reviewed this documentation and advises that it is satisfied with Cork Co Co's Designer's response to the queries outlined in the submission made to An Bord Pleanála dated 5th of July 2022 subject to the following requirements:

- Development shall be undertaken strictly in accordance with the plans and details submitted by the email of the 9th of November 2022 (including the contents of the email) and should be submitted in full to An Bord Pleanála with this correspondence.

- Development shall be undertaken in accordance with the requirements of TII Publications. Prior to commencement of development, plans and details of works on, or in the vicinity of the national road network as required under TII Publications shall be submitted for the written agreement of the planning authority in consultation with TII.

  The designer is reminded that TII Publications DN-STR-03001 - Technical Approval of Road Structures on Motorways and Other National Roads for structures specifies the procedures to be followed in order to obtain Technical Acceptance for structures on motorway and other national road schemes and for the submission of as built records. The procedures cover the design of all road structures, including bridges, tunnels, subways, culverts, buried corrugated steel structures, retaining walls, reinforced earth structures, gantries, environmental noise barriers and temporary structures under or over motorways or other roads carrying public traffic.

The Technical Acceptance requirements for the assessment, alteration, modification, strengthening and repair of all road structures shall be agreed with the Structures Engineering & Asset Management Section of TII prior to the commencement of development.

- Prior to commencement of development, the Final Construction Management Plan (CMP) shall be submitted for the written agreement of the planning authority subject to the written agreement of TII. The CMP will reflect mitigation and monitoring for the national road network.

The Authority trusts that the foregoing proves of assistance to the Applicant and in due course An Bod Pleanála

Yours sincerely,

Tara Spain
Head of Landuse Planning

Cc
Cormac Manning,
Coastal Management and Flood Projects Department Cork County Council, Floor 10, County Hall Co. Cork

APPENDIX C

Revised Planning Drawings

19011-TJOC-XX-XX-DR-C-0053 Rev C02	Proposed Fish Bypass Plan
19011-TJOC-PL-XX-DR-C-0054 Rev C02	Proposed Fish Bypass Longitudinal Section
19011-TJOC-XX-XX-DR-C-0060 Rev C02	Weir Remediation Plan of Proposed Weir

FERMOY NORTH FLOOD DEFENCE EMBANKMENT

CONCRETE AND STONE CLADDING

LANDSCAPED 1:4 SLOPE

LANDSCAPED 1:2 SLOPE

PERTURBATION BOULDERS, RANDOM PLACEMENT

FISH POOLS CREATED BY VARYING LEVEL OF ROCK WEIR WALLS

FERMOY

(Town Council)

FERMOY BRIDGE

THERE SHALL BE A CLEAR DISTANCE OF 10m MINIMUM FROM THE UPSTREAM FACE OF THE BRIDGE TO THE EXCAVATION FOR THE RESTING POOL

Fermoy Bridge

BED OF RIVER TO BE DREDGED TO MINIMUM BED LEVEL OF 18.50 AT BASE OF 1:10 SLOPE FROM EXISTING RIVER BED, AND 19.10 AT OUTLET FROM FISH BYPASS

BM 25.87

MAXIMUM SIDE SLOPES TO DREDGED AREA FOR RESTING POOL SHALL BE 1:10

Weir

Salmon Leap

ASHE QUAY

Toilets

Hotel

FERMOY SOUTH FLOOD DEFENCE WALLS

BARNANE WALK

Boat Club

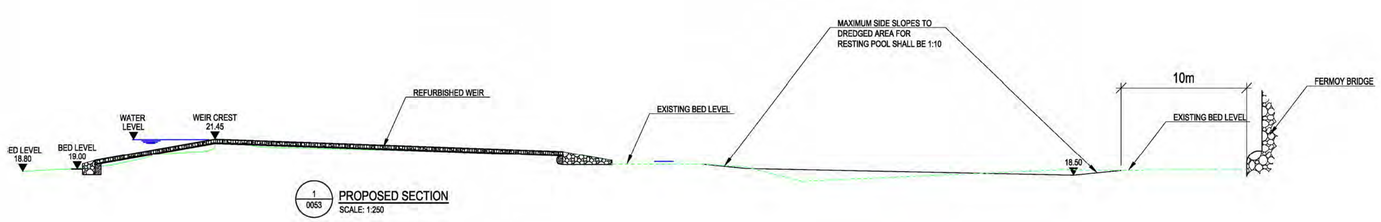
Town Council Bdy

UND

CF

10kV

0 5 10 15 20 30 40 50m
1:500



1/0053 PROPOSED SECTION
SCALE: 1:250

NOTES:

1. REFER TO DRAWINGS 0054 AND 0055 FOR SECTION DETAILS OF PROPOSED FISH BYPASS CHANNEL.
2. ALL LEVELS SHOWN RELATE TO ORDNANCE DATUM MALIN HEAD.

LEGEND:

EXISTING RIVER BED LEVELS 19.02

PROPOSED LEVELS 19.02

EXISTING TREES

EXISTING TREES TO BE REMOVED

PROPOSED PLANTING

REV	STAT	DESCRIPTION	DATE
C02	AP	PLANNING SUBMISSION RESPONSE	.....
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: PROPOSED FISH BYPASS PLAN

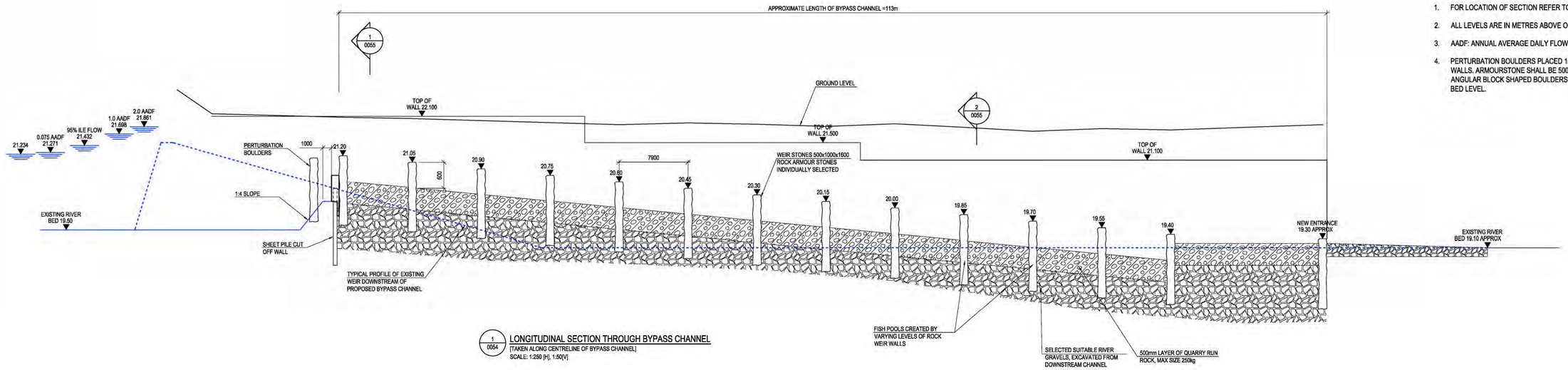
SCALE: 1:500 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER
19011-TJOC-XX-XX-DR-C-0053

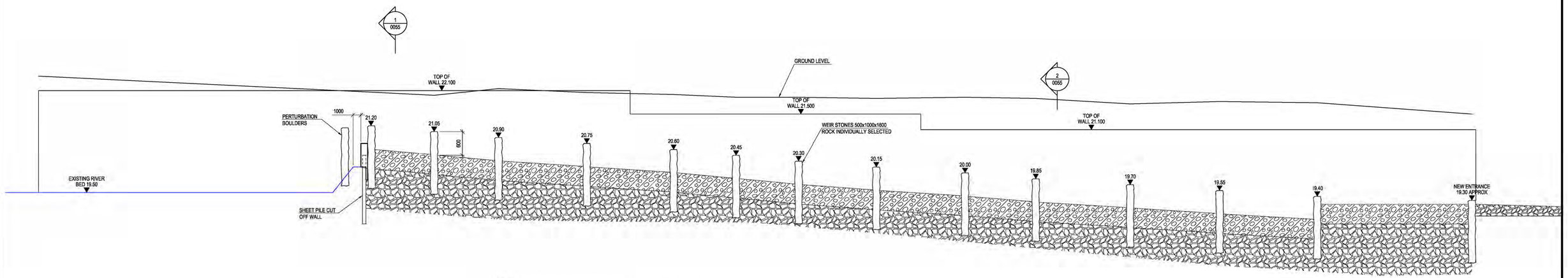
REV: C02

NOTES:

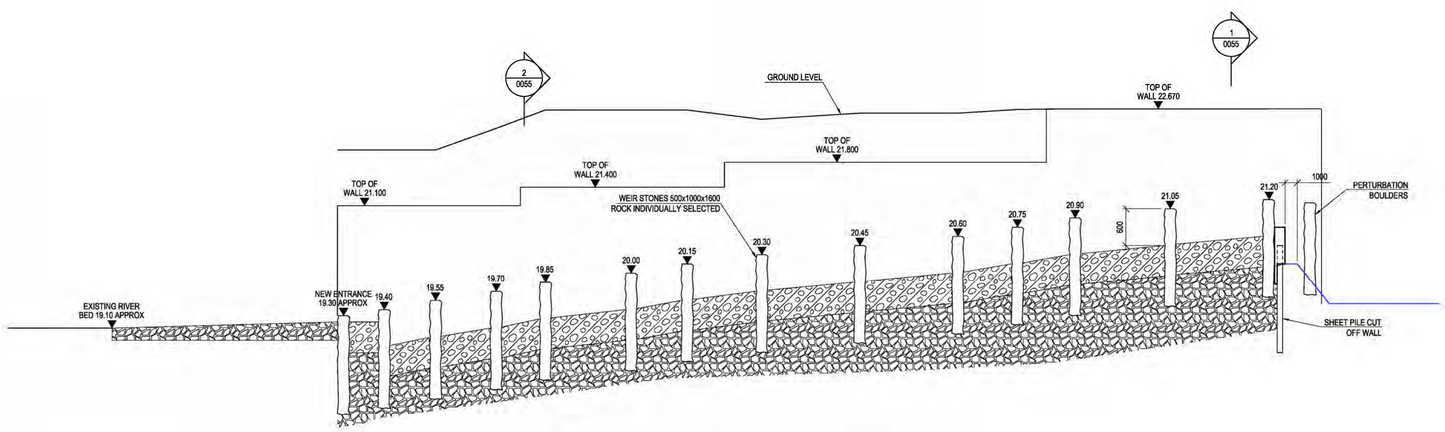
1. FOR LOCATION OF SECTION REFER TO DRAWING 0053.
2. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM MALIN HEAD.
3. AADF: ANNUAL AVERAGE DAILY FLOW
4. PERTURBATION BOULDERS PLACED 1m UPSTREAM OF GAPS IN THE WEIR WALLS. ARMOURSTONE SHALL BE 500x1000x1600 HIGH MIN. DIMENSIONS ANGULAR BLOCK SHAPED BOULDERS PROJECTION 500mm ABOVE THE RAMP BED LEVEL.



1 0054 **LONGITUDINAL SECTION THROUGH BYPASS CHANNEL**
[TAKEN ALONG CENTRELINE OF BYPASS CHANNEL]
SCALE: 1:250 [H], 1:50[V]



2 0054 **ELEVATION OF NORTHERN WALL OF BYPASS CHANNEL**
SCALE: 1:250 [H], 1:50[V]



3 0054 **ELEVATION OF SOUTHERN WALL OF BYPASS CHANNEL**
SCALE: 1:250 [H], 1:50[V]

REV	STAT	DESCRIPTION	DATE
C02	AP	PLANNING SUBMISSION RESPONSE	----
C01	AP	ISSUED FOR PLANNING	02.08.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

TJ O'CONNOR & ASSOCIATES CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

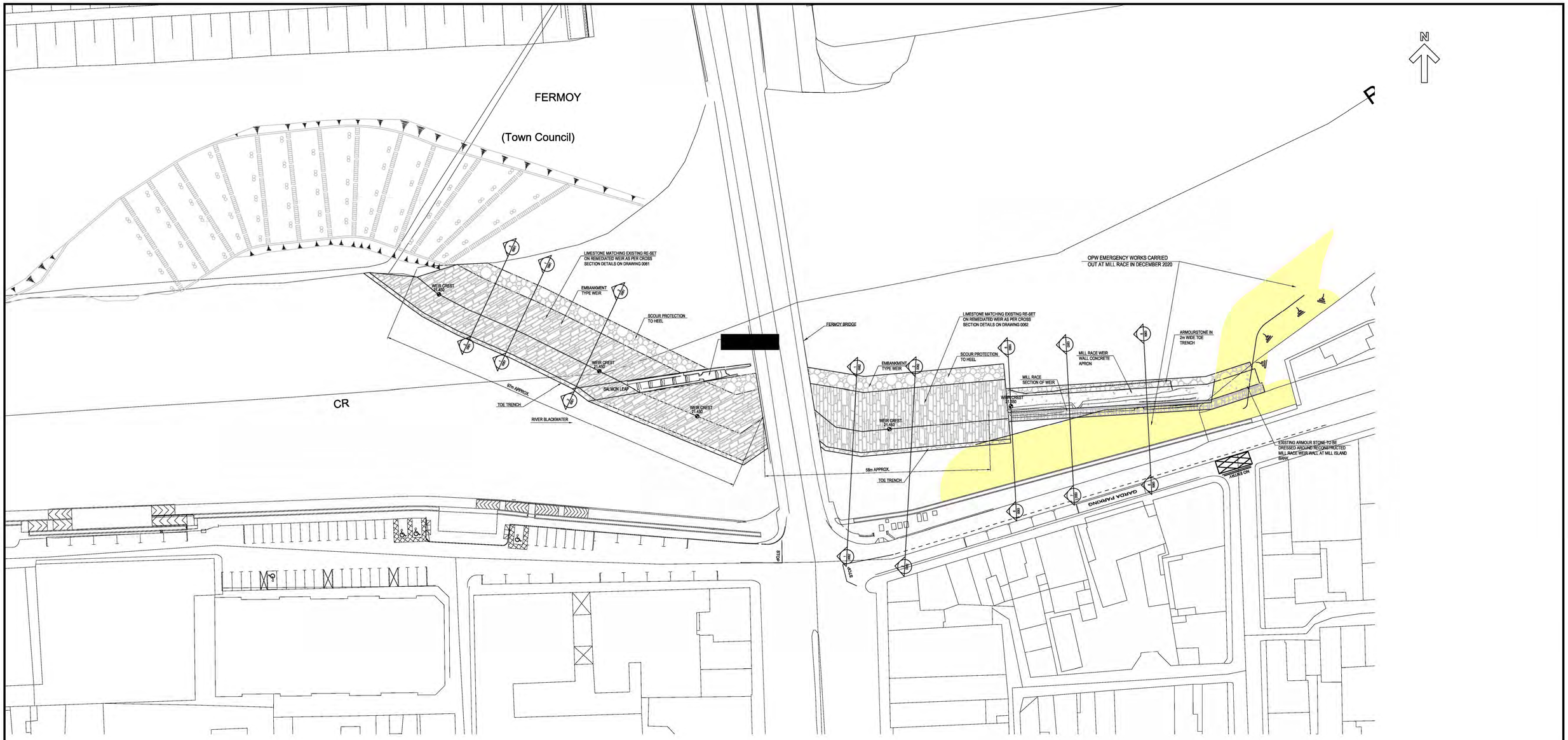
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: PROPOSED FISH BYPASS LONGITUDINAL SECTION

SCALE: 1:250 [H], 1:50 [V] (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 19011-TJOC-XX-XX-DR-C-0054

REV: C02



0 5 10 15 20 30 40 50m
1:500

NOTES:

1. FOR SECTIONS THROUGH PROPOSED EMBANKMENT WEIR REFER TO DRAWINGS 0061 AND 0062.
2. FOR SECTIONS THROUGH PROPOSED MILL RACE WEIR REFER TO DRAWING 0063.
3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM MALIN HEAD.
4. WEIR REMEDIATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE CONSERVATION ENGINEER'S RECOMMENDATIONS.

APPROXIMATE EXTENT OF BED STABILISATION WORKS UNDERTAKEN BY THE OPW IN 2020

REV	SUIT	DESCRIPTION	DATE
C02	AP	PLANNING SUBMISSION RESPONSE - SECTION LABELS REVISED	.....
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY EMBANKMENT WEIR REMEDIATION AND FISH BYPASS CHANNEL

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: WEIR REMEDIATION PLAN OF PROPOSED WEIR

SCALE: 1:500 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER
19011-TJOC-PL-XX-DR-C-0060

REV: C02

APPENDIX D

Fermoy Weir
Murphy Surveys Ltd Survey 2018

LEGEND

Street furniture & Services

- Over Head Wires (LUAS) - Pylon ESB
- Flowerbed
- Pipe
- Lift
- Barrier
- Pump
- Trial Pit
- Bus/Tram Shelter
- Postbox
- Valve - General
- Water Valve
- Gas Valve
- Sluice Valve
- Air Valve
- Stop Cock
- C P Post
- Marker Post
- Traffic light
- Parking Meter
- Plane Aerial Mark
- Smart Card Validator
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- Road Sign
- Bus Stop
- Bollard
- Beacon
- Coalhole Cover
- Bore Hole
- Electricity Pole
- Telegraph pole
- OCS Pole
- CCTV Camera Pole
- Lamp Post
- Foul Manhole
- Surface Water MH
- Manholes
- Air Conditioning Vents
- Services Inspection Cover
- Traffic Inspection Cover
- Cable TV Inspection Cover
- ESAT Inspection Cover
- NTL Inspection Cover
- Eircom Inspection Cover
- Rodding Eye
- Phone Box
- Bench Seat
- Kiosk
- Gully
- Waste Bin
- Hydrant
- Fire Hydrant
- ESB Box
- ESB Inspection Cover
- Traffic Control Box
- LUAS Technical Cubicle
- Ticket Vending Machine
- Water Meter Cover
- Telecom Inspection Cover
- Monument / Toilets
- Tank Storage
- Basement: MH, Cover & Pipe
- Dished Aerial Mark
- Stay for pole
- Pipe Protection
- Washout
- Duct
- Gas Cover
- C P Box
- Gas Vent
- Car Park Vent

Natural Features

- Surface Change
- Land Drain
- Bottom of Slope
- Top of Slope
- Ditch
- Water Edge / Lake / Pond
- Hedge / Trees Drip Line / Vegetation
- Tree Coniferous
- Water Level
- Water Level
- Crown Level
- Invert level
- Bed Level
- Spotheight
- Top of Tree
- Tree Deciduous

Golf

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- Green
- Tee Box

Other

- Survey Station
- Photo point
- River Alignment

Built Features

Roads & Road Markings

- Building
- Edge of Road
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- Bridge Abutment
- Bridge Deck
- Bridge Parapet
- Building Façade
- Footpath / Platform Train & Tram
- Damp Proof Course / Verge
- Bridge Pier / Wall & Gate Pillar / LUAS Trackbed
- Cycleway / Private Landing Area
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- Gate
- Road Centreline
- Top of Wall
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- Floor Level
- Apex Height
- Eaves Height
- Parapet Height
- Soffit Elevation
- Step Level
- Concrete Pad
- Track

Murphy Surveys Ltd. Disclaimer

The user or recipient of this survey data understands and acknowledges this data may be inaccurate or contain errors or omissions and the user or recipient assumes full responsibility for any risks or damages resulting from, arising from, or in connection with any use of or reliance upon data displayed herein. Although significant care has been exercised to produce surveys that satisfy survey accuracy standards, these surveys are only as accurate as the source data from which they were compiled. Although all reasonable steps have been taken to locate all features visible at the time of the survey, there is no guarantee that all will be shown on the drawing, as some above ground features may have obstructed the survey. Wherever possible, areas unable to be surveyed will be labelled as "UTS".

The Company shall not be liable for any inaccuracy of the data provided beyond the specified scale or accuracy, or for any matters resulting from their use for purposes other than that stated in the Contract. No liability shall attach to the Surveyor in respect of any consequential loss or damages suffered by the Client.

The Client must promptly notify the Company of any errors in mapping of which it becomes aware. If misleading, inaccurate or otherwise inappropriate information is brought to the Company's attention or the Company itself identifies any such imprecision or error in a survey, it shall use its reasonable endeavours to fix or remove it and if necessary in certain instances, the Company being on notice of any such misleading, inaccurate or otherwise inappropriate information, it will re-conduct the survey and reproduce the data to within the specified scale or accuracy.

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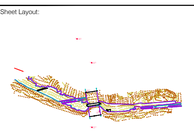

Surveyed by : MSL	Date: Aug 2018	Datum	Malin Head
Drawn by : BK	Date: Aug 2018	Grid System:	
Checked by : KC	Date: Aug 2018	Irish National Grid ☐ ITM ■	

Revisions

No.	Date	Description
0	28.08.18	First Drawing

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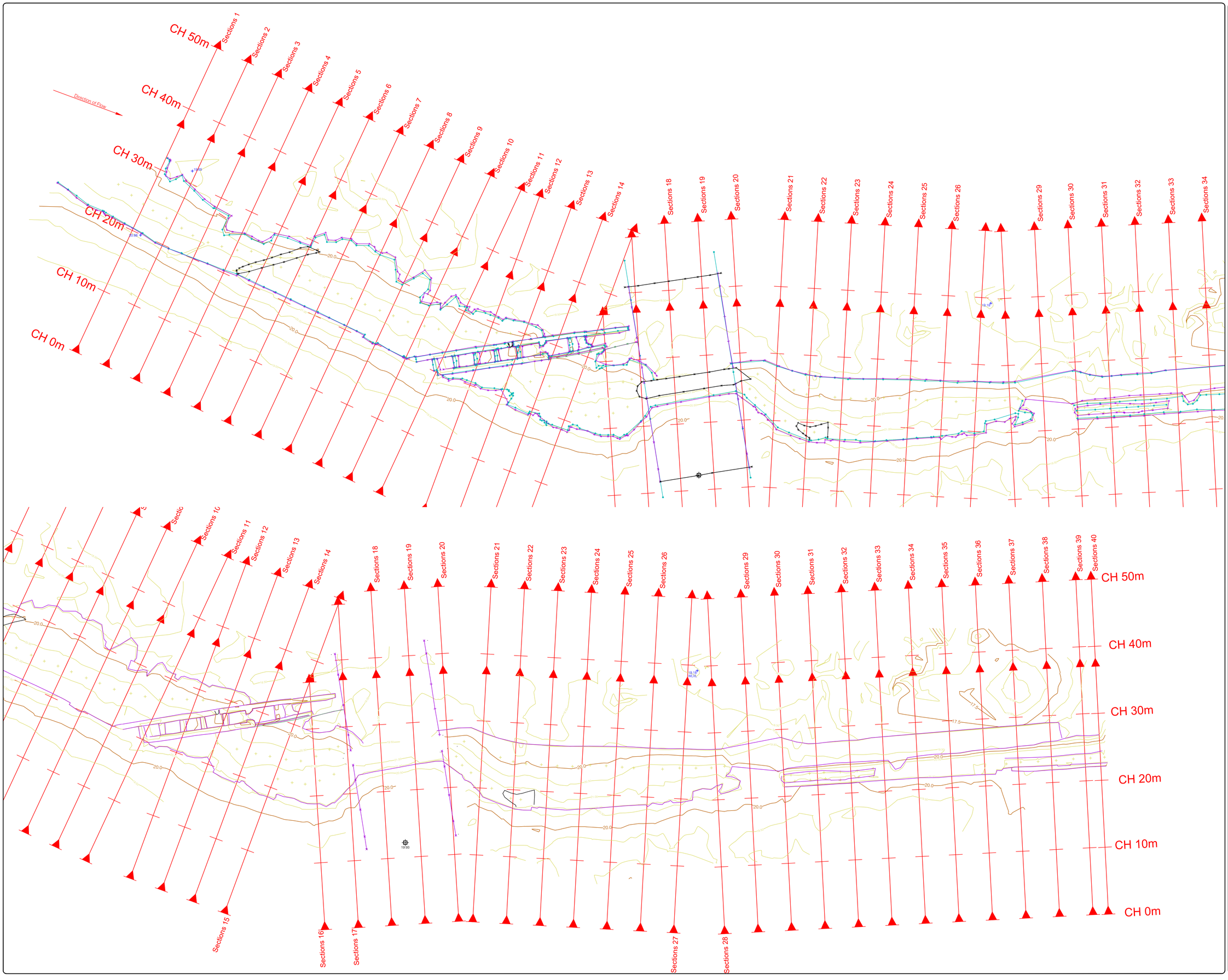
Fax: (+353) 045 484004
Email: info@murphysurveys.ie

Client :	TJ_O_Connor_&_Associates
Project :	27232 18024_Fermoy_Weir
Date : 28.08.18	**Scale :** 1:250@A1
Description :	Topographical Survey
Drawing Number :	**FERMOY WEIR_PLAN**



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- Apex Height
- Eaves Height
- Parapet Height
- Soffit Elevation
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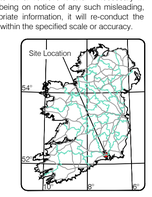

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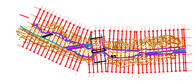

Surveyed by :	MDL	Date: Aug 2018	Datum: Main Head
Drawn by :	BK	Date: Aug 2018	Grid System:
Checked by :	KC	Date: Aug 2018	Irish National Grid ☐ ITM ■

Revisions

No.	Date	Description
0	28.08.18	First Drawing

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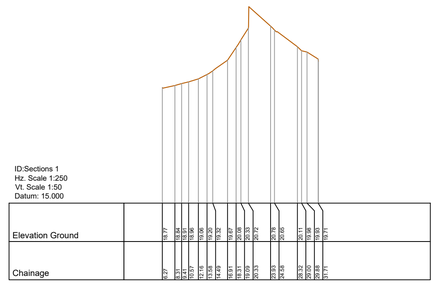
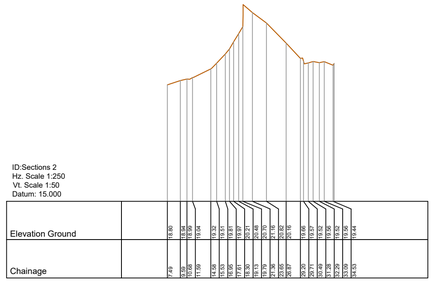
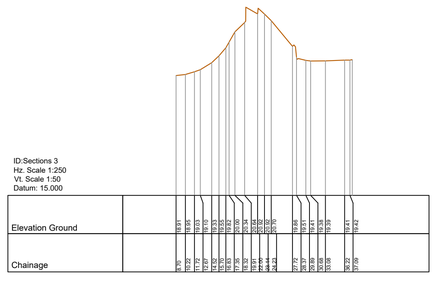
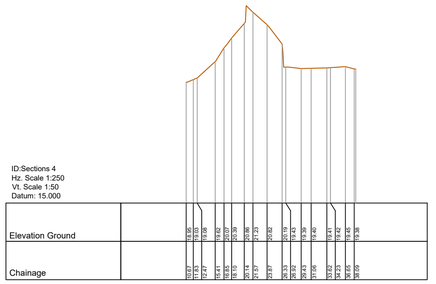
Fax: (+353) 045 484004
Email: info@murphysurveys.ie

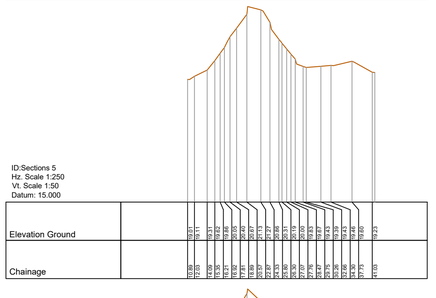
Client :	TJ_O_Connor_&_Associates
Project :	27232 18024_Fermoy_Weir
Date : 28.08.18	**Scale :** 1:250@A1
Description :	Topographical Survey
Drawing Number :	**FERMOY WEIR_CROSS SECTIONS_PLAN**

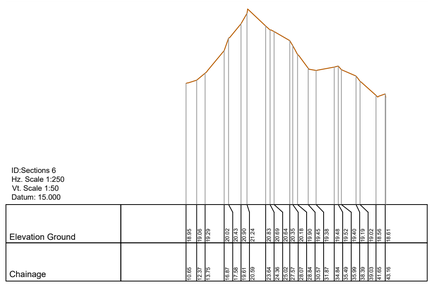


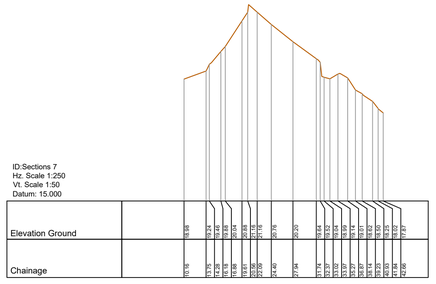


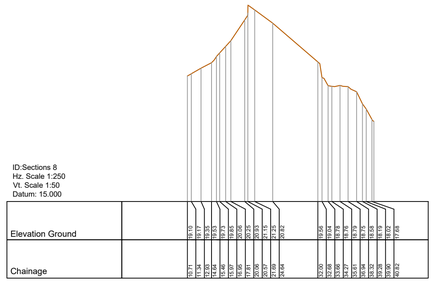


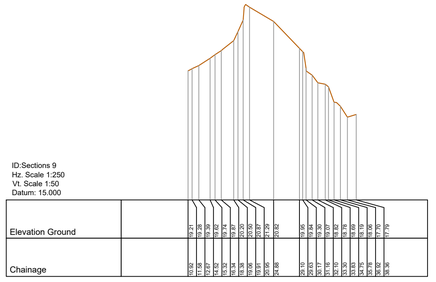


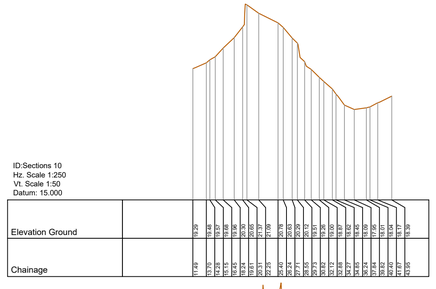


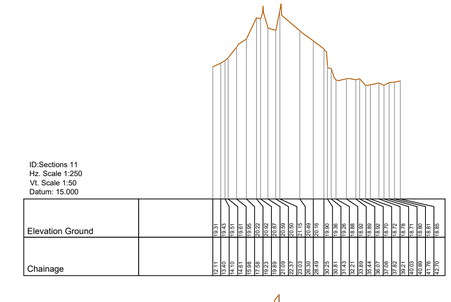


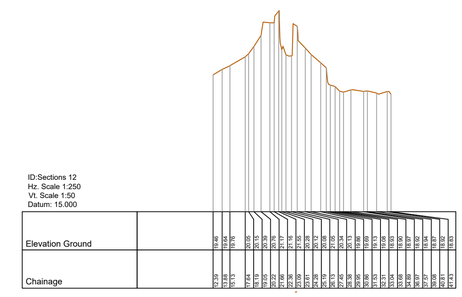


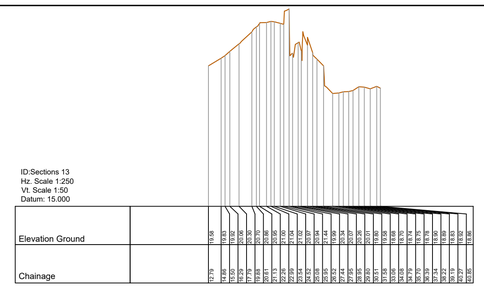


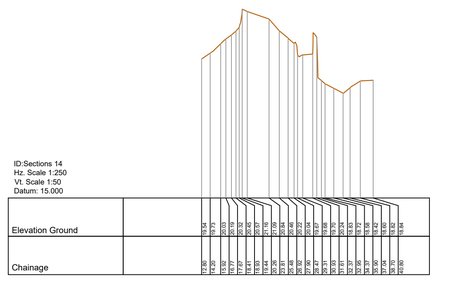


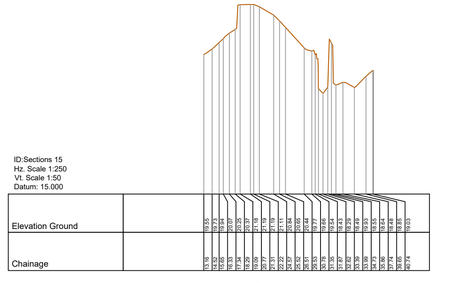


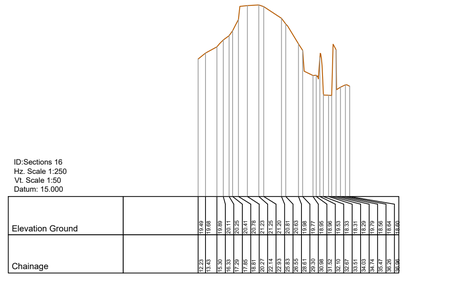


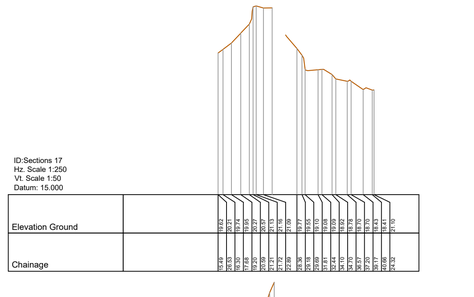


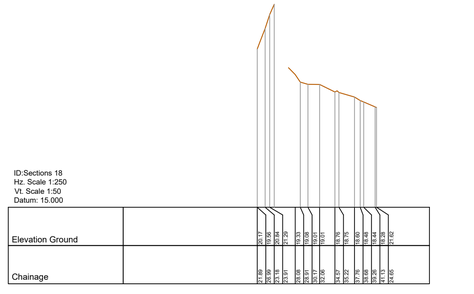


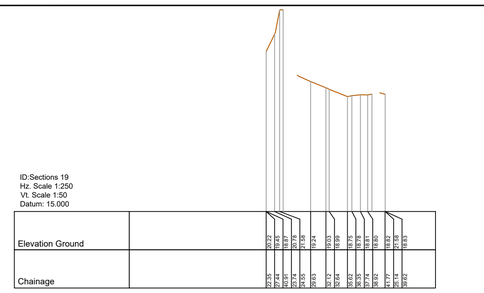


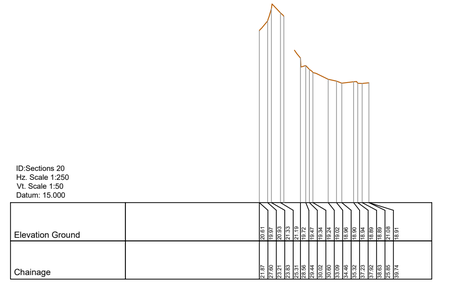


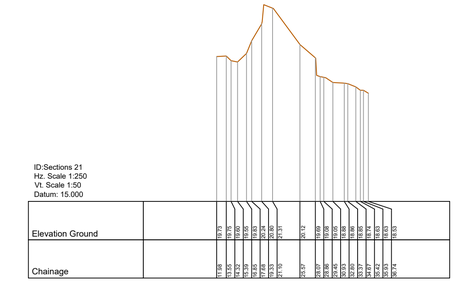


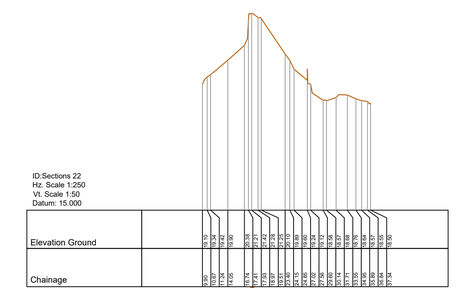


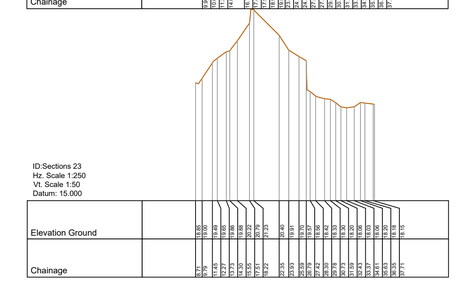


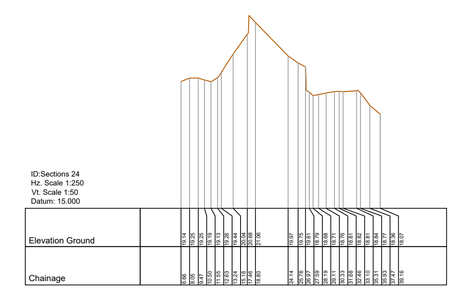












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- PBOX Phone Box
- Duct
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- GY Gully
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- HY Hydrant
- FH Fire Hydrant
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- FWAY Fair Way
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Built Features
Roads & Road Markings

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- Bridge Deck
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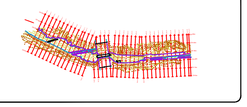
Map Sheet Layout:



Surveyed by : MSL
Drawn by : BK
Checked by : KC

Date: Aug 2018
Date: Aug 2018
Date: Aug 2018

Datum Malin Head
Grid System:
Irish National Grid ☐ ITM ■

Revisions

No	Date	Description
0	28.08.18	First Drawing

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Phone: (+353) 045 484040
Fax: (+353) 045 484004
Email: info@murphysurveys.ie

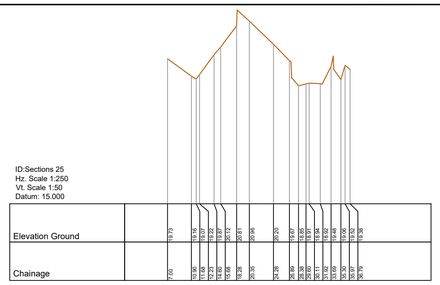
Client : TJ_O'Connor_&_Associates

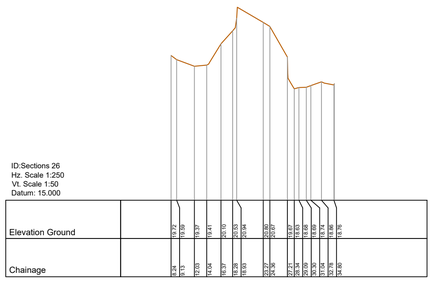
Project : 27232 18024_Fermoy_Weir

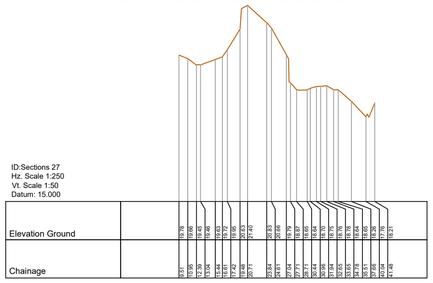
Date : 28.08.18 **Scale :** AS SHOWN@A1

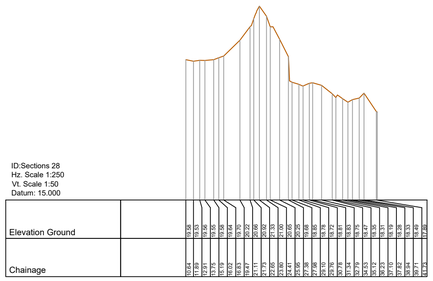
Description : Topographical Survey

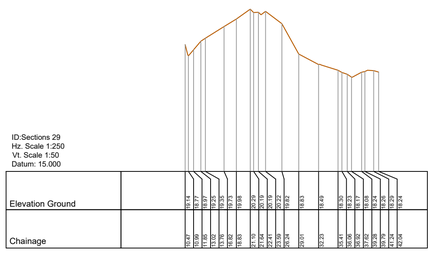
Drawing Number : FERMOY WEIR_CROSS SECTIONS_PROFILE_01

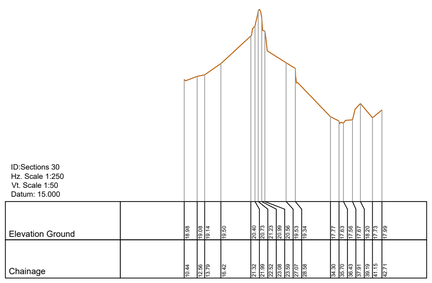


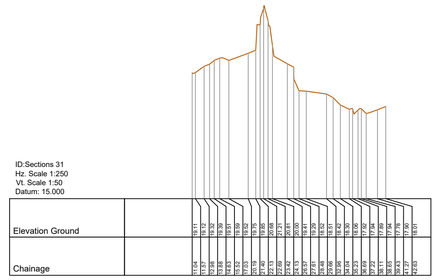


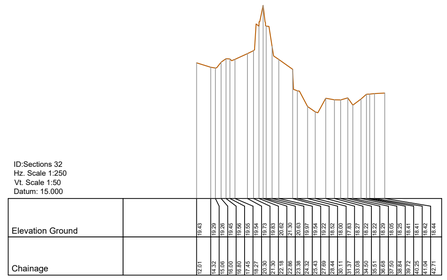


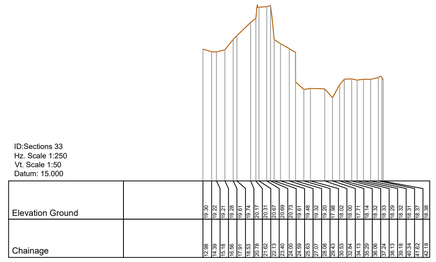


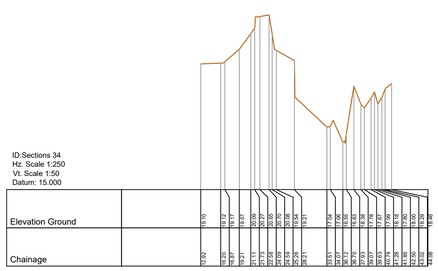


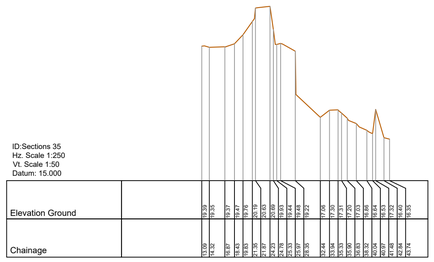


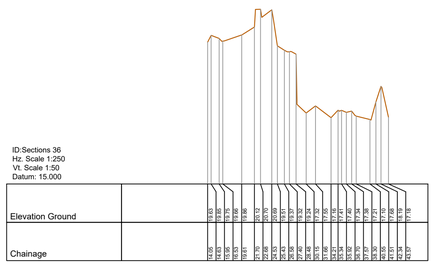


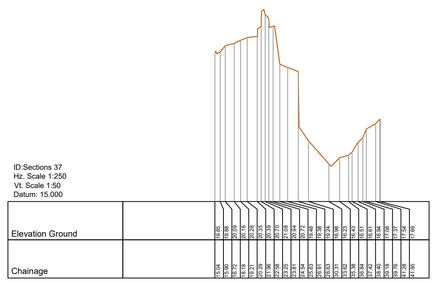


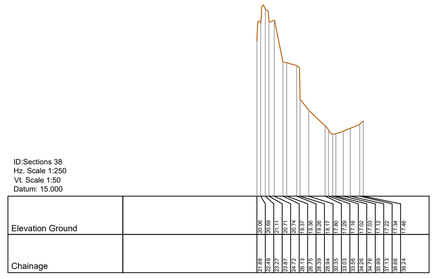


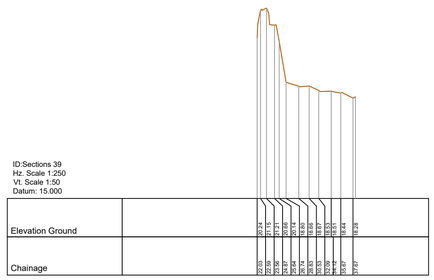


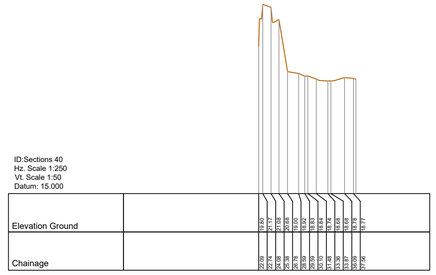












LEGEND

Street furniture & Services

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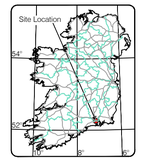
Site Location



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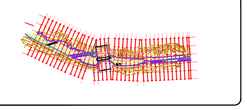

Surveyed by : MSL
Drawn by : BK
Checked by : KC

Date: Aug 2018
Date: Aug 2018
Date: Aug 2018

Datum: Malin Head
Grid System:
Irish National Grid ☐ ITM ■

Revisions

No	Date	Description
0	28.08.18	First Drawing

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Topographic surveys, Measured Building Surveys, Setting-Out, As-Built Surveys, Hydrographic Surveys, Legal Mapping, Pipeline Surveys, Services Location, Ground Penetrating Radar, Laser Scanning, Rectified Photography

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Ireland

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Fax: (+353) 045 484004
Email: info@murphysurveys.ie

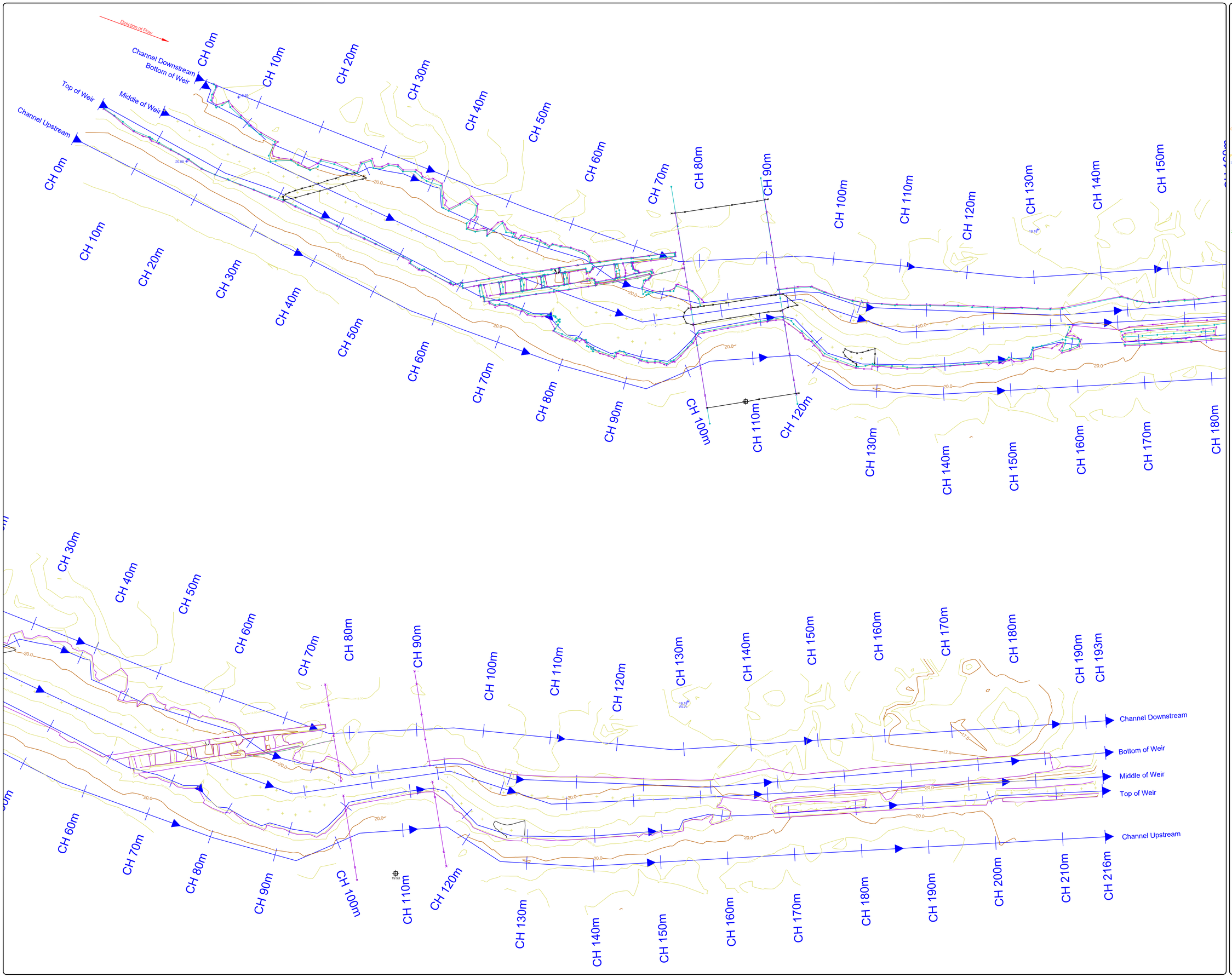
Client : TJ_O_Connor_&_Associates

Project : 27232 18024_Fermoy_Weir

Date : 28.08.18 **Scale :** AS SHOWN@A1

Description : Topographical Survey

Drawing Number : FERMOY WEIR_CROSS SECTIONS_PROFILE_02



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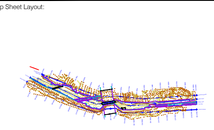

Surveyed by :	MSL	Date: Aug 2018	Datum: Malin Head
Drawn by :	BK	Date: Aug 2018	Grid System:
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Revisions

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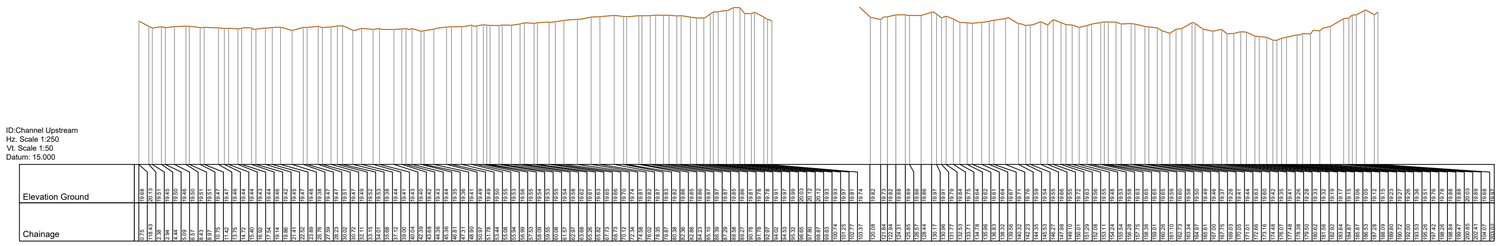
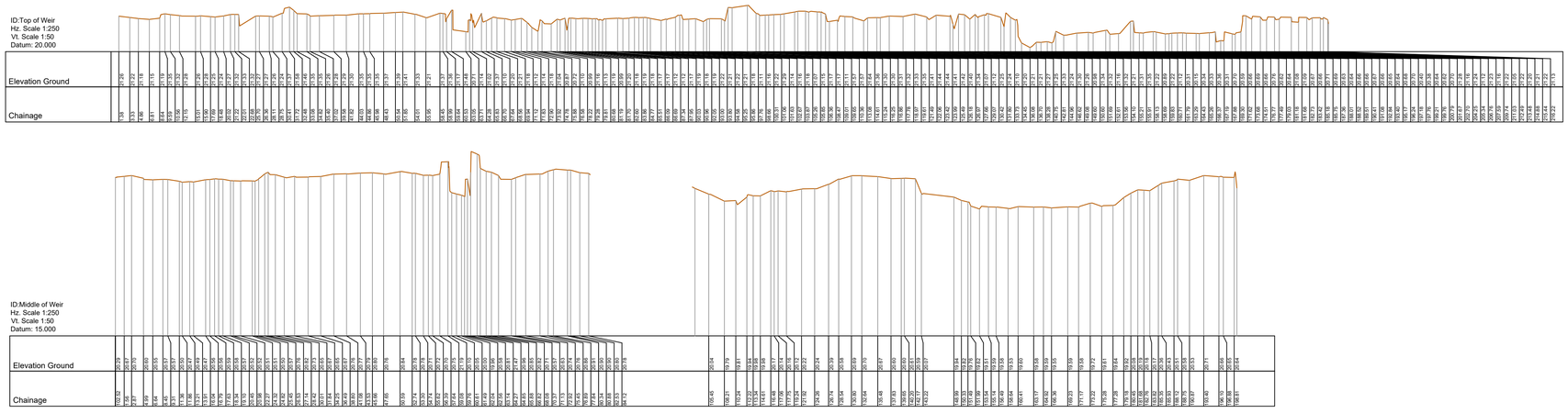
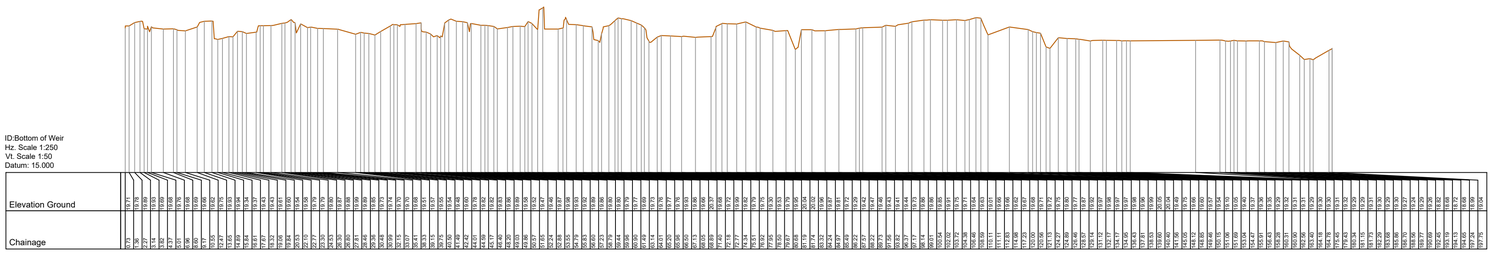
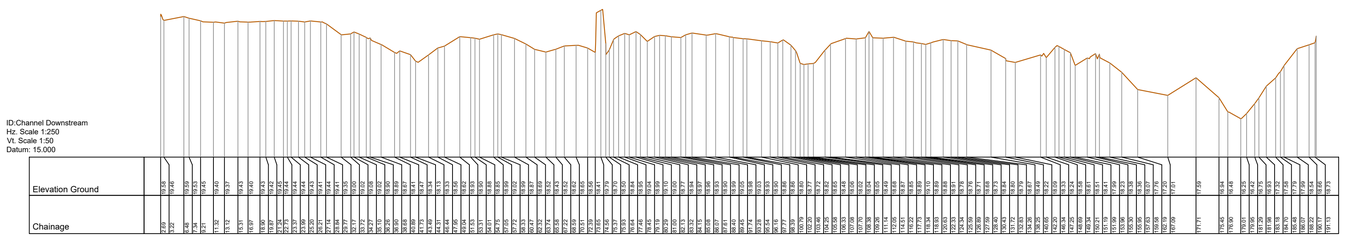
Client :	TJ_O_Connor_&_Associates
Project :	27232 18024_Fermoy_Weir
Date : 28.08.18	**Scale :** 1:250@A1
Description :	Topographical Survey
Drawing Number :	FERMOY WEIR_LONG SECTION_PLAN









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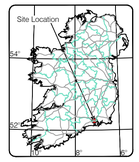
- EVE Eaves Height
- Kerb Top
- Top of Wall
- PAR Parapet Height
- Bridge Abutment
- Hoarding
- SOFF Soffit Elevation
- Bridge Deck
- Property Line
- STPL Step Level
- Bridge Parapet
- Road Scar
- COND Concrete Pad
- Building Façade
- Top of Fence
- Track
- Footpath / Platform Train & Tram
- Wall / Retaining Wall
- Damp Proof Course / Verge
- Railway / Tram Rail / Grating / Ramp
- Bridge Pier / Wall & Gate Pillar / LUAS Trackbed
- Building Canopy / Roof / Overhang
- Cycleway / Private Landing Area

Murphy Surveys Ltd. Disclaimer

The user or recipient of this survey data understands and acknowledges this data may be inaccurate or contain errors or omissions and the user or recipient assumes full responsibility for any risks or damages resulting from, arising from, or in connection with any use of or reliance upon data displayed herein. Although significant care has been exercised to produce surveys that satisfy survey accuracy standards, these surveys are only as accurate as the source data from which they were compiled. Although all reasonable steps have been taken to locate all features visible at the time of the survey, there is no guarantee that all will be shown on the drawing, as some above ground features may have obstructed the survey. Wherever possible, areas unable to be surveyed will be labelled as "UTS".

The Company shall not be liable for any inaccuracy of the data provided beyond the specified scale or accuracy, or for any matters resulting from their use for purposes other than that stated in the Contract. No liability shall attach to the Surveyor in respect of any consequential loss or damages suffered by the Client.

The Client must promptly notify the Company of any errors in mapping of which it becomes aware. If misleading, inaccurate or otherwise inappropriate information is brought to the Company's attention or the Company itself identifies any such imprecision or error in a survey, it shall use its reasonable endeavours to fix or remove it and if necessary in certain instances, the Company being on notice of any such misleading, inaccurate or otherwise inappropriate information, it will re-conduct the survey and reproduce the data to within the specified scale or accuracy.



Map Sheet Layout:

Surveyed by : MSL	Date: Aug 2018	Datum	Malin Head
Drawn by : BK	Date: Aug 2018	Grid System:	
Checked by : KC	Date: Aug 2018	Irish National Grid ☐ ITM ■	

Revisions

No	Date	Description
0	28.08.18	First Drawing

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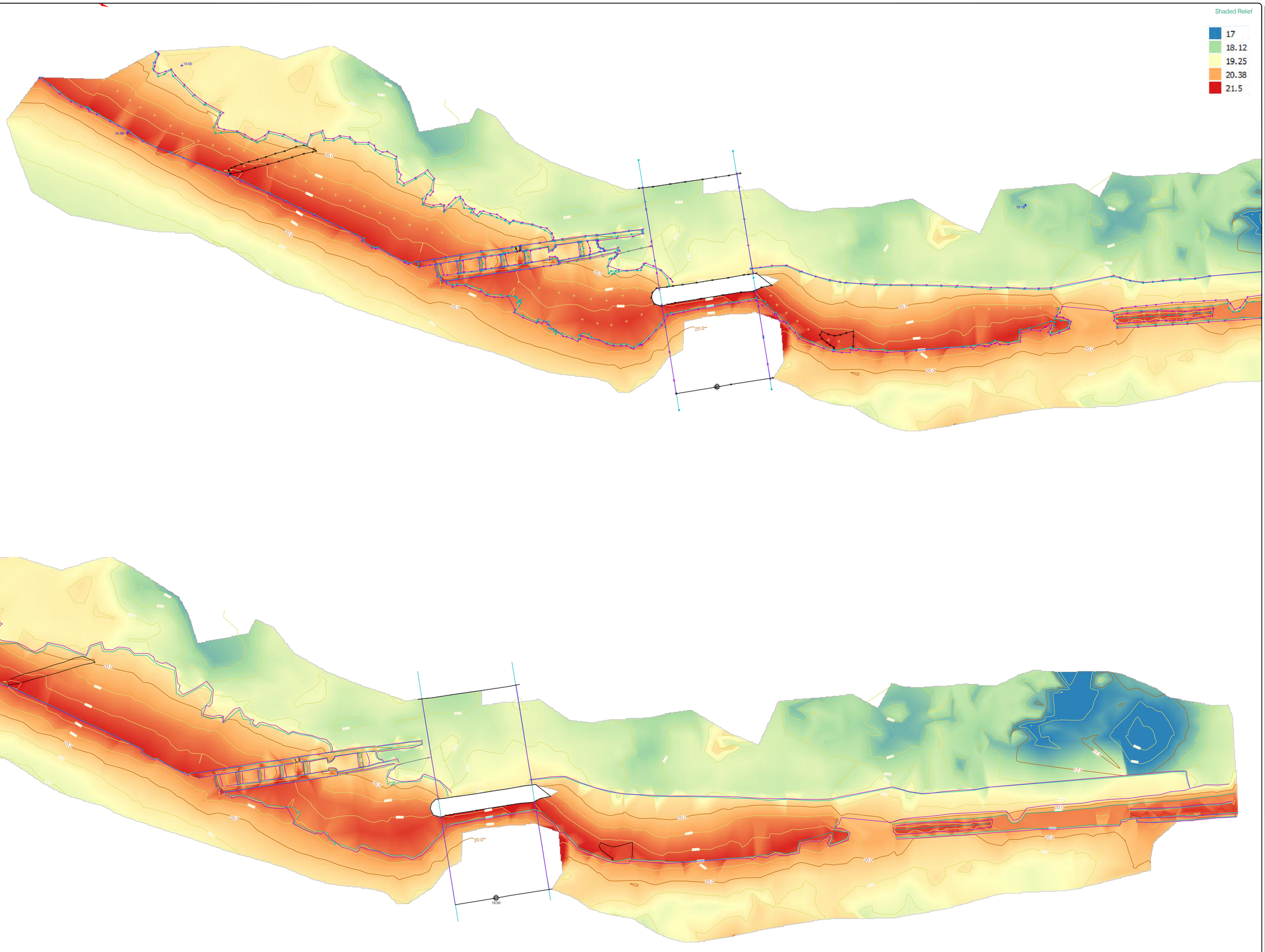
Email: info@murphysurveys.ie

Client :	TJ_O_Connor_&_Associates
Project :	27232 18024_Fermoy_Weir
Date : 28.08.18	**Scale :** AS SHOWN@A1
Description :	Topographical Survey
Drawing Number :	**FERMOY WEIR_LONG SECTION_01**



LEGEND

Street furniture & Services

- Over Head Wires (LUAS) - Pylon ESB
- Flowerbed
- Pipe
- Lift
- Barrier
- Pump
- Trial Pit
- Bus/Tram Shelter
- Postbox
- Valve - General
- Water Valve
- Gas Valve
- Sluice Valve
- Air Valve
- Stop Cock
- C P Post
- Marker Post
- Traffic light
- Parking Meter
- Plane Aerial Mark
- Smart Card Validator
- Unknown Valve
- Road Sign
- Bus Stop
- Bollard
- Beacon
- Coalhole Cover
- Bore Hole
- Electricity Pole
- Telegraph pole
- OCS Pole
- CCTV Camera Pole
- Lamp Post
- Foul Manhole
- Surface Water MH
- Manholes
- Air Conditioning Vents
- Services Inspection Cover
- Traffic Inspection Cover
- Cable TV Inspection Cover
- ESAT Inspection Cover
- NTL Inspection Cover
- Eircom Inspection Cover
- Rodding Eye
- Phone Box
- Bench Seat
- Kiosk
- Gully
- Waste Bin
- Hydrant
- Fire Hydrant
- ESB Box
- ESB Inspection Cover
- Traffic Control Box
- LUAS Technical Cubicle
- Ticket Vending Machine
- Water Meter Cover
- Telecom Inspection Cover
- Monument / Toilets
- Tank Storage
- Basement: MH, Cover & Pipe
- Disined Aerial Mark
- Stay for pole
- Pipe Protection
- Washout

Natural Features

- Surface Change
- Land Drain
- Bottom of Slope
- Top of Slope
- Ditch
- Water Edge / Lake / Pond
- Hedge / Trees Drip Line / Vegetation
- Tree Coniferous
- Water Level
- Crown Level
- Invert level
- Bed Level
- Spotheight
- Top of Tree
- Tree Deciduous

Golf

- Fair Way
- Green
- Tee Box

Other

- Survey Station
- Photo point
- River Alignment

Built Features

Roads & Road Markings

- Building
- Edge of Road
- Kerb Bottom
- Kerb Top
- Bridge Abutment
- Bridge Deck
- Bridge Parapet
- Building Façade
- Footpath / Platform Train & Tram
- Damp Proof Course / Verge
- Bridge Pier / Wall & Gate Pillar / LUAS Trackbed
- Cycleway / Private Landing Area
- Fence
- Gate
- Road Centreline
- Top of Wall
- Hoarding
- Property Line
- Road Scar
- Top of Fence
- Floor Level
- Apex Height
- Eaves Height
- Parapet Height
- Soffit Elevation
- Step Level
- Concrete Pad
- Track
- Wall / Retaining Wall
- Railway / Tram Rail / Grating / Ramp
- Building Canopy / Roof / Overhang

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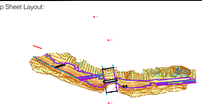
Map Sheet Layout:



Surveyed by:	MSL	Date:	Aug 2018	Datum	Malin Head
Drawn by :	BK	Date:	Aug 2018	Grid System:	
Checked by :	KC	Date:	Aug 2018	Irish National Grid ☐ ITM ■	

Revisions

No	Date	Description
0	28.08.18	First Drawing

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Email: info@murphysurveys.ie

Client :	TJ_O_Connor_&_Associates
Project :	27232 18024_Fermoy_Weir
Date : 28.08.18	**Scale :** 1:250@A1
Description :	Topographical Survey
Drawing Number :	**FERMOY WEIR_DTM**

APPENDIX E

OPW 2020 Emergency Works
HECRAS Model Results

1/730 HEC-RAS SECTION LOCATIONS
SCALE: 1:250

REV	STAT	DESCRIPTION	DATE
P01	S2	ISSUED FOR INFORMATION	.....

DRAWING STATUS: ISSUED FOR INFORMATION

CHECKED BY:	REVIEWED BY:	APPROVED BY:
RON	JM	JM

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: MUNSTER BLACKWATER RIVER - FERMOY SOUTH EAST AND SOUTH WEST DRAINAGE SCHEMES

CLIENT: OFFICE OF PUBLIC WORKS

DRAWING TITLE: HEC-RAS SECTION LOCATIONS

SCALE: 1:250 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 2961 - 730

REV: P01

HEC-RAS Plan: Mill Race Vel. River: Blackwater Reach: Blackwater

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Blackwater	76	10% ile	96.98	18.59	21.22	20.52	21.30	0.000678	1.11	76.63	42.16	0.26
Blackwater	76	15% ile	80.24	18.59	20.75	20.35	21.07	0.004734	2.51	31.98	21.40	0.66
Blackwater	76	20% ile	63.51	18.59	20.46	20.16	20.76	0.005642	2.46	25.79	20.39	0.70
Blackwater	76	25% ile	46.77	18.59	20.16	19.94	20.44	0.006595	2.35	19.92	19.10	0.73
Blackwater	76	30% ile	58.13	18.59	20.36	20.09	20.66	0.005934	2.43	23.92	20.06	0.71
Blackwater	76	40% ile	38.71	18.59	19.99	19.81	20.26	0.007404	2.30	16.80	18.13	0.76
Blackwater	76	50% ile	22.28	18.59	19.58	19.52	19.83	0.010978	2.25	9.92	14.98	0.88
Blackwater	76	95% ile	8.58	18.59	19.18	19.18	19.37	0.017069	1.89	4.55	12.53	1.00
Blackwater	66	10% ile	96.98	18.39	21.22	20.31	21.29	0.000473	1.00	85.48	42.35	0.22
Blackwater	66	15% ile	80.24	18.39	20.76	20.14	21.01	0.003126	2.19	36.64	21.86	0.54
Blackwater	66	20% ile	63.51	18.39	20.47	19.95	20.69	0.003503	2.10	30.25	21.15	0.56
Blackwater	66	25% ile	46.77	18.39	20.17	19.73	20.36	0.003762	1.94	24.09	20.09	0.57
Blackwater	66	30% ile	58.13	18.39	20.37	19.89	20.59	0.003583	2.05	28.29	20.82	0.56
Blackwater	66	40% ile	38.71	18.39	20.00	19.61	20.18	0.004017	1.87	20.74	19.35	0.58
Blackwater	66	50% ile	22.28	18.39	19.57	19.31	19.72	0.004952	1.70	13.10	16.51	0.61
Blackwater	66	95% ile	8.58	18.39	19.07	18.98	19.18	0.008732	1.52	5.66	13.04	0.74
Blackwater	53	10% ile	96.98	18.12	20.75	20.39	21.23	0.005702	3.07	31.62	17.82	0.73
Blackwater	53	15% ile	80.24	18.12	20.43	20.20	20.92	0.007225	3.09	25.98	17.17	0.80
Blackwater	53	20% ile	63.51	18.12	20.08	19.98	20.59	0.009368	3.14	20.23	16.02	0.89
Blackwater	53	25% ile	46.77	18.12	19.72	19.72	20.24	0.012525	3.18	14.73	14.36	1.00
Blackwater	53	30% ile	58.13	18.12	19.96	19.90	20.48	0.010653	3.19	18.24	15.60	0.94
Blackwater	53	40% ile	38.71	18.12	19.58	19.58	20.05	0.012855	3.03	12.76	13.61	1.00
Blackwater	53	50% ile	22.28	18.12	19.21	19.21	19.59	0.013712	2.73	8.18	10.76	1.00
Blackwater	53	95% ile	8.58	18.12	18.77	18.77	19.01	0.015784	2.14	4.00	8.49	1.00
Blackwater	37	10% ile	96.98	17.80	20.79	20.08	21.13	0.003235	2.57	37.89	18.19	0.56
Blackwater	37	15% ile	80.24	17.80	20.47	19.88	20.79	0.003696	2.50	32.16	17.73	0.59
Blackwater	37	20% ile	63.51	17.80	20.13	19.67	20.43	0.004440	2.43	26.16	17.21	0.63
Blackwater	37	25% ile	46.77	17.80	19.75	19.41	20.03	0.005372	2.35	19.86	15.97	0.67
Blackwater	37	30% ile	58.13	17.80	20.01	19.59	20.30	0.004671	2.41	24.14	16.75	0.64
Blackwater	37	40% ile	38.71	17.80	19.56	19.27	19.82	0.005828	2.29	16.91	15.14	0.69
Blackwater	37	50% ile	22.28	17.80	19.10	18.89	19.33	0.007099	2.11	10.56	12.46	0.73
Blackwater	37	95% ile	8.58	17.80	18.66	18.46	18.77	0.005243	1.47	5.85	9.53	0.60
Blackwater	36.5		Lat Struct									
Blackwater	22	10% ile	96.98	17.49	20.05	20.05	20.98	0.012050	4.29	22.62	12.07	1.00
Blackwater	22	15% ile	80.24	17.49	19.82	19.82	20.65	0.012144	4.04	19.85	11.89	1.00
Blackwater	22	20% ile	63.51	17.49	19.56	19.56	20.28	0.012360	3.76	16.89	11.69	1.00
Blackwater	22	25% ile	46.77	17.49	19.29	19.29	19.88	0.012696	3.42	13.68	11.46	1.00
Blackwater	22	30% ile	58.13	17.49	19.48	19.48	20.16	0.012472	3.66	15.88	11.62	1.00
Blackwater	22	40% ile	38.71	17.49	19.35	19.14	19.72	0.007473	2.69	14.38	11.51	0.77
Blackwater	22	50% ile	22.28	17.49	19.00	18.72	19.23	0.005832	2.14	10.42	10.09	0.67
Blackwater	22	95% ile	8.58	17.49	18.63	18.25	18.71	0.002706	1.23	6.98	8.80	0.44
Blackwater	12	10% ile	96.98	17.28	19.30	18.76	19.44	0.001199	1.24	61.78	44.30	0.32
Blackwater	12	15% ile	80.24	17.28	18.73	18.76	20.37	0.042878	5.67	14.14	14.00	1.80
Blackwater	12	20% ile	63.51	17.28	19.20	18.76	19.27	0.000666	0.89	57.13	44.28	0.23
Blackwater	12	25% ile	46.77	17.28	19.17	18.76	19.20	0.000393	0.67	55.69	44.28	0.18
Blackwater	12	30% ile	58.13	17.28	19.19	18.76	19.24	0.000575	0.82	56.61	44.28	0.22
Blackwater	12	40% ile	38.71	17.28	19.59	18.62	19.61	0.000103	0.40	74.56	44.35	0.09
Blackwater	12	50% ile	22.28	17.28	19.15	18.25	19.16	0.000092	0.32	55.13	44.27	0.09
Blackwater	12	95% ile	8.58	17.28	18.66	17.86	18.68	0.000583	0.65	13.19	13.42	0.21
Blackwater	2	10% ile	96.98	17.08	19.29	18.76	19.43	0.001182	1.26	62.22	44.30	0.32
Blackwater	2	15% ile	80.24	17.08	19.24	18.76	19.33	0.000930	1.09	59.66	44.29	0.28
Blackwater	2	20% ile	63.51	17.08	19.19	18.76	19.26	0.000648	0.90	57.76	44.28	0.23
Blackwater	2	25% ile	46.77	17.08	19.16	18.70	19.20	0.000380	0.68	56.41	44.28	0.18
Blackwater	2	30% ile	58.13	17.08	19.18	18.76	19.24	0.000559	0.83	57.27	44.28	0.22
Blackwater	2	40% ile	38.71	17.08	19.59	18.53	19.61	0.000100	0.40	75.37	44.35	0.09
Blackwater	2	50% ile	22.28	17.08	19.15	18.17	19.16	0.000089	0.33	55.94	44.27	0.09
Blackwater	2	95% ile	8.58	17.08	18.66	17.77	18.68	0.000480	0.61	13.98	13.39	0.19
Blackwater	-17	10% ile	96.98	16.85	19.28	18.56	19.41	0.000794	1.05	65.74	38.36	0.25
Blackwater	-17	15% ile	80.24	16.85	19.23	18.56	19.32	0.000595	0.89	63.68	38.01	0.22
Blackwater	-17	20% ile	63.51	16.85	19.19	18.56	19.25	0.000396	0.72	62.20	37.57	0.18
Blackwater	-17	25% ile	46.77	16.85	19.16	18.56	19.19	0.000224	0.54	61.16	37.26	0.13
Blackwater	-17	30% ile	58.13	16.85	19.18	18.56	19.23	0.000337	0.66	61.82	37.46	0.16
Blackwater	-17	40% ile	38.71	16.85	19.59	18.43	19.60	0.000074	0.35	77.58	38.39	0.08
Blackwater	-17	50% ile	22.28	16.85	19.15	18.05	19.16	0.000052	0.26	60.86	37.17	0.06
Blackwater	-17	95% ile	8.58	16.85	18.67	17.57	18.67	0.000019	0.13	43.90	33.99	0.04
Blackwater	-24	10% ile	96.98	17.91	19.13	19.13	19.38	0.001890	1.14	47.67	37.57	0.38
Blackwater	-24	15% ile	80.24	17.91	19.13	19.13	19.30	0.001294	0.95	47.67	37.57	0.31
Blackwater	-24	20% ile	63.51	17.91	19.13	19.13	19.24	0.000810	0.75	47.67	37.57	0.25
Blackwater	-24	25% ile	46.77	17.91	19.13	19.13	19.19	0.000440	0.55	47.67	37.57	0.18
Blackwater	-24	30% ile	58.13	17.91	19.13	19.13	19.22	0.000679	0.69	47.67	37.57	0.23
Blackwater	-24	40% ile	38.71	17.91	19.10	19.10	19.56	0.013502	3.00	12.90	14.03	1.00
Blackwater	-24	50% ile	22.28	17.91	18.80	18.80	19.13	0.014753	2.54	8.79	13.39	1.00
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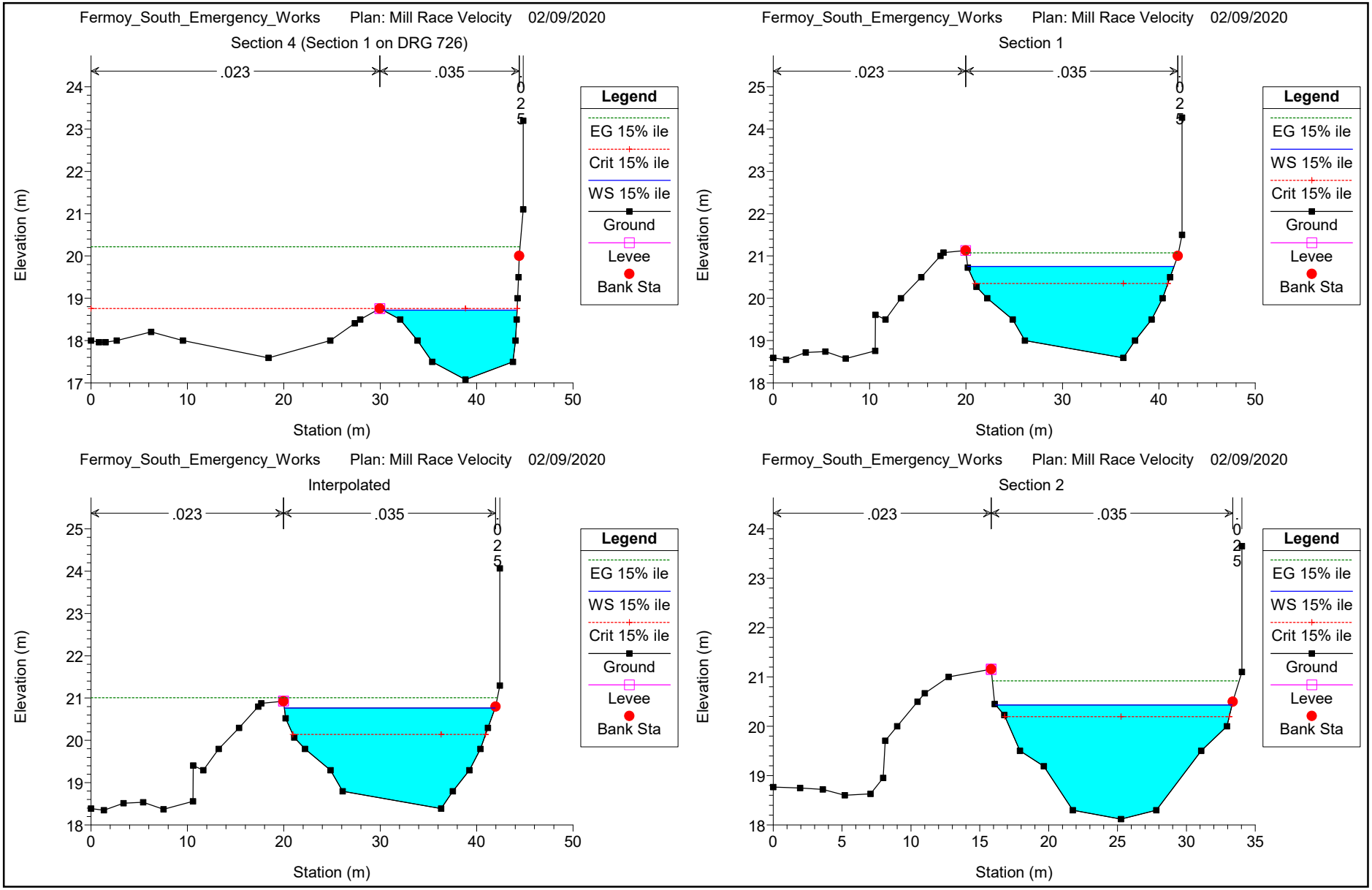
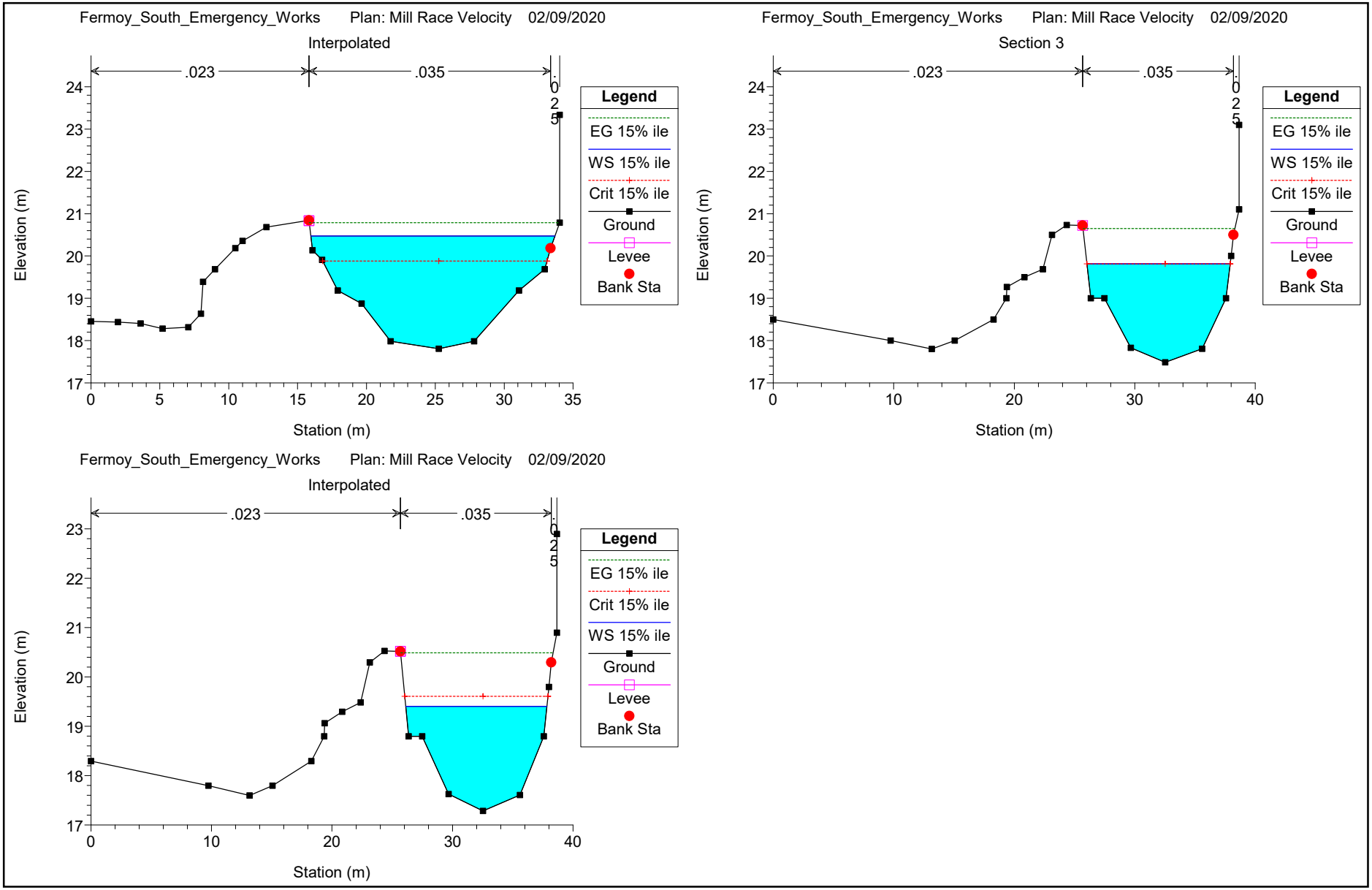
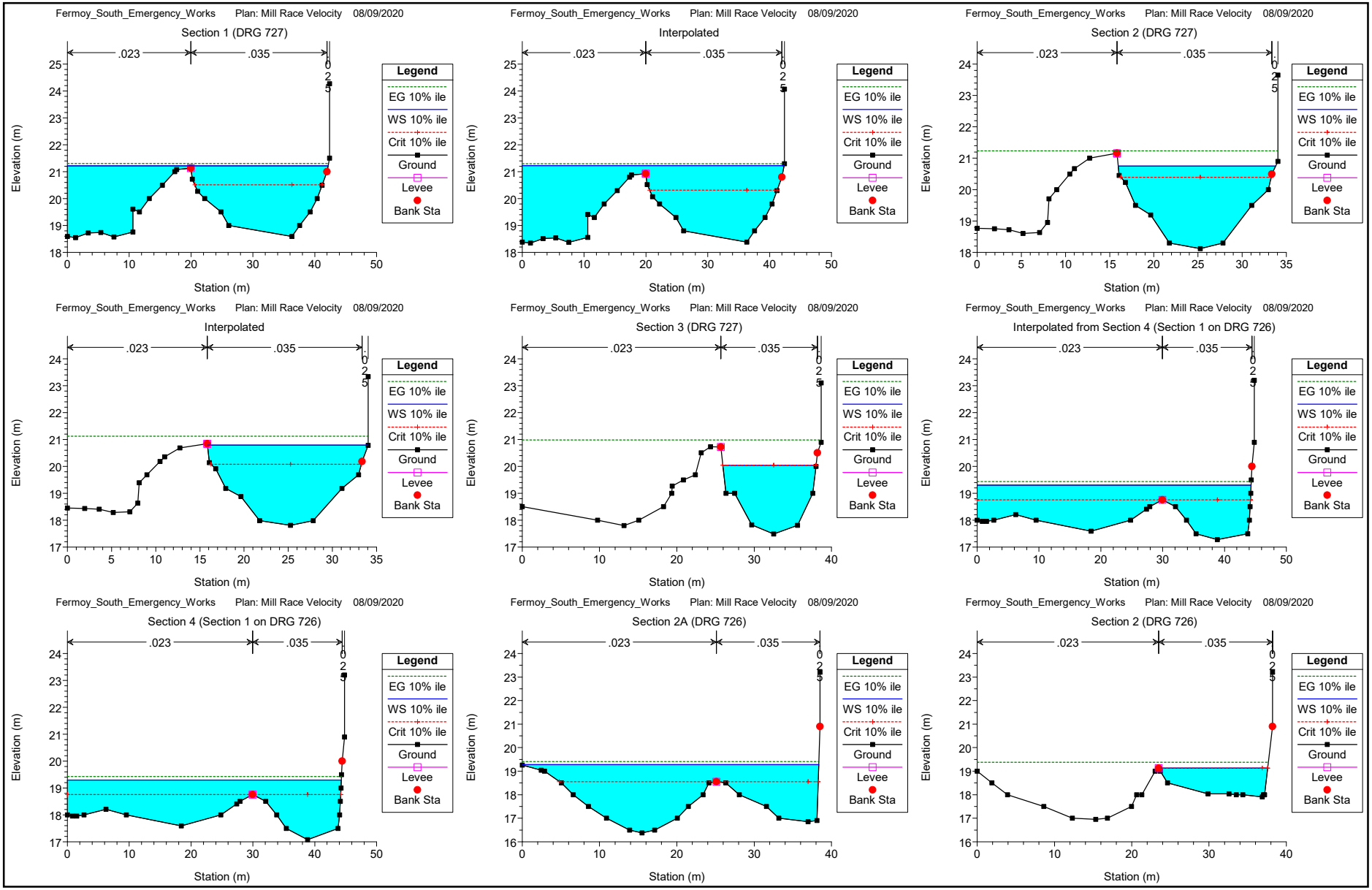

Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Section 4 (Section 1 on DRG 726)
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
Crit 15% ile
WS 15% ile
Ground
Levee
Bank Sta
Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Section 1
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
WS 15% ile
Crit 15% ile
Ground
Levee
Bank Sta
Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Interpolated
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
WS 15% ile
Crit 15% ile
Ground
Levee
Bank Sta
Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Section 2
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
WS 15% ile
Crit 15% ile
Ground
Levee
Bank Sta


Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Interpolated
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
WS 15% ile
Crit 15% ile
Ground
Levee
Bank Sta
Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Section 3
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
WS 15% ile
Crit 15% ile
Ground
Levee
Bank Sta
Fermoy_South_Emergency_Works Plan: Mill Race Velocity 02/09/2020
Interpolated
.023
.035
.025
Elevation (m)
Station (m)
Legend
EG 15% ile
Crit 15% ile
WS 15% ile
Ground
Levee
Bank Sta


Fermoy_South_Emergency_Works Plan: Mill Race Velocity 08/09/2020
Section 1 (DRG 727)
Interpolated
Section 2 (DRG 727)
Interpolated
Section 3 (DRG 727)
Interpolated from Section 4 (Section 1 on DRG 726)
Section 4 (Section 1 on DRG 726)
Section 2A (DRG 726)
Section 2 (DRG 726)
.023
.035
Legend
EG 10% ile
WS 10% ile
Crit 10% ile
Ground
Levee
Bank Sta
Elevation (m)
Station (m)

APPENDIX F

Flood Risk Assessment Report Rev C02

FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

Flood Risk Assessment

March 2023

T.J. O'CONNOR & ASSOCIATES
CIVIL & STRUCTURAL CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18
PH: 01 2952321, FAX: 01 2954541, EMAIL: tjoc@tjoc.ie, WEB: www.tjoc.ie

Document Verification

Client:	Cork County Council
Project Name:	Fermoy Weir Remediation & Fish Bypass Channel
Project Ref:	19011
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1. INTRODUCTION

1.1. Project Background

Cork County Council has identified the need to carry out remediation works to the existing weir in Fermoy and to construct a new permanent fish bypass channel on the north bank of the river Blackwater adjacent to Fermoy bridge. T.J. O'Connor & Associates (TJOC) were appointed by Cork County Council (CCC) to provide civil engineering consultancy services for the project and to develop a scheme to fulfil CCC's requirements while also complying with the relevant standards and statutory requirements.

The project requires CCC to fulfil its obligations to maintain and repair the weir at Fermoy, a Protected Structure under Section IV of the Planning & Development Act 2000, while complying with the conservation and fisheries obligations to provide for the free passage of fish along the river Blackwater Special Area of Conservation (SAC) arising under the Water Framework Directive, Habitats Directive and Inland Fisheries Act 2010 and related legislation.

1.2. Site of the Proposed Development

1.2.1. Site Description

Fermoy is located approx. 35km north of Cork City. The existing weir and fish pass are located on the River Blackwater, at Kent Bridge, Fermoy, which is situated in the centre of Fermoy town and to the west of the M8 motorway. Figure 1-1 below shows a site location map for the scheme.

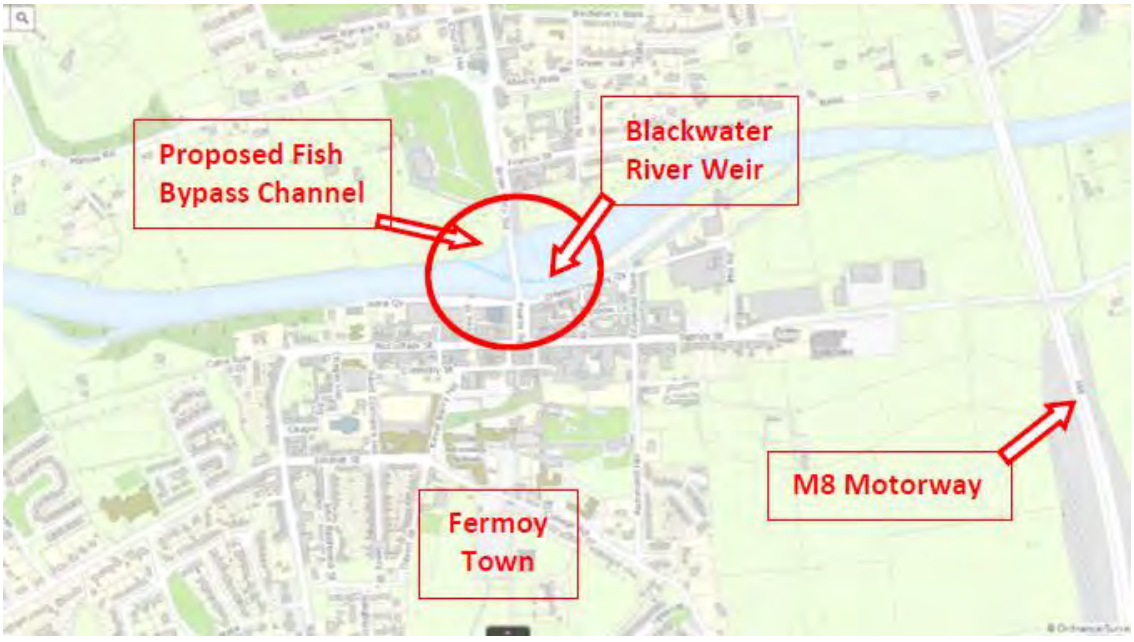


Figure 1-1: Site Location

1.2.2. Existing Scenario

The existing Fermoy weir was constructed in the past using different methods over its length. In general, the weir is constructed as a stone filled embankment with large natural stone bedded in mortar and capped with a thin in-situ concrete capping.

The weir is categorised into two sections namely the embankment section on the upstream side which extends for a distance of 37m east of the second bridge pier. The second section of the weir is referred to as the Mill Race section and forms the remaining section of the weir. Photos of the embankment and Mill Race sections of weir are shown in Figures 1-2 and 1-3 respectively below.

Figure 1-2: Embankment Section of Weir & Existing Fish Pass – June 2021 (Looking Upstream)

The weir has been subjected to localised damage over the years with the capping disintegrating due to the powerful flows in the River Blackwater. The weir has also been breached in two locations.

The effect of the ongoing breaches in the weir is that normal flow in the river Blackwater does not spill over the weir. Instead, the flow in the river is directed through an increasingly narrow section of channel between the downstream section of the weir (Mill Race section) and O'Neill Crowley Quay before passing through the breach in the weir. The velocity of flow within this narrow channel is very high and is almost always in excess of 2m/s. This resultant turbulent flow has contributed to the progressive nature of the breach which is evident in Figure 1-3 overleaf.

Figure 1-3: Mill Race Section of Weir & Breaches – June 2021 (Looking Downstream)

The existing fish pass is incorporated in the weir and is located on the upstream side (west side) of the bridge. This is shown on the Existing Site Layout Plan Drawing No. 19011-TJOC-PL-XX-DR-0051 in Appendix A and can also be seen in Figure 1-2 previous.

The fish pass is located towards the centre of the weir and is of masonry construction. In recent years the fish pass has fallen into a state of disrepair with many of the masonry blocks unravelling and becoming dislodged, some of which can be seen in Figures 1-4 and 1-5 below.

Figure 1-4: View of Existing Fish Pass – June 2021 (Looking Upstream)

Figure 1-5: View of Existing Fish Pass – June 2020 (Upstream)

1.3. Proposed Development

Fermoy weir was constructed in the early 19th Century but has fallen into disrepair with the rate of deterioration accelerating in recent years. The weir is listed as a protected structure, designated as such under the Fermoy Town Development Plan. Cork County Council, as the owner of the weir, is obliged to protect the weir against further deterioration.

Despite the presence of the existing fish pass in the weir, the weir acts as a barrier to the passage of some fish.

The project proposed by CCC involves remediating the existing weir in Fermoy, which is listed as a protected structure under the Planning and Development Act, 2000 and which is also located in the River Blackwater which is designated a Special Area of Conservation (SAC) under the Habitats Directive.

The project requires a solution that will enable CCC to fulfil their obligations to maintain and repair the weir (as its owner) at Fermoy, a Protected Structure under Section IV of the Planning & Development Act 2000 and comply with the conservation and fisheries obligations to provide for the free passage of fish along the river Blackwater arising under the Water Framework Directive, Habitats Directive and Inland Fisheries Act 2010 and related legislation.

In order to comply with the above legislative requirements, CCC propose to construct a new fish bypass channel in the northern bank of the river on the western side of Fermoy bridge and remediate the protected structure that is the weir.

1.3.1. Physical Characteristics of the Development

The proposed project comprises the remediation of the existing weir, including reconstruction of the breaches, and the construction of a rough channel pool bypass to provide for fish passage around the weir. A plan of the proposed works is illustrated on drawing No. 19011-TJOC-PL-XX-DR-C-0052 in Appendix B.

The weir remediation works can be divided into two different elements which comprise the remediation of the upstream section of the weir, including the existing fish ladder incorporated in the weir, and the downstream section of the weir. The weir is categorised as a rubble embankment type weir upstream of the bridge and extending for a distance of 37m east of Fermoy bridge. The remaining section of the weir, extending eastwards, is a gravity wall type weir (Mill Race section). It is this section that has been breached in the approx. locations as shown on the Existing Site Layout Plan drawing 19011-TJOC-PL-XX-DR-C-0051 in Appendix A. These breaches are also visible in Figure 1-4 as noted previously.

A plan of the proposed remediated weir is shown at Drawing 19011-TJOC-PL-XX-DR-C-0060. Proposed remedial details to the existing fish pass are included on Drawing Nos. 19011-TJOC-PL-XX-DR-C-0054 and 19011-TJOC-PL-XX-DR-C-0055. Both of these drawings are included in Appendix B.

1.3.2. Weir remediation - Embankment Section

The remediation of the embankment (crump) section of the weir will involve the removal of the existing concrete apron and resetting of the limestone setts with the addition of random rubble fill (similar to the existing) where required. A high tensile geotextile will be incorporated to assist in reducing wash out of the fill in the embankment. At both the upstream heel and downstream toe of the crump weir section, the undercut / missing stonework will be reset on concrete heel and toe footings along with the addition of rock armour on both the upstream and downstream sides to prevent undercurrents undermining the embankment, in particular on the downstream section in the future.

The crest of the crump weir will be reinstated to a level corresponding to the historic level of the weir as evident from the historic photographs of the weir. A level of 21.45mOD is proposed for this section on the remediated weir.

Cross-sections through the embankment section of the weir, showing the proposed remediation works, are shown at Drawing No.'s 19011-TJOC-PL-XX-DR-C-0061 and 19011-TJOC-PL-XX-DR-C-0062 in Appendix B.

1.3.3. Weir Remediation – Mill Race Weir Wall

The remediation of the Mill Race section of the weir, east of the Bridge, will involve reconstructing the breached sections with existing or new stonework to closely resemble the existing masonry. Given the nature of this section of the weir, it is proposed to inject natural cement (also referred to as Prompt) into the fill sections and place mass concrete in the core of the new section of the weir. The stonework facing will then be pointed in natural cement and the downstream face of the weir protected by adding rock armour. The capping of the Mill Race wall will be removed, the wall raised and the capping reset to a remediated level higher than the adjacent Crump weir, with a level of 21.55mOD proposed.

Cross-sections through the Mill race weir walt section of the weir, showing the proposed remediation works, are shown at Drawing No. 19011-TJOC-PL-XX-DR-C-0063 in Appendix B.

1.3.4. Proposed Fish Bypass

The proposed bypass consists of constructing a curved rock (rough channel pool) ramp type of bypass in the northern bank of the river Blackwater, west of Fermoy bridge. The rock ramp will provide a ladder for fish migrating upstream and resting pools would be created by the varying levels of rock weir walls.

It is proposed to minimise the height of vertical walls on the sides of the curved bypass channel and grade the bypass channel into the existing landscape.

In order to provide for the required level of fish passage, a 28m wide rock ramp type bypass channel, with a crest level of 21.20mOD at the upstream end, is proposed to be constructed in the northern bank of the river.

Upstream water levels will be maintained by providing an approximate 50/50 flow spit between flows in the river and the proposed bypass channel at long term mean flow levels and by reinstating the crest level of the existing weir to 21.45mOD along the length of the embankment (Crump) weir and to 21.55mOD along the length of the Mill Race Weir Wall. All flows up to 12.5% of the long term mean flow will be diverted through the bypass channel. This satisfies Inland Fisheries Ireland requirements for compliance with the DCENR Guidelines on the Construction and Operation of Small-Scale Hydro-Electric Scheme and Fisheries.

A drawing of the proposed fish bypass channel is presented on Drawing No. 19011-TJOC-PL-XX-DR-C-0053. Long-sections and cross-sections of the Fish Bypass channel are included on Drawing No.'s 19011-TJOC-PL-XX-DR-C-0054 and 19011-TJOC-PL-XX-DR-C-0055 in Appendix B.

The bypass channel will facilitate free movement of migratory fish species listed as qualifying interests for the Blackwater River SAC (Sea Lamprey, River Lamprey, Twaite Shad and Atlantic Salmon and movement of Brook Lamprey). The fish pass will also be passable by eel.

1.4. Scope of Assessment

The scope of the assessment includes the following;

- Review the OPW National Flood Hazard Mapping.
- Review any historic flood information for the site.
- Review any relevant Catchment Flood Risk Assessment and Management Studies.
- Review of Fermoy North and South Flood Relief Schemes (including safety files and supporting documentation).
- Identify any risk of fluvial, tidal, pluvial and groundwater flooding.
- Identify any increased risks of flooding upstream as a result of the proposed development.
- Develop potential mitigation measures if required for receptors.

2. THE PLANNING SYSTEM AND FLOOD RISK MANAGEMENT

The Department of Environment, Heritage and Local Government and the OPW published Guidelines for Planning Authorities on the managing flood risk with regard to planning in a document entitled *"The Planning System and Flood Risk Management".*

These Guidelines are issued under Section 28 of the Planning and Development Act 2000 which requires An Bord Pleanála and Local Planning Authorities to implement these Guidelines in assessing planning applications under the Planning Acts.

The core objectives of the Guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off;
- Ensure effective management of residual risk for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders; and
- Ensure that the requirements of European Union and national law, in relation to the natural environment and nature conservation, are complied with at all stages of flood risk management.

The Flood Risk Management Guidelines require the adoption of a sequential approach of flood risk management by regional and local authorities, developers and their agents in attempting to:

- Avoid the risk, where possible;
- Substitute less vulnerable uses, where avoidance is not possible; and
- Mitigate and manage the risk, where avoidance and substitution are not possible (including justification).

2.1. Definition of Flood Zones

Flood zones are defined in the Guidelines as *"geographical areas within which the likelihood of flooding is within a particular range"*. There are three types of flood zones as summarised in Table 2-1 below.

Table 2-1: Definition of Flood Zones

Flood Zone	Description
A	Probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
B	Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 and 0.5% or 1 in 200 for coastal flooding)
C	Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

2.2. Definition of Vulnerability Classes

The Guidelines grades types of development in accordance with how vulnerable they would be to flooding. Table 2-2 below is reproduced from Table 3.1 of the *"Planning System and Flood Risk Management Guidelines"* and outlines the typical developments under the three vulnerability classes.

Table 2-2: Definition of Vulnerability Classes

Class	Description
Highly Vulnerable	Includes: Garda, ambulance, fire stations, hospitals, schools, residential dwellings and institutions, primary transport and utilities distribution and potential significant sources of pollution in the event of flooding.
Less Vulnerable	Includes: retail, leisure, warehousing, commercial, industrial and non-residential institutions etc.
Water Compatible Development	Includes: **flood control infrastructure**, docks, marinas, wharves, **navigation facilities**, ship building, fish processing, **water-based recreation and tourism** (excluding accommodation), lifeguard and coastguard stations, amenity open space and outdoor sports and recreational facilities.

Underlining indicates uses relevant to this development

2.3. Appropriate Development and the Justification Test

Table 3.2 of *"The Planning System and Flood Risk Management Guidelines"* outline those types of development that would be considered appropriate to each flood zone and is reproduced in Table 2-3 below. A justification test is required in instances where development is proposed in areas of moderate or high flood risk. The test is designed to rigorously assess the appropriateness or otherwise, of these developments which would be at risk of flooding.

Table 2-3: Matrix of Vulnerability versus Flood Zones

Class	Flood Zone A	Flood Zone B	Flood Zone C
Highly Vulnerable	Justification Test	Justification Test	Appropriate
Less Vulnerable	Justification Test	Appropriate	Appropriate
Water Compatible Development	Appropriate	Appropriate	Appropriate

The proposed fish bypass channel, which is considered as a navigation facility for fish, is classed as water compatible development in Table 2-3 above.

The weir, before it fell into a state of disrepair, maintained the water level upstream which facilitated recreational activities such as rowing with the weir itself also promoting tourism in the town of Fermoy due to its long-term existence in the river Blackwater. As such, the proposed remedial works to the weir are also categorised as water compatible development in Table 2 above.

The Justification Test is discussed further in Section 4.7 of this report.

3. STAGE 1 – FLOOD RISK IDENTIFICATION

3.1. Available Information

In order to conduct the assessment, the following sources of information have been consulted as summarised in Table 3-1:

Table 3-1: Review of Available Information

	Information Source	Coverage	Quality	Confidence	Identified Flood Risks	Flood Risk
Primary Data Sources & Modelled Data	OPW National Flood Hazard Mapping (www.floodmaps.ie)	National	High	Moderate	Flood maps indicate that the site is in Flood Zone A	No
	OPW South Western CFRAM-Fluvial	Regional	High	High	Flood maps indicate that the site is in Flood Zone A	No
	OPW South Western CFRAM-Tidal	Regional	High	High	Site is inland and remote from coastal flood zones	No
	Fermoy North and South Flood Defence Schemes (Munster Blackwater Drainage Scheme)	Local	High	High	Both schemes were constructed to alleviate the flood risk in Fermoy.	No
Secondary Data Sources	OPW Historic Flood Records	National	Varies	Varies	Previous flooding occurred in the town of Fermoy adjacent to the site prior to construction of OPW Munster Blackwater Fermoy Drainage scheme.	-
	Walkover Survey	Local	Moderate	Moderate	Site comprises existing weir located in the river Blackwater as well lands on the northern bank of the river. Proposed development is water compatible, i.e. remediated weir and new fish bypass channel	-

Other information sources referred to are as follows;

- Guidelines for Planning Authorities on "The Planning System and Flood Risk Management", November 2009 (OPW and Department of Environment, Heritage and Local Government)
- Cork County Council County Development Plan 2014 – 2020 (as varied)
- South Western CFRAM Study

3.2. Identified Flood Sources

3.2.1. CFRAM Programme

The National Catchment Flood Risk Assessment and Management (CFRAM) Programme was developed to meet the requirements of the European Union Floods Directive (2007/60/EC), as well as to deliver on the core components of the 2004 National Flood Policy. The CFRAM Programme is split into three phases, being:

- The Preliminary Flood Risk Assessment (PFRA) – 2011
- The CFRAM Studies and parallel activities – 2011-2015
- Implementation and Review – 2016 onwards

The PFRA was completed in 2011 and comprised of a national screening exercise, based on available and readily-derivable information, to identify areas where there may be a significant risk associated with flooding.

The proposed development site at Fermoy is located within the confines of the South Western CFRAM Study. This study produced flood extent and flood depth maps for fluvial flooding associated with the River Blackwater. These maps provide the basis for determining the flood zone for the development in line with the Planning System and Flood Risk Management Guidelines.

3.2.2. Historic Flooding at the Site

The historic flooding information available on www.floodinfo.ie was reviewed. A summary of the historic flooding records is provided in Table 3-2 below.

Table 3-2: Summary of Historical Flood Events

No.	Date of Event	Source	Areas Affected
1	30th December 2013	Run-off from Surface Water Drainage	Junction of Elbow Lane / Market Place / Fitzgerald Place, Fermoy
2	19th and 20th November 2009	Fluvial	Fermoy
3	6th November 2000	Fluvial	Fermoy
4	30th December 1998	Fluvial	Fermoy
5	October 1988	Fluvial	Fermoy
6	6th August 1986	Fluvial	Fermoy
7	November 1980	Fluvial	Fermoy
8	Recurring	Unknown	Fermoy

It can be seen from Table 3-2 above that the town of Fermoy is susceptible to fluvial flooding from the river Blackwater.

It should be noted that the Fermoy North and Fermoy South flood defence schemes were completed by the OPW in 2009 and 2014 respectively. These schemes have significantly alleviated the risk of flooding to the town of Fermoy as a result. These schemes comprised the construction of flood defence walls, embankments and the installation of demountable flood barriers which are erected prior to an impending flood event.

Since the completion of the Fermoy North and Fermoy South Flood Defence Schemes, the demountable barriers have been erected on a number of occasions. Significant flows were experienced on the River Blackwater on the 30th December 2015 and again on 24th February 2021. Minor flooding occurred behind the defences in Brian Boru Square in the February 2021 event as a result of pump failures at Rathealy Road PS.

3.3. Source-Pathway-Receptor Model

The assessment of flood risk requires an understanding of where the water comes from (the source), how and where it flows (the pathways) and the people and assets affected by it (the receptors).

Water-compatible development is permissible in Flood Zone A as shown in Table 2-3. Therefore, tidal and fluvial flood events will not impact the proposed development which consists of remediating the weir and constructing a new fish bypass channel in the northern bank of the river. However, the potential impacts of reinstating the breaches in the weir, and any increased flood risks associated with the increased upstream water level upstream of the weir, also need to be considered.

The Source-Pathway-Receptor model is used to assess and inform the management of flood risks. The Source-Pathway-Receptor analysis is presented in Table 3-3 below.

Table 3-3: Source-Pathway-Receptor Analysis

Source	Pathway	Receptor	Likelihood	Impact	Risk
Fluvial	Potential for remediated weir to impact upstream landowners and / or increase flood risk due to increased upstream water level from reinstating breaches in weir.	Upstream properties and / or landowners	Possible.	Low	Low
Fluvial	Changes to river levels as a result of remediating weir and constructing	People, Property. The OPW Fermoy flood defence schemes incorporate specified	Possible	High	Low

	new fish bypass channel	trigger levels for erecting demountable flood barriers when these levels are observed in the river.			
Tidal	Site is remote from coastal flooding zones. Development is also water compatible	-	Very remote	-	-

3.4. Consultation with OPW

The OPW were consulted in regards to the proposed weir remediation and fish bypass channel works for the purpose of establishing what consents and approvals are required to be obtained from them for the works (e.g., Section 50, etc.)

During this consultation process the OPW advised that the impacts of the reinstated weir and new fish bypass channel on upstream lands, and on the current trigger levels for erecting the OPW Fermoy flood defence scheme barriers, would need to be considered as part of the flood risk assessment. The OPW also advised that there should be no increase in flood risk at Fermoy as a result of the proposed works.

4. STAGE 2 – INITIAL FLOOD RISK ASSESSMENT

4.1. Introduction

The Initial Flood Risk Assessment comprises of the following activities:

- Confirmation of the sources of flooding that may affect the development site;
- Assessment of the adequacy of existing information;
- Determination of surveys and modelling approach appropriate to match the complexity of the flood risk issues;
- Determine extent of flooding and assess potential impact of a development on flooding downstream; and
- Scope possible mitigation measures.

The potential source(s) of flooding as identified in the Stage 1 are:

1. Fluvial flooding.

An initial flood risk assessment for this source is considered in the Section 4.2.

4.2. Fluvial Flood Risk

Fluvial flood maps were produced for the South Western CFRAM study. Map No. MMD/296235/E/DR/I18HFY/EXFCDEXF/F/Sht005 included in Appendix C illustrates that the proposed development is located within Flood Zone A.

The design flows for the Fermoy Flood Relief Scheme are set out in Table 4-1 below. These figures are derived from Irish Growth Curves as set out in the Jacobs Babtie "Additional comment on the Fermoy design flow calculation" dated February 2014, reproduced at Appendix G.

Table 4-1: Fermoy FRS Design Flows

Return Period	FSR Irish Growth Curve	Flood Flow m^3/s
2	1	376
5	1.26	475
10	1.44	542
25	1.68	633
50	1.86	701
100	2.06	776
200	2.25	847

The design levels for the Fermoy Flood scheme with the barriers in place correspond to 25.25mOD at Gauge 18107 on the north bank downstream of Fermoy Bridge. A trigger

level of 25.28mOD is noted for Q100 at the gauge d/s of Fermoy Bridge (Ref 18107) in Section 6.2 of the OPW's Fermoy Flood Alleviation Scheme Fermoy North Protocol Demountable Structures Protocol, v1.2, April 2015, with the comment "Design Flood – Plan for exceedance of defence levels". The location of these defences is shown at Drawing 19011-TJOC-PL-XX-DR-C-0089 HecRas Modelling Output Locations at Appendix D.

The proposed level for the remediated section of the weir is 21.45moD and 21.55mOD at the upstream embankment section and downstream Mill Race section of the weir respectively with the level of the new bypass channel proposed at 21.20mOD on the upstream side. As such, the proposed development will be submerged during flood events of this magnitude. However, water compatible development which, as per the Planning System and Flood Risk Management Guidelines, is appropriate development within Flood Zone A as illustrated in Table 2-3 previous.

As noted in Section 3.4, the OPW advised that the impacts of the reinstated weir and new fish bypass channel on upstream lands and on the current trigger levels for the erecting the Fermoy flood defence scheme barriers would need to be considered as part of this FRA. In view of this, a hydraulic model has been prepared as part of the Stage 3 FRA in Section 5 of this report to consider these impacts.

4.3. Pluvial Flood Risk

Pluvial flooding occurs due to insufficient capacity in the local drainage network system which results in overland flows as well as the ponding of water in topographically low points. It is usually associated with high intensity rainfall. While pluvial flooding is an important consideration, it can be addressed by site specific drainage and management measures aimed at mitigating the effects of pluvial flooding.

The review of historic flooding at the location of the proposed development, and in close proximity as summarised in Table 3-2, illustrates that the sources of flooding for the flood events which occurred closest to the site were all associated with fluvial flooding. In addition, as the proposed development works are water compatible and are all situated in the river Blackwater, the development will not be at risk to pluvial flooding.

4.4. Overland Flow Flood Risk

Overland flooding can often be characterised by flood waters overspilling watercourses during significant rainfall events, pluvial flooding or by a combination of both, which results in flows overland and subsequent flooding often caused by ponding.

The proposed development site is water compatible and is located in the river Blackwater. Therefore, it is not at risk to flooding from overland flood flows or does not interfere with existing overland flood flow routes.

4.5. Tidal Flood Risk

The Floodinfo maps for Fermoy show that the development site is neither within or near the 0.5% AEP coastal flood zone or the coastal extreme event zone.

The river Blackwater is not subject to tidal influence at Fermoy. As such, tidal flood risk is not considered any further in this report.

4.6. Existing Fermoy Flood Defence Schemes

The Fermoy North and South flood defence schemes were completed in 2009 and 2014 respectively. The overall objective of both projects was to develop a flood alleviation scheme to protect the town of Fermoy from flooding up to a 1% AEP flood event as the town had been severely affected by flooding from the River Blackwater in the past.

The schemes included for the construction of both temporary and permanent demountable walls as well as an earthen embankment on both sides of the Blackwater River. The schemes also included for the construction of storm drains and pumping stations behind the defences to prevent, or substantially, reduce the periodic localised flooding of lands and properties in the area.

The Fermoy Flood Relief Scheme consists of a number of flood alleviation elements which when all correctly operational will protect the North and South side of the River Blackwater against a flood with an annual probability of occurrence of 1% AEP.

The scheme comprises of the following elements:

- Demountable defences;
- Pull up posts and demountable defences on low permanent flood walls;
- Flood walls;
- Embankments and land drains;
- Drainage collection systems;
- Foul and storm pumping stations including intake/outlet debris screens and nonreturn valves;
- Penstock closures;
- Mobile pumps.

Extensive hydrological studies were commissioned by the OPW to inform the design of the Fermoy Flood Defence Schemes. Flood estimates were derived for Fermoy for the eight historical events between 1980 and 2002 using a model which routed flows measured at Killavullen (Babtie 2003). These flood estimates were reviewed in 2011 by Jacobs and DHV to take account of discrepancies that were identified between observed and predicted flood levels in Fermoy.

Following the construction of the Fermoy North and South Drainage Schemes, the OPW undertook some model calibration surveys. However, the hydraulic model was not updated to reflect post construction. The original model included pre-and post-construction scenarios.

Further modelling has been undertaken using HEC-RAS 2D modelling software to consider the flood implications of the diversion of flows to the Bypass and the minor alterations to the weir level and is discussed further in Section 5. The deterioration and subsequent breach of sections of the weir in recent years has led to the flow regime being altered. The flow is now concentrated at the Mill Race as a consequence, which resulted in significant erosion that required emergency works to be undertaken by the OPW in the autumn of

2020 to avoid undermining the existing flood defence structures. The current flow regime has also been assessed in the modelling which is discussed in Section 5 of this report.

The Office of Public Works have implemented a Flood Warning System for the River Blackwater that will provide the defence installers with at least 8 hours warning time to allow their staff to implement those works that are necessary to complete the defences.

In summary, for a predicted major flood event, the following interventions are required:

- Erection of warning signs;
- Traffic diversion;
- Public preparedness & liaise with local authorities & Gardai;
- Erection of demountable defences;
- Opening / closing of penstocks;
- Installation of mobile submersible pumps.

Protocols have been implemented by the OPW to provide for these interventions on both the Fermoy North and Fermoy South flood defences with trigger levels applied for different modes of operation.

4.7. Justification Test

As discussed in Section 2.3, a Justification Test is required in cases where development is proposed in areas of moderate or high flood risk. Water compatible development within Flood Zone A is permissible and does not require a Justification Test to be carried out.

Therefore, in this instance it is not necessary to apply the Justification Test for the proposed development as water compatible development is permissible in Flood Zone A.

4.8. Stage 2 Conclusion

Following the assessment of flood risk for the proposed development and the available information for the site, it is concluded that the proposed development is entirely located within Flood Zone A as determined from the South Western CFRAMS flood mapping. This is the most up to date information available for classifying the site at the time of writing this report.

The proposed development is located in the river Blackwater and is water compatible development which is permissible in Flood Zone A under the Planning System and Flood Risk Management Guidelines.

As the proposed development is water compatible, it is not considered to be at risk to fluvial or pluvial flooding. The river Blackwater is not subject to tidal influence at Fermoy and is therefore not at risk to tidal flooding.

There is no information or previous hydraulic modelling available to assess the impact of the proposed development on upstream lands or on the trigger levels for the Fermoy flood defence schemes as required based on the OPW consultations discussed previously. This flood risk assessment will therefore need to assess these impacts on the basis of developing a site-specific hydraulic model for the proposed development. This will enable

the impact of the proposed development on upstream lands, and on the trigger levels for the Fermoy flood defence schemes (if any), to be assessed. This is addressed in the Stage 3 Site-Specific Flood Risk Assessment in Section 5 of this report.

4.9. Allowance for Climate Change

The *"Planning System and Flood Risk Management Guidelines"* advise a precautionary approach with regard to climate change. The precautionary approach includes:

- Ensuring that the levels of structures designed to protect against flooding, such as flood defences, land-raising or raised floor levels are sufficient to cope with the effects of climate change over the lifetime of the development they are designed to protect; and
- Ensuring that structures to protect against flooding and the development protected are capable of adaptation to the effects of climate change when there is more certainty about the effects and still time for such adaptation to be effective.

5. STAGE 3 – DETAILED FLOOD RISK ASSESSMENT

5.1. Previous Modelling

Extensive hydrological studies were commissioned by the OPW to inform the design of the Fermoy Flood Defence Schemes. Flood estimates were derived for Fermoy for the eight historical events between 1980 and 2002 using a model which routed flows measured at Killavullen (Babtie 2003).

A design memo was also prepared by DHV in 2007, based on the previous hydrological studies mentioned above, to determine the trigger levels (detected in the river) for when to erect the demountable flood barriers. In order to define this set of trigger levels, detailed information on the flood levels for different return periods and frequencies had to be developed. These flood estimates were reviewed in 2011 by Jacobs and DHV to take account of discrepancies that were identified between observed and predicted flood levels in Fermoy. The flood levels predicted in the 2007 memo were identified as being the source of the discrepancies.

Following the construction of the Fermoy North and South Drainage Schemes, the OPW undertook some model calibration surveys. However, the hydraulic model was not updated to reflect post construction. The original model included pre-and post-construction scenarios. This model was not available for use in this flood risk assessment exercise.

The OPW also commissioned a 1D Hydraulic model of the Blackwater at Fermoy for the South West CFRAMS Study.

A 2D HEC-RAS model, which has been developed for this FRA and is discussed in further detail in the following sections, incorporates elements of the CFRAMS 1D model in respect of cross-sections upstream and downstream in the immediate vicinity of the weir and bridge.

5.2. Hydrology

5.2.1 Catchment Description

The River Blackwater rises in County Kerry in the Mullaghareirk Mountains and initially flows in a southern direction to Rathmore before flowing in an easterly direction to join the Irish Sea at Youghal. The river passes through a number of towns along its route with the largest being Mallow, Fermoy and Youghal. Fermoy is located approximately 50km upstream of the mouth of the river and is not tidally influenced as previously noted in Section 4.5.

The valley is broad and relatively flat and is surrounded by mountains with the ranges of Knockmealdown, Kilworth, Galtee, Ballyhoura and Mullaghareirk to the north and the Boggeragh range to the south.

The catchment is entirely rural and is dominated by pasture and grazing with lesser extents of cultivated land and some forest cover principally in the west. No significant urban areas exist that are likely to affect the flood flow characteristics of the river. There is also a lack

of large and medium sized water bodies (lakes or reservoirs), which can have an influence on flood flows, for such a large catchment.

5.2.2. Design Flows

A review of the available information was undertaken to identify the most appropriate flow data for use as the design flows in the 2D HEC-RAS model.

There are 4 No. gauging stations located in the vicinity of Fermoy Weir as shown in Figure 5-1 below. These gauges are as follows;

1. 18124 Fermoy Rowing Club – depth only gauge.
2. 18106 U/S Fermoy Bridge – depth only gauge.
3. 18107 D/S Fermoy Bridge – depth and flow gauge.
4. 18117 Fermoy Mill – depth only gauge.

It is noted that although gauge 18124 (Fermoy Rowing Club) is located within the vicinity of the proposed development, the HEC-RAS model developed for this FRA commences downstream of this gauge. Therefore, the gauge could not be calibrated with the model as it is outside the model extents.

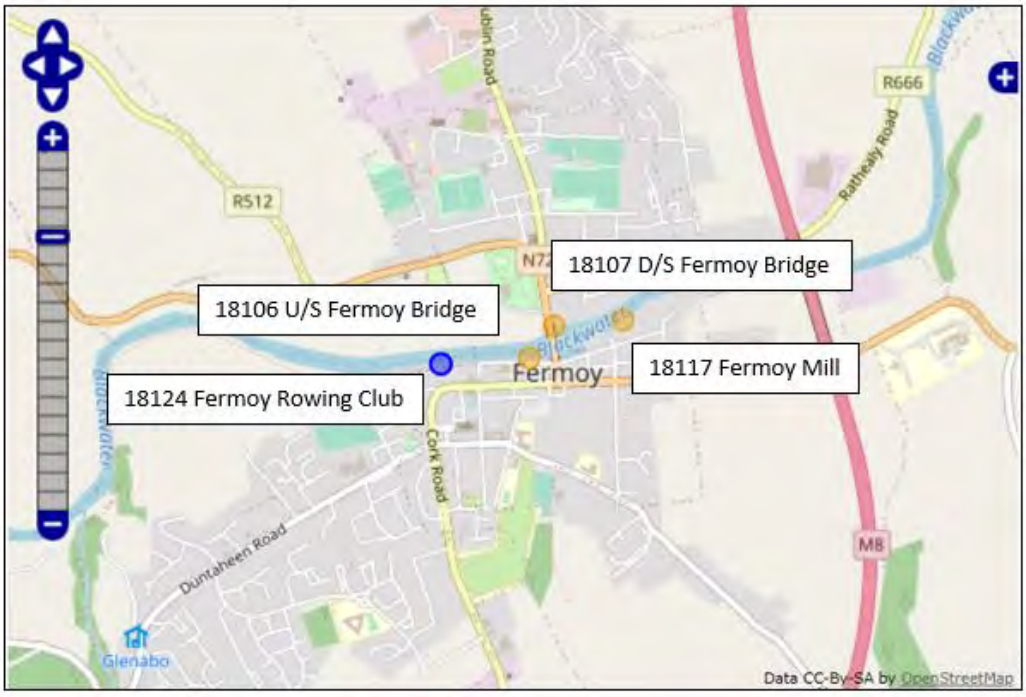


Figure 5-1: Existing Gauging Stations in Fermoy

Various data was considered by TJOC when determining the design flows to use for the HEC-RAS model. The OPW were also consulted with regard to the design flows and data to use for the model. The OPW advised that the rating curve used in the HEC-RAS model should be reviewed taking account of the increased length of observations of depth and flow available at gauge 18107, building on information originally gathered between 2006 and 2011.

Measured data at Fermoy gauge 18107 was provided by the OPW for the period of 2006 – 2021. The max and min flows observed during this period were 509m3/s and 7.4m3/s respectively.

Rating curves were then developed for a range of datasets which consisted of the OPW 2006 – 2021 data, annual max data extracted from the waterlevel.ie website in addition to the observed data used in the 2014 Jacobs Babtie report (spot gaugings and fitted trendline data in Figure 5-2 below), included at Appendix G. The rating curves were initially developed using a polynomial line of best fit for each dataset. Predicted flows for the higher depths were then extrapolated using the respective equation for each of the rating curves. The rating curves that were initially developed are illustrated in Figure 5-2 below.

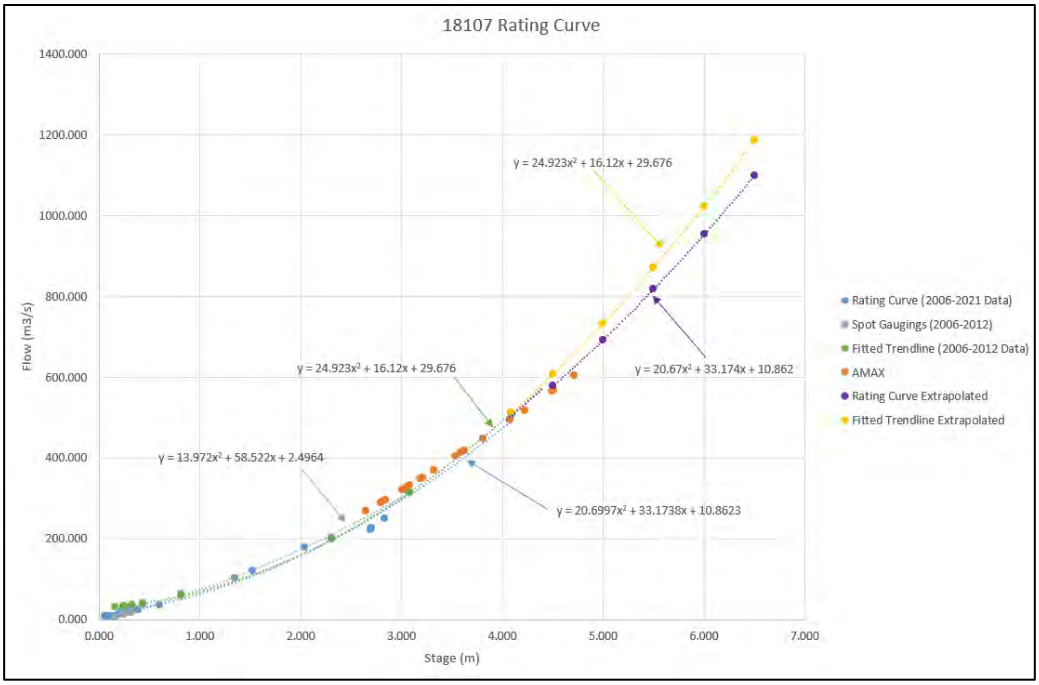


Figure 5-2: Rating Curves Initially Developed

The various rating curves considered are presented in Table 5-1 below.

Table 5-1: Comparison of Rating Curve Formulae

	Source	Formula	Flow	Depth	R^2 number
A	Jacob's Fitted trendline 2014	$Q = 24.923x^2 = 16.12x + 29.676$	776m³/s	5.158	0.9483
B	TJO'C Polynomial Equation (2006-2021 data)	$Q = 20.6697x^2 + 33.1738x + 10.8623$	776m³/s	5.335m	0.9657
C	OPW format 2014 Rating Curve	$Q = 63.4(h+0.1)^{1.432}$	776m³/s	5.65m	0.9863
D	TJOC Updated OPW Format Rating Curve (2006-2021 data)	$Q=57.07(h+0.075)^{1.4825}$	776m³/s	5.741m	0.9825

Following consultation with the OPW, the OPW advised that the traditional form of equation for the measured data would yield a level at the design flows higher than the polynomial equations (rating curves in Figure 5-2) which would potentially result in significant differences. The OPW recommended the model to be calibrated based on the traditional form of rating curve and the subsequent derived flows for the calibration events. Therefore, the spline (Polynomial) type equations (A and B in Table 5-1 above) were excluded from further consideration.

A rating curve was subsequently developed from the 2006 – 2021 data to determine the fitting of this observed data to the standard rating curve format to assess its suitability for use in the hydraulic model. These calculations are set out in Appendix F. It should be noted that the analysis undertaken by Jacobs Babtie in 2014 developed a rating curve, corresponding to the flows in Table 4-1, using the standard form of rating equation. This rating curve and the associated equation is illustrated in Figure 5-3 below which was extracted from the Jacobs Babtie 2014 report (see Appendix G).

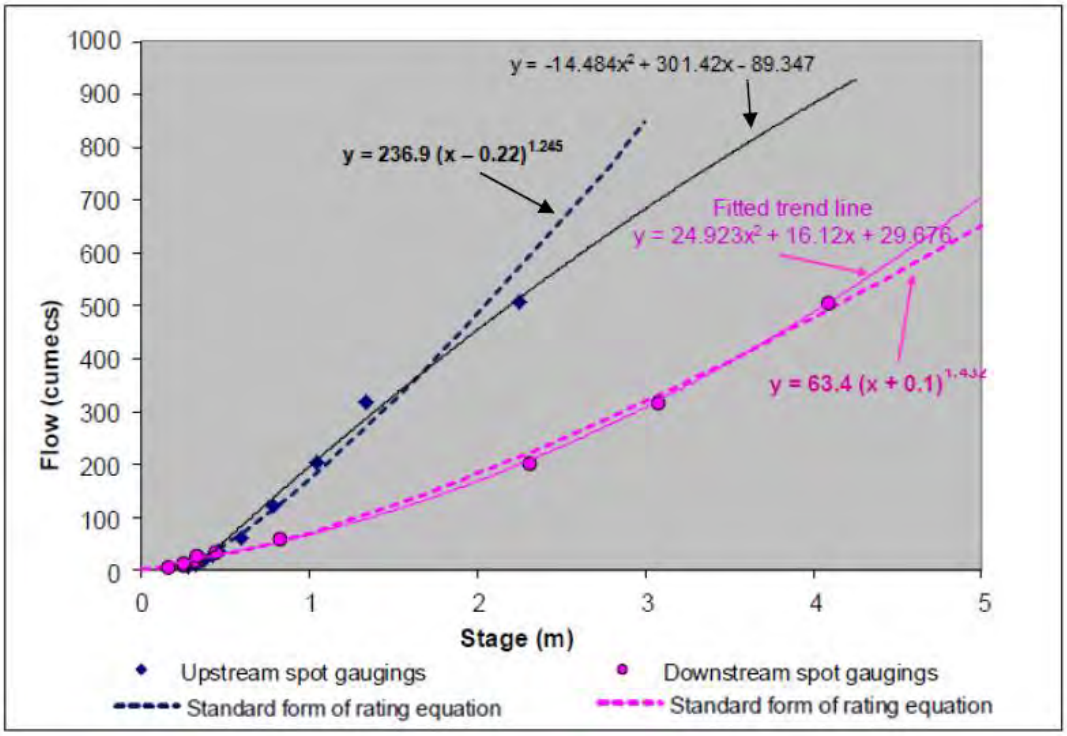


Figure 5-3: Rating Curve Developed in 2014 Jacobs Babtie Report

The regression (R^2 value) analysis in Appendix F, which was undertaken for the 2006 – 2021 measured data provided by the OPW at gauge 18107, determined a predicted regression analysis R^2 value of 0.9824. However, the 2014 Jacobs analysis determined a better regression analysis R^2 value of 0.9862 (with the same data) than the analysis undertaken in Appendix F. It was therefore concluded that there was no benefit in revising the rating curve from that used in the 2014 Jacobs report.

Following consultation with the OPW, the design flows used in the HEC-RAS model were the final design flows contained in the 2014 Jacobs Babtie report referenced in Section 4.2 above and as summarised in Table 4-1. In addition to this, data was abstracted from the gauges in the area for the flood events on 30th December 2015 (prior to the breaches

occurring in the weir) and also for the flood event of 24th February 2021 (with breaches in the weir). This data was also used to calibrate the model and is discussed further in Section 5.3.

5.3. Hydraulic Model

5.3.1. Model Configuration

As previously noted, a 2D HEC-RAS model has been developed as part of this flood risk assessment. The OPW commissioned a 1D hydraulic model of the Blackwater at Fermoy as part of the South West CFRAMS Study. The 2D HEC-RAS model which has been developed for this flood risk assessment incorporates elements of the OPW's 1D model in respect of cross-sections upstream and downstream of the weir and bridge. The 2D HEC-RAS model produced for this report has been developed to consider the implications of the detailed layout of the proposed weir remediation and fish bypass channel. As noted in Section 3.4, the OPW requires that any proposed modification to the weir and any works within the flood plain will not result in any increased flood risk at Fermoy.

The model extends for a distance of approx. 365m upstream and 380m downstream of Kent bridge. The model has been developed with the weir in its existing condition with a separate model also prepared with the weir in its proposed remediated state as per the details on the drawings included in Appendix B of this report. The proposed fish bypass channel, as also detailed on the above-mentioned drawings, is also incorporated into the proposed hydraulic model in conjunction with the weir in its remediated state.

The model extent is shown at Figure 5-4 below.

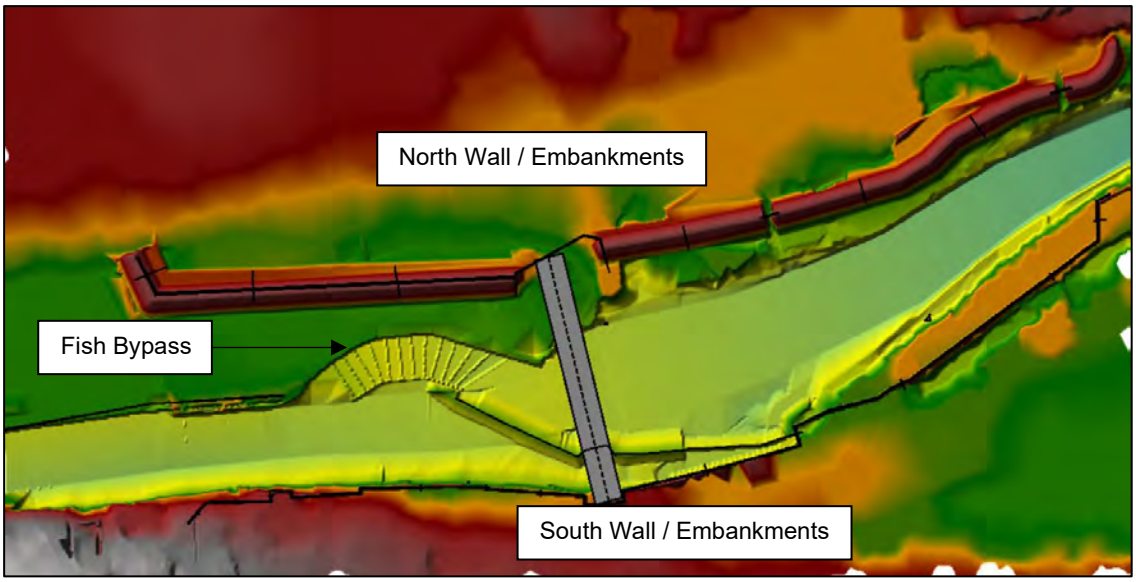


Figure 5-4: HEC-RAS 2D Model Extent (Proposed Scenario)

5.3.2. Topographical Information & Model Surface

The surface for the hydraulic model was developed based on a range of datasets which were compiled together to generate the surface for the hydraulic model. The data was compiled from a range of sources, the majority of which TJOC have on file from previous and current projects in Fermoy over the years. The data used to generate the 2D surface in HEC-RAS is made up of the following sources;

- 2003 Aerial Survey conducted by BKS for the greater Fermoy area.
- Fermoy North and South flood defence schemes as-built drawings, surveys and studies.
- 2018 weir survey undertaken by Murphy Geospatial.
- 2020 river bed survey undertaken by Murphy Geospatial.
- As-built drawings from the OPW 2020 emergency works.

Therefore, it should be noted that the HEC-RAS modelling is limited to the accuracy and extent of the survey information available and that the model has been developed for the assessment of flood risk associated with the proposed development.

5.3.3. Model Calibration

The HEC-RAS models (existing and proposed scenarios) produced by TJOC for this FRA have been reviewed and calibrated against observed peak flood events on the 30th December 2015 and the 24th February 2021.

The following process was adopted when calibrating the hydraulic model:

1. The existing model was calibrated against the flood event on 30th December 2015 with no breaches within the weir (existing model).
2. The breaches in the weir were introduced to the model and the model calibrated against the flood event of 24th February 2021 (existing model).
3. The proposed scheme was then introduced (i.e. remediated weir with no breaches and new fish bypass channel) to the calibrated model and the model simulations were re-run (proposed model).

In order to provide a true representation of the selected flood events in 2015 and 2021, an outflow stage hydrograph was introduced to both existing models to confirm the water surface elevations (WSE) obtained from the HEC-RAS model correlated with the associated flood events. Stage hydrographs from gauge 18117 (Fermoy Mill) were used for the selected flood events from 2015 and 2021 for input into the HEC-RAS model and are shown in Figures 5-5 and 5-6 respectively.

The information obtained and displayed within Figure 5-5 to Figure 5-11, indicate flood levels relating to Poolbeg datum. The conversion is made from Poolbeg datum to Malin datum within Table 5-1, in order to correlate with the existing and proposed scenario as within Section 5.3.8. Furthermore, the datum indicated on the OPW website is set at 19.220moD while the surface for the HecRas model has a level of 19.350mOD at this location.

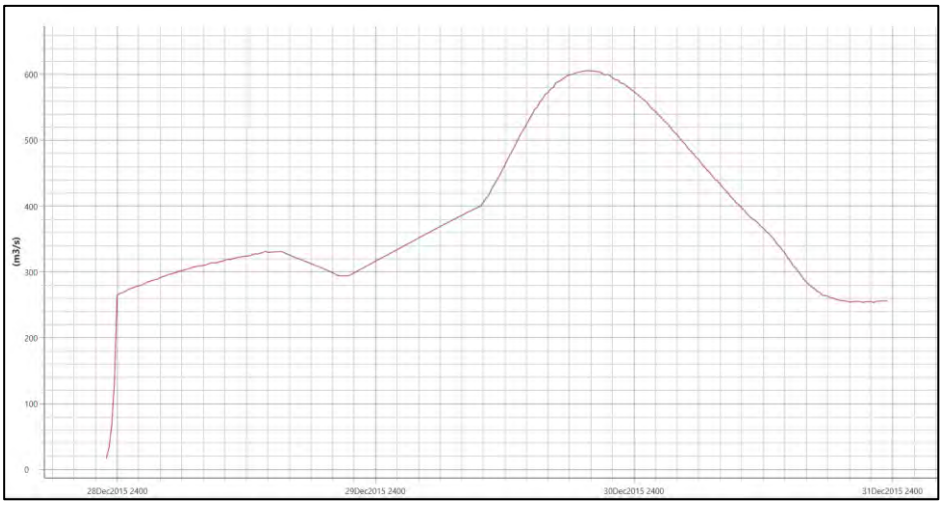


Figure 5-5: Outflow Stage Hydrograph from HEC-RAS Corresponding to OPW Data for 30/12/2015 Flood Event

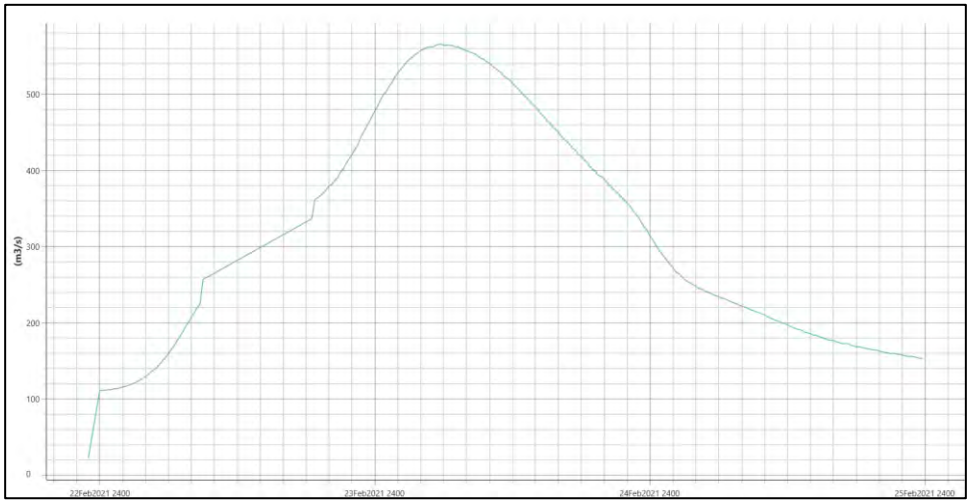


Figure 5-6: Outflow Stage Hydrograph from HEC-RAS Corresponding to OPW Data for 24/02/2021 Flood Event

5.3.4. Calibration with December 30th 2015 Flood Event

Flow information for the 30th December 2015 flood was obtained from the OPW website www.waterlevel.ie.

The period of flow data used for the 2015 flood was taken from 29/12/2015 at 00:00 to 31/12/2015 at 23:45 to provide a hydraulic model commencing 1 day before the peak flood and 1 day after the recorded flood event. The time distribution for the model was therefore run over a 3-day simulation period.

There was a gap in the OPW gauge information at gauge 18107 for the data for the 2015 flood between the period of 15:30 on 29/12/2015 to 10:00 on 30/12/2015. This gap in information was addressed by interpolating between the data by applying the same curve distribution from the depth profiles within gauge 18106 and 18117. The information gap can be seen below in Figure 5-7 with the interpolated data shown in Figure 5-8. The

maximum flow rate recorded during the December 2015 flood was 606.014m3/s which occurred at 20:00.

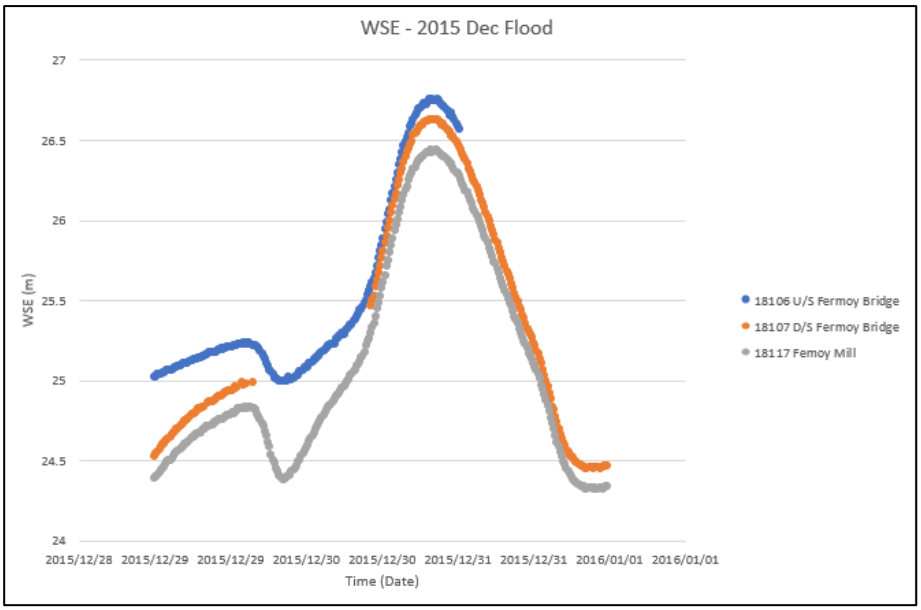


Figure 5-7: Gap in Flow Data at Gauge 18107

Gauge 18106 Upstream of Fermoy Bridge

The max water level obtained from the OPW website for gauge 18106 on 30th December 2015 was 26.756AOD Poolbeg (*24.046mOD Malin*). Figure 5-9 illustrates the water surface elevation (WSE) at this gauge for both the existing HEC-RAS (Modelled data) and OPW (Observed data). The HEC-RAS model estimated a water level of 24.202mOD Malin, resulting in a depth of 0.156m above the OPW observed water level. Allowing for adjustment due to the difference in levels between the gauge datum and the HecRas model surface results in a model predicted depth of 0.026m above OPW observed water level.

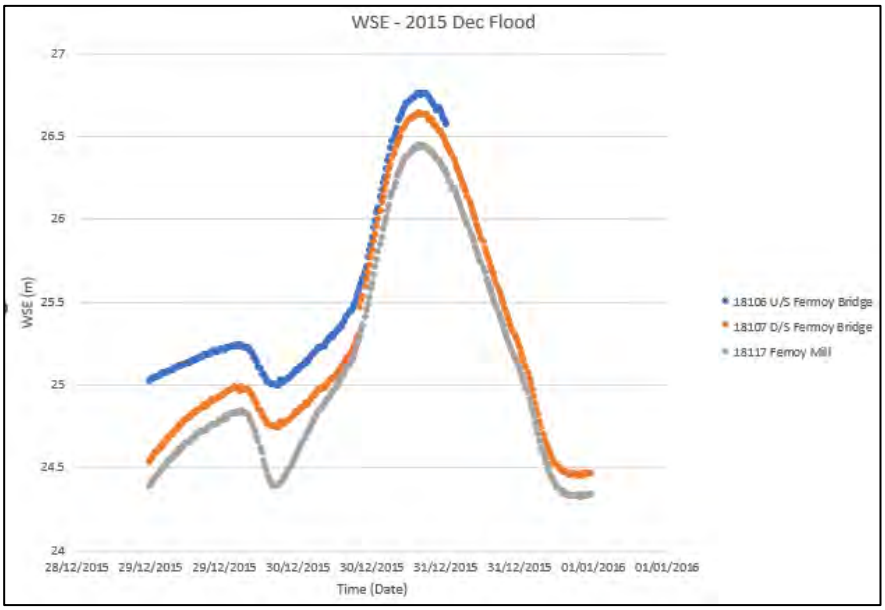


Figure 5-8: Interpolated Flow Data for 30/12/2015 at Gauge 18107

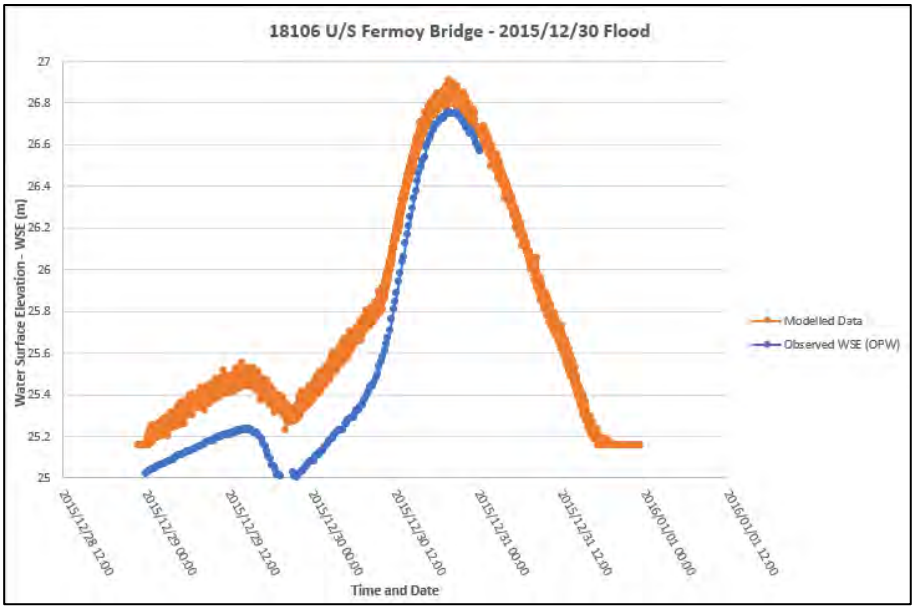


Figure 5-9: Modelled vs Observed Data for 30/12/2015 Flood at Gauge 18106

Gauge 18107 Downstream of Fermoy Bridge

The max water level obtained from the OPW website for gauge 18107 on 30th December 2015 was 26.631AOD Poolbeg (*23.921mOD Malin*). Figure 5-10 illustrates the WSE at this gauge for both the existing HEC-RAS (Modelled data) and OPW (Observed data). The HEC-RAS model estimated a water level of 24.020mOD Malin, resulting in a depth of 0.099m below the OPW observed water level. Allowing for adjustment due to the difference in levels between the gauge datum and the HecRas model surface results in a depth of 0.031m below the OPW observed water level.

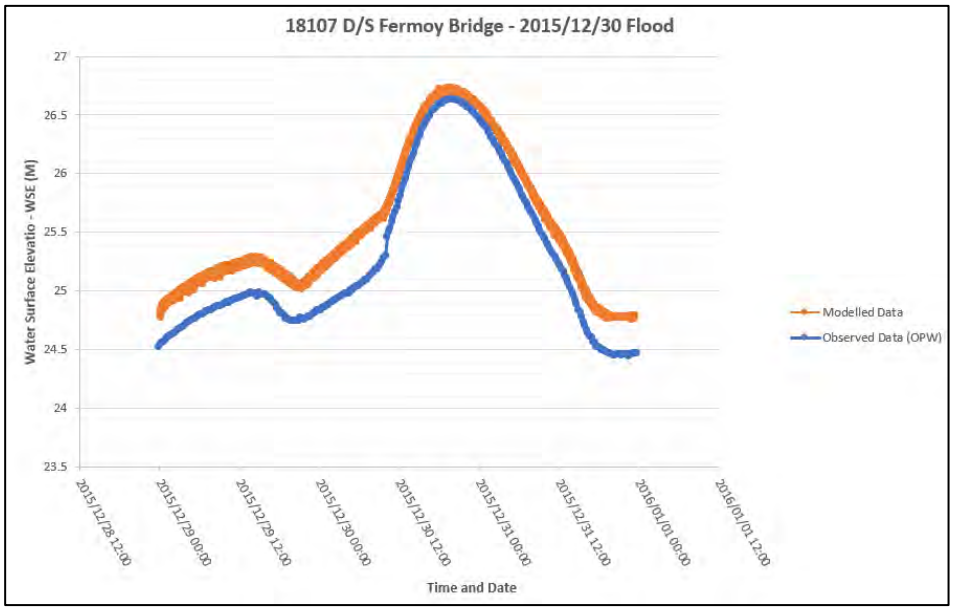


Figure 5-10: Modelled vs Observed Data for 30/12/2015 Flood at Gauge 18107

Gauge 18117 Fermoy Mill

The peak water level obtained from the OPW website for gauge 18117 on 30th December 2015 was 26.441AOD Poolbeg (*23.731mOD Malin*). Figure 5-11 illustrates the WSE at this gauge for both the existing HEC-RAS (Modelled data) and OPW (Observed data). The HEC-RAS model estimated a water depth of 23.950mOD Malin, resulting in a depth of 0.219m above the OPW observed water level. Allowing for adjustment due to the difference in levels between the gauge datum and the HecRas model surface results in a depth of 0.089m above OPW observed water level.

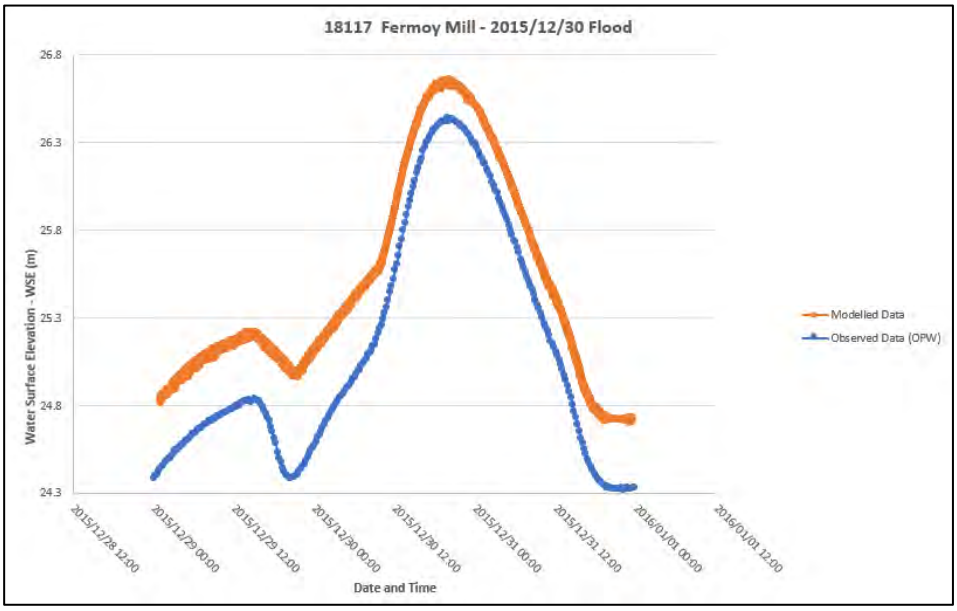


Figure 5-11: Modelled vs Observed Data for 30/12/2015 Flood at Gauge 18117

5.3.5. Summary of Calibration with 30th December 2015 Flood Event

The existing surface generated within the HEC-RAS model was modified to exclude the breaches within the weir to model the flood event on 30th December 2015 given the breaches were not present at this time. The model was then calibrated by adjusting the Manning *n* values to 0.05 within the channel and to 0.06 within the floodplains. The outflow boundary conditions within the unsteady flow data were set using the stage hydrograph as shown in Figure 5-5. The water levels from gauge 18117 were utilised to calibrate the model to the 30th December 2015 flood event with the computed levels summarized in Table 5-2 based on Malin datum.

Table 5-2: Summary of Water Depths for Flood Event on 30th December 2015

Gauge	18106	18107	18117
Water Level – OPW (mOD)	24.046	23.921	23.731
Water Level – HEC-RAS Model (mOD)	24.202	24.020	23.950
Difference between model and Observed (m)	+0.156m	+0.099m	+0.219m
Difference with datum adjustment (m)	+0.026m	-0.031m	+0.089m

5.3.6. Calibration with 24th February 2021 Flood Event

Flow information for the 24 February 2022 flood, was obtained from the OPW website www.waterlevel.ie.

The data used for the 2021 flood was taken from 2021/02/23 at 00:00 to 2021/02/25 at 23:45 to provide a hydraulic model commencing one day ahead of the peak flood and one day after the recorded flood event. The time distribution for the model was therefore run over a three-day simulation period. The data for the time period used is illustrated in Figure 5-12 and is shown for the three gauges in the study area.

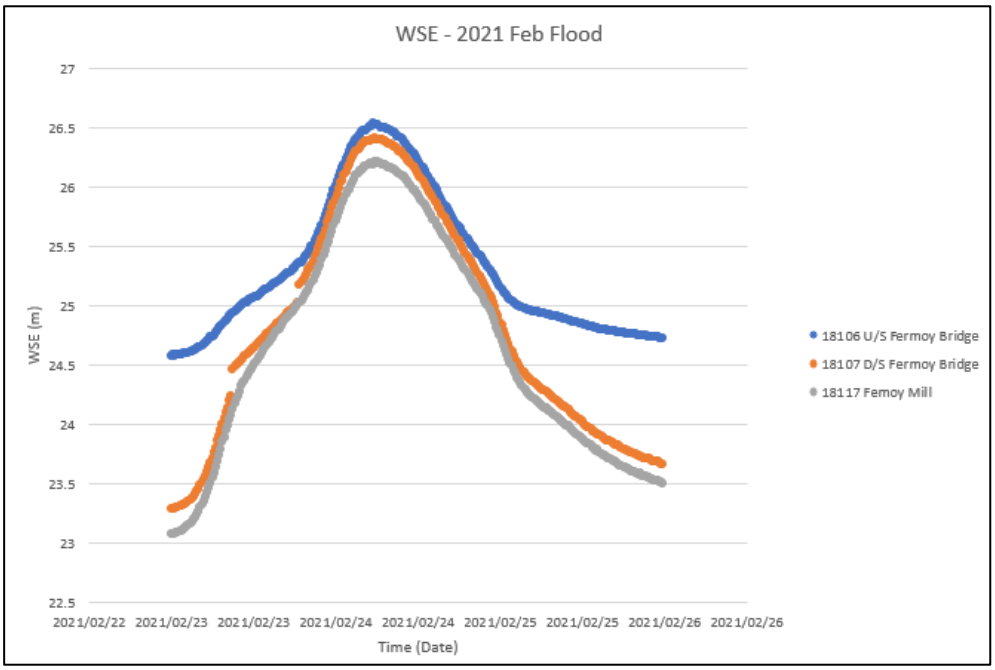


Figure 5-12: Water Levels Extracted from 24th February 2021 OPW Flood Data

The information obtained and displayed within Figure 5-12 to Figure 5-15, indicate flood levels relating to Poolbeg datum. The conversion is made from Poolbeg datum to Malin datum within Table 5-2, in order to correlate with the existing and proposed scenario as within Section 5.3.8. Furthermore, the datum indicated on the OPW website is set at 19.220moD Malin while the corresponding level in the surface model for the HecRas model is 19.350mOD.

Gauge 18106 Upstream of Fermoy Bridge

The max water level obtained from the OPW website for gauge 18106 on 24th February 2021 was 26.530AOD Poolbeg (*23.820mOD Malin*). Figure 5-13 illustrates WSE at this gauge for both the existing HEC-RAS (Modelled data) and OPW (Observed data). The HEC-RAS model estimated a water level of 24.010mOD Malin, resulting in a depth of 0.190m above the OPW observed water level. Allowing for adjustment due to the difference in levels between the gauge datum and the HecRas model surface results in a depth of 0.060m above the OPW observed water level.

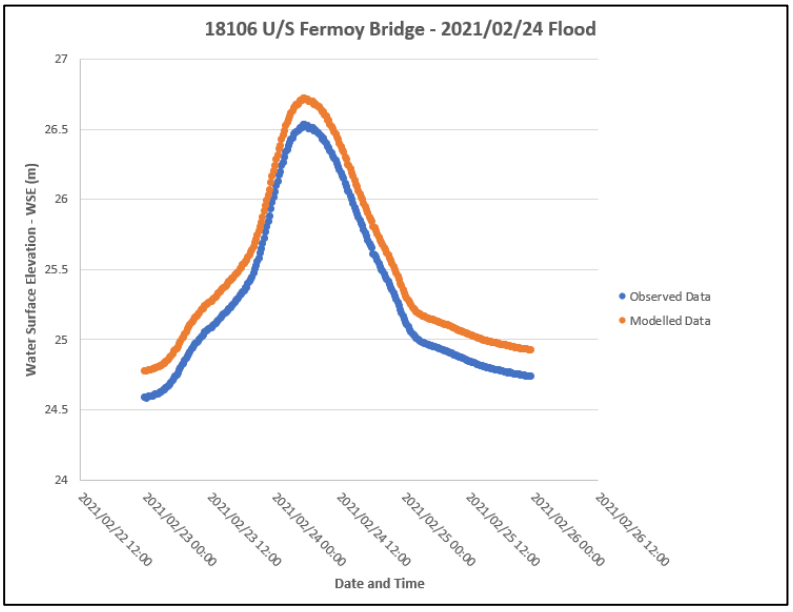


Figure 5-13: Modelled vs Observed Data for 24/02/2021 at Flood at Gauge 18106

Gauge 18107 Downstream of Fermoy Bridge

The max water depth obtained from the OPW website for gauge 18107 on 24th February 2021 was 26.409AOD Poolbeg (*23.699mOD Malin*). Figure 5-14 illustrates the WSE at this gauge for both the existing HEC-RAS (Modelled data) and OPW (Observed data). The HEC-RAS model estimated a water level of 23.740mOD Malin, resulting in a depth of 0.041m above the OPW observed water level. Allowing for adjustment due to the difference in levels between the gauge datum and the HecRas model surface results in a depth of 0.089m below the OPW observed water level.

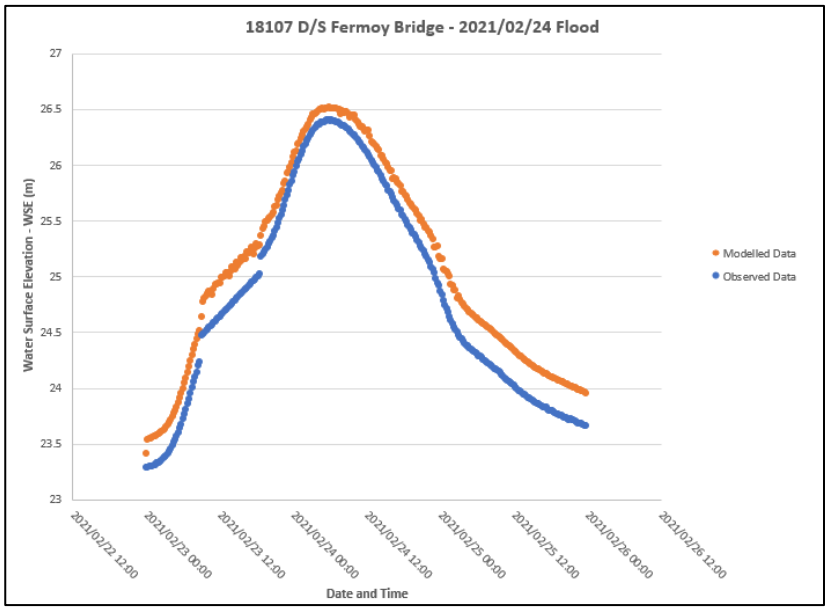


Figure 5-14: Modelled vs Observed Data for 24/02/2021 at Flood at Gauge 18107

Gauge 18117 Fermoy Mill

The max water level obtained from the OPW website for gauge 18117 on 24th February 2021 was 26.213AOD Poolbeg (*23.503mOD Malin*). Figure 5-15 illustrates the WSE at this gauge for both the existing HEC-RAS (Modelled data) and OPW (Observed data). The HEC-RAS model estimated a water level of 23.680mOD Malin, resulting in a depth of 0.177m above the OPW observed water level. Allowing for adjustment due to the difference in levels between the gauge datum and the HecRas model surface results in a depth of 0.047m above OPW observed water level.

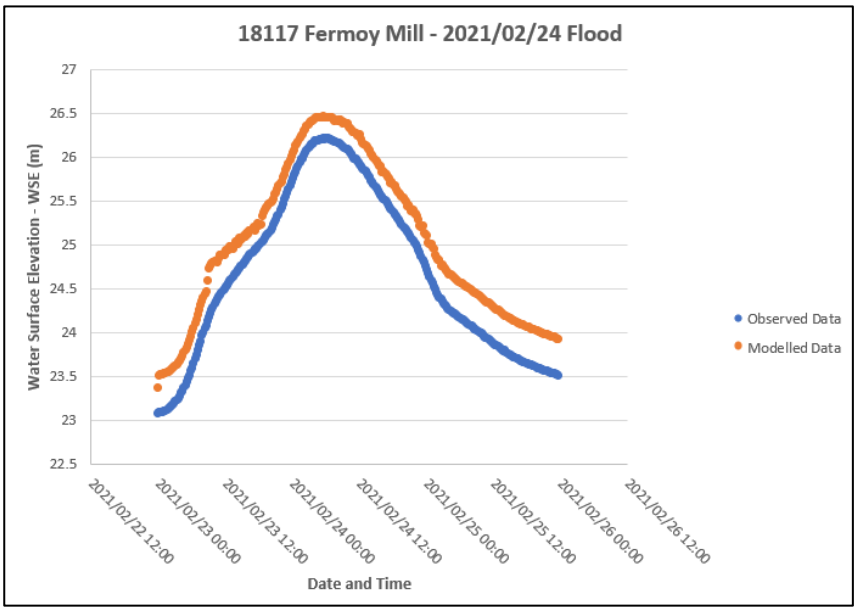


Figure 5-15: Modelled vs Observed Data for 24/02/2021 at Flood at Gauge 18117

5.3.7. Summary of Calibration with 24th February 2021 Flood Event

The surface used in the existing model included the breaches within the weir as surveyed during the 2018 topographical survey, in addition to details on the riverbed works undertaken by the OPW in 2020 as part of the emergency works along the Mill Race. The model was calibrated by adjusting the Manning *n* values to 0.05 within the channel and to 0.06 within the floodplains. The outflow boundary conditions within the unsteady flow data were set using the stage hydrograph, as shown in Figure 5-12. The water levels from gauge 18117 were utilised to calibrate the model to the 24th February 2021 flood event with the computed levels summarized in Table 5-3.

Table 5-3: Summary of Water Depths for Flood Event on 24th February 2021

Gauge	18106	18107	18117
Water Level – OPW (mOD)	23.820	23.699	23.503
Water Level – HEC-RAS Model (mOD)	24.010	23.740	23.680
Difference between model and Observed levels (m)	+0.190m	+0.041m	+0.177m
Difference with datum adjustment (m)	+0.060m	-0.089m	+0.047m

5.3.8. Model Results

Hydraulic modelling was undertaken for a range of return periods ranging from 1 in 2 year to 1 in 200 year flood events for both the existing and proposed scenarios.

The levels predicted at gauges 18106, 18107 and 18117 in the HEC-RAS model for both the existing and proposed scenarios are shown in Table 5-4 below. The differences between the levels predicted in the existing and proposed scenarios are illustrated in Table 5-5 below.

It should be noted that the figures for *"Existing"* below relate to existing weir but on the basis that there are no breaches present. This is to allow an assessment on the impact of the proposed fish bypass channel to be carried out and to enable a like for like comparison to be undertaken, i.e. with the weir fully in place in both scenarios.

Table 5-4: Modelled Water Levels at Each Gauge

Return Period	AEP %	Peak Q (m^3/s)	Water Lvl (mOD) at Gauge (Existing)			Water Lvl (mOD) at Gauge (Proposed)		
			18106	18107	18117	18106	18107	18117
10%ile	10%ile	100.675	21.87	20.58	20.54	21.31	20.59	20.53
5%ile	5%ile	146.389	22.00	21.01	20.96	21.56	21.02	20.96
1%ile	1%ile	253.617	22.34	21.88	21.82	22.14	21.89	21.82
1:2	50	376	22.94	22.70	22.62	22.94	22.73	22.66
1:5	20	475	23.62	23.37	23.28	23.55	23.34	23.28
1:10	10	542	24.01	23.77	23.68	23.94	23.74	23.67
1:25	4	633	24.54	24.32	24.21	24.44	24.25	24.19
1:50	2	701	25.03	24.62	24.56	24.81	24.61	24.55
1:100	1	776	25.33	25.02	24.96	24.94	24.71	24.65

Table 5-5: Difference Between Water Levels in Existing & Proposed Model (mOD)

Design Flow	18106	18107	18117
10%ile	-0.560	0.010	-0.010
5%ile	-0.440	0.010	0.000
1%ile	-0.200	0.010	0.000
1:2	0.000	0.030	0.040
1:5	-0.070	-0.030	0.000
1:10	-0.070	-0.030	-0.010
1:25	-0.100	-0.070	-0.020
1:50	-0.220	-0.010	-0.010
1:100	-0.390	-0.310	-0.310

It can be seen from Table 5-4 that the proposed scheme does not increase the risk of flooding for the 1 in 5year up to the 1 in 100year flood events. The levels predicted at the three gauges, for the various return periods in the proposed scenario, are lower or equal when compared to the existing scenario. The 10mm increase at gauge 18107 for the %ile flows are considered to be localised. The 1 in 2year produced an increase of 30mm at gauge 18107 and an increase of 40mm at gauge 18117. While these increased flood levels are localised at gauge 18107, the magnitude are considered minor as the flood increase does not pose a flood risk to the upstream or downstream within the design flow return periods.

The net loss in cross-sectional area at the existing weir and Mill Race weir wall is of the order of 34.9m^2. The net addition in cross-sectional are by the construction of the fish Bypass channel is approximately 41.3m^2, Therefore, there is a net increase in cross sectional area at the weir of the order of 6.4m^2.

Graphical results from the hydraulic modelling are reproduced in Appendix D of this report. These illustrate the results for the flood depths and velocities for the various return periods. The results of the existing and proposed scenarios for the various return periods are shown together for illustrative purposes.

It can be seen from the graphical results that the proposed development does not increase the risk of flooding in the area and does not alter the flood regime.

5.4. Detailed Fluvial Flood Risk Assessment

5.4.1. Risk to OPW Fermoy Flood Defence Scheme Trigger Levels

The outputs from the HEC-RAS modelling were reviewed against the trigger levels for the Fermoy North and South Flood Defence Schemes to assess if the proposed works would have a negative impact on the levels associated with the flood protocols. These levels are shown in Tables 5-5 and 5-6 for the Fermoy North and Fermoy South respectively for the various return periods.

The trigger levels for the associated modes at each wall, as shown in Tables 5-6 and 5-7, were obtained from the Fermoy North Protocol Report, April 2015 and the Fermoy South Protocol Report, February 2022. It should be noted that the 1 in 2year and 1 in 5year flood

events were modelled without the flood defence system in place as the flood defence barriers are not erected for flood events of this magnitude. The location of these points are shown at Drg 19011-TJOC-PL-XX-DR-C-0089 included at Appendix D.

Table 5-6: Comparison of OPW Trigger Levels vs Predicted Levels (Fermoy North)

Wall No.	Mode No.	Defence Height (mOD)	Trigger Level (mOD)	Existing						Proposed					
				1:2	1:5	1:10	1:25	1:50	1:100	1:2	1:5	1:10	1:25	1:50	1:100
Embankment 1	Not Available			23.18	23.76	24.19	24.69	25.21	25.46	23.14	23.73	24.1	24.59	24.985	25.33
Embankment 2				23.10	23.7	24.13	24.64	25.17	25.41	23.04	23.64	24.02	24.52	24.88	25.27
Embankment 3				22.96	23.57	24.03	24.54	25.09	25.35	22.96	23.57	23.96	24.46	24.82	25.21
Wall 8 Bridge	1	25.20	22.21	-	-	-	-	-	-	-	-	-	-	-	-
	2	25.40	22.41	-	-	-	-	-	-	-	-	-	-	-	-
	3	25.70	22.71	22.74	-	-	-	-	-	22.9	-	-	-	-	-
	4	26.05	23.06	-	23.40	23.91	24.42	24.99	25.28	-	23.52	23.91	24.41	24.78	25.17
Embankment 4	Not Available			22.68	23.34	23.74	24.27	24.60	25.00	22.71	23.33	23.72	24.23	24.60	24.99
Wall 12/13 Thomas Street	4	26.10	23.06	22.65	23.31	23.71	24.25	24.58	24.98	22.69	23.31	23.70	24.21	24.58	24.97
Embankment 5	Not Available			22.63	23.29	23.68	24.22	24.55	24.96	22.66	23.28	23.68	24.19	24.55	24.95
Embankment 6	Not Available			22.58	23.24	23.63	24.16	24.51	24.91	22.61	23.23	23.63	24.14	24.51	24.90
Wall 15/16 Sub Aqua	3	25.75	22.71	22.55	23.21	23.60	24.13	24.48	24.88	22.59	23.20	23.60	24.11	24.48	24.87

Table 5-7: Comparison of OPW Trigger Levels vs Predicted Levels (Fermoy South)

Wall No.	Mode No.	Defence Height (mOD)	Trig lvl (mOD)	Existing (mOD)						Proposed (mOD)					
				1:2	1:5	1:10	1:25	1:50	1:100	1:2	1:5	1:10	1:25	1:50	1:100
Wall 6	3	24.25	22.71	-	-	-	-	-	-	-	-	-	-	-	-
	6	25.30	23.81	-	-	-	24.69	25.15	-	-	-	-	24.57	24.92	-
	7	26.10	24.86	-	-	-	-	-	25.45	-	-	-	-	-	25.30
Wall 7	6	25.30	23.81	-	-	24.16	24.68	25.14	25.44	-	-	24.06	24.56	24.91	25.30
Wall 8	1	24.25	22.21	-	23.7	-	-	-	-	-	23.64	-	-	-	-
	6	25.30	23.81	-	-	24.13	24.64	-	-	-	-	24.02	24.52	-	-
	7	25.85	24.86	-	-	-	-	25.11	25.43	-	-	-	-	24.88	25.26
Wall 9	6	25.30	23.81	-	23.7	24.13	24.64	-	-	-	23.64	24.02	24.52	-	-

	7	25.85	24.86	-	-	-	-	25.11	25.43	-	-	-	-	24.88	25.26
Wall 10	1	24.25	22.21	-	23.68	-	-	-	-	-	23.62	-	-	-	-
	6	25.30	23.81	-	-	24.1	24.63	-	-	-	-	24.01	24.51	-	-
	7	25.85	24.86	-	-	-	-	25.10	25.42	-	-	-	-	24.87	25.25
Wall 11	6	25.30	23.81	-	23.68	24.10	24.63	25.1	-	-	23.62	24.01	24.51	24.87	-
	7	25.85	24.86	-	-	-	-	-	25.42	-	-	-	-	-	25.25
Wall 12	1	24.00	22.21	-	23.64	-	-	-	-	-	23.59	-	-	-	-
	6	25.30	23.81	-	-	24.09	24.60	25.08	-	-	-	23.98	24.48	24.84	-
	7	25.80	24.86	-	-	-	-	-	25.39	-	-	-	-	-	25.23
Wall 13	6	25.30	23.81	23.05	23.64	24.09	24.60	25.08	-	22.99	23.59	23.98	24.48	24.84	-
	7	25.80	24.86	-	-	-	-	-	25.39	-	-	-	-	-	25.23
Wall 14	1	24.00	22.21	22.94	23.61	-	-	-	-	22.93	23.54	-	-	-	-
	6	25.30	23.81	-	-	24.00	24.54	-	-	-	-	23.93	24.43	24.8	-
	7	25.80	24.86	-	-	-	-	25.02	25.32	-	-	-	-	-	25.19
Wall 15	6	25.30	23.81	22.94	23.61	24.00	24.54	-	-	22.93	23.54	23.93	24.43	24.8	-
	7	25.80	24.86	-	-	-	-	25.02	25.32	-	-	-	-	-	25.19
Wall 17	5	25.00	23.51	22.84	23.55	-	-	-	-	22.86	23.49	-	-	-	-
	6	25.30	23.81	-	-	23.94	24.49	-	-	-	-	23.88	24.39	24.76	-
	7	26.00	24.86	-	-	-	-	24.88	25.24	-	-	-	-	-	25.15
Wall 19	6	25.00	23.81	22.85	23.54	23.89	24.43	24.62	25.02	22.73	23.35	23.74	24.25	24.61	25.01
Wall 22	5	24.50	23.51	22.64	23.3	23.70	-	-	-	22.68	23.3	23.69	-	-	-
	6	25.00	23.81	-	-	-	24.23	24.58	-	-	-	-	24.20	24.57	-
	7	25.70	24.86	-	-	-	-	-	24.98	-	-	-	-	-	24.96
Wall 24	4	24.00	23.06	-	23.25	23.64	-	-	-	-	23.25	23.64	-	-	-
	6	25.00	23.81	-	-	-	24.17	24.55	-	-	-	-	24.15	24.52	-
	7	25.55	24.86	-	-	-	-	-	24.92	-	-	-	-	-	24.91
Wall 26	4	24.00	23.06	-	23.22	-	-	-	-	-	23.22	-	-	-	-
	5	24.90	23.51	-	-	23.62	-	-	-	-	-	23.62	-	-	-
	6	25.00	23.81	-	-	-	24.15	24.52	-	-	-	-	24.13	24.50	-
	7	25.55	24.86	-	-	-	-	-	24.90	-	-	-	-	-	24.89

A comparison between the levels predicted for the existing and proposed scenarios for the Fermoy North and Fermoy South walls are illustrated in Tables 5-8 and Table 5-9 below.

Table 5-8: Comparison of Predicted Existing & Proposed Levels (Fermoy North)

Wall No.	Mode No.	1:2	1:5	1:10	1:25	1:50	1:100
Embankment 1	Not Available	0.04	0.03	0.09	0.1	0.225	0.13
Embankment 2	Not Available	0.06	0.06	0.11	0.12	0.29	0.14
Embankment 3	Not Available	0	0	0.07	0.08	0.27	0.14
Wall 8 Bridge	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
	3	-0.16	0	0	0	0	0
	4	0	-0.12	0	0.01	0.21	0.11
Embankment 4	Not Available	-0.03	0.01	0.02	0.04	0	0.01
Wall 12/13 Thomas Street	4	-0.04	0	0.01	0.04	0	0.01
Embankment 5	Not Available	-0.03	0.01	0	0.03	0	0.01
Embankment 6	Not Available	-0.03	0.01	0	0.02	0	0.01
Wall 15/16 Sub Aqua	3	-0.04	0.01	0	0.02	0	0.01

Table 5-9: Comparison of Predicted Existing & Proposed Levels (Fermoy South)

Wall No.	Mode No.	1:2	1:5	1:10	1:25	1:50	1:100
Wall 6	3	0	0	0	0	0	0
Wall 6	6	0	0	0	0.12	0.23	0
Wall 6	7	0	0	0	0	0	0.15
Wall 7	6	0	0	0.1	0.12	0.23	0.14
Wall 8	1	0	0.06	0	0	0	0
Wall 8	6	0	0	0.11	0.12	0	0
Wall 8	7	0	0	0	0	0.23	0.17
Wall 9	6	0	0.06	0.11	0.12	0	0
Wall 9	7	0	0	0	0	0	0.17
Wall 10	1	0	0.06	0	0	0	0
Wall 10	6	0	0	0.09	0.12	0	0
Wall 10	7	0	0	0	0	0.23	0.17
Wall 11	6	0	0.06	0.09	0.12	0.23	0
Wall 11	7	0	0	0	0	0	0.17
Wall 12	1	0	0.05	0	0	0	0
Wall 12	6	0	0	0.11	0.12	0.24	0
Wall 12	7	0	0	0	0	0	0.16
Wall 13	6	0.06	0.05	0.11	0.12	0.24	0
Wall 13	7	0	0	0	0	0	0.16
Wall 14	1	0.01	0.07	0	0	0	0
Wall 14	6	0	0	0.07	0.11	0.22	0
Wall 14	7	0	0	0	0	0	0.13
Wall 15	6	0.01	0.07	0.07	0.11	0.22	0

Wall 15	7	0	0	0	0	0	0.13
Wall 17	5	-0.02	0.06	0	0	0	0
Wall 17	6	0	0	0.06	0.1	0.12	0
Wall 17	7	0	0	0	0	0	0.09
Wall 19	6	0.12	0.19	0.15	0.18	0.01	0.01
Wall 22	5	-0.04	0	0.01	0	0	0
Wall 22	6	0	0	0	0.03	0.01	0.02
Wall 22	7	0	0	0	0	0	0
Wall 24	4	0	0	0	0	0	0
Wall 24	6	0	0	0	0.02	0.03	0.01
Wall 24	7	0	0	0	0	0	0
Wall 26	4	0	0	0	0	0	0
Wall 26	5	0	0	0	0	0	0
Wall 26	6	0	0	0	0.02	0.02	0.01
Wall 26	7	0	0	0	0	0	0

The wall locations referred to in Tables 5-6 and 5-7 for the Fermoy North and South flood defence schemes are illustrated on drawings 2667-1, 2961-002 and 2961-003 in Appendix E. and at Drg 19011-TJOC-PL-XX-DR-C-0089 in Appendix D.

It can be seen from Table 5-8 and 5-9 that the levels predicted in the existing scenario (prior to the breach in 2016), for the various return periods are higher than the proposed levels predicted in most cases, when adjusted in line with the calibration for the 2015 and 2021 flood events. The results show that the proposed levels for the 1 in 2year flood event are higher than the levels predicted for the proposed scenario at Walls 8, 12/13, 15/16 and at Embankments 4, 5 and 6. This is also the case for wall 8 in the 1 in 5year flood event. This is attributed to the fact that a greater portion of the flow from the river will be diverted to the new fish bypass channel located on the north bank of the river. It should be emphasised that the increased levels predicted for the proposed scenario only occur for the lower flood events (1 in 2 and 1 in 5 year). The levels predicted in the proposed scenario are lower than the levels in the existing scenario for the higher return period floods.

Similarly with walls 17 and 22 in the 1 in 2year flood event, the proposed levels are predicted to be higher than the existing for this scenario. The increase in the level at wall 17 is attributable to the fact that the reinstated weir has a higher crest level when compared to the weir (without the breaches) that was modelled in the existing scenario. This results in a localised increase in the water level on the upstream side of the weir which is consistent with the location of Wall 17.

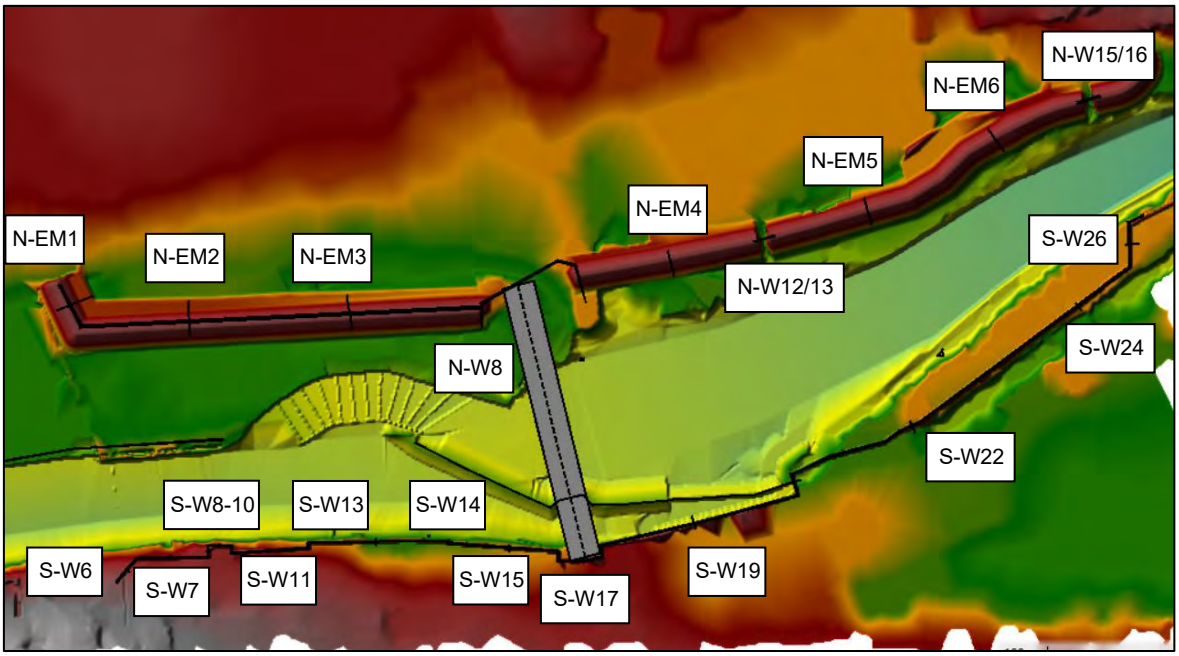


Figure 5-16: Graphical representation of North and South Walls relating to Hec-Ras models

5.4.2. Freeboard Assessment

Information provided by the OPW on the barrier heights, from the barrier confirmation drawings, was reviewed against the predicted levels for the existing and proposed scenarios to assess the level of freeboard available. These results are summarised in Tables 5-10 and 5-11 below.

Table 5-10: Freeboard Assessment (Fermoy North)

Wall No.	Mode No.	Barrier Confirmation Height (mOD)	Existing Freeboard (m)	Proposed Freeboard (m)	Difference (m)
Wall 8 Bridge	3	25.8	0.52	0.63	0.11
	4	25.9	0.62	0.73	0.11
Wall 12/13 Thomas Street	4	25.65	0.67	0.68	0.01
Wall 15/16 Sub Aqua	3	25.65	0.67	0.68	0.01

Table 5-11: Freeboard Assessment (Fermoy South)

Wall No.	Mode No.	Barrier Confirmation Height (mOD)	Existing Freeboard (m)	Proposed Freeboard (m)	Difference (m)
Wall 6	6	25.85	0.4	0.55	0.15
Wall 6	7	26	0.55	0.7	0.15
Wall 7	6	25.85	0.41	0.55	0.14
Wall 8	1	25.85	0.41	0.55	0.14
Wall 8	7	25.85	0.42	0.59	0.17
Wall 9	6	26	0.57	0.74	0.17
Wall 9	7	25.85	0.42	0.59	0.17
Wall 10	1	25.85	0.42	0.59	0.17
Wall 10	7	25.85	0.43	0.6	0.17
Wall 11	6	26	0.58	0.75	0.17
Wall 11	7	25.8	0.38	0.55	0.17
Wall 12	1	26	0.58	0.75	0.17
Wall 12	7	25.8	0.41	0.57	0.16
Wall 13	6	25.8	0.41	0.57	0.16
Wall 13	7	25.8	0.41	0.57	0.16
Wall 14	1	25.8	0.41	0.57	0.16
Wall 14	7	25.8	0.48	0.61	0.13
Wall 15	6	25.85	0.53	0.66	0.13
Wall 15	7	25.8	0.48	0.61	0.13
Wall 17	5	25.85	0.53	0.66	0.13
Wall 17	6	25.8	0.56	0.65	0.09
Wall 17	7	25.85	0.61	0.7	0.09
Wall 19	6	25.7	0.68	0.69	0.01
Wall 22	5	25.9	0.88	0.89	0.01
Wall 22	7	25.65	0.67	0.69	0.02
Wall 24	4	25.85	0.87	0.89	0.02
Wall 24	7	25.55	0.63	0.64	0.01
Wall 26	4	25.55	0.63	0.64	0.01
Wall 26	6	25.55	0.65	0.66	0.01
Wall 26	7	25.75	0.85	0.86	0.01

It is demonstrated in Tables 5-10 and 5-11 above that the proposed scenario does not have any negative impact on the available freeboard for the existing Fermoy North and Fermoy South FDS schemes when compared to the existing scenario. Therefore, the proposed works will not lead to any increased risk of flooding at Fermoy.

It should be noted that the modelling for this FRA is limited based on the level of information available for the study area as noted previously. It is also noted that this FRA was prepared in accordance with the Planning System and Flood Risk Management Guidelines as part of a planning submission to An Bord Pleanála for the proposed scheme and as such, would

not be of the same level of detail to that typically required for a flood defence scheme nor is it intended to be..

5.4.3. Risk to Upstream and Downstream Lands

The impact of the proposed works on the flood risk to upstream lands was also considered in this FRA.

As demonstrated in Tables 5-8 and 5-9, the water levels predicted in the proposed scenario are lower than those predicted for the existing scenario for majority of flood events. The localised exceptions to this have been discussed previously in Section 5.4.2.

There are no increases in flows or depths at the downstream end of the model which implies that there is no alteration to the existing situation, as a consequence of the proposed development, downstream of the proposed woks.

The HEC-RAS model was further developed to include consideration of the lower flood events comprising the 10%ile, 5%ile and 1%ile flows as recorded for Gauge 18106 on the OPW Hydrodata website. The flows and levels exceeded for the given percentage of time are summarised at Table 5-12 below.

Table 5-12: Flow & Levels for Lower Flood Events

	Observed Gauge 18106		Existing Scenario	Proposed Scenario
	Flow m^3/s	Level mOD Malin		
10%ile	100.675	20.491	20.580	20.590
5%ile	146.389	20.915	21.010	21.020
1%ile	253.617	21.736	21.880	21.890

The HEC-RAS model predicts slightly higher levels for the existing and proposed scenarios in each of these lower flow conditions. The proposed model shows a minimal increase of 10mm over the depth in the existing scenario for Gauge 18106 with these flows. However, this increase is localised and is not reflected in the levels predicted for the existing and proposed scenarios at Gauge 18106 upstream or Gauge 18117 downstream. This demonstrates that in lower flow conditions there will be no increase in flood depths either upstream or downstream of the proposed works.

5.5. Landscaping Scheme

The construction of the new fish bypass channel will result in the loss of some trees both on the riverbank and on the line of black poplar trees extending north towards the western flood embankment on the north side of the river. There is an obligation to provide compensatory planting for those trees removed as a mitigation for screening due to the loss of mature trees. There is also a requirement to provide shade and cover to the fish bypass.

In a meeting held with the applicant and their engineering advisor on the 23rd August 2022, the OPW expressed concerns with dense planting in the flood plain during a flood event and advised that trees with tall narrow trunks would be preferable as they would have less impact in a flood scenario. The landscaping design can be adjusted in consultation with the OPW to take account of these concerns. However, it is noted that screening would also need to be provided to limit access to the side of the fish bypass channel to provide shade to fish passing through the bypass.

The planting scheme as proposed, apart from the ground cover and shade planting along the edges of the bypass channel (where the bank is battered towards the tops of the bypass channel walls) could not be considered to be dense. Notwithstanding this and taking account of the requirement for Section 9 approval, the applicant will endeavour to reach agreement on a landscaping scheme which satisfies the concerns of the OPW and meets the requirements for screening planting, compensatory planting and shade cover within the fish bypass.

The landscaping plan, as currently proposed, is shown in Figure 5-16. However, this can be modified to address the concerns of the OPW as part of the Section 9 process as noted above.

The OPW flood defence embankments comprise a clay wedge which is located in front of the embankment to act as a cut-off to prevent seepage beneath the embankment. There is no planting or excavation proposed within the clay wedge area in front of the flood embankment. The modelling parameters used for roughness of the riverbank reflect the presence of isolated trees within the flood plain and also local areas of denser planting along the bank of the bypass channel.

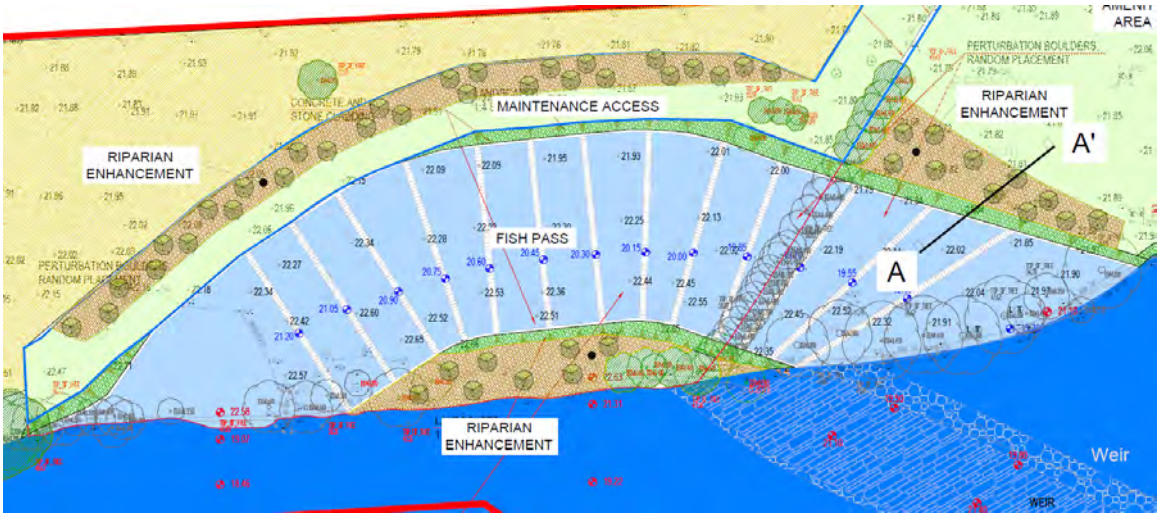


Figure 5-16: Proposed Landscaping Scheme (to be Amended with OPW)

5.6. Residual Risks

A site compound will be required during the construction phase of the works for the storage of materials, plant and equipment, and for a site office(s). It is envisaged that the location of the site compound will be to the west of the proposed Bypass channel.

The works will be undertaken within flood defence walls and embankments which comprise the Munster Blackwater Fermoy Drainage Scheme. Therefore, site offices, if located on a compound within the site on the north bank of the river, could be at risk of flooding and would be inaccessible when the flood defence demountable barriers are erected. Therefore, it is recommended that any site offices and welfare facilities located within the site should be located above the 10% AEP flood level at this location, based on the OPW's flood maps of the area. Site office accommodation at this location shall be located at first floor level with storage facilities at ground floor level. Further consultation with the OPW on these proposals will be undertaken during the Section 9 consent approval process.

6. APPLICATION OF "FLOOD RISK MANAGEMENT GUIDELINES"

6.1. Flood Zone & Vulnerability Class of the Site

As is demonstrated in Section 3 above:

1) The proposed development site is classified as Flood Zone A based on the CFRAM flood maps of Fermoy in Appendix C.
2) The type of development proposed is appropriate for the relevant flood zone, i.e. water compatible development in Flood Zone A.
3) The development is not considered at risk to fluvial flooding as it is water compatible development.
4) The development of the site does not alter the risk from pluvial flooding.
5) The development of the site does not alter overland flood flow paths.
6) The site is not at risk from coastal flooding.
7) The site is with in an area with a history of flooding and is within a designated Drainage scheme under the Arterial Drainage Act.
8) The proposed development will not increase flood risk upstream.
9) The proposed development will not have a negative impact on the OPW flood defence scheme.

As can be seen in Table 2-2, water compatible development is permissible in Flood Zone A and does not require a Justification Test to be carried out as noted in the Planning System and Flood Risk Management Guidelines.

7. CONCLUSIONS

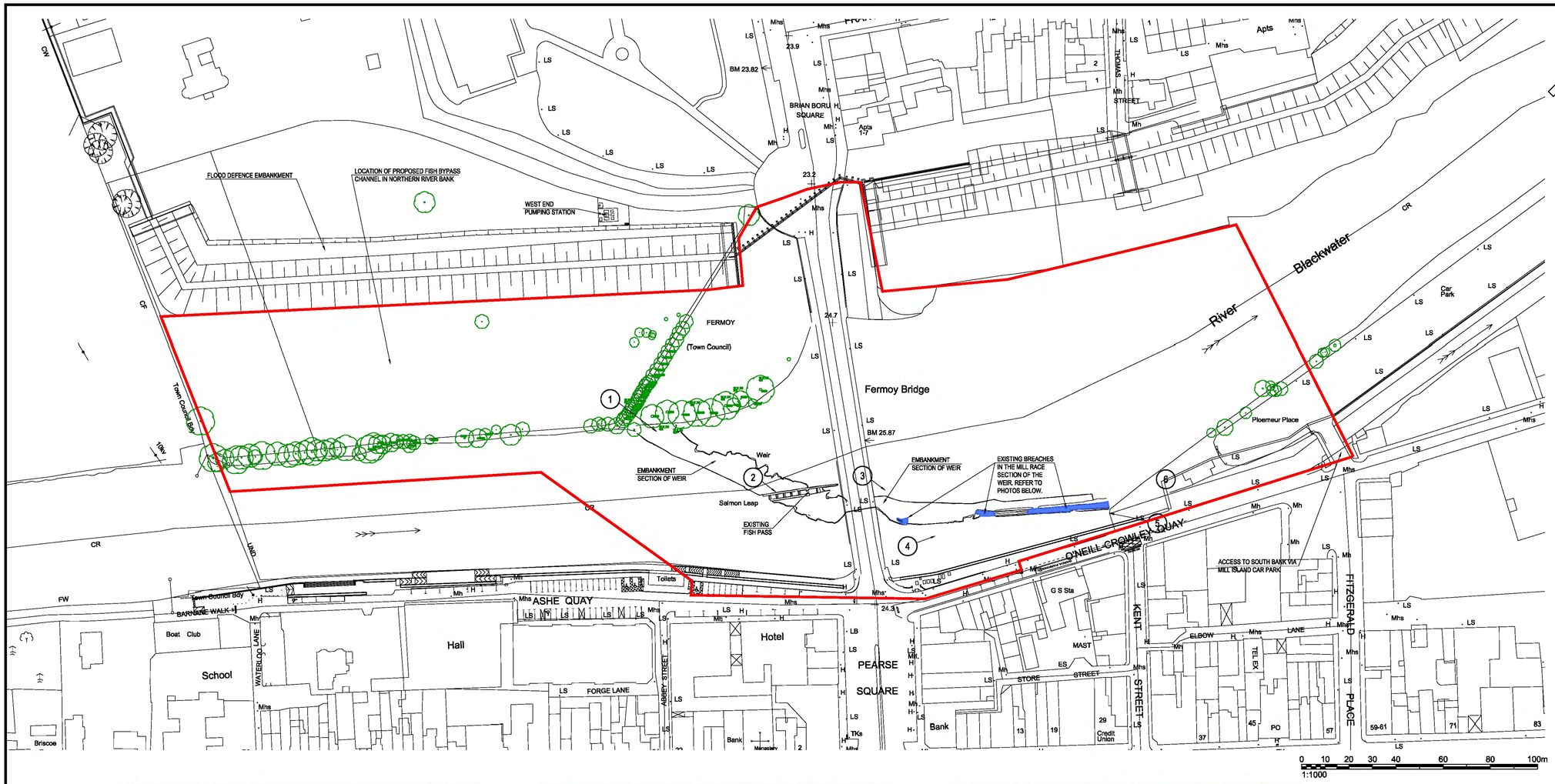
A flood risk assessment was carried out to establish if the proposed development at Fermoy would be at risk of flooding.

The flood risk assessment concluded that:

1) The proposed development is classified as water compatible development under the Planning System and Flood Risk Management Guidelines.
2) The site is classified as Flood Zone A.
3) The site lies within an area which is at risk to fluvial flooding.
4) The development of the site does not alter the risk from pluvial flooding.
5) The development of the site does not interfere with existing overland flood flow paths.
6) The site is not at risk from coastal flooding.
7) There is a history of flooding at the site.
8) The development is considered appropriate in accordance with *"The Planning System and Flood Risk Management Guidelines for Planning Authorities"* as published by the Department of Environment, Heritage and Local Government and the OPW.
9) The proposed development will not increase flood risk upstream or downstream of the development.
10) The proposed development will not have a negative impact on the OPW flood defence scheme.
11) The proposed development will not increase the flood risk in the area as demonstrated by the modelling results in Section 5.
12) The modelling for this FRA is limited based on the level of information available for the study area and was prepared in accordance with the Planning System and Flood Risk Management Guidelines as part of a planning submission to An Bord Pleanála for the proposed scheme. Therefore, the modelling may not be to the same level of detail to that which typically would be required for the confirmation of the design of a flood defence scheme.

APPENDIX A

Existing Site Layout Plan
(Drg. No. 19011-TJOC-PL-XX-DR-C-0051)



NOTES:

1. TREE INFORMATION SHOWN ON THIS DRAWING IS TAKEN FROM GEODATA SURVEYING LTD. TOPOGRAPHICAL SURVEY OF JUNE 2020.
2. EXISTING WEIR INFORMATION SHOWN ON THIS DRAWING IS TAKEN FROM WEIR SURVEY CARRIED OUT BY MURPHY GEOSPACIAL IN AUGUST 2018. EXTENT OF BREACHES SHOWN ARE AS SURVEYED IN 2018 AND MAY HAVE INCREASED IN THE TIME SINCE THE SURVEY HAD BEEN CARRIED OUT.
3. PHOTOS TAKEN IN MARCH 2021.

LEGEND:

SITE BOUNDARY

EXISTING TREES

PHOTO LOCATION AND DIRECTION

EXISTING BREACHES IN WEIR

PHOTO 1 - EMBANKMENT WEIR

PHOTO 3 - INTERFACE BETWEEN EMBANKMENT AND MILL RACE WEIR

PHOTO 5 -EXISTING BREACHES IN MILL RACE SECTION OF WEIR

PHOTO 2 - EXISTING FISH LADDER

PHOTO 4 - EXISTING BREACHES IN MILL RACE SECTION OF WEIR
(LOOKING DOWNSTREAM)

PHOTO 6 -EXISTING BREACHES IN MILL RACE SECTION OF WEIR
(LOOKING UPSTREAM)

REV	STAT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: EXISTING SITE LAYOUT PLAN

SCALE: 1:1000 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 19011-TJOC-PL-XX-DR-C-0051

REV: C01

APPENDIX B

Proposed Development Layout Plans

19011-TJOC-PL-XX-DR-C-0053_FISH_PASS_PLAN
19011-TJOC-PL-XX-DR-C-0054_FISH_PASS_LONG_SECTION
19011-TJOC-PL-XX-DR-C-0055_FISH_PASS_SECTIONS
19011-TJOC-PL-XX-DR-C-0060_PLAN_PROPOSED_WEIR
19011-TJOC-PL-XX-DR-C-0061_PROPOSED_SECTIONS
19011-TJOC-PL-XX-DR-C-0062_PROPOSED_SECTIONS
19011-TJOC-PL-XX-DR-C-0063_PROPOSED_SECTIONS
19011-TJOC-PL-XX-DR-C-0080_EX_FISH_LADDER_DETAILS

FERMOY NORTH FLOOD DEFENCE EMBANKMENT

CONCRETE AND STONE CLADDING

LANDSCAPED 1:4 SLOPE

LANDSCAPED 1:2 SLOPE

PERTURBATION BOULDERS, RANDOM PLACEMENT

FISH POOLS CREATED BY VARYING LEVEL OF ROCK WEIR WALLS

FERMOY

(Town Council)

FERMOY BRIDGE

THERE SHALL BE A CLEAR DISTANCE OF 10m MINIMUM FROM THE UPSTREAM FACE OF THE BRIDGE TO THE EXCAVATION FOR THE RESTING POOL

Fermoy Bridge

BED OF RIVER TO BE DREDGED TO MINIMUM BED LEVEL OF 18.50 AT BASE OF 1:10 SLOPE FROM EXISTING RIVER BED, AND 19.10 AT OUTLET FROM FISH BYPASS

BM 25.87

MAXIMUM SIDE SLOPES TO DREDGED AREA FOR RESTING POOL SHALL BE 1:10

Weir

Salmon Leap

ASHE QUAY

Toilets

Hotel

FERMOY SOUTH FLOOD DEFENCE WALLS

BARNANE WALK

Boat Club

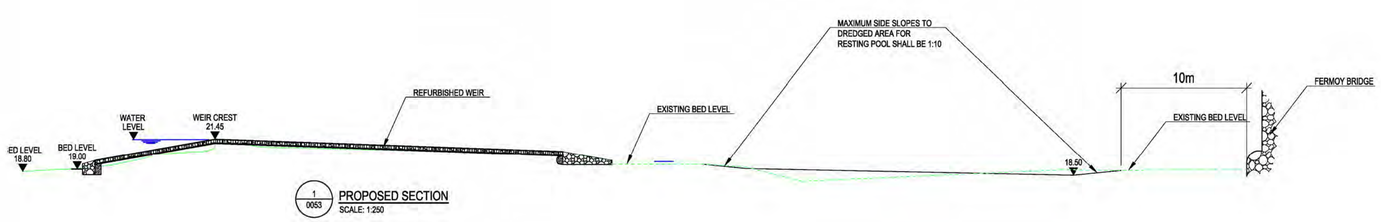
Town Council Bdy

UND

CF

10kV

0 5 10 15 20 30 40 50m
1:500



1/0053 PROPOSED SECTION
SCALE: 1:250

NOTES:

1. REFER TO DRAWINGS 0054 AND 0055 FOR SECTION DETAILS OF PROPOSED FISH BYPASS CHANNEL.
2. ALL LEVELS SHOWN RELATE TO ORDNANCE DATUM MALIN HEAD.

LEGEND:

EXISTING RIVER BED LEVELS 19.02

PROPOSED LEVELS 19.02

EXISTING TREES

EXISTING TREES TO BE REMOVED

PROPOSED PLANTING

REV	STAT	DESCRIPTION	DATE
C02	AP	PLANNING SUBMISSION RESPONSE	.....
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

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PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: PROPOSED FISH BYPASS PLAN

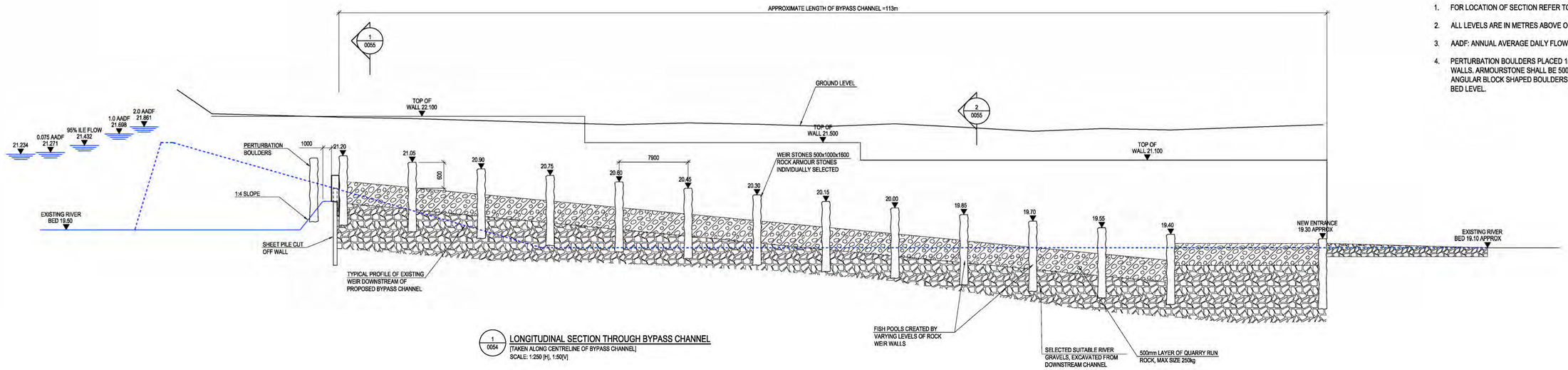
SCALE: 1:500 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER
19011-TJOC-XX-XX-DR-C-0053

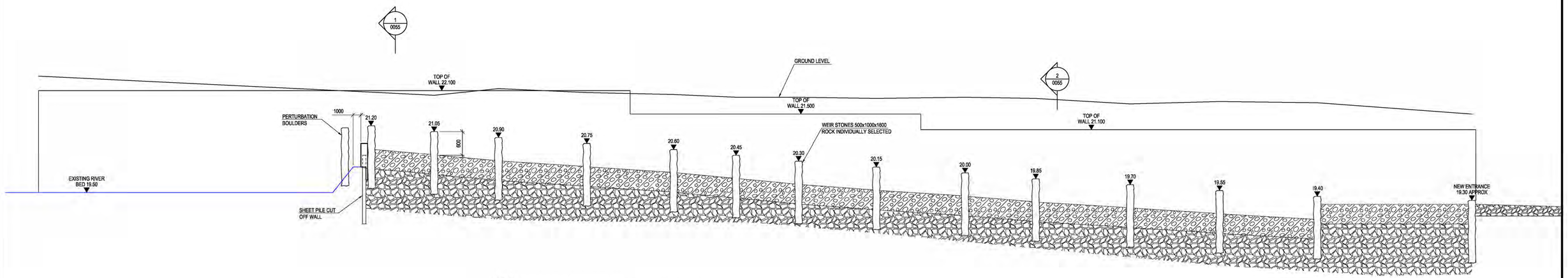
REV: C02

NOTES:

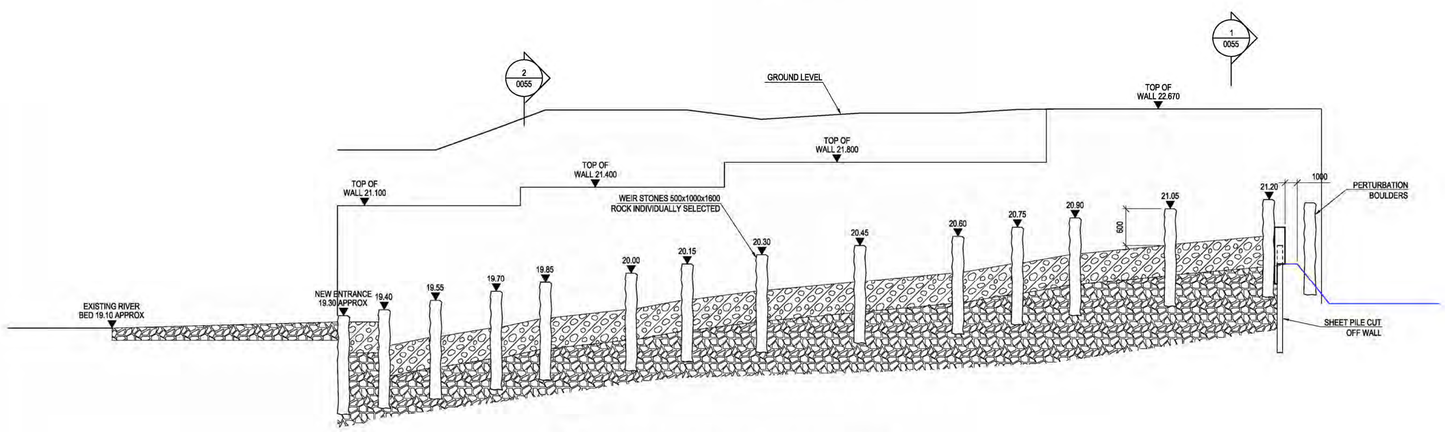
1. FOR LOCATION OF SECTION REFER TO DRAWING 0053.
2. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM MALIN HEAD.
3. AADF: ANNUAL AVERAGE DAILY FLOW
4. PERTURBATION BOULDERS PLACED 1m UPSTREAM OF GAPS IN THE WEIR WALLS. ARMOURSTONE SHALL BE 500x1000x1600 HIGH MIN. DIMENSIONS ANGULAR BLOCK SHAPED BOULDERS PROJECTION 500mm ABOVE THE RAMP BED LEVEL.



1 0054 **LONGITUDINAL SECTION THROUGH BYPASS CHANNEL**
[TAKEN ALONG CENTRELINE OF BYPASS CHANNEL]
SCALE: 1:250 [H], 1:50[V]



2 0054 **ELEVATION OF NORTHERN WALL OF BYPASS CHANNEL**
SCALE: 1:250 [H], 1:50[V]



3 0054 **ELEVATION OF SOUTHERN WALL OF BYPASS CHANNEL**
SCALE: 1:250 [H], 1:50[V]

REV	STAT	DESCRIPTION	DATE
C02	AP	PLANNING SUBMISSION RESPONSE	----
C01	AP	ISSUED FOR PLANNING	02.08.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

TJ O'CONNOR & ASSOCIATES CONSULTING ENGINEERS
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PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

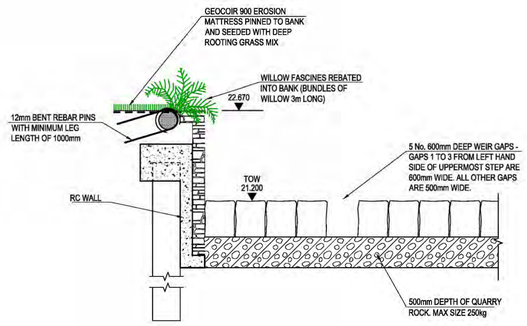
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: PROPOSED FISH BYPASS LONGITUDINAL SECTION

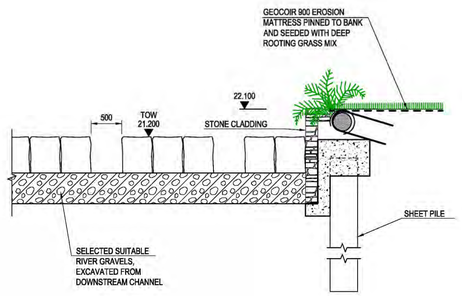
SCALE: 1:250 [H], 1:50 [V] (A1)

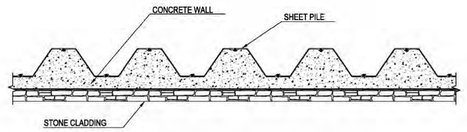
PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 19011-TJOC-XX-XX-DR-C-0054

REV: C02



1 / 0055 SECTION
SCALE: 1:50

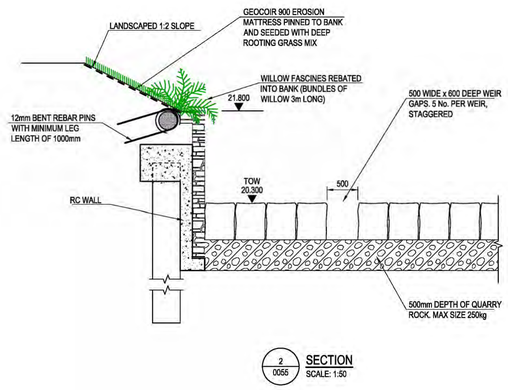




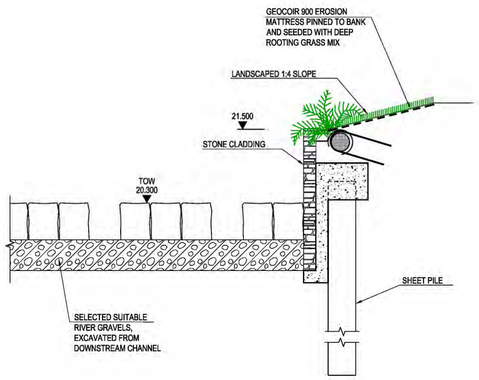
4 / 0055 DETAIL PART PLAN OF SHEET PILE WALL
SCALE: 1:50

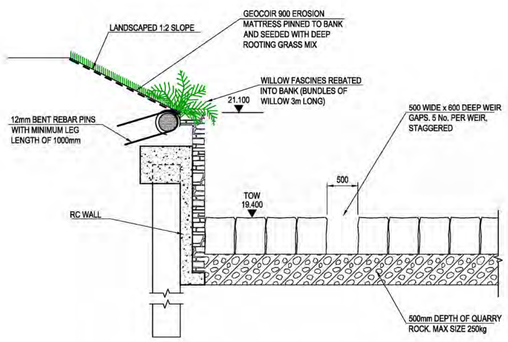
NOTES:

1. FOR LOCATION OF SECTIONS REFER TO DRAWING 0053.
2. ALL LEVELS ARE IN METERS ABOVE ORDNANCE DATUM MALIN HEAD

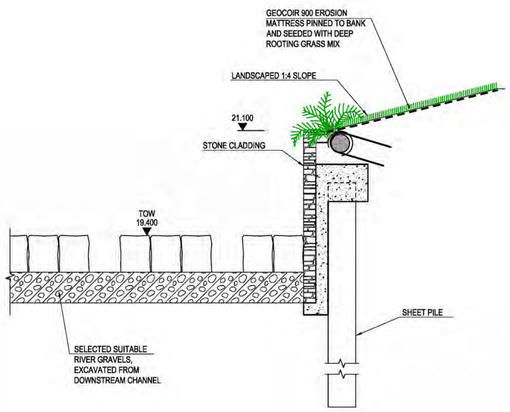


2 / 0055 SECTION
SCALE: 1:50





3 / 0055 SECTION
SCALE: 1:50



REV	STAT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

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PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

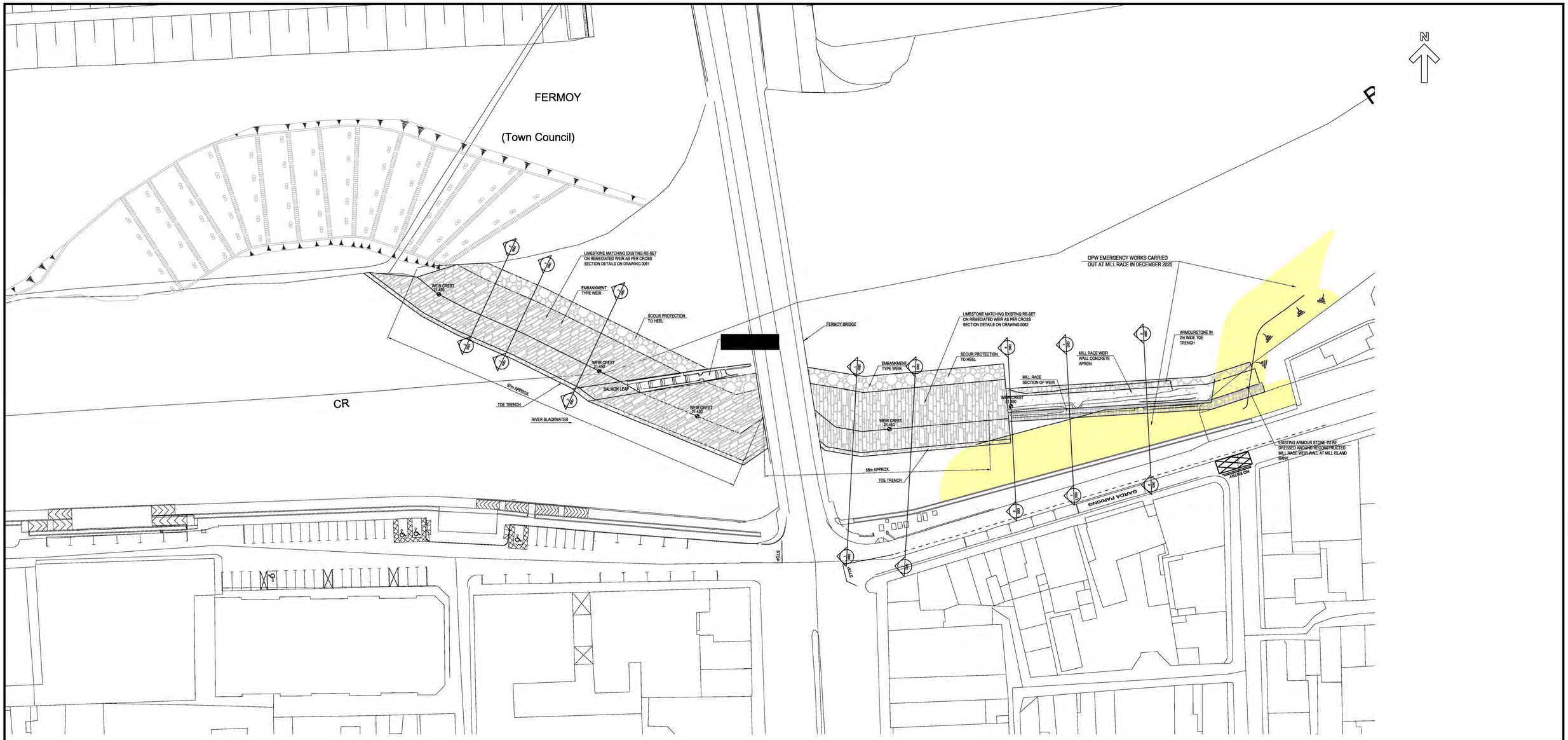
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: FISH BYPASS SECTIONS

SCALE: 1:50 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 19011-TJOC-XX-XX-DR-C-0055

REV: C01



0 5 10 15 20 30 40 50m
1:500

NOTES:

1. FOR SECTIONS THROUGH PROPOSED EMBANKMENT WEIR REFER TO DRAWINGS 0061 AND 0062.
2. FOR SECTIONS THROUGH PROPOSED MILL RACE WEIR REFER TO DRAWING 0063.
3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM MALIN HEAD.
4. WEIR REMEDIATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE CONSERVATION ENGINEER'S RECOMMENDATIONS.

APPROXIMATE EXTENT OF BED STABILISATION WORKS UNDERTAKEN BY THE OPW IN 2020

REV	SUIT	DESCRIPTION	DATE
C02	AP	PLANNING SUBMISSION RESPONSE - SECTION LABELS REVISED	.....
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

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Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY EMBANKMENT WEIR REMEDIATION AND FISH BYPASS CHANNEL

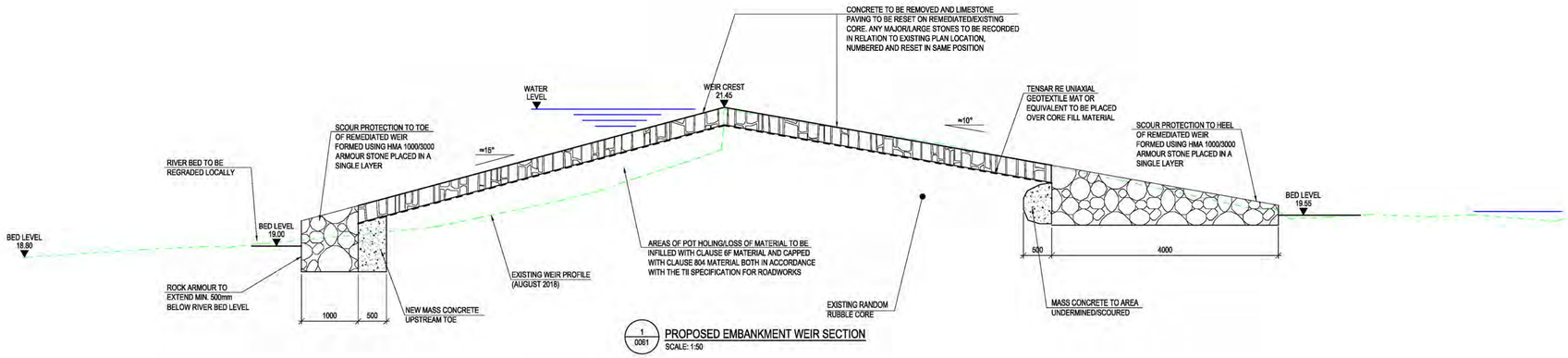
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: WEIR REMEDIATION PLAN OF PROPOSED WEIR

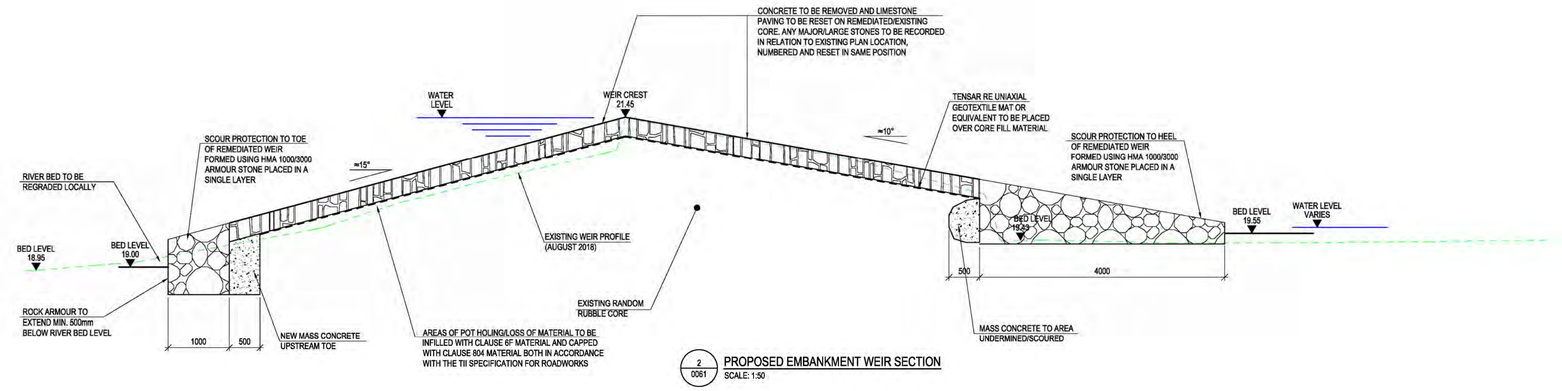
SCALE: 1:500 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER
19011-TJOC-PL-XX-DR-C-0060

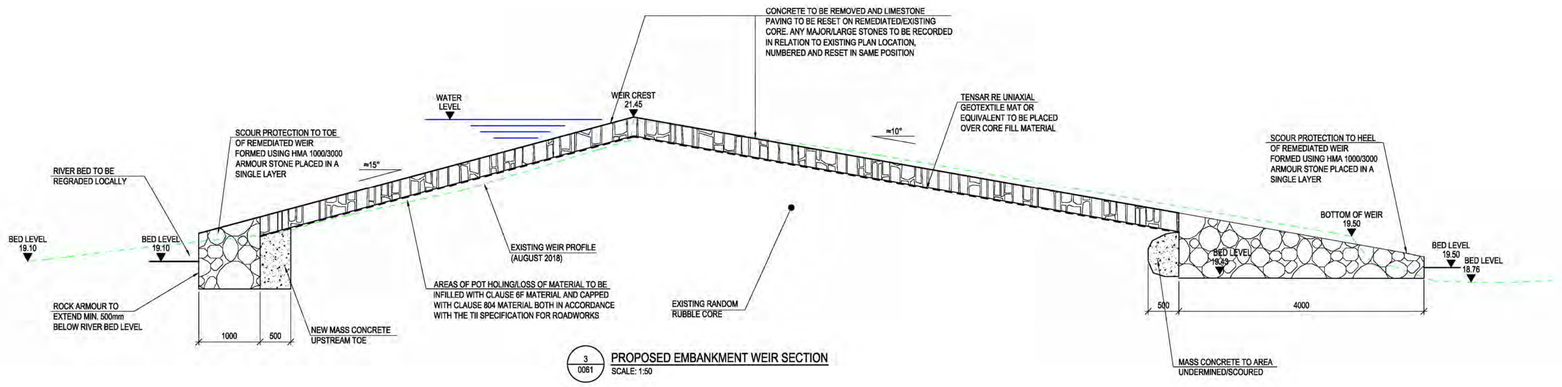
REV: C02



1 / 0061 PROPOSED EMBANKMENT WEIR SECTION
SCALE: 1:50



2 / 0061 PROPOSED EMBANKMENT WEIR SECTION
SCALE: 1:50



3 / 0061 PROPOSED EMBANKMENT WEIR SECTION
SCALE: 1:50

NOTES:

1. ALL LEVELS SHOWN ARE IN METERS ABOVE ORDNANCE DATUM, MALIN HEAD.
2. FOR LOCATIONS OF SECTIONS REFER TO DRAWING 0060.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH SURVEY DRAWINGS OF EXISTING WEIR STRUCTURE AND WITH SECTION DRAWINGS 0062 AND 0063.
4. WEIR REMEDIATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE CONSERVATION ENGINEER'S RECOMMENDATIONS.

REV	SUIT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

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Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

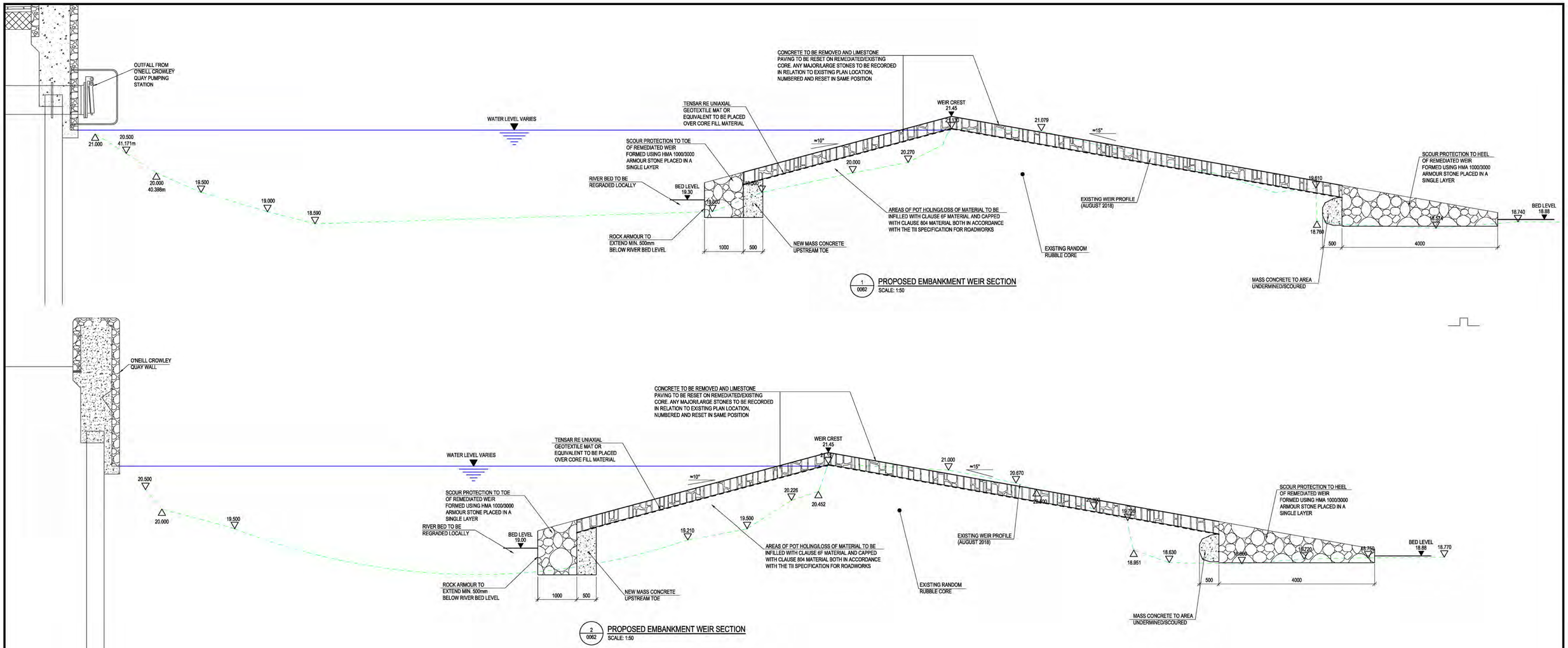
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: WEIR REMEDIATION PROPOSED SECTIONS

SCALE: AS SHOWN (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER
19011-TJOC-PL-XX-DR-C-0061

REV: C01



1/0062 PROPOSED EMBANKMENT WEIR SECTION
SCALE: 1:50

2/0062 PROPOSED EMBANKMENT WEIR SECTION
SCALE: 1:50

NOTES:

1. ALL LEVELS SHOWN ARE IN METERS ABOVE ORDNANCE DATUM, MALIN HEAD.
2. FOR LOCATIONS OF SECTIONS REFER TO DRAWING 0060.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH SURVEY DRAWINGS OF EXISTING WEIR STRUCTURE AND WITH SECTION DRAWINGS 0061 AND 0063.
4. WEIR REMEDIATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE CONSERVATION ENGINEER'S RECOMMENDATIONS.

REV	SUIT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
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Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

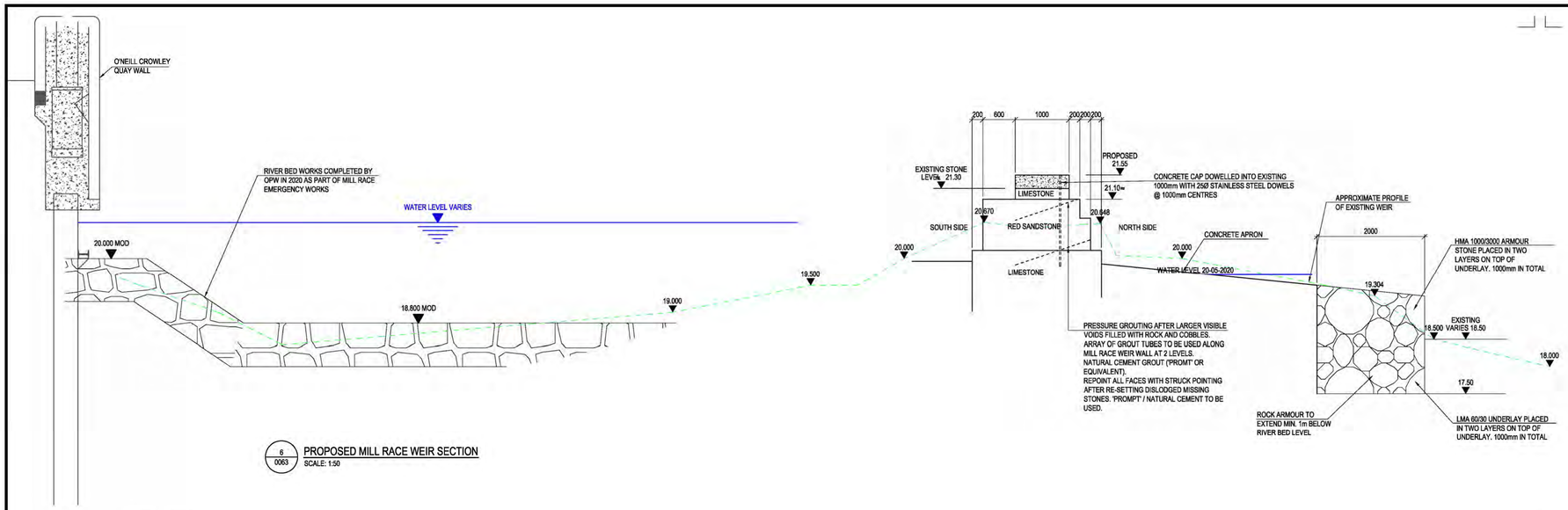
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: WEIR REMEDIATION PROPOSED SECTIONS

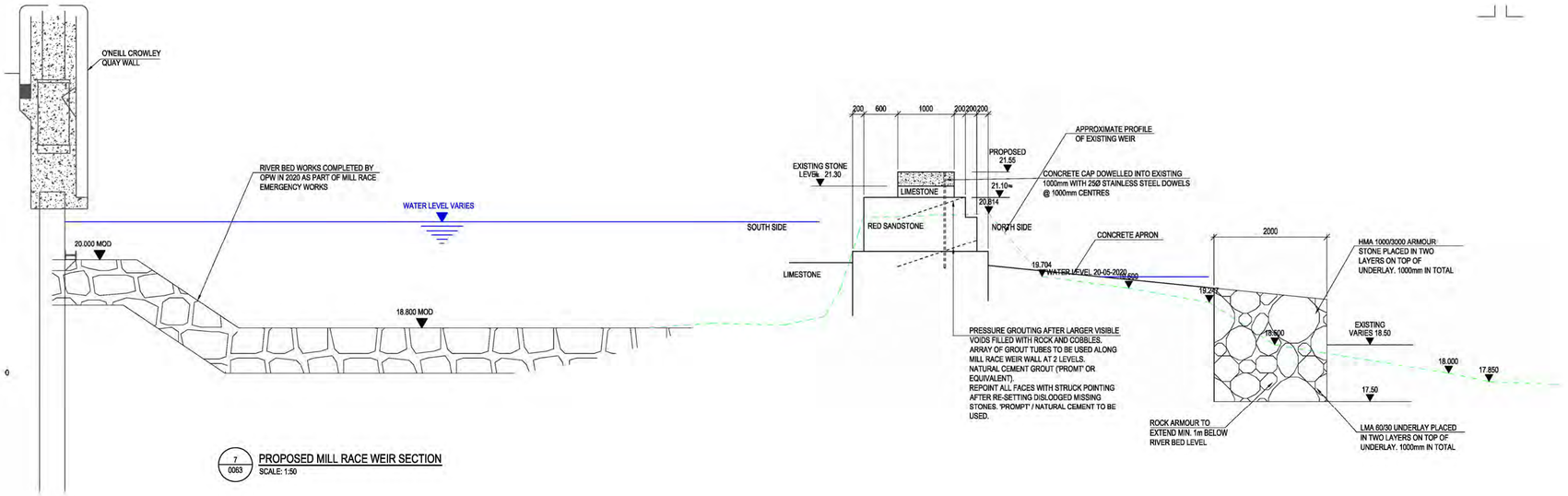
SCALE: AS SHOWN (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER
19011-TJOC-PL-XX-DR-C-0062

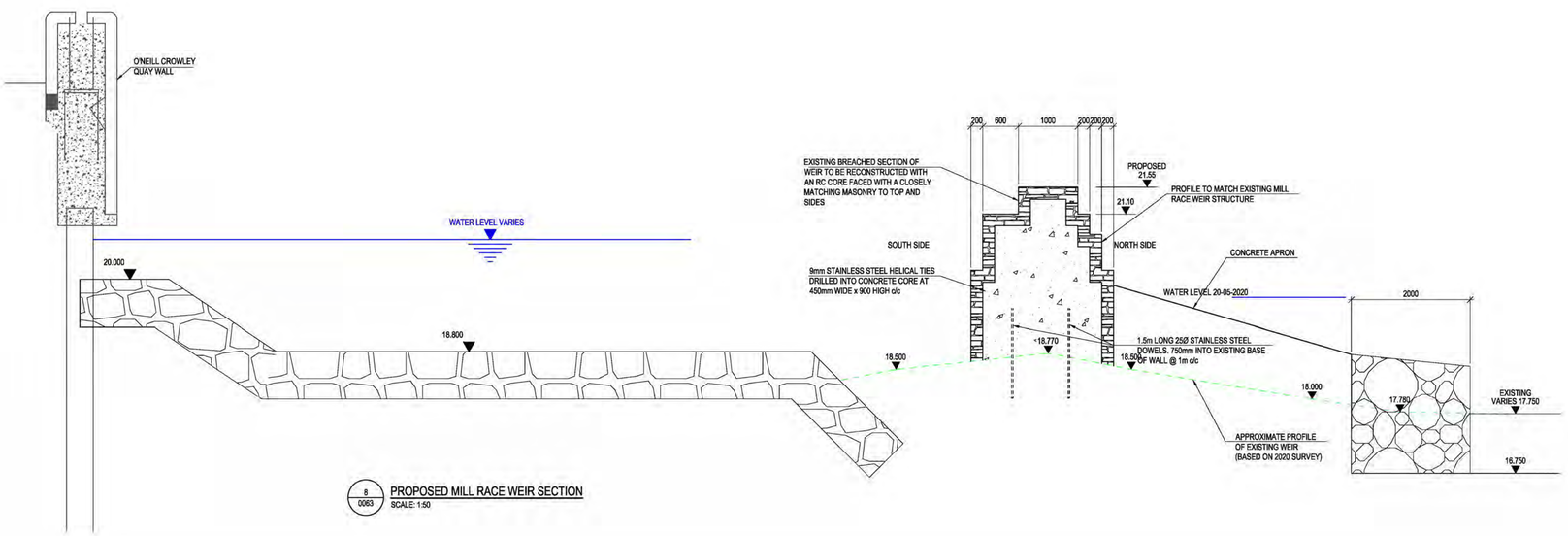
REV: C01



6 / 0063 PROPOSED MILL RACE WEIR SECTION
SCALE: 1:50



7 / 0063 PROPOSED MILL RACE WEIR SECTION
SCALE: 1:50



8 / 0063 PROPOSED MILL RACE WEIR SECTION
SCALE: 1:50

NOTES:

1. ALL LEVELS SHOWN ARE IN METERS ABOVE ORDNANCE DATUM, MALIN HEAD.
2. FOR LOCATIONS OF SECTIONS REFER TO DRAWING 0060.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH SURVEY DRAWINGS OF EXISTING WEIR STRUCTURE AND WITH SECTION DRAWINGS 0061 AND 0062.
4. WEIR REMEDIATION SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE CONSERVATION ENGINEER'S RECOMMENDATIONS.

REV	SUIT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	02.06.2022

DRAWING STATUS: ISSUED FOR PLANNING

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Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

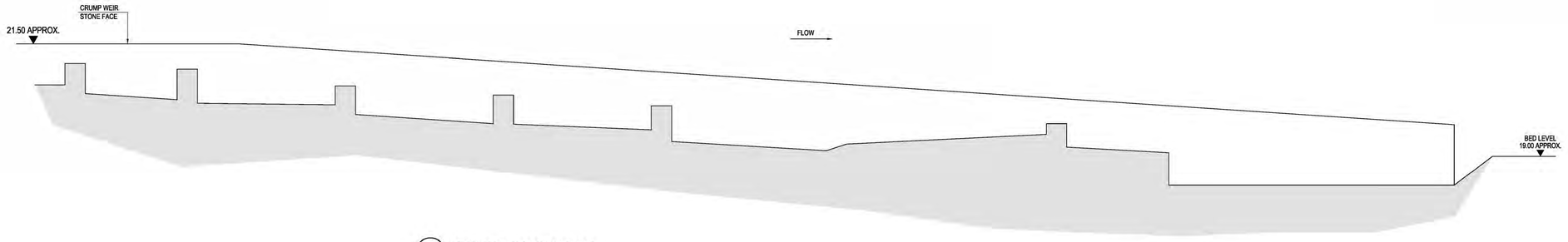
CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: WEIR REMEDIATION PROPOSED SECTIONS

SCALE: AS SHOWN (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 19011-TJOC-PL-XX-DR-C-0063

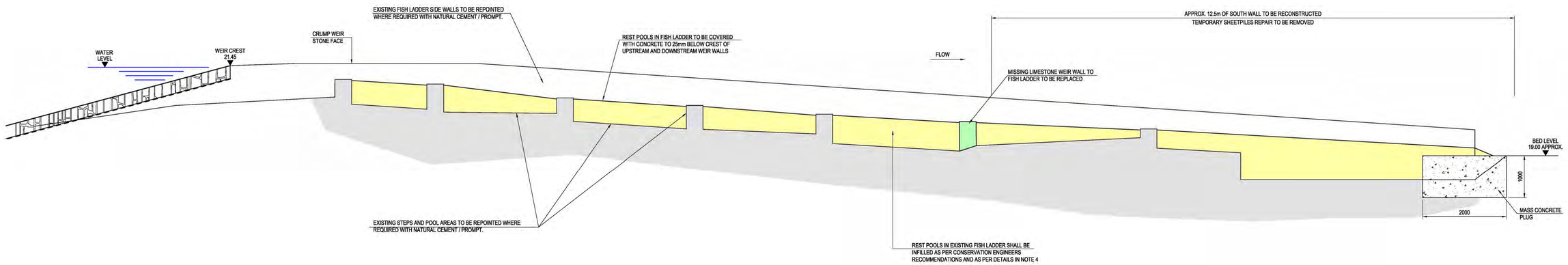
REV: C01



1/0081 EXISTING FISH LADDER SECTION
SCALE: 1:50

NOTES:

1. ALL WORKS CARRIED OUT IN THE RIVER AND TO THE FISH PASS TO BE AGREED WITH INLAND FISHERIES IRELAND PRIOR TO COMMENCEMENT OF THE WORKS.
2. WORKS IN THE RIVER WILL ONLY BE PERMITTED BETWEEN THE BEGINNING OF AUGUST TO MID SEPTEMBER IN ACCORDANCE WITH INLAND FISHERIES IRELAND GUIDELINES.
3. PROPOSED REMEDIAL WORK DETAILS AS PER CONSERVATION ENGINEER, TREVOR WOODS CONSULTING ENGINEERS, DETAILS.
4. COVERING
   DPM 1500 GAUGE TO BE LAID UP PASS INSIDE WALLS OVER BASE AND LAPPED MINIMUM 1m BETWEEN SHEETS / JOINTS.
   TYPE 6F FILL WITHIN 300mm EXISTING CAPPING.
   150mm CLAUSE 804 BLINDED WITH LEAN MIX CONCRETE.
   150mm CONCRETE SLAB (FIBRE MESH POLYPROPYLENE FIBRES)
   SURFACE TO BE STAMPED WITH RANDOM STONE PATTERN.
5. ALL LEVELS AS PER MURPHY SURVEYS 2018 SURVEY OF WEIR STRUCTURE.
6. EXISTING FISH LADDER SHALL BE INFILLED IN ORDER TO AVOID WHITE WATER CREATED BY THE STEPS IN THE LADDER ATTRACTING FISH FROM DOWNSTREAM OF THE WEIR.



2/0081 PROPOSED FISH LADDER SECTION
SCALE: 1:50

REV	STAT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	02.08.2022

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

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Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: EXISTING FISH LADDER REMEDIATION DETAILS - SHEET 2

SCALE: AS SHOWN (A1)

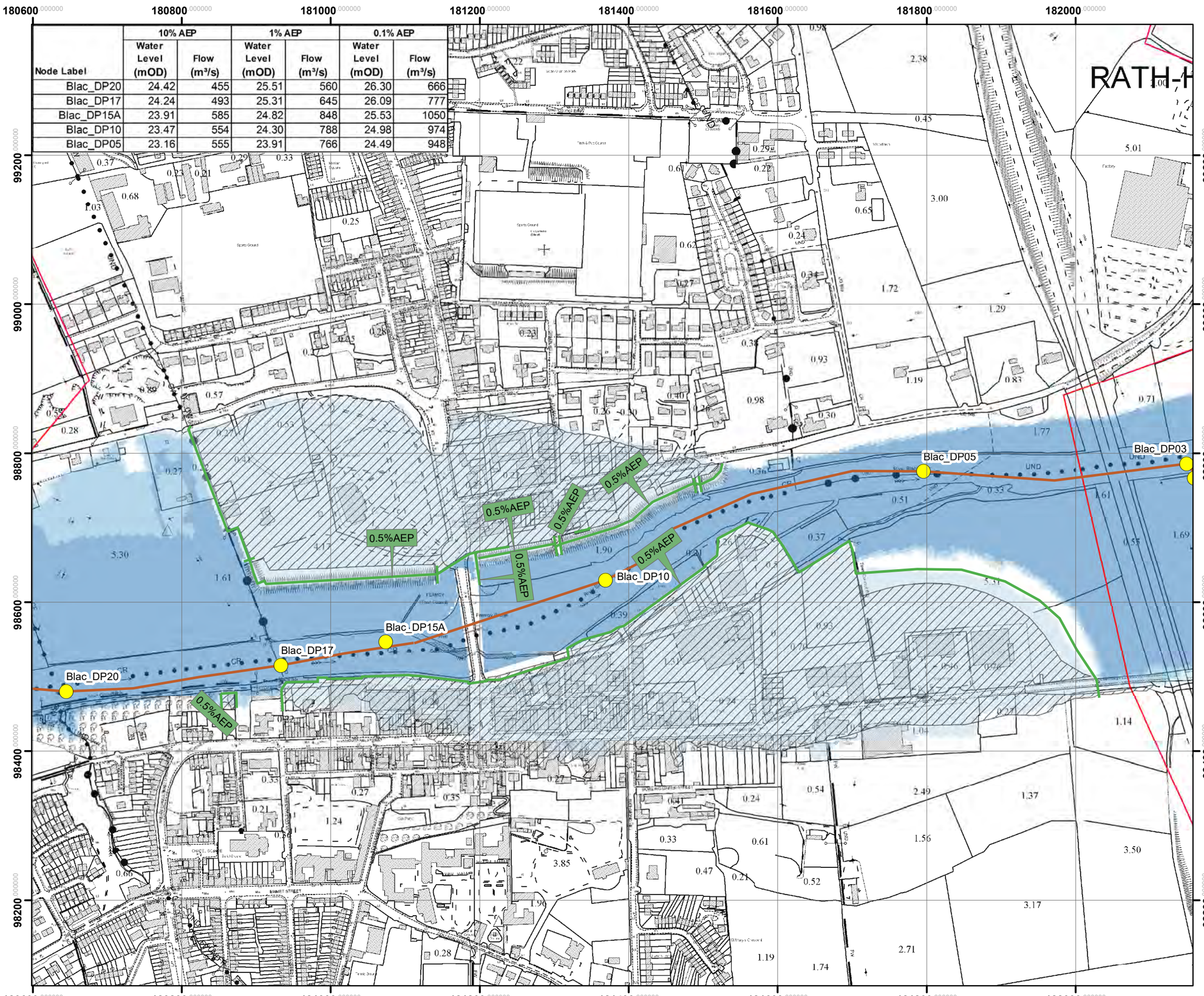
PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 190080-TJOC-PL-XX-DR-C-0081

REV: C01

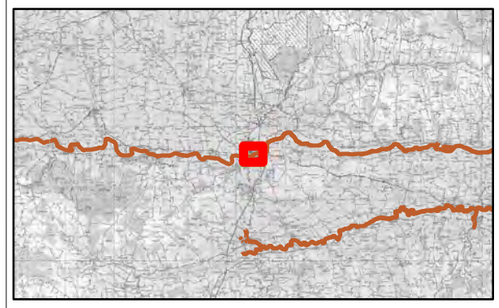
APPENDIX C

South Western CFRAM Fluvial Flood Zoning Map

Node Label	10% AEP Water Level (mOD)	10% AEP Flow (m^3/s)	1% AEP Water Level (mOD)	1% AEP Flow (m^3/s)	0.1% AEP Water Level (mOD)	0.1% AEP Flow (m^3/s)
Blac_DP20	24.42	455	25.51	560	26.30	666
Blac_DP17	24.24	493	25.31	645	26.09	777
Blac_DP15A	23.91	585	24.82	848	25.53	1050
Blac_DP10	23.47	554	24.30	788	24.98	974
Blac_DP05	23.16	555	23.91	766	24.49	948



Location Plan:



Legend:

- Model Nodes
- Flood Defence - Embankment
- Modelled River Centreline
- Defended Area
- AFA Boundary
- 10% AEP Flood Extent
- 1% AEP Flood Extent
- 0.1% AEP Flood Extent

IMPORTANT USER NOTICE: THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

SOUTH WESTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

Office of Public Works
Jonathan Swift Street
Trim Co. Meath

Mott MacDonald Ireland
5 Eastgate Avenue
Little Island
Co. Cork

Project:
South Western CFRAM Study

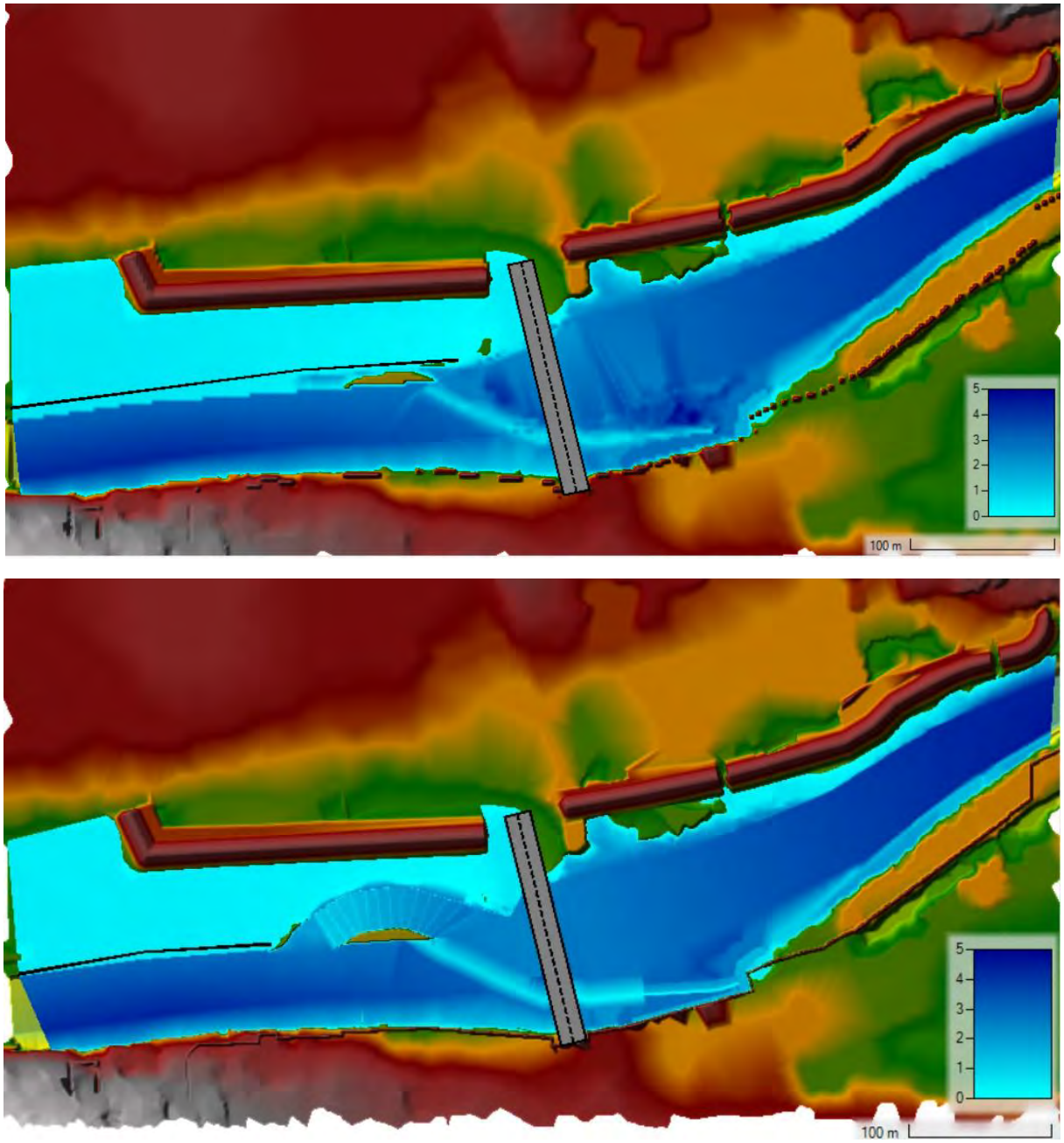
Map:
Fermoy - Flood Extent

Map type:	Flood Extent		
Source:	Fluvial Flooding		
Map area:	Urban Area		
Scenario:	Current		
Drawn by:	Lee Cutting	Date:	June 2016
Checked by:	Marianne Piggott	Date:	June 2016
Approved by:	Christian Hetmank	Date:	June 2016
Map No.:	MMD/296235/E/DR/I18HFY/EXFCDEXF/F/Sht005		
Sheet:	5 of 7	Revision:	F
Drawing Scale:	1:5,000	Plot Scale:	1:1@A3

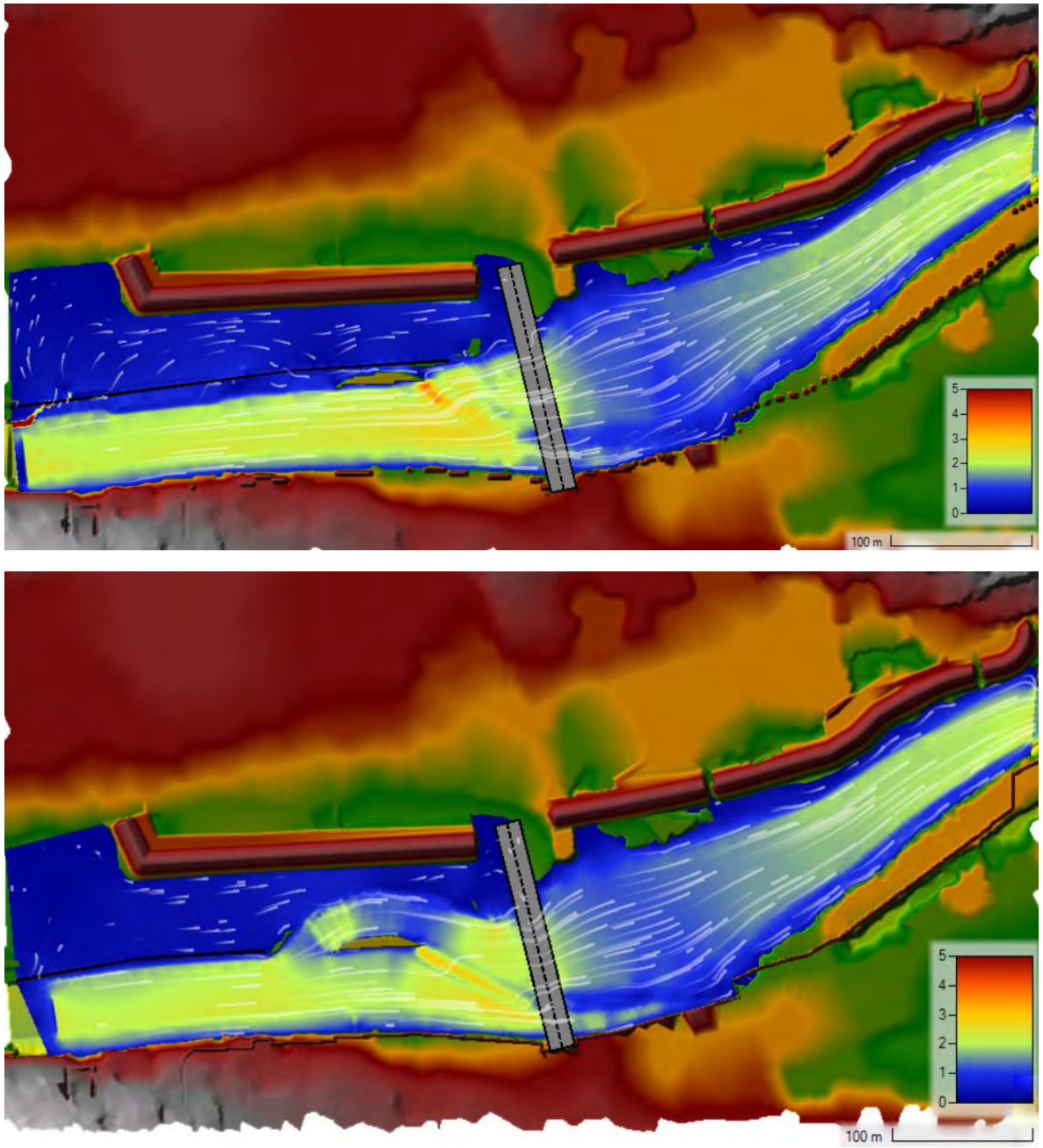
APPENDIX D

HEC-RAS Model Outputs

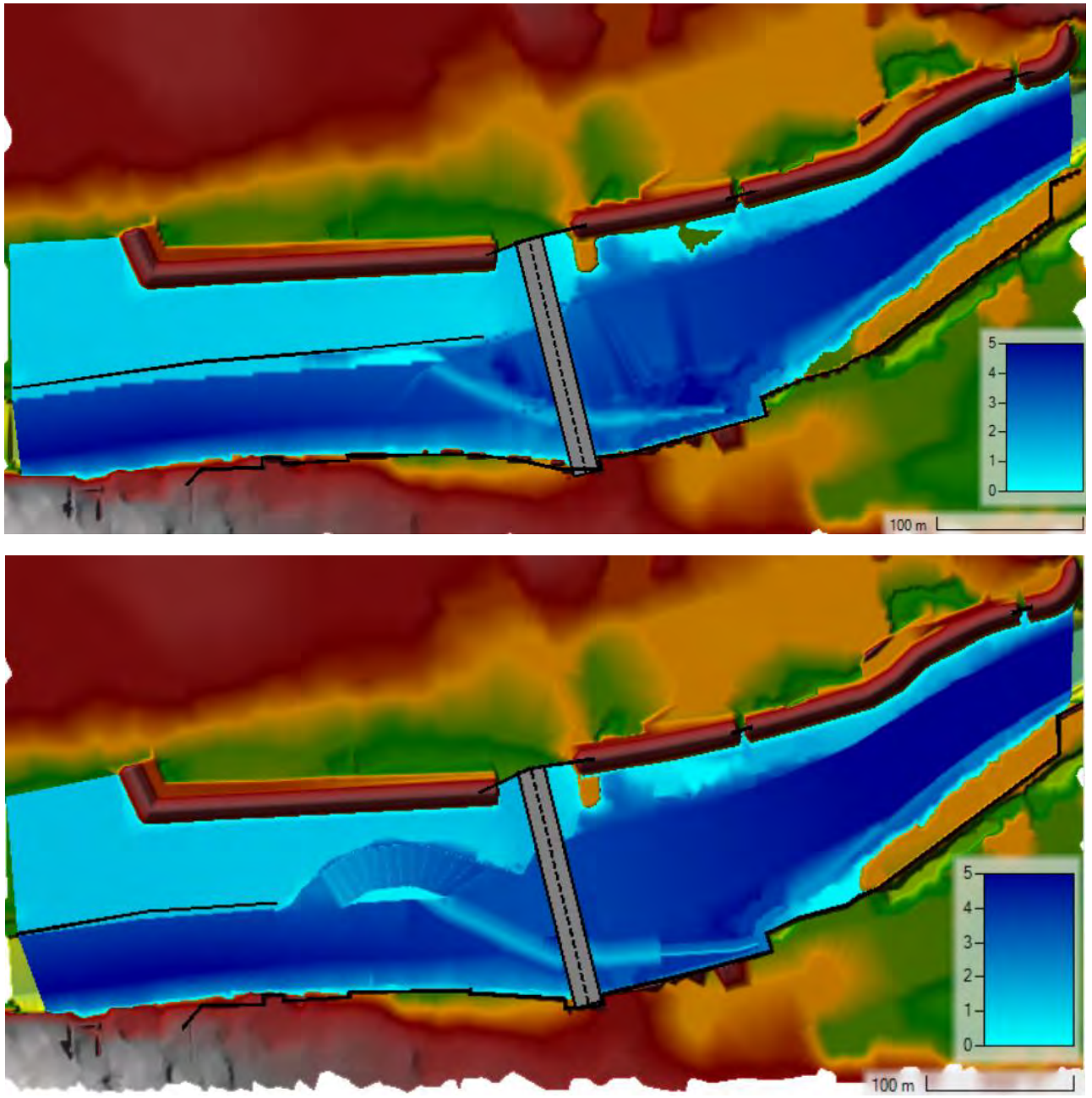
1 in 2 Year Depths – Existing (Top) & Proposed (Bottom)



1 in 2 Year Max Velocities – Existing (Top) & Proposed (Bottom)



1 in 5 Year Depths – Existing (Top) & Proposed (Bottom)



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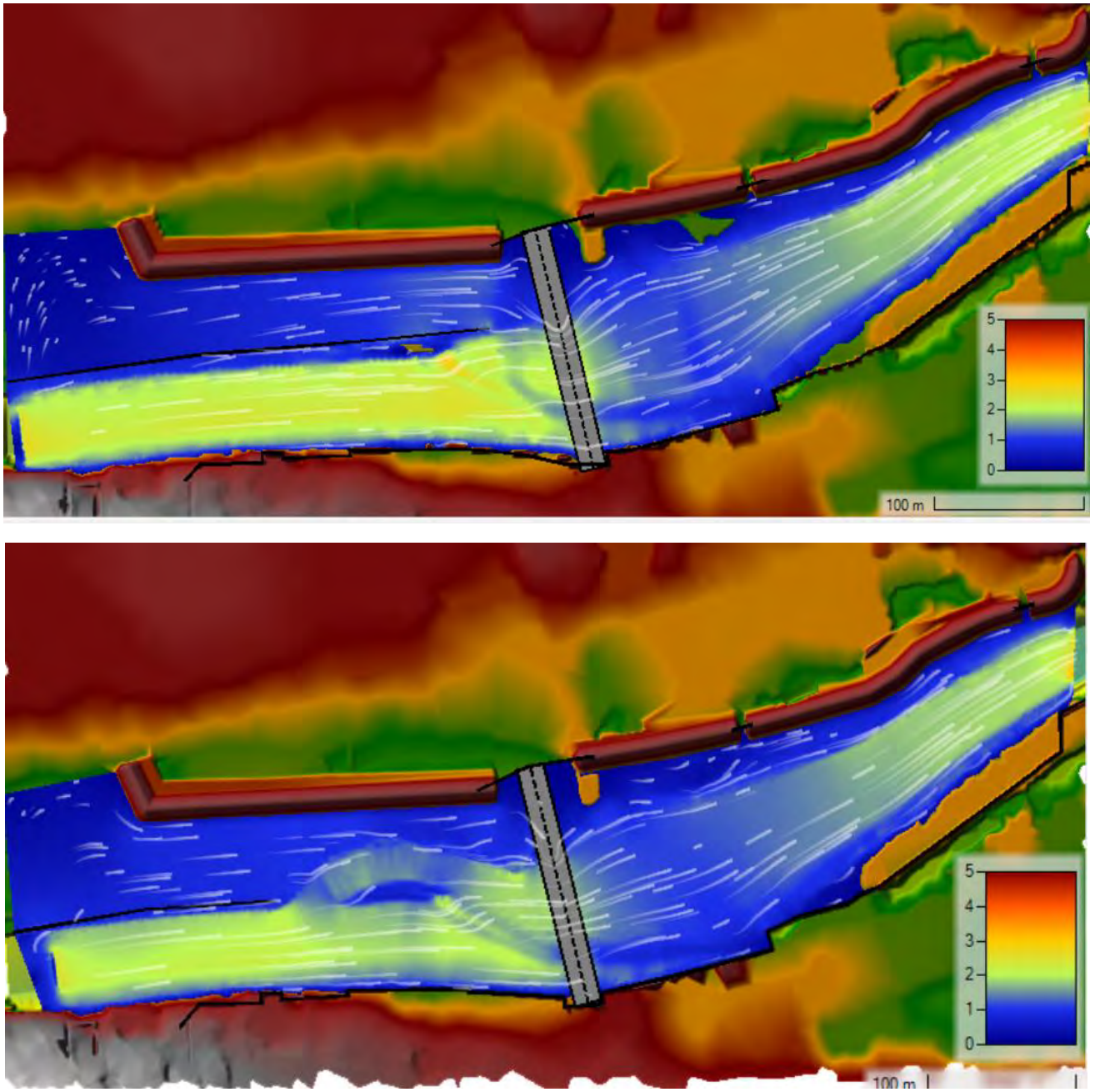
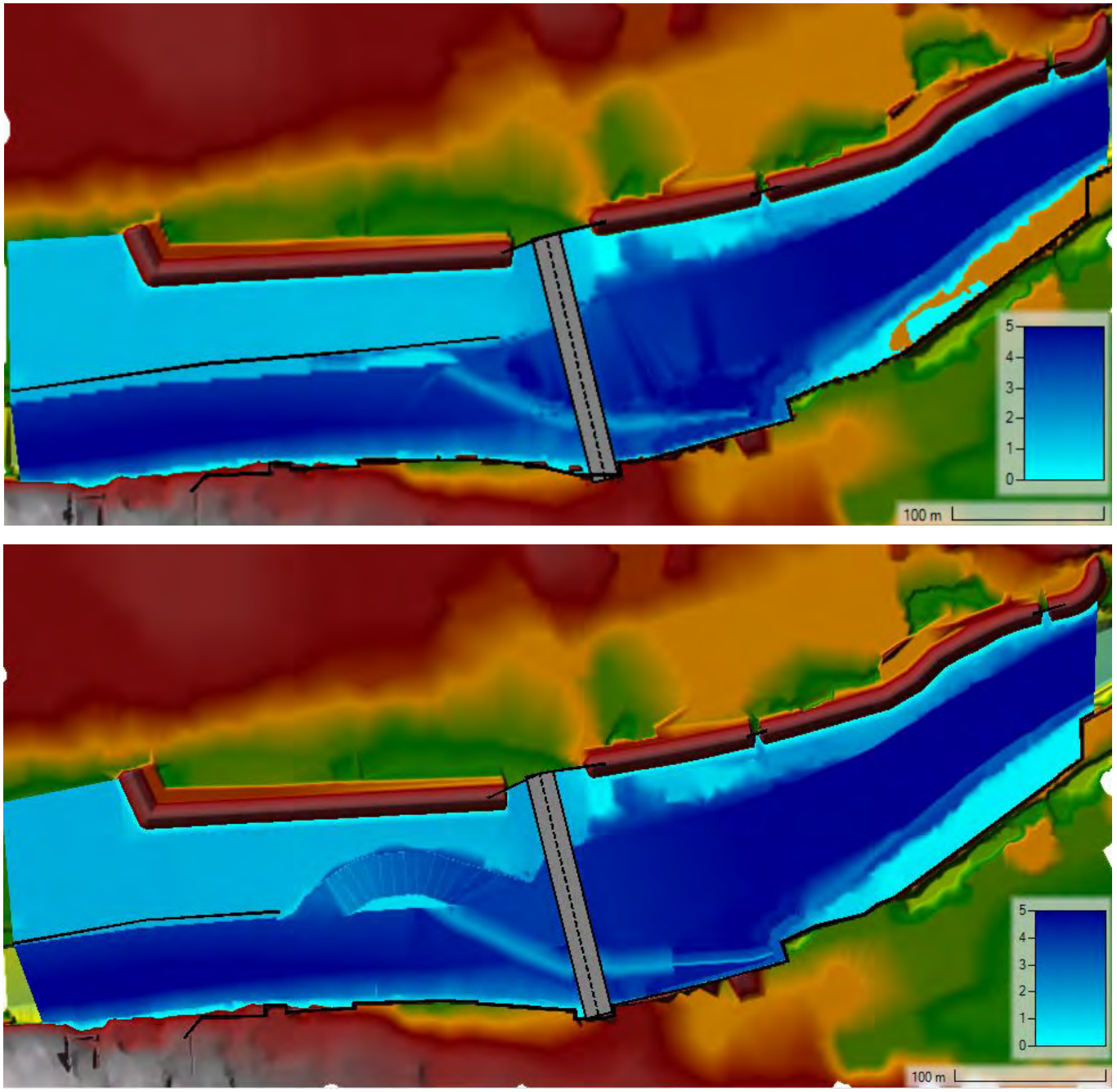
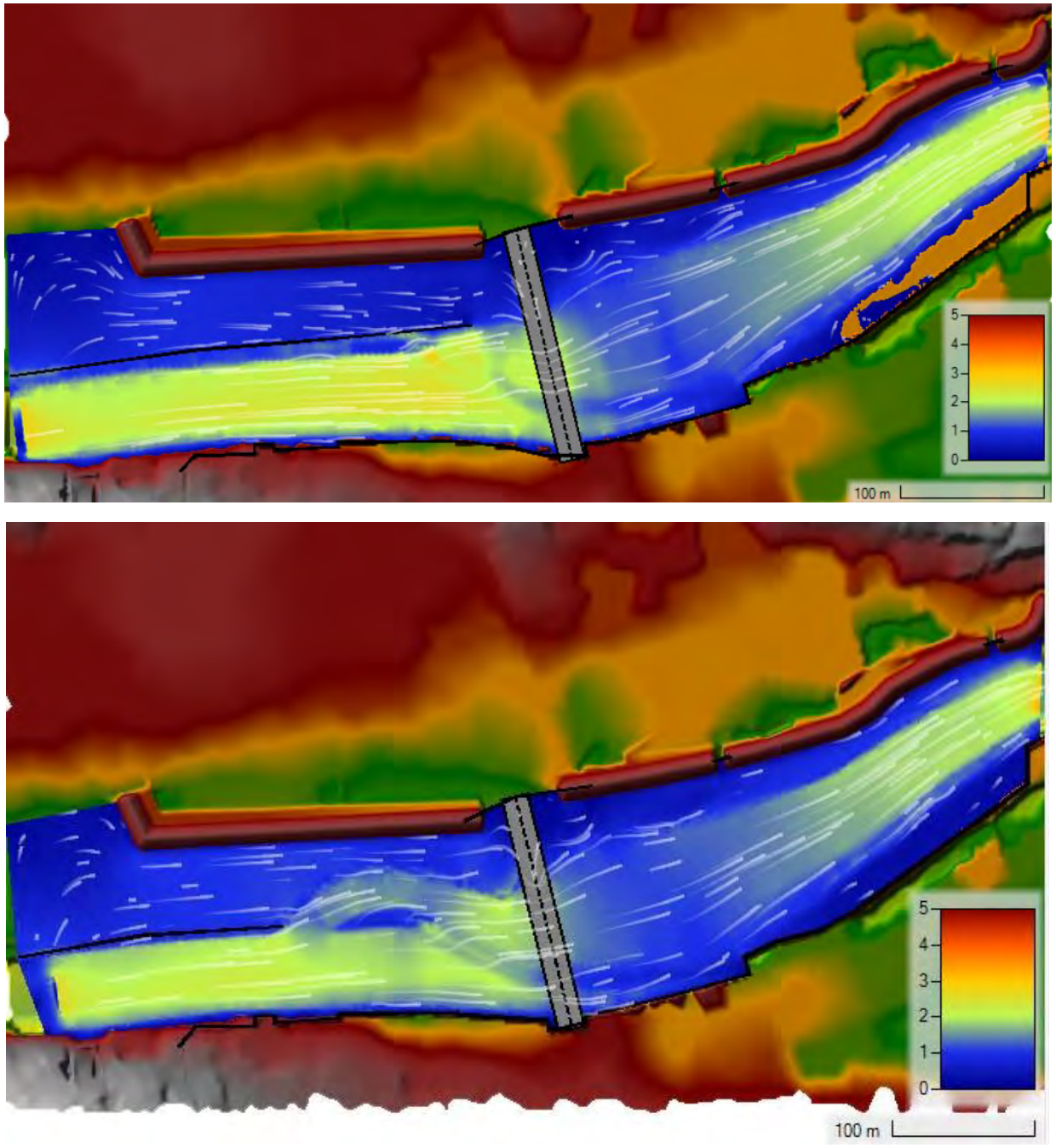


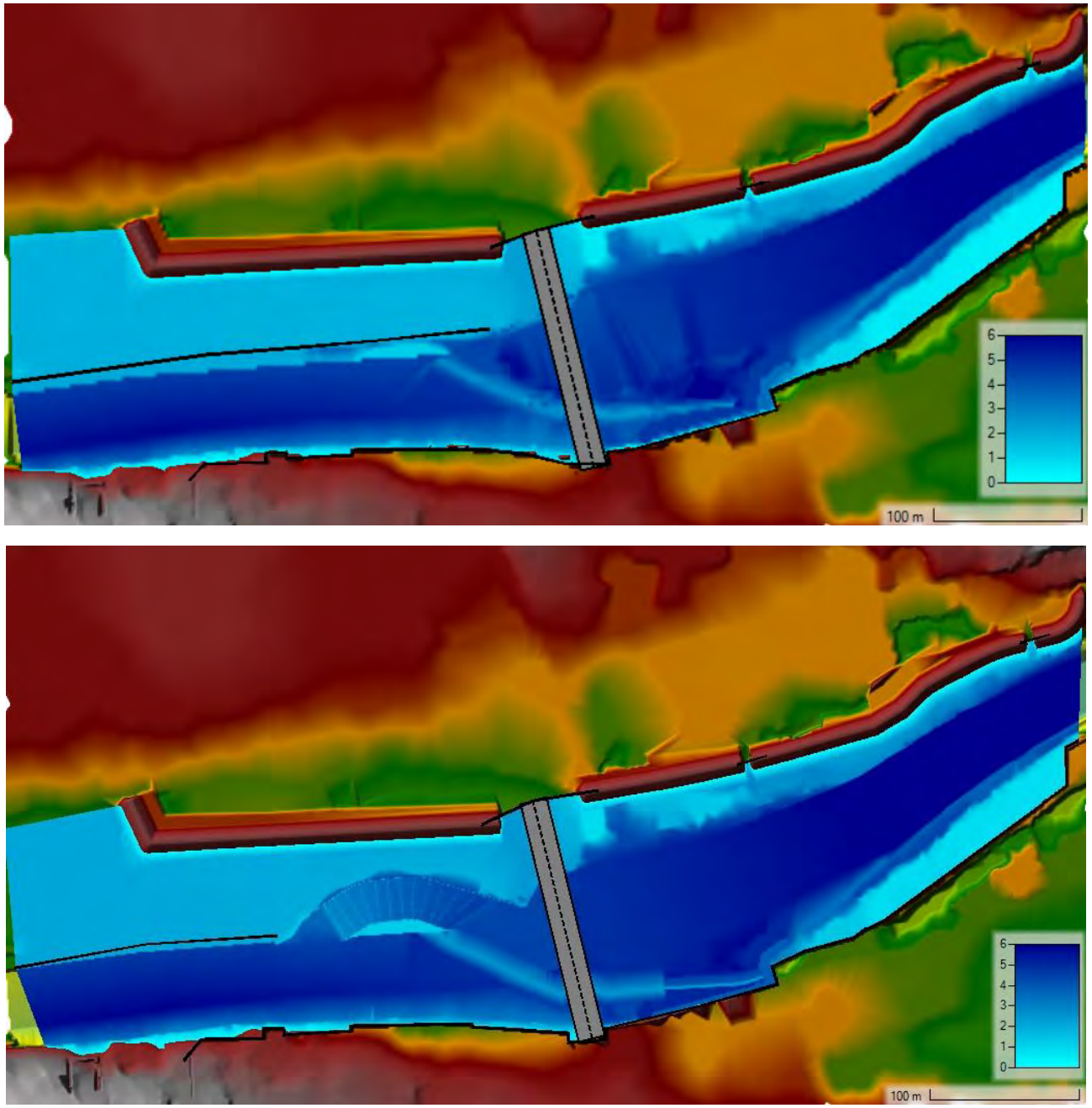
1 in 10 Year Depths – Existing (Top) & Proposed (Bottom)



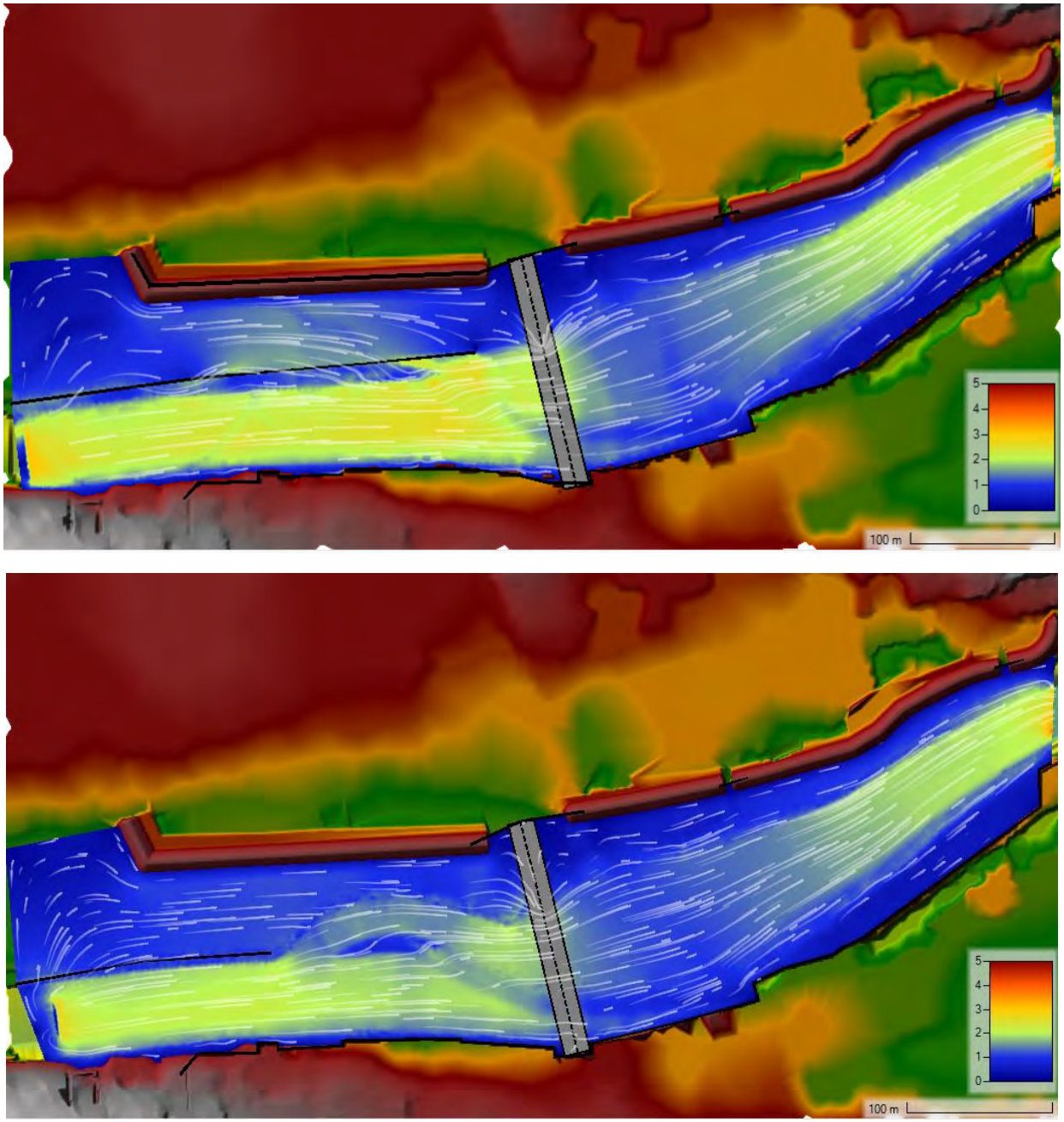
1 in 10 Year Max Velocities – Existing (Top) & Proposed (Bottom)



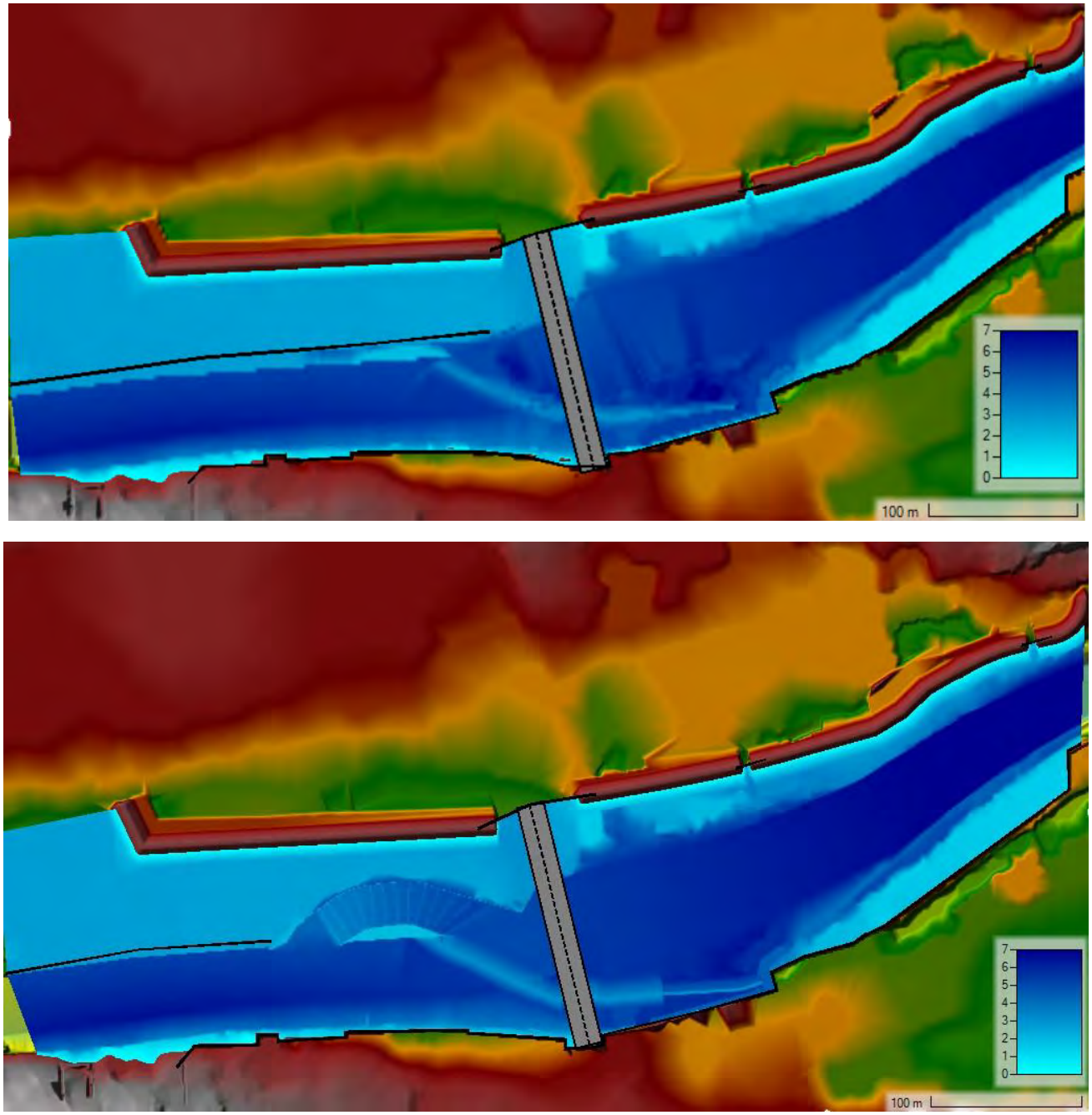
1 in 25 Year Depths – Existing (Top) & Proposed (Bottom)



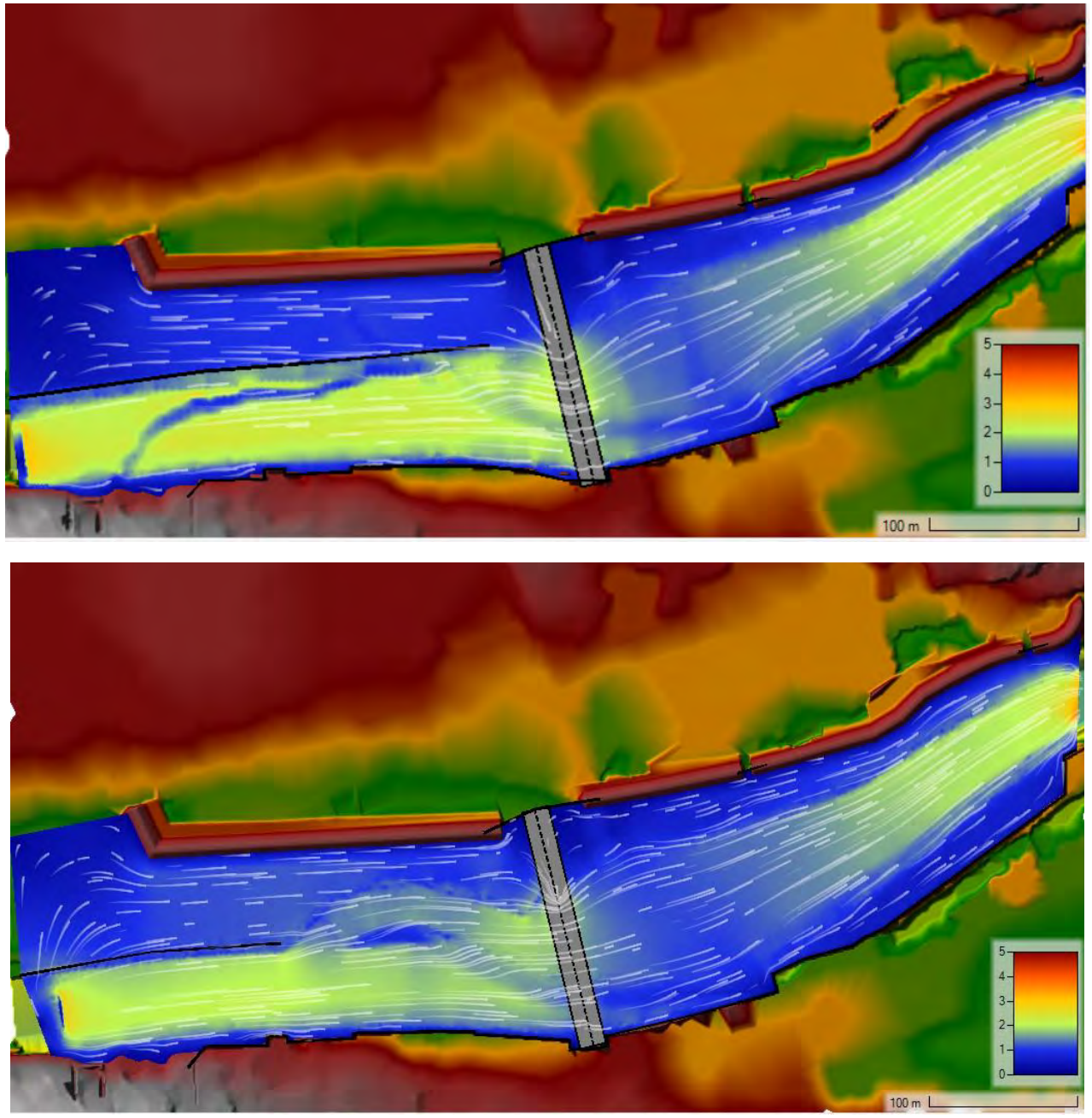
1 in 25 Year Max Velocities – Existing (Top) & Proposed (Bottom)



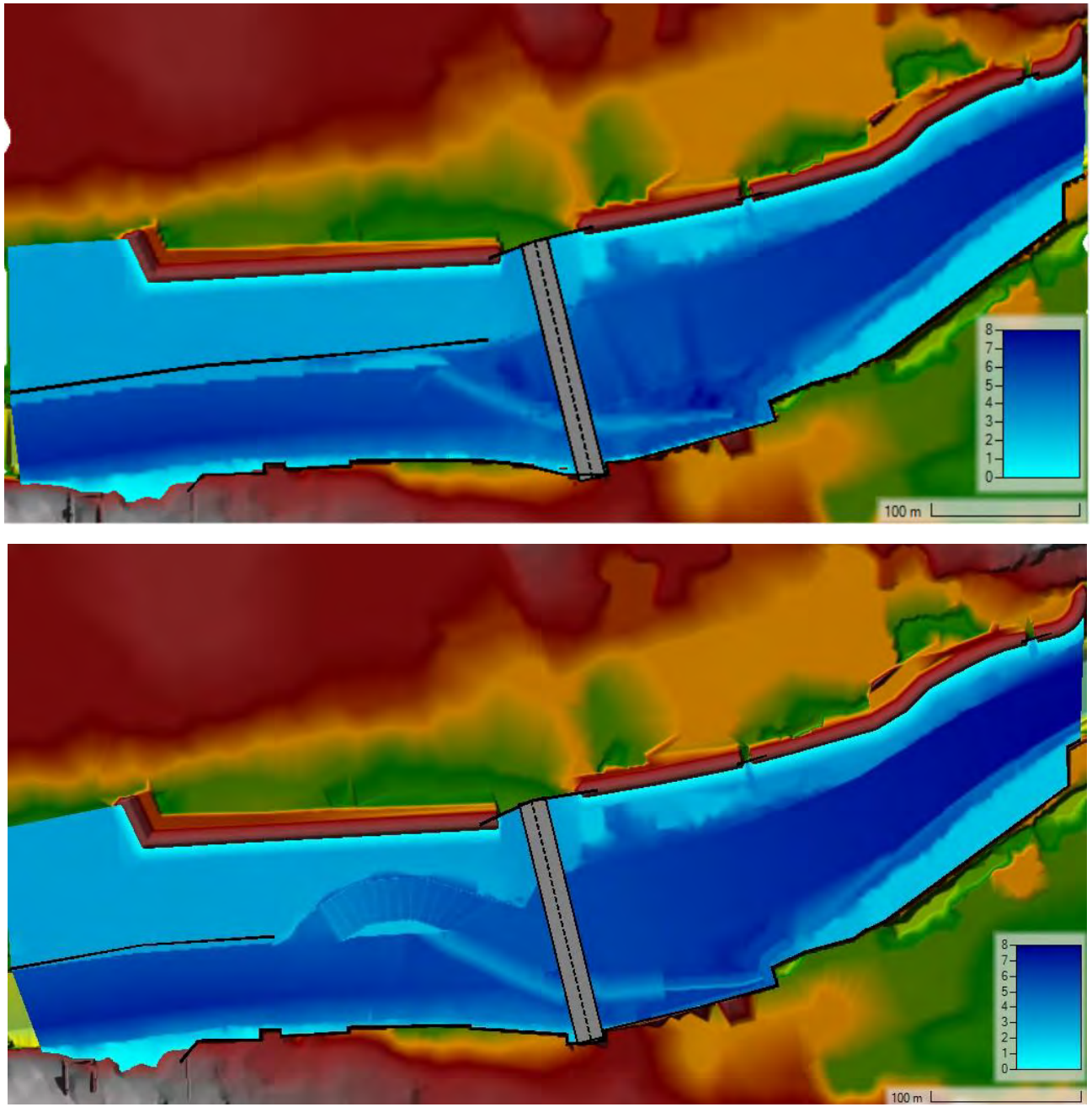
1 in 50 Year Depths – Existing (Top) & Proposed (Bottom)



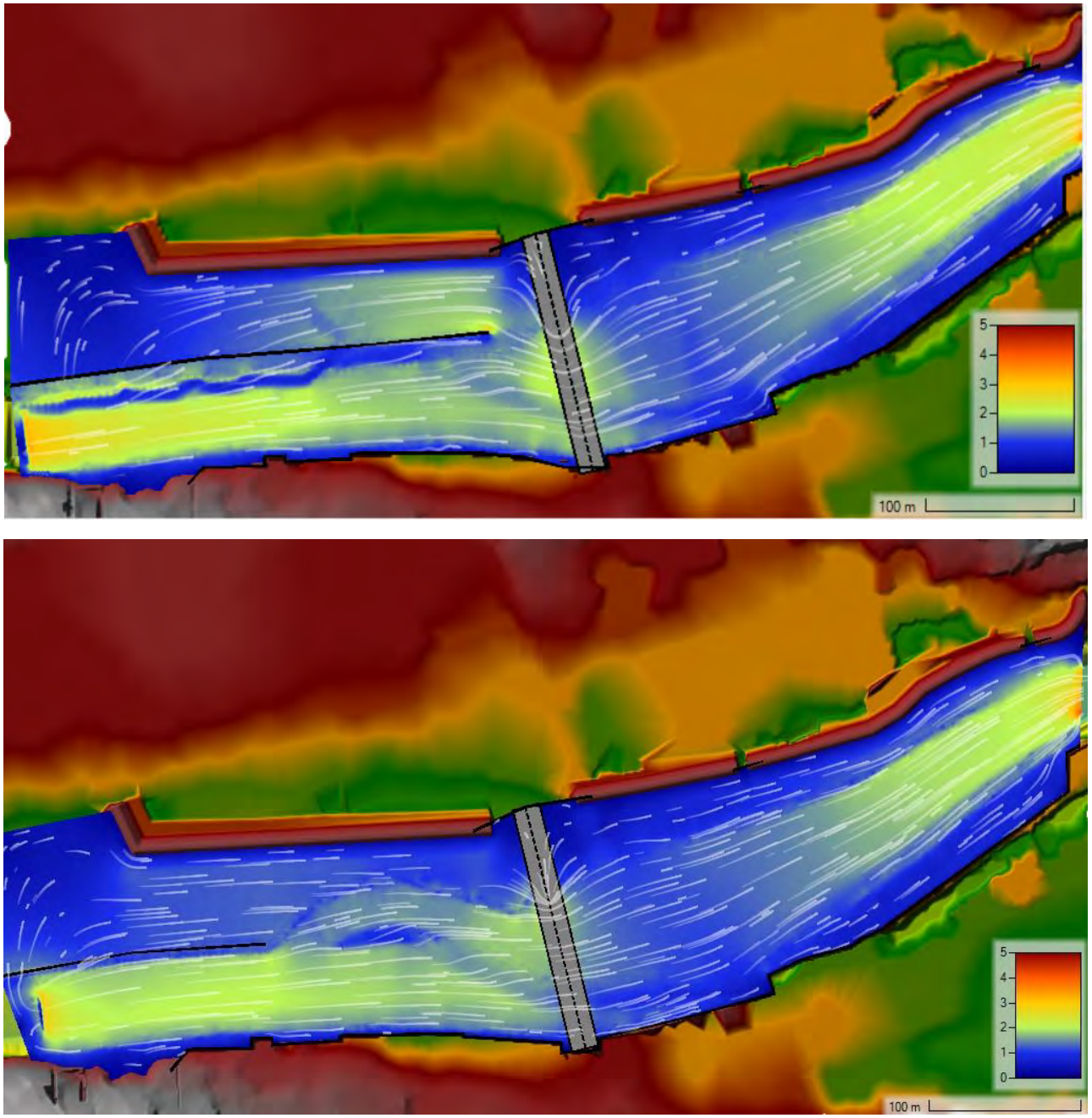
1 in 50 Year Max Velocities – Existing (Top) & Proposed (Bottom)



1 in 100 Year Depths – Existing (Top) & Proposed (Bottom)



1 in 100 Year Max Velocities – Existing (Top) & Proposed (Bottom)



STONE CLAD RC WALL CONSTRUCTED AGAINST EXISTING MASONRY WALL

STONE CLAD RC WALL

STONE CLAD RC WALL

STONE CLAD RC WALL

STONE CLAD RC WALL

STONE CLAD RC WALL

STONE CLAD RC WALL

STONE CLAD RC WALL

DEMOUNTABLE WALL STRUCTURE ON PILED FOUNDATION BELOW GROUND SURFACE LEVEL

DEMOUNTABLE WALL STRUCTURE

DEMOUNTABLE WALL STRUCTURE

EXISTING STONE WALL

FLOOD GATE

STORMWATER PUMPING STATION

STORMWATER PUMPING STATION

PUMPING STATION CONTROL BUILDING

EMBANKMENT 1

EMBANKMENT 2

FARTHEN EMBANKMENT

EMBANKMENT 3

EMBANKMENT 4

FARTHEN EMBANKMENT

EMBANKMENT 5

FARTHEN EMBANKMENT

EMBANKMENT 6

WALL 8

WALL 12/13

WALL 15/16

WALL 26

WALL 24

WALL 22

WALL 7

WALL 9

WALL 10

WALL 13

WALL 15

WALL 6

WALL 8

WALL 11

WALL 12

WALL 14

WALL 17

WALL 19

GAUGE 18107

GAUGE 18117

GAUGE 18106

Fermoy Park

Bandstand

Swimming Pool

Abercromby Place

Nursing Home

FRANCES STREET

BRIAN BORU SQUARE

THOMAS STREET

The Promenade

RATHEALY ROAD

Club House

Fermoy Bridge

River Blackwater

CR

Weir

Salmon Leap

FERMOY (Town Council)

Town Council Bdy

Ploemeur Place

Car Park

MILL ROAD

Mart

Lisieux Villas

O'NEILL CROWLEY QUAY

KENT STREET

FITZGERALD PLACE

PEARSE SQUARE

BARRANE WALK

WATERLOO LANE

ABBEY STREET

FORGE LANE

Boat Club

School

Hall

Hotel

Bank

Manastery (Site of)

Credit Union

PO

Car Park

Briscoe Tce

O'Rahilly Row

PATRICK STREET

MAST

STORE

ELBOW LANE

TEL EX

Apts

7-18

1-7

BM 23.82

BM 25.87

BM 32.54

BM 24.94

CW

CF

UND

FW

10Kv

N

0 10 20 30 40 60 80 100m
1:1000

LEGEND	
DEMOUNTABLE STRUCTURES	
PENSTOCK	
PERMANENT WALL WITH DEMOUNTABLE STRUCTURES	
PERMANENT WALLS	
WALL REPORTED ON	
GAUGE LOCATIONS	

REV	STAT	DESCRIPTION	DATE
C01	AP	ISSUED FOR PLANNING	01.03.2023

DRAWING STATUS: ISSUED FOR PLANNING

CHECKED BY:	REVIEWED BY:	APPROVED BY:
LC	MV	DC

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@tjoc.ie Web: www.tjoc.ie

PROJECT: FERMOY WEIR REMEDIATION AND FISH BYPASS CHANNEL

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: HECRAS MODELLING OUTPUT LOCATIONS EXISTING LAYOUT

SCALE: 1:1000 (A1)

PROJECT - ORIGINATOR - VOLUME - LOCATION - TYPE - ROLE - NUMBER: 19011-TJOC-PL-XX-DR-C-0089

REV: C01

APPENDIX E

Fermoy North & South FDS Wall Locations

LEGEND:

DEMOUNTABLE STRUCTURES

EMBANKMENT

EXTENT OF 1:100 YEAR FLOOD PLAIN

STONE CLAD RC WALL CONSTRUCTED AGAINST EXISTING MASONRY WALL

WALL 1

WALL 2A & B

WALL 3

WALL 4

STONE CLAD RC WALL

WALL 5

EMBANKMENT No.1

DEMOUNTABLE WALL STRUCTURE ON PILED FOUNDATION BELOW GROUND SURFACE LEVEL

STORMWATER PUMPING STATION

WALL 7

WALL 8

WALL 6

STONE CLAD RC WALL

EARTHEN EMBANKMENT

FLOOD GATE

AREA OF EXISTING ROAD EXCAVATED AND RECONSTRUCTED TO NEW LEVELS

EMBANKMENT No.2

DEMOUNTABLE WALL STRUCTURE

EARTHEN EMBANKMENT

WALL 11

WALL 10

WALL 9

EXISTING STONE WALL

STONE CLAD RC WALL

WALL 12

WALL 13

WALL 14

STONE CLAD RC WALL

NEW DRIVEWAY

EMBANKMENT No.3

STORMWATER PUMPING STATION

PUMPING STATION CONTROL BUILDING

EARTHEN EMBANKMENT

WALL 15

STONE CLAD RC WALL

DEMOUNTABLE WALL STRUCTURE

EMBANKMENT No.4

EARTHEN EMBANKMENT

WALL 16

Fermoy Park

Camping Site

Bandstand

Swimming Pool

Rectory

Church (C of I)

Church Place

Church (Presby)

School

Nursing Home

Abercromby Place

St James Place

ALLEN'S WALK

THOMAS STREET

FRANCES STREET

RATHEALY ROAD

Promenade

BRIAN BORU SQUARE

FERMOY (Town Council)

Town Council Bdy

Weir

Salmon Leap

Fermoy Bridge

Blackwater River

Car Park

Ploemeur Place

Mart

LS MILL ROAD

ASHE QUAY

BARNANE WALK

Boat Club

School

Hall

WATERLOO LANE

ABBEY STREET

FORGE LANE

Hotel

PEARSE SQUARE

Bank

Credit Union

G S Sta

MAST

KENT STREET

ELBOW LANE

FITZGERALD PLACE

McCURTAIN STREET

PATRICK STREET

O'NEILL CROWLEY QUAY

Toilets

Briscoe Tce

Bishop's Place

Presbytery

BM 28.03

BM 32.62

BM 23.85

BM 24.94

BM 32.54

BM 25.87

BM 25.65

AMENDMENTS TO WALLS FOLLOWING COMPLETION OF ORIGINAL WORKS ADDED TO DRAWINGS. WALL AND EMBANKMENT NUMBERS ADDED					.....	AB
LEGEND ADDED					MAR'17	AB
RECORD DRAWINGS COMPLETED FROM CONTRACTORS RECORDS					MAR '12	AB
TENDER ISSUE					JAN '09	
TENDER ISSUE					FEB '07	
			AUT	CON	Dr.	DATE
CONSTRUCTOR/DESIGNER	FIRST DRAFT MAY '07					15-05-07

Document: ☐ informative ☐ draft ■ Final version

MUNSTER BLACKWATER RIVER – FERMOY NORTH DRAINAGE SCHEME

OFFICE OF PUBLIC WORKS

DHV Environment and Transportation Amersfoort, The Netherlands

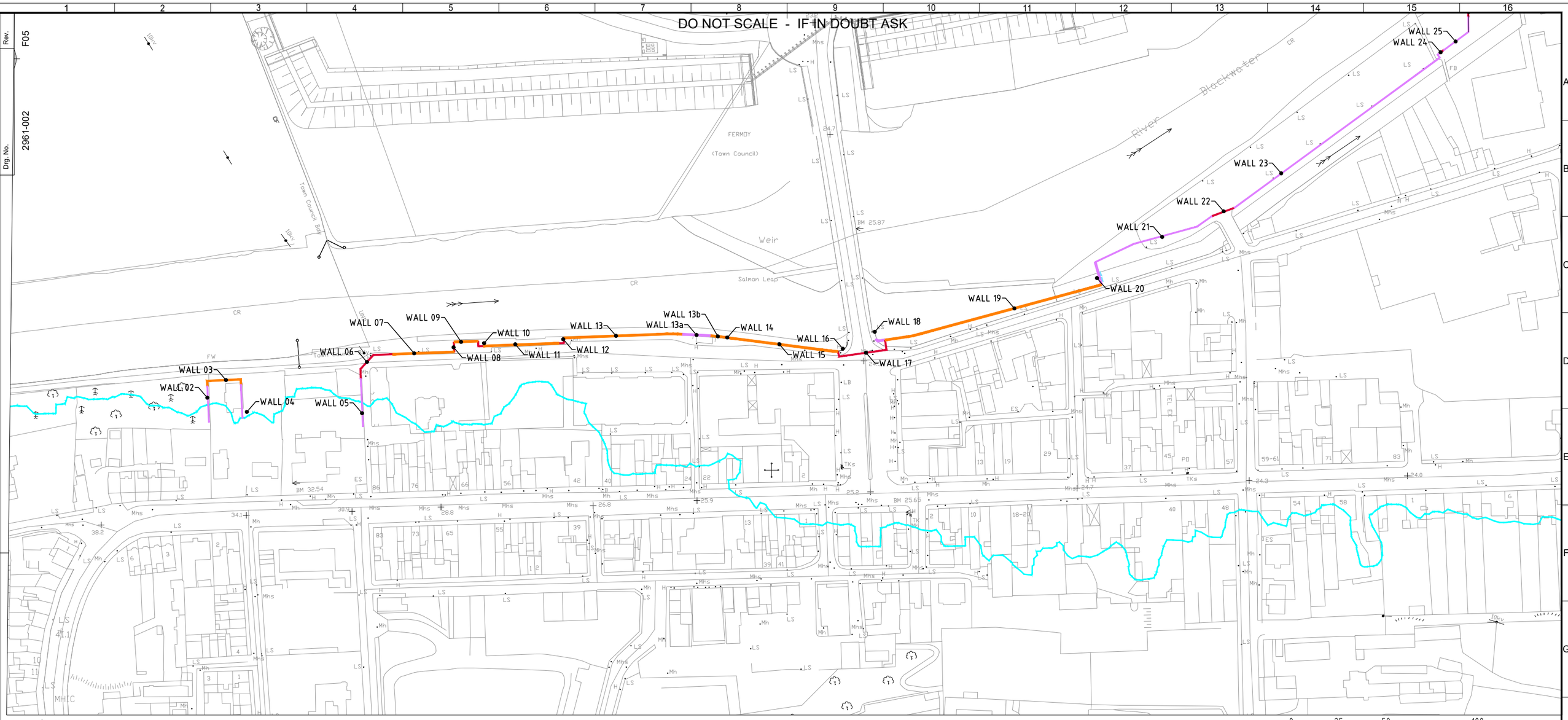
LAYOUT OF FLOOD DEFENCE WORKS

SCALE	PAPERSIZE
1:1000	A1
JOB NUMBER	DRAWING Nr. / REV.
2667	1 AB

DO NOT SCALE - IF IN DOUBT ASK

Rev. F05

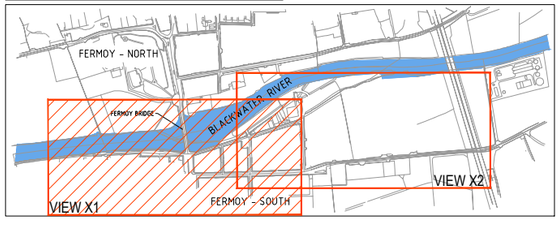
Drg. No. 2961-002



LAYOUT VIEW X1

SCALE: 1:1000

KEYPLAN



LEGEND

- DEMOUNTABLE STRUCTURES
- PENSTOCK
- PERMANENT WALL IN COMBINATION WITH DEMOUNTABLE STRUCTURES
- PERMANENT WALL
- EXTENT OF 1:100 YEAR FLOOD EVENT
- EARTH EMBANKMENTS

DATE	DRWN	CHKD	REVD	ISSUE	
19/05/21	JMCA	PH	JB	F01	AS BUILT

AS BUILT

Lagan Construction Ltd | Rosemount House, 21 - 23 Sydenham Rd, Belfast, BT3 9HA
Tel: +44 (0) 28 9045 5531 Fax: +44 (0) 28 9045 8940

Customer: COMMISSIONERS OF PUBLIC WORKS IN IRELAND (OPW)

Title: MUNSTER BLACKWATER RIVER
FERMOY SOUTH EAST AND SOUTH WEST DRAINAGE SCHEMES
LAYOUT OF FLOOD DEFENCE WORKS -SHEET 1

Drawn	Checked	Approved	Original Sheet Size
J. McA	PH	JB	A1
Date 05/03/2015	Date 20/11/2019	Date 20/11/2019	Original Scale 1:1000
Drg. No. 2961-002			Rev. F05

DO NOT SCALE - IF IN DOUBT ASK

Rev.F05

Dwg. No. 2961-003

WALL 28
WALL 27
WALL 29
WALL 30
WALL 31
WALL 32
WALL 33
WALL 34
WALL 35
WALL 37
WALL 36
WALL 38
WALL 26
WALL 25
WALL 24
WALL 23
WALL 22

Blackwater CR

Town Council Bdy

D1.0
D1.1
D1.2
R1.1
R1.0

10KV

FF
FB
LS
UND
Mh
Mhs
H
FES
TKs
PD

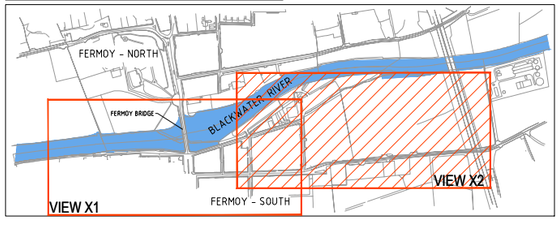
22.0
22.3
23.1
23.7
24.0
24.3
24.4

57
59-61
71
83
54
58
48
40
1
6
12

LAYOUT VIEW X2
SCALE: 1:1000

0 25 50 100m

KEYPLAN



LEGEND

- DEMOUNTABLE STRUCTURES
- PENSTOCK
- PERMANENT WALL IN COMBINATION WITH DEMOUNTABLE STRUCTURES
- PERMANENT WALL
- EXTENT OF 1:100 YEAR FLOOD EVENT
- EARTH EMBANKMENTS

AS BUILT

DATE	DRWN	CHKD	REVD	ISSUE	
19/05/21	JMCA	PH	JB	F01	AS BUILT

Lagan Construction Ltd | Rosemount House, 21 - 23 Sydenham Rd, Belfast, BT3 9HA
Tel: +44 (0) 28 9045 5531 Fax: +44 (0) 28 9045 8940

Customer: COMMISSIONERS OF PUBLIC WORKS IN IRELAND (OPW)

Title: MUNSTER BLACKWATER RIVER
FERMOY SOUTH EAST AND SOUTH WEST DRAINAGE SCHEMES
LAYOUT OF FLOOD DEFENCE WORKS -SH2

Drawn	Checked	Approved	Original Sheet Size
J. McA	PH	JB	A1
Date 05/03/2015	Date 20/11/2019	Date 20/11/2019	Original Scale 1:1000

Drg. No. 2961-003 Rev. F05

APPENDIX F

Rating Curve Calculations

Fermoy Weir Remediation - Levels for Calibrating FRA Model

Gauge 18107 21.92 mOD Poolbeg

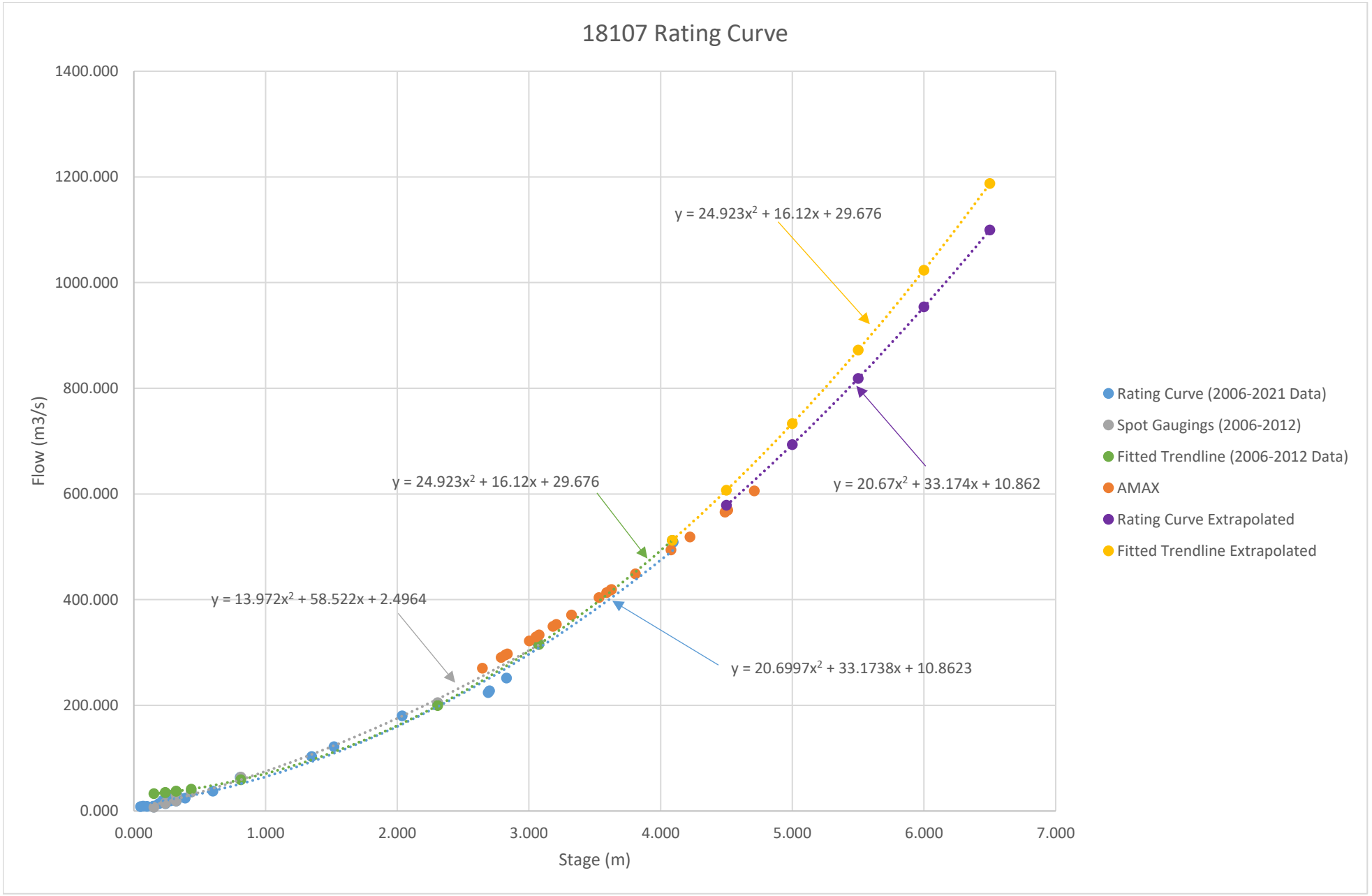
Note: Data (levels) at gauges 18106 and 18117 are in 15 min intervals. Therefore levels shown relate to nearest 15 min increment where exact time was not available

	18107 (OPW Measured Data sent by Email)					18106		18117	
Date	Time	Stage (m)	Poolbeg Lvl (mOD	Malin Lvl (mOD)	Flow (m3/s)	Poolbeg Lvl (mOD)	Malin Lvl (mOD)	Poolbeg Lvl (mOD)	Malin Lvl (mOD)
27/09/2021	01:04:12	0.1	22.02	19.32	8.644	23.215	20.515	21.641	18.941
12/07/2021	14:40:12	0.19	22.11	19.41	13.801	23.446	20.746	21.757	19.057
12/04/2021	14:31:22	0.28	22.2	19.5	19.342	23.669	20.969	21.825	19.125
04/02/2021	15:10:00	1.35	23.27	20.57	103.135	24.573	21.873	23.056	20.356
17/07/2020	13:36:00	0.15	22.07	19.37	9.250	23.123	20.423	21.648	18.948
25/06/2020	14:08:00	0.39	22.31	19.61	24.509	23.616	20.916	21.903	19.203
06/12/2019	14:31:45	0.6	22.52	19.82	37.350	23.953	21.253	22.109	19.409
10/01/2019	16:04:00	0.284	22.204	19.504	30.058	24.203	21.503	21.977	19.277
10/01/2019	12:35:00	0.32	22.24	19.54	28.673	24.204	21.504	21.979	19.279
08/11/2018	15:16:00	0.29	22.21	19.51	27.123	24.18	21.48	21.944	19.244
06/11/2018	15:24:00	0.31	22.23	19.53	27.097	24.186	21.486	22.016	19.316
06/11/2018	14:29:00	0.31	22.23	19.53	26.336	24.174	21.474	21.992	19.292
05/11/2018	16:03:00	0.245	22.165	19.465	22.668	24.128	21.428	21.899	19.199
05/11/2018	10:48:00	0.22	22.14	19.44	20.264	24.081	21.381	21.853	19.153
30/10/2018	15:18:00	0.07	21.99	19.29	9.143	23.802	21.102	21.618	18.918
31/07/2018	14:36:00	0.05	21.97	19.27	8.475	23.79	21.09	21.615	18.915
04/12/2015	14:25:00	2.83	24.75	22.05	251.705	25.116	22.416	24.18	21.48
28/02/2014	13:00:00	2.038	23.958	21.258	180.025	*No data*	*No data*	23.859	21.159
08/06/2012	13:00:00	2.7	24.62	21.92	227.680	25.078	22.378	24.486	21.786
08/06/2012	12:31:00	2.69	24.61	21.91	224.000	25.072	22.372	24.48	21.78
17/01/2012	13:31:00	0.436	22.356	19.656	36.030	24.385	21.685	22.882	20.182
24/10/2011	13:07:00	2.307	24.227	21.527	204.000	24.954	22.254	24.107	21.407
15/06/2011	14:59:00	0.24	22.16	19.46	14.800	24.23	21.53	21.735	19.035
15/06/2011	14:17:00	0.24	22.16	19.46	13.700	24.232	21.532	21.735	19.035
09/11/2010	15:16:00	1.52	23.44	20.74	121.765	24.703	22.003	23.283	20.583
07/08/2009	12:45:00	0.329	22.249	19.549	30.340	24.301	21.601	21.893	19.193
03/06/2009	14:21:00	0.322	22.242	19.542	18.700	24.296	21.596	21.823	19.123
17/12/2008	09:24:00	0.807	22.727	20.027	63.547	24.51	21.81	22.532	19.832
10/01/2008	16:15:00	4.096	26.016	23.316	509.000	26.105	23.405	25.869	23.169
14/09/2007	15:15:00	0.151	22.071	19.371	7.400	24.198	21.498	21.659	18.959
01/12/2006	14:34:00	3.065	24.985	22.285	318.000	25.249	22.549	*No data*	*No data*

OPW Measured Data (above)		
Flow	Level (mOD)	Stage (m)
7.400	19.371	0.151
8.475	19.270	0.050
8.644	19.320	0.100
9.143	19.290	0.070
9.250	19.370	0.150
13.700	19.460	0.240
13.801	19.410	0.190
14.800	19.460	0.240
18.700	19.542	0.322
19.342	19.500	0.280
20.264	19.440	0.220
22.668	19.465	0.245
24.509	19.610	0.390
26.336	19.530	0.310
27.097	19.530	0.310
27.123	19.510	0.290
28.673	19.540	0.320
30.058	19.504	0.284
30.340	19.549	0.329
36.030	19.656	0.436
37.350	19.820	0.600
63.547	20.027	0.807
103.135	20.570	1.350
121.765	20.740	1.520
180.025	21.258	2.038
204.000	21.527	2.307
224.000	21.910	2.690
227.680	21.920	2.700
251.705	22.050	2.830
318.000	22.285	3.065
509.000	23.316	4.096
578.705825	-	4.5
693.4738	-	5
818.576625	-	5.5
954.0143	-	6
1099.786825	-	6.5

Extrapolated	*Eq. = 20.6697x^2 + 33.1738x + 10.8623*
Extrapolated	*Eq. = 20.6697x^2 + 33.1738x + 10.8623*
Extrapolated	*Eq. = 20.6697x^2 + 33.1738x + 10.8623*
Extrapolated	*Eq. = 20.6697x^2 + 33.1738x + 10.8623*
Extrapolated	*Eq. = 20.6697x^2 + 33.1738x + 10.8623*

Annual Max Data (waterlevel.ie)				
Year	AMAX WL Poolbeg	AMAX WL Malin	Stage (m)	Estimated Flow
2001	25.548	22.848	3.628	419.2
2002	24.998	22.298	3.078	333.3
2003	24.740	22.040	2.820	295.1
2004	25.999	23.299	4.079	494.2
2005	25.243	22.543	3.323	370.8
2006	25.510	22.810	3.590	413.1
2007	26.142	23.442	4.222	518.8
2008	25.128	22.428	3.208	353
2009	26.429	23.729	4.509	569.2
2010	24.567	21.867	2.647	270.4
2011	25.103	22.403	3.183	349.2
2012	24.709	22.009	2.789	290.7
2013	25.729	23.029	3.809	448.9
2014	24.923	22.223	3.003	322
2015	26.631	23.931	4.711	605.6
2016	24.973	22.273	3.053	329.5
2017	25.542	22.842	3.622	418.3
2018	25.453	22.753	3.533	404
2019	24.756	22.056	2.836	297.5
2020	26.409	23.709	4.489	565.7
2021	24.702	22.002	2.782	*No data*


18107 Rating Curve
1400.000
1200.000
1000.000
800.000
600.000
400.000
200.000
0.000
Flow (m3/s)
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
Stage (m)
y = 24.923x² + 16.12x + 29.676
y = 24.923x² + 16.12x + 29.676
y = 20.67x² + 33.174x + 10.862
y = 13.972x² + 58.522x + 2.4964
y = 20.6997x² + 33.1738x + 10.8623
Rating Curve (2006-2021 Data)
Spot Gaugings (2006-2012)
Fitted Trendline (2006-2012 Data)
AMAX
Rating Curve Extrapolated
Fitted Trendline Extrapolated

Jacobs 2014 Final Technical Report (Gauge 18107 - Ref Fig 2.1)						
Date	**Start Time**	**Finish Time**	**Average Time**	**Discharge (m3/s)**	**Stage (m)***	**Stage (mOD Malin)**
01/12/2006	13:56	15:12	14:34	318	3.075	22.295
14/09/2007	15:00	15:30	15:15	7	0.152	19.372
10/01/2008	16:02	16:13	16:07	509	4.088	23.308
17/12/2008	09:06	09:43	09:24	64	0.813	20.033
03/06/2009	14:06	14:41	14:24	19	0.32	19.54
07/08/2009	12:38	13:13	12:55	30	0.322	19.542
09/11/2010	15:04	15:29	15:16	122	*(missing)*	-
15/06/2011	14:06	14:30	14:17	14	0.238	19.458
15/06/2011	14:47	15:10	14:59	15	0.238	19.458
24/10/2011	12:57	13:17	13:07	205	2.307	21.527
17/01/2012	13:20	13:43	13:31	36	0.436	19.656

** taken from the average time and read from the 15-min stage*

7	0.152	19.372
14	0.238	19.458
15	0.238	19.458
19	0.32	19.54
30	0.322	19.542
36	0.436	19.656
64	0.813	20.033
205	2.307	21.527
318	3.075	22.295
509	4.088	23.308

SEE FIG 2.1 BELOW		
Standard Form of Rating Equation		
RC Equation =>	y = 63.4(x+0.1)^1.432	
Stage (m)	**tage (mOD Malin**	**Flow**
3.075	22.295	331.6
0.152	19.372	8.8
4.088	23.308	492.9
0.813	20.033	55.7
0.32	19.54	18.3
0.322	19.542	18.4
(missing)	-	-
0.238	19.458	13.4
0.238	19.458	13.4
2.307	21.527	223.0
0.436	19.656	26.0

SEE FIG 2.1 BELOW	
Fitted Trendline Equation	
y = 24.923x^2 + 16.12x + 29.676	
Stage (m)	**Flow**
3.075	314.9
0.152	32.7
4.088	512.1
0.813	59.3
0.32	37.4
0.322	37.5
(missing)	-
0.238	34.9
0.238	34.9
2.307	199.5
0.436	41.4

**Above figures arranged in order below*

0.152	19.372	8.8
0.238	19.458	13.4
0.238	19.458	13.4
0.32	19.54	18.3
0.322	19.542	18.4
0.436	19.656	26.0
0.813	20.033	55.7
2.307	21.527	223.0
3.075	22.295	331.6
4.088	23.308	492.9

0.152	32.7
0.238	34.9
0.238	34.9
0.32	37.4
0.322	37.5
0.436	41.4
0.813	59.3
2.307	199.5
3.075	314.9
4.088	512.1
4.5	606.91
5	733.35
5.5	872.26
6	1023.62
6.5	1187.45

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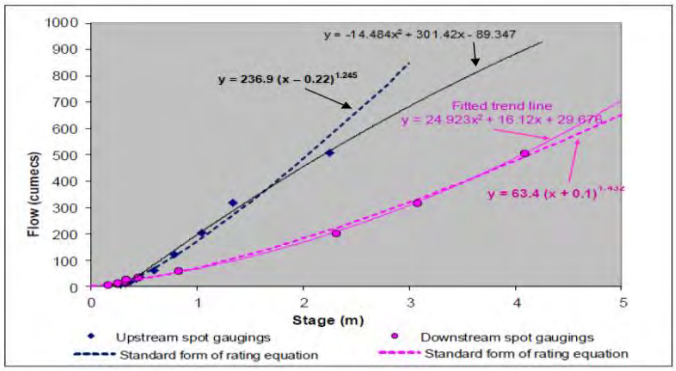
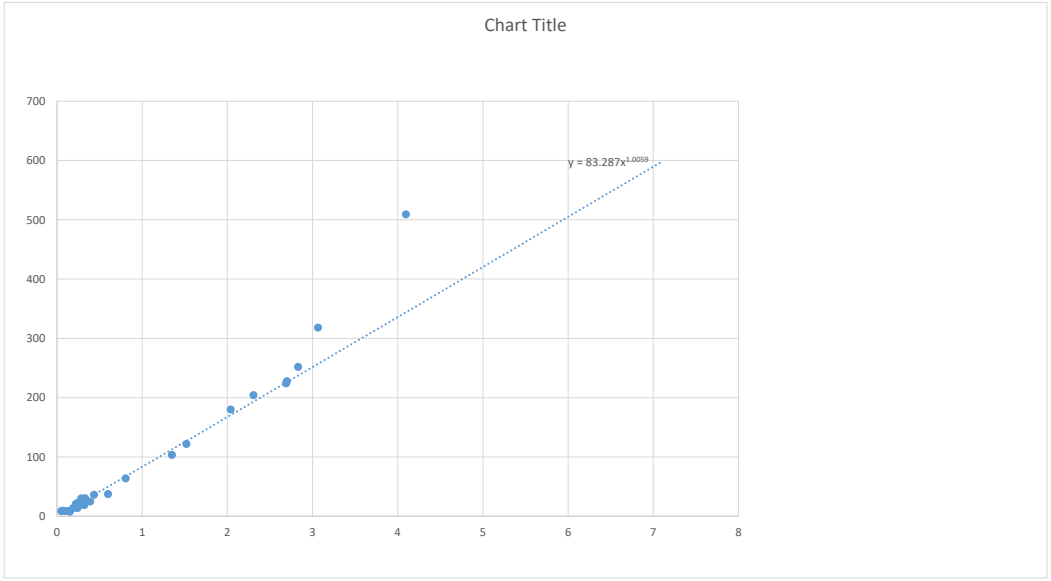


Figure 2.1 The spot gaugings and the provisional rating relationships derived in the Jacobs 2012 report.

Station No.	Station name	Date	Time	Stage	Flow	Area	Mean velocity	Remark
18107	Fermoy Br D/S	27/09/2021	01:04:12	0.1	8.644	96.652	0.089	Measured 20m d/s from Staff. Showery weather.
18107	Fermoy Br D/S	12/07/2021	14:40:12	0.19	13.801	58.119	0.237	Measured 20m d/s of Staff. Weather overcast. ~r~nFermoy Mills (18117) SGR = 0.840m~r~nEntered here as per JC 10/07/2021
18107	Fermoy Br D/S	12/04/2021	14:31:22	0.28	19.342	63.19	0.306	Measured 30m d/s from Staff. Showers.
18107	Fermoy Br D/S	04/02/2021	15:10:00	1.35	103.135	155.22	0.664	18124 gauging: Measured 20m d/s from Staff. Dry.
18107	Fermoy Br D/S	17/07/2020	13:36:00	0.15	9.25	56.82	0.163	Taken at Fermoy Mills (Station 18117) Measured 50m d/s from Staff.~r~nNote: Loop method may be inaccurate. EW: SGR convereted from 18106 gauging entry.~r~n
18107	Fermoy Br D/S	25/06/2020	14:08:00	0.39	24.509	114.6	0.214	18124 gauging: Measured 30m d/s from Staff. Boat velocity similar to water velocity.
18107	Fermoy Br D/S	06/12/2019	14:31:45	0.6	37.35	126.7	0.295	18124 gauging: Measured next to Staff. Windy weather.
18107	Fermoy Br D/S	10/01/2019	16:04:00	0.284	30.058	139.98	0.215	18106 gauging: Measured 50m u/s of Staff. Dry, cold weather.
18107	Fermoy Br D/S	10/01/2019	12:35:00	0.32	28.673	7.87	3.643	Fermoy Bridge D/S. Measured halfway d/s of Town Bridge - u/s of Motorway Bridge. Dry weather. Slow moving. SGR 18107 Fermoy br d/s 0.320m, SGR 18106 Fermoy Br u/s 0.284m
18107	Fermoy Br D/S	08/11/2018	15:16:00	0.29	27.123	147.44	0.184	Converted from 18106 gauging entry. Measured at Rowing Club. Dry at moment. Showery conditions. Channel clear.
18107	Fermoy Br D/S	06/11/2018	15:24:00	0.31	27.097	74.963	0.361	Measured 300m d/s of Bridge. Wet overnight. Water risen. Showery conditions.
18107	Fermoy Br D/S	06/11/2018	14:29:00	0.31	26.336	150.27	0.175	18106 gauging: Wet, cold conditions. Heavy rain overnight.
18107	Fermoy Br D/S	05/11/2018	16:03:00	0.245	22.668	69.603	0.326	Measured 300m d/s of Bridge.
18107	Fermoy Br D/S	05/11/2018	10:48:00	0.22	20.264	67.833	0.299	Measured 300m d/s of Bridge. Heavy showers. Water Level up in the last few days after heavy rain. Cold conditions.
18107	Fermoy Br D/S	30/10/2018	15:18:00	0.07	9.143	59.07	0.155	18117 gauging: Measured 70m d/s of Staff. Light drizzle. Cold weather. Calm conditions.
18107	Fermoy Br D/S	31/07/2018	14:36:00	0.05	8.475	115.85	0.073	18106 gauging: Measured 50m u/s at Fermoy Bridge (18106) staff. Drizzle, wind blowing d/s.
18107	Fermoy Br D/S	04/12/2015	14:25:00	2.83	251.705	216.2	1.164	Originally entered under 18106. Measured d/s face of Motorway Bridge.~r~nData reprocessed using GPS and the widths obtained were closer in values and similar with the Area's.
18107	Fermoy Br D/S	28/02/2014	13:00:00	2.038	180.025	192.416	0.936	Measured from d/s face of bridge (1.140 - 1.150 at u/s)
18107	Fermoy Br D/S	08/06/2012	13:00:00	2.7	227.68	180.7	1.26	Taken on d/s face of motorway bridge, eddies to L and R bank
18107	Fermoy Br D/S	08/06/2012	12:31:00	2.69	224	172.3	1.3	Missing ensembles due to sunken and floating debris, result may be slightly higher, no moving bed. a
18107	Fermoy Br D/S	17/01/2012	13:31:00	0.436	36.03			Taken from Motorway bridge, very windy day, difficult to control boat from bridge, a lot of eddies on L and R bank
18107	Fermoy Br D/S	24/10/2011	13:07:00	2.307	204			
18107	Fermoy Br D/S	15/06/2011	14:59:00	0.24	14.8			
18107	Fermoy Br D/S	15/06/2011	14:17:00	0.24	13.7			
18107	Fermoy Br D/S	09/11/2010	15:16:00	1.52	121.765			
18107	Fermoy Br D/S	07/08/2009	12:45:00	0.329	30.34			SECTIONLOG: Gauging taken by Nick YSI - Hydroboard;
18107	Fermoy Br D/S	03/06/2009	14:21:00	0.322	18.7			
18107	Fermoy Br D/S	17/12/2008	09:24:00	0.807	63.547			
18107	Fermoy Br D/S	10/01/2008	16:15:00	4.096	509			SECTIONLOG: Munster Blackwater - Broad Crested Weir;
18107	Fermoy Br D/S	14/09/2007	15:15:00	0.151	7.4			COMMENTS: Software crash. The measurement was completed in four transects and the result was noted as 7.4 cumecs (approx). This was also noted as within 5% coefficient of Variation. (F O'Neill & D O'Keeffe 14/9/07); SECTIONLOG: Munster Blackwater - Boat with winch;
18107	Fermoy Br D/S	01/12/2006	14:34:00	3.065	318			Taken d/s of town road br



OPW Format Curve

Q=c(h-a)**n

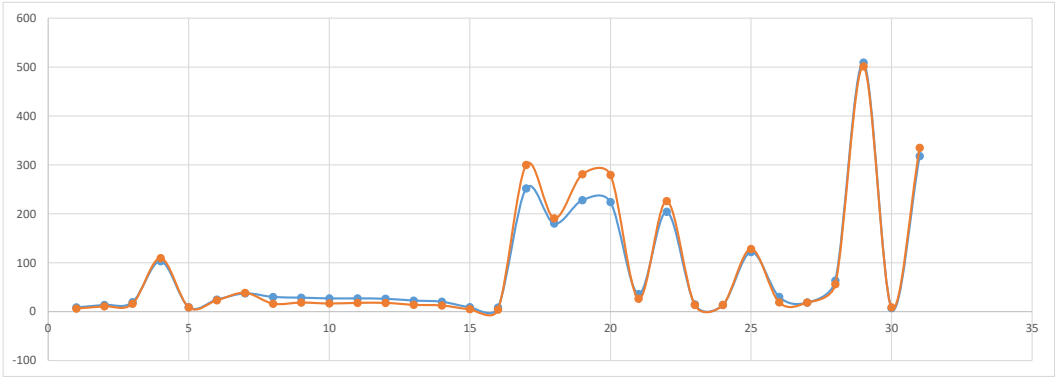
	a	-0.1
	c	64.3
	n	1.432

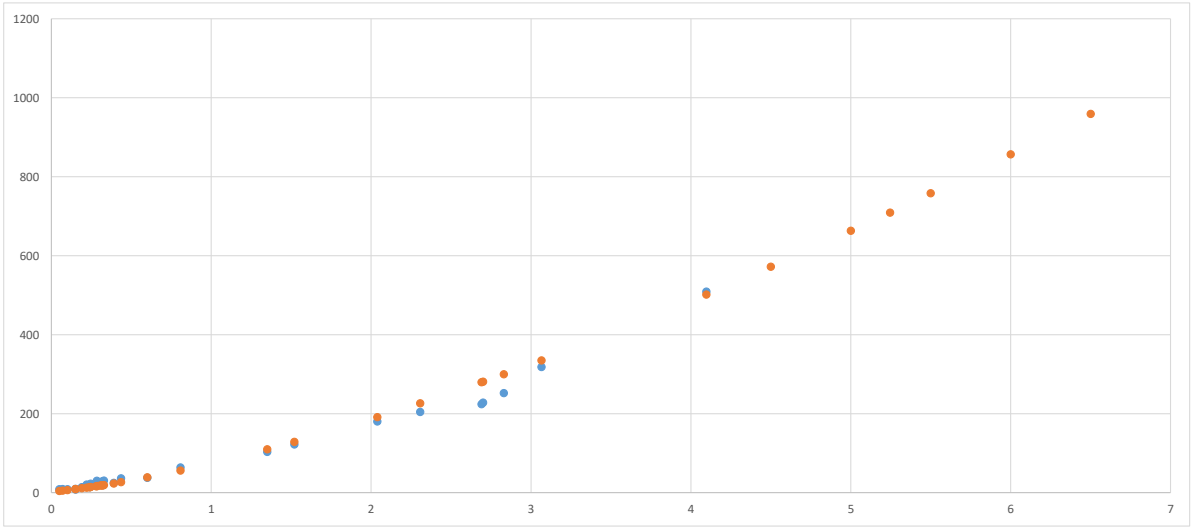
$$Q=64.3(h+0.1)^{1.432}$$

Observatio	Stage	Flow	Qe	Error	Square of error
1	0.1	8.644	6.416	2.227681	4.962564
2	0.19	13.801	10.924	2.877422	8.279559
3	0.28	19.342	16.086	3.255518	10.5984
4	1.35	103.135	109.469	-6.3337	40.11573
5	0.15	9.25	8.832	0.417959	0.17469
6	0.39	24.509	23.151	1.357893	1.843874
7	0.6	37.35	38.583	-1.23259	1.519276
8	0.284	30.058	16.330	13.72848	188.4713
9	0.32	28.673	18.565	10.10762	102.1639
10	0.29	27.123	16.696	10.42688	108.7199
11	0.31	27.097	17.936	9.161336	83.93008
12	0.31	26.336	17.936	8.400336	70.56565
13	0.245	22.668	14.008	8.660265	75.00019
14	0.22	20.264	12.577	7.686749	59.0861
15	0.07	9.143	5.084	4.058903	16.47469
16	0.05	8.475	4.250	4.225149	17.85189
17	2.83	251.705	299.754	-48.0493	2308.734
18	2.038	180.025	190.889	-10.8645	118.037
19	2.7	227.68	280.893	-53.2132	2831.648
20	2.69	224	279.458	-55.4578	3075.564
21	0.436	36.03	26.325	9.704602	94.17929
22	2.307	204	226.196	-22.1959	492.6581
23	0.24	14.8	13.718	1.082064	1.170862
24	0.24	13.7	13.718	-0.01794	0.000322
25	1.52	121.765	128.303	-6.5379	42.74414
26	0.329	30.34	19.138	11.2023	125.4915
27	0.322	18.7	18.692	0.007887	6.22E-05
28	0.807	63.547	55.912	7.635054	58.29405
29	4.096	509	501.316	7.684215	59.04716
30	0.151	7.4	8.883	-1.48267	2.198323
31	3.065	318	334.770	-16.7697	281.2225
				Sum of erı	10280.75

4.5	571.847
5	662.905
5.5	757.908
6	856.650
6.5	958.954
5.245	708.977
5.762	809.194

R2 predict 0.986284





Proposed 18107 Rating Curve

Q=c(h-a)**n

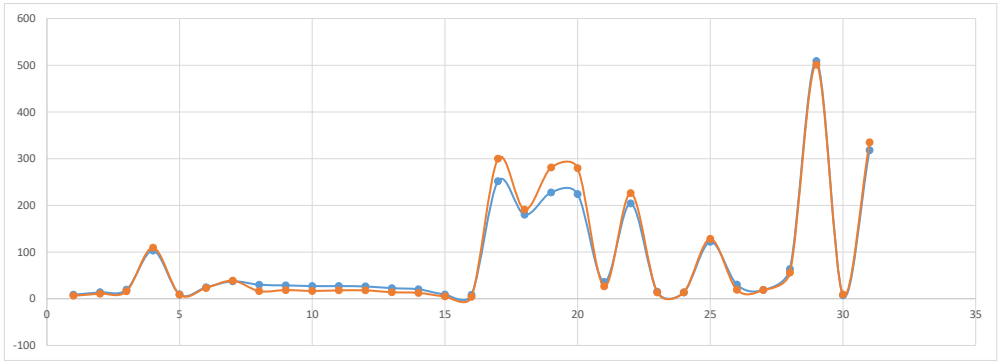
a	-0.075
c	57.07122
n	1.482478

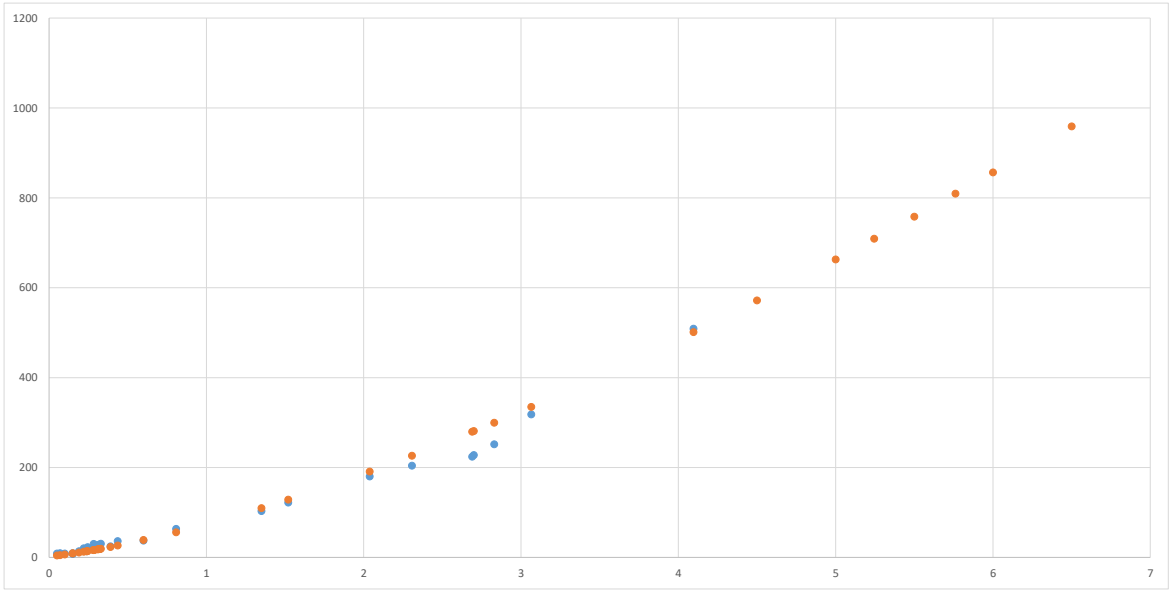
$Q=57.07(h+0.075)^{1.4825}$

$Q=63.156(h+0.005)^{1.427}$

Observatio	Stage	Flow	Qe	Error	Square of error
1	0.1	8.644	4.308	4.336373	18.80413
2	0.19	13.801	7.969	5.832215	34.01473
3	0.28	19.342	12.293	7.049484	49.69522
4	1.35	103.135	96.482	6.653449	44.26839
5	0.15	9.25	6.252	2.997664	8.985991
6	0.39	24.509	18.341	6.167973	38.0439
7	0.6	37.35	31.869	5.481336	30.04505
8	0.284	30.058	12.498	17.55959	308.3393
9	0.32	28.673	14.401	14.27237	203.7006
10	0.29	27.123	12.809	14.31368	204.8814
11	0.31	27.097	13.863	13.23353	175.1263
12	0.31	26.336	13.863	12.47253	155.564
13	0.245	22.668	10.539	12.12867	147.1046
14	0.22	20.264	9.342	10.92199	119.2899
15	0.07	9.143	3.260	5.883402	34.61442
16	0.05	8.475	2.616	5.859188	34.33008
17	2.83	251.705	277.345	-25.6404	657.4297
18	2.038	180.025	173.011	7.014123	49.19792
19	2.7	227.68	259.146	-31.4661	990.1137
20	2.69	224	257.763	-33.7628	1139.93
21	0.436	36.03	21.094	14.93606	223.0859
22	2.307	204	206.645	-2.645	6.996002
23	0.24	14.8	10.296	4.503875	20.28489
24	0.24	13.7	10.296	3.403875	11.58636
25	1.52	121.765	114.026	7.738614	59.88615
26	0.329	30.34	14.890	15.45029	238.7113
27	0.322	18.7	14.509	4.191146	17.56571
28	0.807	63.547	47.378	16.16912	261.4406
29	4.096	509	474.143	34.85698	1215.009
30	0.151	7.4	6.294	1.106425	1.224176
31	3.065	318	311.246	6.753661	45.61194
				Sum of err	6544.881

4.5	543.791
5	634.177
5.5	728.968
6	827.955
6.5	930.956
5.245	680.088
5.741	776.168





R^2 observed = 0.958269

R^2 predicted = 0.982483

APPENDIX G

2014 Jacobs Babtie
"Additional comment on the Fermoy design flow calculation"

JACOBS®

Fermoy Flood Alleviation Scheme

Additional comment on the Fermoy design flow calculation

February 2014

JACOBS

Document Control Sheet

BPP 04 F8
Version 16; October 2013

Project: Fermoy Flood Alleviation Scheme
Client: T.J. O'Connor and Associates Project No: B1551200
Document title: Additional comment on the Fermoy design flow calculation
Ref. No:

	Originated by	Checked by	Reviewed by	
ORIGINAL	NAME **David Price**	NAME **Ronnie Falconer**	NAME **Ronnie Falconer**	
Approved by	NAME **Laurence McGregor**	As Project Manager I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue**		INITIALS LMcG
DATE	**6 Feb 2014**	**Document status Final Report**		

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Approved by	NAME	As Project Manager I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue**		INITIALS
DATE		**Document status**		

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Approved by	NAME	As Project Manager I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue**		INITIALS
DATE		**Document status**		

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DATE		**Document status**		

JACOBS

Contents

1 Introduction

In December 2012 Jacobs submitted the following hydrological report to T.J. O'Connor and Associates entitled:

"Review of the hydrological estimates of the Fermoy Flood Alleviation Scheme (2012 update)"

That report examined how the gauging station data obtained within Fermoy from two hydrometric stations could be interpreted to refine the understanding of the design flood flow for the Blackwater River at Fermoy.

Subsequently, and in light of the reported work, the OPW have invited technical consideration of two technical comments\observations. The two technical comments\observations are:

i) They noted that the newly derived provisional Fermoy rating curve for the upstream gauge did not appear to follow a simple rating relationship. They commented that expected points of inflection associated with the hydraulic drowning of the weir and/or the start of out-of-bank flows were not apparent in the curve and suggested that this may have resulted in an underestimation of the QMED. They therefore preferred the estimates from the downstream gauge that would not be subject to as much rating relationship complexity. Consequently they suggested that a QMED value of 380 to 390 m^3/s would be more appropriate.

ii) Secondly they identified that the flood growth curve used for Fermoy was, in their opinion, not steep enough (i.e. the growth factors are too low) and that they would like to see the flood estimates based on the old Irish FSR growth curve.

The following sections provide technical responses on both of these issues.

2 Use of the upstream and downstream Fermoy gauging stations for the estimation of QMED

The sections of the December 2012 report that cover the provisional rating relationships for the upstream and downstream gauges are reproduced in Appendix A and Appendix B.

The upstream gauging station is located immediately upstream of the weir which in turn is immediately upstream of the multiple arched road bridge over the river. The downstream gauge is located immediately downstream of the bridge where the high flow hydraulic control is considered to be less complicated.

Figure 2.1 graphically presents the spot gauging data and the provisional ratings suggested in the December 2012 work. (The fitted polynomial lines were used to derive the annual maximum series since no rating extrapolation was required to estimate QMED, and the polynomial lines offered a better fit to the spot gauging data than the conventional rating equation[also given]).

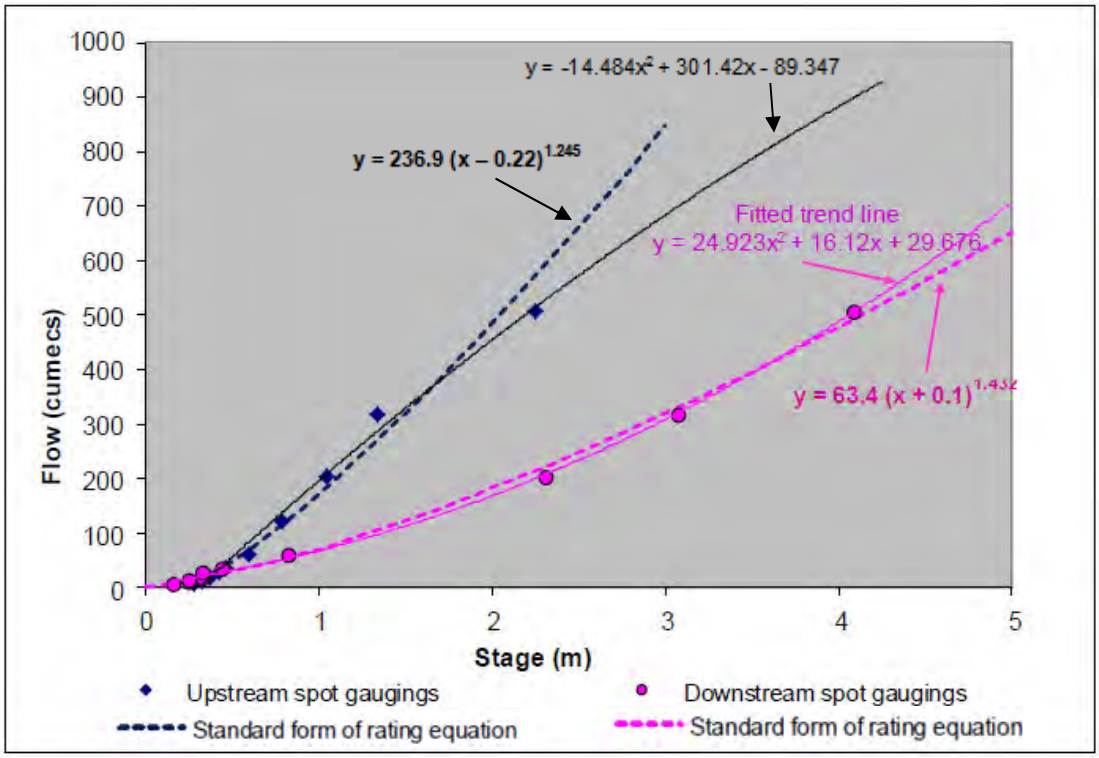

Figure 2.1 The spot gaugings and the provisional rating relationships derived in the Jacobs 2012 report.

The 2012 report gave equal weight to the flow estimates of both stations and qualified the acceptance of the estimates in the following way:

i) There are too few gaugings to provide a particularly robust high flow relationship and further high flow spot gaugings are required if the ratings are to be considered as anything more than provisional.

ii) Some doubt exists regarding the accuracy of the highest spot gaugings and this uncertainty is translated to the high flow rating relationship.

iii) Only 11 years of data was available and this is length of data is unlikely to yield a particularly reliable estimate of the long-term QMED flow based on this data alone. However a climatic adjustment factor was derived in the December 2012 study from surrounding long-term gauges to help reduce this uncertainty. (Factor = 0.98)

Table 2.1 presents the annual maximum series and associated QMED values derived in the 2012 study for both gauges together with the average of the two gauges. The 2012 report suggested that, given the inherent uncertainties in both sets of estimates, the average of the two should be taken as the final estimate of QMED from the data alone.

(Note that a 0.98 climatic adjustment factor was determined in a later chapter in the 2012 report and the final long-term QMED value was consequently suggested to be 370 *0.98 = 363 m^3/s).

Table 2.1 The 2012 report annual maximum and QMED estimates for the two gauging stations together with average values

		Flow (cumecs)		
Year*	**Date**	**Upstream**	**Downstream**	**Average**
2001	02/02/2002	401	416	409
2002	28/11/2002	286	315	301
2003	15/11/2003	265	273	269
2004	28/10/2004	504	510	507
2005	14/01/2006	335	358	347
2006	03/12/2006	380	409	394
2007	10/01/2008	531	542	537
2008	30/01/2009	312	338	325
2009	20/11/2009	598	609	603
2010	06/02/2011	237	247	242
2011	30/11/2011	306	333	320
	QMED (2001 - 2011)	357	384	370

The OPW comment\observation regarding the added complexity of the upstream gauge's stage-flow relationship is reasonable. Figure 2.2 shows the expected typical influence on the rating relationship when a weir drowns at high flows due to the high flow control moving downstream. It may be that the upstream gauge rating at Fermoy will show a similar pattern (note that the axes in Figures 2.1 and 2.2 are the other way round). The plotting positioning of the upstream gauge spot gaugings could be consistent with such a pattern. The complexity of the channel suggests that more spot gaugings at high flows should be collected if the validity of this speculation is to be properly assessed.

Additionally the upstream gauge has a small amount of floodplain on its northern bank, the width of which is similar to the width of the river. The bankful capacity of a large river is often considered to be approximately the QMED flow. It is therefore possible that this north bank floodplain will become active at a stage that corresponds to approximately the QMED flow; depending on the conveyance, this could also introduce a slight inflexion in the rating curve and render the estimation of QMED from the inferred rating slightly more difficult. However this would serve to

steepen the rating curve in Figure 2.1 and would not offer an explanation that would be consistent with the plotting positions of the spot gaugings.

The downstream gauge does not have the same level of within-channel hydraulic complexity and should follow a more predictable rating curve shape that is more typical of a simple river reach. The floodplain at this point is also very limited.

For these reasons it is therefore acceptable to place more confidence in the QMED obtained from the downstream gauge.

However, as emphasised in the three above qualifications (i, ii and iii), there does remain an appreciable degree of uncertainty with the resulting QMED estimate of 384 m^3/s. It is noted that the OPW suggest a value of between 380 – 390 m^3/s. However when the 0.98 climatic adjustment factor is applied **it suggests a final QMED value of 376 m^3/s be taken forward.**

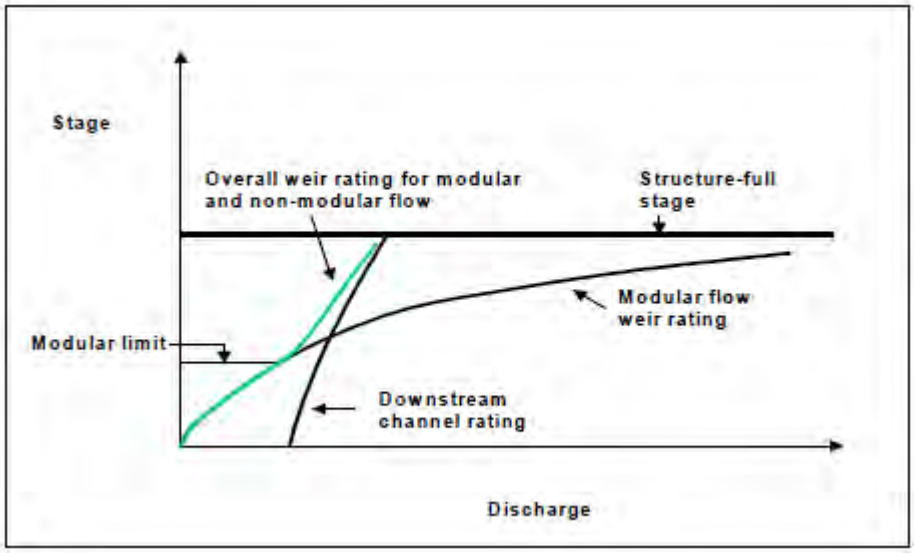

Figure 2.2 In-bank structure rating curve with drowning – constant downstream rating curve

(Source: Ramsbottom DM & Whitlow CD, 2003. Extension of Rating Curves at Gauging Stations Best Practice Guidance Manual, R&D Manual W6-061/M)

3 Choice of flood growth curve for Fermoy

The Jacobs 2012 report presented an interesting comparison of candidate flood growth curves for the Blackwater at Fermoy (Figure 3.1)

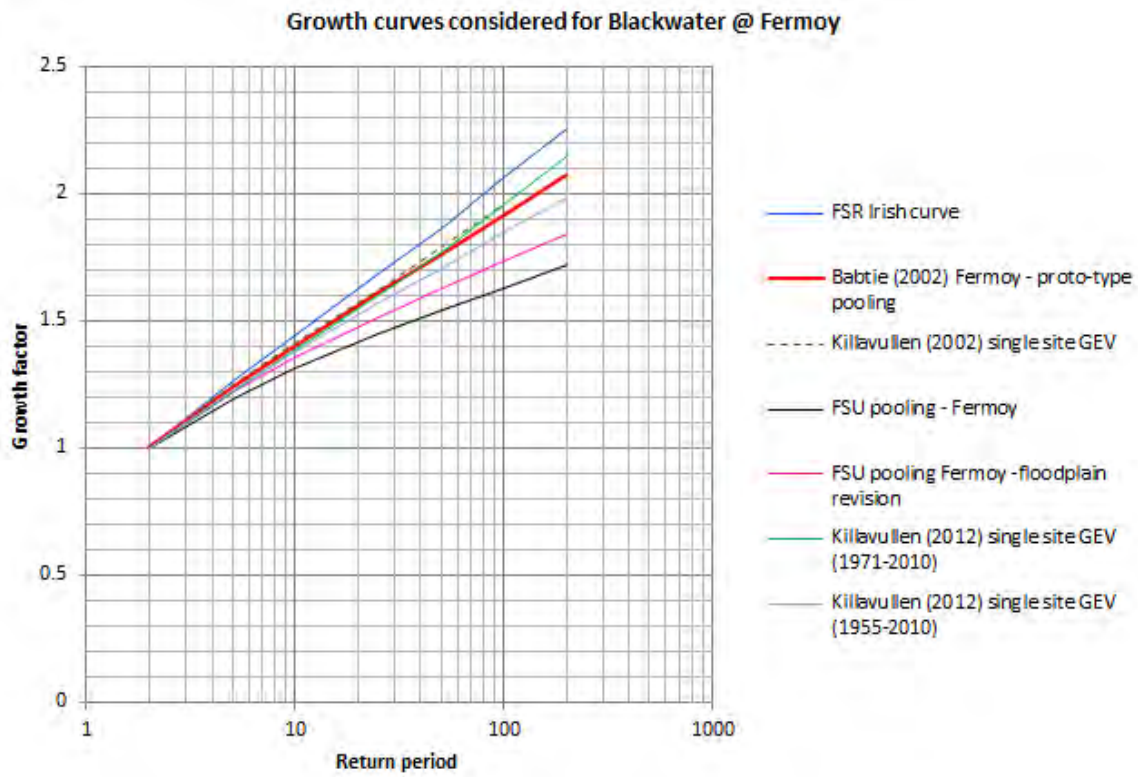

Figure 3.1 Candidate flood growth curves available for Fermoy

In the original work (Babtie 2002)[1] a prototype pooling group statistical analysis was used. This used similar variables to pool upon to those used in the original UK FEH method, viz: catchment area, SAAR and SOIL. The analysis used only Irish gauging stations\catchments. Following this, a careful manual revision to the resulting pooling group was undertaken which removed those catchments that included major lake and floodplain influence. This was achieved with the assistance of OPW staff who had good understanding of the functioning of the catchments. This resulted in the red curve (Babtie (2002) Fermoy – prototype pooling) in Figure 3.1. The steepness of the Babtie 2002 curve was similar to the Killavullen single site analysis which seemed to add credence to its adoption. [Additionally the Babtie 2002 study also investigated the sensitivity of the growth curve to the presence of arterial drainage though the results were relatively insensitive to this aspect].

[1] Babtie, 2002. Munster Blackwater River (Fermoy) Drainage Scheme: Hydrology Report, Report to OPW.

Since the Babtie 2002 study the methodology to derive flood growth curves in Ireland has received much research attention and has culminated in the new FSU pooling group approach. This has been specifically developed for the Irish conditions, and during the 2012 analysis it was assumed likely to provide the best flood growth curve (given that it benefitted from the FSU research work and has the benefit of longer flood records). Default application of the FSU method was reported in Appendix B of the Jacobs 2012 report and is shown as the black line in Figure 3.1. Given the Babtie 2002 experience this FSU pooling was refined to remove those catchments with large lake and flood plain influences; giving the pink curve in Figure 3.1. These curves are significantly less steep than the Babtie 2002 curves.

To set these growth curves in context, the Flood Studies Report (FSR) growth curve has also been presented in Figure 3.1. This is the steepest of all the curves.

Whilst the FSU curve was expected to be the favoured curve (since it has resulted from the detailed research and the extra flood data of the FSU), there remains a justified argument to consider the Babtie (2002) growth curve (given the detailed consideration of the pooling group gauges). However it is unclear what the justification for the use of the FSR Irish growth curve is. Table 3.1 presents the estimates of return period flows based on a QMED of 376 m^3/s (refer to Section 2) using different flood growth curves.

Table 3.1 Return period flood estimates

Return Period	Flood growth curves			Flood flow (m^3/s)		
	FSR Irish growth curve	Babtie 2002 prototype pooling	FSU with floodplain revision	FSR Irish growth curve	Babtie 2002 prototype pooling	FSU with floodplain revision
2	1	1	1	376	376	376
5	1.26	1.24	1.22	475	466	459
10	1.44	1.40	1.35	542	526	509
25	1.68	1.61	1.51	633	604	568
50	1.86	1.76	1.63	701	663	611
100	2.06	1.92	1.73	776	721	652
200	2.25	2.08	1.84	847	780	691

In the December 2012 report a rapid assessment of the likely return periods of the largest events within the period of record at Fermoy was made:

"……. a rapid provisional assessment of rankings can be made from Figures 6.2 and 6.3 [the annual maximum series at Killavullen and Ballyduff] *and the application of the Gringorten formula to provide provisional return periods of these events based upon analysis of long-term donor gauge information. This suggests that the 20/11/2009 event should be thought of as being closer to a 15-20 year event and the 10/01/2008 and the 28/10/2004 events are more likely to have return periods between 5-10 years".*

If the Fermoy rating curve is reliable (and hence valid estimates exist of the peak flows of these events), then these coupled with the above return period estimates offer a means of assessing the worth of the candidate flood frequency curves given in Table 3.1.

The downstream gauge estimate of the 20 Nov 2009 event is 609 m^3/s, 10 January 2008 is 542 m^3/s, and 28 October 2004 is 510 m^3/s. The "FSR Irish growth curve"

flood flows in Table 3.1 suggest these events to have return periods of 10-25 years, 10 years and 5 to 10 years respectively. The “Babtie (2002) Prototype pooling” flood flows suggest return periods of 25 years, 10-15 years, and 5 to 10 years. The “FSU with floodplain revision” suggests return periods of 50 years, 20 years and 10 years. Based on this perspective the estimates derived using the Irish growth curve provide a slightly better fit than the Babtie 2002 estimates. The “FSU with floodplain revision” estimates offer a poorer fit. (This assessment is dependent on the accuracy of the recorded flows, which, as indicated in Section 2, can only be considered as provisional estimates).

Setting the Fermoy flood levels for these events in the context of a long-term flood level series for the town would be useful since the ranking assessment undertaken in the 2012 study was based on the Killavullen and Ballyduff records for which there are speculated issues. Undertaking a Fermoy flood level appraisal has been beyond the resources of this current study, though would (if possible) strengthen this line of evidence.

4 Conclusions

It is accepted that more weight can be given to the QMED estimate derived from the downstream Fermoy flow gauge. Together with a climatic adjustment based on long-term local records the recommended QMED for the Blackwater at Fermoy is 376m^3/s. This is slightly lower than the OPW suggestion of 380 – 390 m^3/s because the 0.98 climatic adjustment factor has been applied.

The QMED estimate should still be considered as a provisional estimate since the amount of data used in its derivation is less than ideal, and it is recommended that further high flow spot gauging is undertaken together with continued operation of both the gauging stations.

Use of either the FSR Irish growth curve or the original Babtie (2002) prototype pooling growth curve gives reasonable agreement between the estimated flows and return periods of the largest events within the Fermoy record. The FSR Irish growth curve provides a slightly better fit and on this basis suggests that the design flows should be estimated from a QMED of 376 m^3/s coupled with the FSR Irish growth curve.

Appendix A "Review of the rating curve for the Fermoy Bridge Upstream gauge" (reproduced from the Jacobs 2012 report)

The earlier Jacobs report "Review of the hydrological estimates of the Fermoy Flood Alleviation Scheme" [dated March 2011] provided an approximate rating curve for the Fermoy Bridge Upstream level station. This section re-visits that work and presents in full the information available to this 2012 study.

Table 2.1 provides the available spot gauging data. Figure 2.1 presents this information in graphical form.

Date	Start time	Finish time	Stage* (m)	Flow (m^3/s)
01/12/2006	13:56	15:12	1.335	318
14/09/2007	15:00	15:30	0.280	7
10/01/2008	16:02	16:13	2.250	509
17/12/2008	09:06	09:43	0.596	64
03/06/2009	14:06	14:41	0.365	19
07/08/2009	12:38	13:13	0.421	30
09/11/2010	15:04	15:29	0.780	122
15/06/2011	14:06	14:30	0.318	14
15/06/2011	14:47	15:10	0.318	15
24/10/2011	12:57	13:17	1.040	205
17/01/2012	13:20	13:43	0.460	36

* stage given on the spot gauging forms

Table 2.1 Fermoy Bridge Upstream gauge spot gauging data (Stn no 18106)

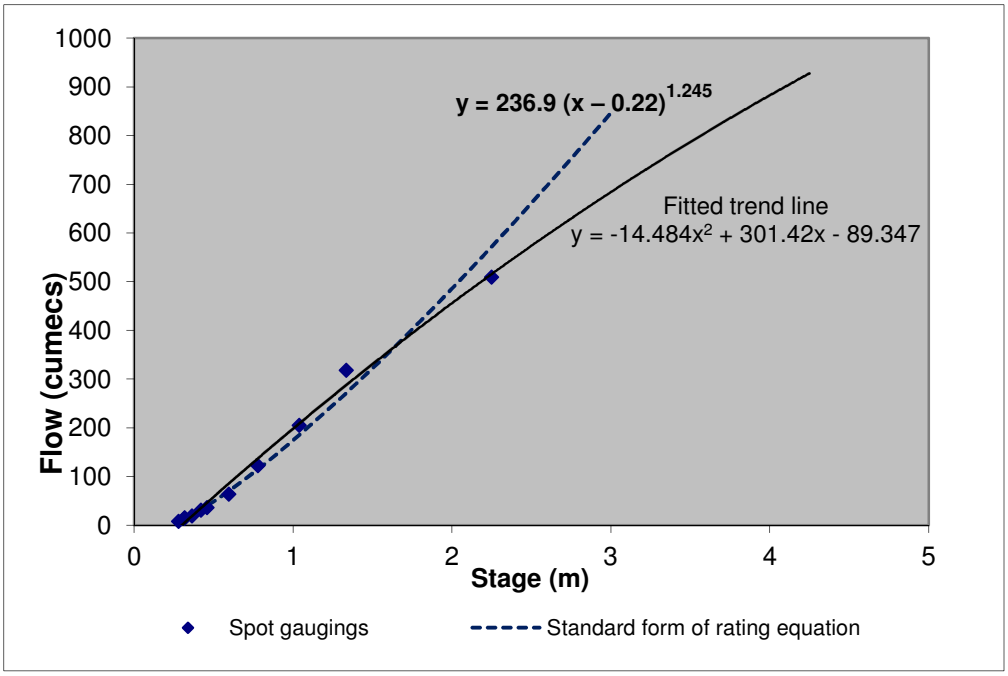

Figure 2.1 Fermoy Bridge Upstream rating relationship

There are insufficient high flow spot gaugings to form a robust high flow rating curve. The steer given by this data can only be that of provisional estimates. The highest spot gauging is however a notably high gauging with only 2 of the annual maximum flows recorded in the 11-year period of record exceeding it. This high gauging is very likely to have exceeded the QMED flow. Consequently if the spot gauging is reliable then the QMED analysis is not hampered by a reliance on an extrapolated rating curve.

The plotting position of the spot gaugings does not fit a usual rating relationship ie Q=c(h-a)^b (as evidenced by the attempted best fit curve given in Figure 2.1). This feature is likely to be attributable to the hydraulic control passing down to the bridge at the higher flows.

For the purposes of this study the fitted trend line given in Figure 2.1 has been used as the provisional means of estimating the high flows. This is offered for high flows only and no reliance upon it should be given for low and medium flows below 100 cumecs).

The Jacobs 2011 report comments that there may be grounds for being cautious about accepting the reliability of the high flow spot gaugings. No further comment on the reliability of the spot gauging flows is given here since no further insight on this issue has been received. As before it is recommended that the site should continue to be targeted for high flow spot gaugings: as this will be the best means of establishing the level-flow relationship to use with the continuous flow record.

Appendix B "Rating curve for the Fermoy Bridge Downstream gauge" (reproduced from the Jacobs 2012 report)

Table 3.1 provides the spot gauging information for the Downstream Gauge (Stn no 18107). The flows are identical to that of the Upstream Gauge and the stage is obtained from the recorded stage that occurred at the average time of the gauging. On some of the provided OPW gauging sheets for the Upstream Gauge there is recorded a stage value for the Downstream Gauge. These were used as a check upon the stage values gained from the continuous record based upon the average time of the gauging. Figure 3.1 presents the data graphically.

Table 3.1 Fermoy Bridge Downstream gauge spot gauging data (Stn no 18107)

Date	Start time	Finish time	Average time	Stage*	Discharge
01/12/2006	13:56	15:12	14:34	3.075	318
14/09/2007	15:00	15:30	15:15	0.152	7
10/01/2008	16:02	16:13	16:07	4.088	509
17/12/2008	09:06	09:43	09:24	0.813	64
03/06/2009	14:06	14:41	14:24	0.32	19
07/08/2009	12:38	13:13	12:55	0.322	30
09/11/2010	15:04	15:29	15:16	(missing)	122
15/06/2011	14:06	14:30	14:17	0.238	14
15/06/2011	14:47	15:10	14:59	0.238	15
24/10/2011	12:57	13:17	13:07	2.307	205
17/01/2012	13:20	13:43	13:31	0.436	36

* taken from the average time and read from the 15-min stage

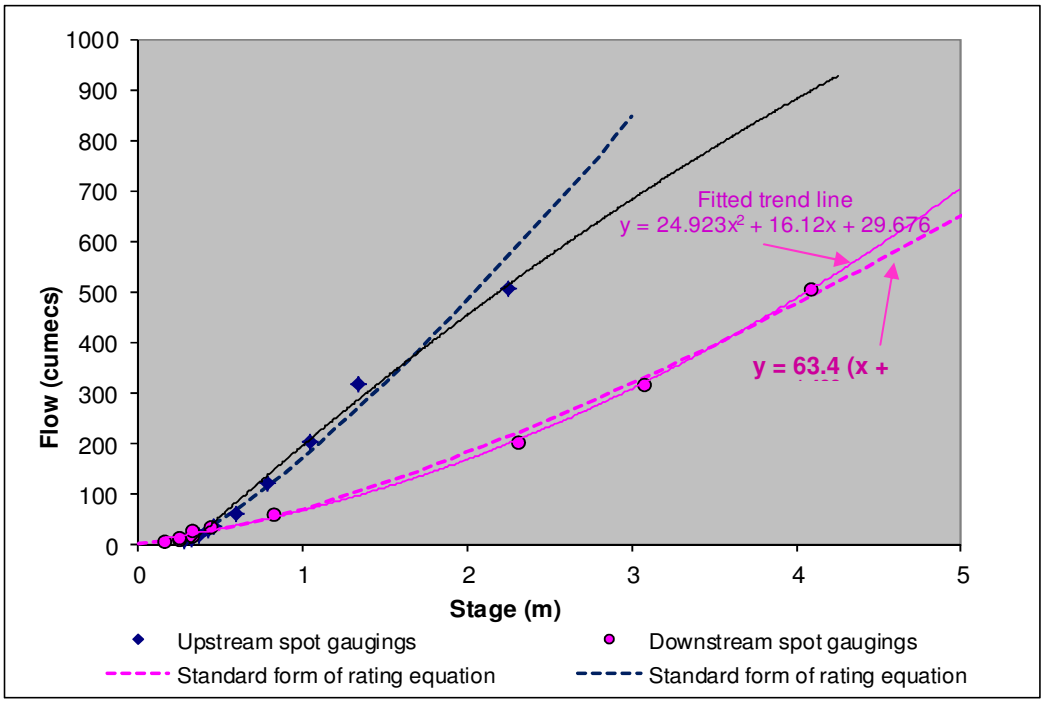

Figure 3.1 Fermoy Bridge Downstream rating relationship (together with that for the Upstream Gauge)

As for the upstream gauge there are insufficient high flow spot gaugings to form a robust high flow rating curve. The steer given by this data can only be that of provisional estimates. The highest spot gauging is however a notably high gauging with only 2 of the annual maximum flows recorded in the 11-year period of record exceeding it. This high gauging is very likely to have exceeded the QMED flow. Consequently if the spot gauging is reliable then the QMED analysis is not hampered by a reliance on an extrapolated rating curve.

Fitting a standard rating equation works well with the data (Figure 3.1). However the equation for the fitted trend line has been used in this study to estimate the flows due to its superior ability to fit the higher flow spot gaugings.

The Jacobs 2011 report comments that there may be grounds for being cautious about accepting the reliability of the high flow spot gaugings. No further comment on the reliability of the spot gauging flows is given here since no further insight on this issue has been received. As before it is recommended that the site should continue to be targeted for high flow spot gaugings: as this will be the best means of establishing the level-flow relationship.

APPENDIX G

Correspondence between the OPW and T.J. O'Connor & Associates

Diarmuid Cahalane

From: Jonathan Lahive <jonathan.lahive@opw.ie>
Sent: 02 March 2023 10:29
To: Diarmuid Cahalane
Cc: Ezra MacManamon; Patrick McAlinney; Ed Fitzgerald; Michael Vaughan; Jana Marais; Cormac Manning; Joan Dineen; Kevin Morey; Gillian Vaughan
Subject: RE: Fermoy Weir Remediation and Fish Bypass Channel - HecRas Modelling

Diarmuid,

Thank you for your reply. The OPW have no further comment at this time until we have concluded our review of the latest documents. As you have noted, the Section 9 consent process is still open and ongoing with a number of issues that need to be worked through before consent can be granted.

Le meas,
Jonathan

Jonathan Lahive
South-West Drainage Maintenance

Oifig na nOibreacha Poiblí
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To send me files larger than 30MB, please use the link below
https://filetransfer.opw.ie/filedrop/jonathan.lahive@opw.ie

From: Diarmuid Cahalane <dcahalane@tjoc.ie>
Sent: 01 March 2023 18:15
To: Jonathan Lahive <jonathan.lahive@opw.ie>
Cc: Ezra MacManamon <ezra.macmanamon@opw.ie>; Patrick McAlinney <patrick.mcalinney@opw.ie>; Ed Fitzgerald <efitzgerald@tjoc.ie>; Michael Vaughan <mvaughan@tjoc.ie>; Jana Marais <JMarais@tjoc.ie>; Cormac Manning <Cormac.Manning@CorkCoCo.ie>; Joan Dineen <Joan.Dineen@CorkCoCo.ie>; Kevin Morey <Kevin.Morey@CorkCoCo.ie>; Gillian Vaughan <Gillian.Vaughan@CorkCoCo.ie>
Subject: RE: Fermoy Weir Remediation and Fish Bypass Channel - HecRas Modelling

Jonathan

We wish to confirm that in our response to An Bord Pleanála, which we will submit on Friday 3rd March 2023, we have addressed all of the issues raised by the OPW, including both those items as set out in their original observations to An Bord Pleanála of the 29th July 2022 and all additional items identified by the OPW in the subsequent discussions and communications with us as agent for the applicant, Cork Co Co.

We have reviewed the rating curve taking account of the additional data gathered by the OPW at the gauges in Fermoy since 2011. We have used a standard format rating curve in our Model which is in fact the OPW format rating curve quoted in the Jacobs Babtie 2014 Hydrology comments. We have calibrated the HecRas model against data for the gauges in Fermoy for two significant flood events, which occurred on the 30th Dec 2015 and the 24th Feb 2021. We have run the model for the existing and proposed scenarios for a range of design flows from 2year design flow to 100year design flow using flows as advised by the OPW. We have also run the model for lower flood flows as represented by the 10%ile, 5%ile and 1%ile flows at the downstream gauge at Fermoy Bridge (gauge 18107).

The HecRas Modelling demonstrates that the proposed development will not have an impact on the flood defence scheme trigger levels or freeboard, will not result in an increase in flood risk in Fermoy and will not alter flood levels in lower return period flood events upstream or downstream of the proposed work. A number of specific issues, including the location of spoil heaps and materials stockpiles and the detail of the landscaping scheme for the north bank can be reviewed in the context of the Section 9 consent process.

Regards

Diarmuid Cahalane

Technical Director

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TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS

Dublin Office
Corrig House, Corrig Road,
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From: Jonathan Lahive <jonathan.lahive@opw.ie>
Sent: 01 March 2023 15:08
To: Diarmuid Cahalane <dcahalane@tjoc.ie>
Cc: Ezra MacManamon <ezra.macmanamon@opw.ie>; Patrick McAlinney <patrick.mcalinney@opw.ie>; Ed Fitzgerald <efitzgerald@tjoc.ie>; Michael Vaughan <mvaughan@tjoc.ie>; Jana Marais <JMarais@tjoc.ie>
Subject: RE: Fermoy Weir Remediation and Fish Bypass Channel - HecRas Modelling

Hi Diarmuid,

Due to unforeseen circumstances, the OPW will not be able to carry out a full review of the latest round of information provided by TJOC prior to your deadline date. As a result, could I ask if you could confirm if all the issues raised by the OPW during this process have been addressed in this latest submission?

Le meas,
Jonathan

Jonathan Lahive
South-West Drainage Maintenance

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To send me files larger than 30MB, please use the link below
https://filetransfer.opw.ie/filedrop/jonathan.lahive@opw.ie

From: Diarmuid Cahalane <dcahalane@tjoc.ie>
Sent: 01 March 2023 10:23
To: Jonathan Lahive <jonathan.lahive@opw.ie>
Cc: Ezra MacManamon <ezra.macmanamon@opw.ie>; Patrick McAlinney <patrick.mcalinney@opw.ie>; Ed Fitzgerald <efitzgerald@tjoc.ie>; Michael Vaughan <mvaughan@tjoc.ie>; Jana Marais <JMarais@tjoc.ie>
Subject: Fermoy Weir Remediation and Fish Bypass Channel - HecRas Modelling

Jonathan

I refer to our conversation yesterday afternoon and the Hecras Model results that I had sent to you in an email last Friday 24th Feb.

In that email I referred to an anomaly in the results for the existing scenario for the 1 in 50 and 1 in 100year return period design flows. We have since refined the HecRas model timesteps to 10 second intervals with corresponding output steps. This has resolved the anomaly and eliminated the instability that produced it. Our updated output summary files are appended herewith.

While the model outputs continue to show a freeboard of less than 500mm depth in the Q100 flow at some locations for the existing scenario only, primarily on the south bank, the shortfall in freeboard is greatly reduced at the locations previously affected by the model instability. The results for the proposed scenario continue to show that a freeboard of greater than 500mm is achievable at all locations for the Q100 flow.

The results confirm that the proposed development has no adverse impact on flood levels across the range of flood events apart from a couple of localised locations for the Q2 and Q5 flows. These primarily occur in the vicinity of Wall 8 on the North bank and can be explained by the diversion of a greater proportion of flows towards the north bank in this area as a result oof the introduction of the 28m wide Fish Bypass channel.

We are now finalising the revisions to the FRA report to reflect these updated results. We will send you a complete copy of the updated FRA report and the text of our response to the OPW's Observations which will be incorporated into the formal submission on behalf of Cork Co Co, the applicant, to An Bord Pleanála. We hope to send you pdf copies of these documents later today.

Regards

Diarmuid Cahalane

Technical Director

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