WATER POWER SERVICES

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The Four Potential Hydro Sites (Google Earth)

Feasibility Study on the Renewable Energy Potential, specifically micro hydro in four pre-specified locations for Toormakeady Sustainable Energy Community, Co. Mayo

Prepared by: Fiacc OBrolchain Dip Arch B.Sc. P Grad Hydro (Vienna)

Summary

Containing the four specific Site Studies. To be read in conjunction with the document Appendices and Drawings, that are common to all schemes

Contents

Description

The key requirement of this report is to prepare a report on the potential for micro hydro at four specific sites within the Toormakeady Sustainable Energy Community (SEC).

The specific characteristics of the four sites are dealt with in this document. These include details of Catchment, Flow, Power Output and further details relevant to the individual sites. As the four sites are very similar there is much of the information that is common to all. The common information is in the accompanying document Appendices and Drawings

Site	Output	Head	pipe length	pipe cost	turbine	Civil works	Connection	EIA/fees	Total Cost	€ per kW	€ per annum	payback
1	35 kW	35 m	650 m	94,000	71,000	82,000	20,000	20,000	287,000	8,200	28,000	10.25
2	40 kW	20 m	500 m	73,000	76,000	82,000	20,000	20,000	271,000	6,775	32,000	8.4
3	40 kW	35 m	800 m	116,000	71,000	82,000	20,000	20,000	309,000	7,725	34,000	9
4	50 kW	40 m	700 m	102,000	71,000	82,000	20,000	20,000	295,000	5,900	40,000	7.4

A Comparison of the Four Sites

The four sites range in power output between 35 and 50 kW and can replace some €130,000 worth of bought in electricity per annum. This could make a significant contribution to making the Toormakeady area self-sufficient in electrical needs using a renewable energy source. The estimated total cost of the four projects is c €1.2 million for 165 kW or just over €7,000 per kW installed which is average for such schemes. On completion of further measurement, it is possible that the output could by increased with a small extra investment cost and this has the potential to reduce this cost to about €5,500 per kW installed.

Environmental Assessment

An Ecological Assessment is included in this study (Appendix II). The conclusion by Aquafact is that, while fisheries must be consulted and there is a requirement for an appropriate assessment of the rivers, there is no requirement for a full EIA. The cost of the assessment would be €6,000 and would be appropriate for all four schemes.

Net Metering and Smart Grid

The Toormakeady Hydro project is planned as a part of the Sustainable Energy Community (SEC) and this part of the overall project has a potential of four generators. With a possible membership of the majority of households in the Toormakeady village area, the way the electricity is distributed is vital to the success of the project.

As stand-alone water turbines these individual schemes have a limited value. This stand-alone value would depend on a strong feed in tariff. This is the rate per kWh, that a scheme would be paid by an electricity procurer. The last feed in tariff that was available was in the region of 9.8c per kWh. This was limited to a 14-year period.

However, the possible value to the SEC is currently 20c per kWh. This is only possible with Net Metering and would only be available to a co-operative venture.

With a Net Metering arrangement, the power can be exported and imported from the grid as the power from the turbines is available, and as the individual co-op members have a demand. The accounting for the power is carried out on a monthly or preferably yearly basis.

This means that the buying and selling of electricity is on a long-term basis and the full value of the power is realised by the co-op.

Further to making this project a significant contributor to the energy needs of the community is the setting up of a Smart Grid by the Toormakeady SEC in conjunction with the ESB.

A smart grid is an electrical grid which includes a variety of operation and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources. Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid.

Smart grid policy is organized in Europe as Smart Grid European Technology Platform.

Roll-out of smart grid technology also implies a fundamental re-engineering of the electricity services industry, although typical usage of the term is focused on the technical infrastructure.

The Toormakeady area is an ideal location for a Smart Grid. While this type of operation is very new to Ireland, there is a need to develop this type of technology, where the opportunity arises. This not only makes this scheme worthwhile but will contribute to gaining experience, so that future development will be possible in making renewable energy more efficient and a more central part of the electricity and energy infrastructure in Ireland.

Development of the Net Metering and Smart Grid aspects of the project are the Energy Co-ops area of expertise. This is also a goal of the Sustainable Energy Authority of Ireland (SEAI) and assistance should be sought from both of these organisations.

Measuring and Turbine Sizing

The estimated flow at the four sites is based on rainfall and the software developed by the Environmental Protection Agency (EPA) *Estimate of Flow Duration Curve for an Ungauged Catchment.* (Appendix IVa and IVb)

While this is probably accurate enough to fit the pipeline and turbines suggested in the four reports, with further measurement there may be an opportunity to increase the size of the turbines which would give significantly more power at a small extra cost.

By installing measuring weirs at the sites (Appendix III), actual flow measurements can be taken and compared to the rainfall during the measurement period.

It is possible that, with the more accurate flow/rainfall records, the overall power output could be raised by as much as 30%, which would reduce the payback time of the four schemes from 9 to 7 years in simple terms.

This is a fairly simple task that could make a significant contribution to the viability of this project.

Permissions and Wayleaves

To build any of these schemes, permission will have to be obtained for the wayleaves for the pipeline, permission to build the intakes and turbine houses and Planning Permission will have to be obtained.

The land ownership and such permissions are not part of this study and there are many ways in which the wayleaves and structures can be dealt with. As the best model for this project is a co-op, there will be a shared interest and ownership hopefully by all of the community. The common interest should help to obtain the necessary co-operation by all involved.

Construction
Construction work in and around rivers has some particular methods and constrictions (Appendix V and VI). For example, in-stream work is only permitted from beginning of May to the end of September. For these schemes this should not be a problem as the in-stream works, intake and draft tube pit, are comparatively small and could be completed in a few weeks.

Interconnection cost
It is not possible to obtain a definitive interconnection cost at this time. ESB Networks will not provide such a cost until Planning Permission has been obtained.

That being said the grid in the Toormakeady area appears to be robust and connection of schemes of this size should not be a difficulty. For the present a flat rate of €20,000 per connection has been suggested, and this should be more than enough to cover these costs. The system for interconnection is illustrated (Appendix VII and VIII) and the form for application NC5A (Appendix IX) has an example of the information needed filled in where possible.

Specification and Quantities
There is an outline and estimate of the specification of the building work and quantities of materials needed to complete the schemes (Appendix X and XI).

Consideration may be given to construction by members of the community as the skills needed are those that most probably available locally. This has the potential to significantly reduce the cost of the project and if tackled one scheme at a time, need not be too much of a burden on the individuals involved

Turbine and Pipe
While there are many manufacturers of turbines and pipe that would suit this project, the price and quality can vary considerably.

The most likely type of turbine would be a cross flow which is very suitable for this type of head and flow.

Cink manufacture cross flow turbines under licence from Ossberger (Appendix XII). The quality is good, and these turbines have a long life, more than 20 years and critically for this project have a good part gate performance. This means that they are still efficient at lower flows, which will be crucial for these schemes.

While pipe lines can be in steel or various plastics, it is usual that a plastic pipe is used on this type of scheme. The quote obtained (Appendix XIV) is for a uPVC pipe. This has the advantage of being comparatively easy to handle and assemble on site.

Grant aid
The opportunity for grant aiding this project would appear to be significant. With Smart Grid, rural development and many further aspects of the project contributing towards a greener environment, this would appear to be an aspect worth investigating.

Time Scale

The first task to be carried out on this project is the measuring of the streams. These must be measured for a minimum of three months before any final decisions can be made.

The pre planning stage of this project is subject to many factors, way leaves, permissions, financing, setting up structures appropriate to the running of the scheme, negotiating with ESB and others with regard to Net Metering and Smart Grid opportunities.

Obtaining Planning Permission can take no less than three months and is often subject to delay due to provision of further information.

Construction time on site can be relatively short. Ordering of bespoke equipment such as turbine and pipe can take some time, up to a year in the case of the turbines.

Conclusion

As a community project these sites have a merit that will only increase with time. As energy becomes more valuable and as non-renewable resources become scarce, the pressure to develop all renewable opportunities will become urgent.

The development of this project so that it will benefit all in the community is complex, but the reward of a secure energy future for an almost infinite time makes the project worth the effort.

For Water Power Services
Fiacc OBrolchain Dip Arch B.Sc. P Grad (Hydro) Vienna

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Summary, Appendices and Drawing List

Drawings

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Drawings

Appendix I Consultants

Fiacc OBrolchain Dip Arch B.Sc. P Grad Hydro is an architect who has specialised in renewable energy, especially small hydro power, for over 30 years. A founder member of both the Irish Hydro Power Association (IHPA) and the European Small Hydropower Association (ESHA), he continues as a member of the Governing Board of ESHA. In 2010 he attended the first post graduate course dedicated to small hydro power. This was organised by Professor Bernard Pelikan of the Technical University of Vienna. Over the years he has been involved in various aspects of a great number of small hydro schemes ranging up to 500 kW and on low and high head sites.

Dr. Brendan O'Connor, Ph.D. Managing director of AQUAFACT. Brendan specialises in the biology and ecology of water-floor communities. He was formerly Assistant Director of NUIG's Benthos Research Group and has been associated with the drafting, management and reporting of all AQUAFACT's contracts. He was a member of the board of the Marine Institute for a 5 year term.

Noel Browne Associates Ltd
Noel Browne runs a multi-disciplinary company operating in the construction industry. They offer services from land surveys, building surveys and mapping/transfer services.

Appendix II

Ecological Assessment for 4 streams

near Toormakeady, Co. Mayo

Produced by

AQUAFACT International Services Ltd

On behalf of

Fiacc O'Brolchain

February 2019

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Appendix II

Report Approval Sheet

Client	Fiacc O'Brolchain
Report Title	Ecological Assessment for 4 streams near Toormakeady
Job Number	JN1520
Report Status	Draft
Issue Date	07/02/19

Rev	Status	Issue Date	Document File Name	Author (s)	Approved by:
1	Draft	07/02/19	Ecological assessment for 4 streams near Toormakeady		Brendan O'Connor

AQUAFACT

Table of Contents

1. Introduction

Mr. Fiacc O'Brolchain requested AQUAFACT to carry out a high level ecological assessment of 3 streams that form part of the Abhainn Gleann Sála catchment and a fourth further north of that catchment at Toormakeady, Co. Mayo (see Figure 1) where it is intended to build hydroelectric schemes to power the village and local surrounding area with electricity.

Figure 1. Site location map of the Abhainn Gleann Sála and a stream in the town land of An Tamhnaigh near Toormakeady, Co. Mayo. (Note sections of afforestation marked on the map).

The assessment was carried out on the 1st February 2019. Each stream was visited and photographs were taken at each location. Plants and birds were identified on site. The area around Toormakeady is not within any Natura site but the Glensaul River flows into Lough Mask which lies within the Lough Cara and Mask Special Area of Conservation (SAC) (site code 001774). The following habitats and species are the Qualifying Interests (QI) for this SAC:

Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110]

Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]

Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]

European dry heaths [4030]

Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]

Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae [7210]

Alkaline fens [7230]

Limestone pavements [8240]

Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0]

Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]

Lutra lutra (Otter) [1355]

Drepanocladus vernicosus (Slender Green Feather-moss) [1393]

Of these, the only QI likely to occur at any/all of the streams is the otter.

2. Results

The streams are located within four different townlands and these are Gort Fraoigh to the south, Doire Mhianaigh, An Trian Láir and An Tamhnaigh which is furthest north. The streams flow off the eastern side of the Sheefry Mountains that rise steeply to *ca* 390m over a relatively short distance. The first three sites as listed are more alike one another than the An Tamhnaigh site as they are faster flowing water bodies that flow through densely wooded areas

Photo. 1. Farmland in upper area of Gort Fraoigh with a section of evergreen forestry in the distance.

Photo. 2. Deciduous wooded area at Gort Fraoigh.

Photo. 3. Wooded area with Holly and Birch close to Doire Mhianaigh.

Photo. 5. Laurel and Rhododendron along the bankside of the Doire Mhianaigh site.

Photo.6. Himalayan Balsam with evergreens in the back ground at the Doire Mhianaigh site.

Photo.7. Wooded area with Alder at Trian Líar.

Photo.8. Slow flowing section through pastureland at An Tamhnaigh.

As noted in some of the above photographs, a number of non-native species were recorded in the area along with some sections of forestry. There are also some areas of managed grasslands.

Bird species recorded included Robin, Wren, Song Thrush, Blackbird, Redwing, Chaffinch, Starling, Magpie, Rook, Jackdaw, Raven, Wood Pigeon and Collard Dove.

3. Discussion

As the survey was carried out in February, many of the plant species that show in Spring could not be recorded. It is recommended that if the scheme gets further consideration that a later Spring/early Summer botanical survey is undertake to record such species.

The area where the 4 streams are located is not especially ecologically sensitive as:

1. It is not located with a Natura site.
2. A number of non-native species were recorded and
3. Managed habitats such as farmland and forestry are present.

This increases the possibility of developing the schemes as it is unlikely that the National Parks and Wildlife Service may object to the development. Nonetheless, as the streams flow into a Natura site, this means that:

1. Construction will have to be carried out in a very sensitive way to ensure there is no additional suspended solids load entering Lough Mask and
2. As the site is so close to a Natura site, a Natura Impact Statement will be required.

It is considered likely that these streams contribute in some way to salmonid populations but this needs to be discussed with Inland Fisheries Ireland.

Appendix III

FLOW

The flow available for these schemes was determined by using software developed by the Environmental Protection Agency (EPA) *Estimate of Flow Duration Curve for an Ungauged Catchment.*
While this software is excellent, it is more accurate for larger rivers than these potential sites. For this study the flows are based on the flow duration curve of the Tuar Mhic Eadaigh Thoir and the Srah stream. Rainfall at the first site is 1,997mm and the second is 1,718 while average rainfall at the two nearest available rainfall gauges to the sites, are 2,424mm at Derrypark and 1,839mm at the Waterworks.
The preliminary selected design flows at the four sites are: 0.14 M^3/sec, 0.28 M^3/sec, 0.15 M^3/sec and 0.17 M^3/sec. This figure represents the upper 95% confidence rate of the 35% long term flow in the rivers and is a normal design size for small hydroelectric schemes. However, as the four sites are mountain streams and there is a high proportion of the time that there is rainfall in this area, it is possible that these design flow figures could be increased. This could not be done without accurately determining the actual flow in the rivers.
It is therefore recommended that this be confirmed by using measuring weirs at the actual sites. Details of how to do this are included below.

MEASURING THE AVAILABLE FLOW

In order to do this:

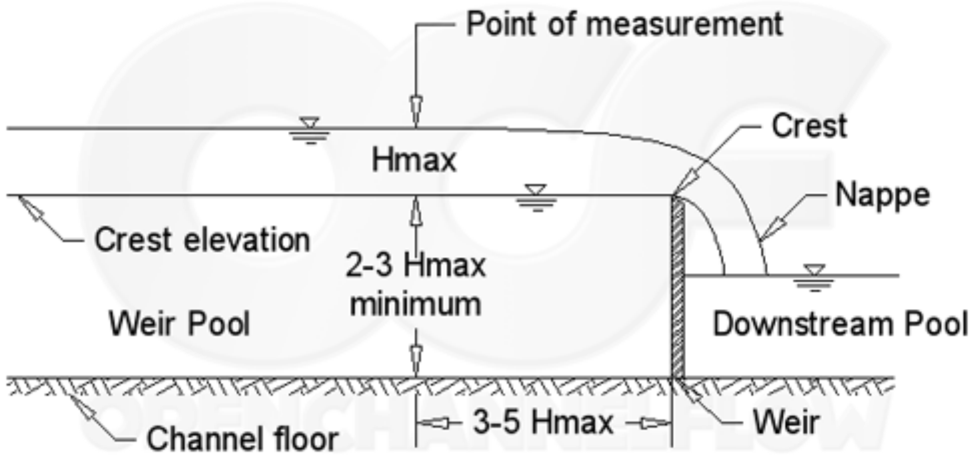
1. A measuring weir will be installed at each site.
2. Measurement taken daily for a minimum of three months.
3. The measurements can then be assessed and compared to rainfall records over the same period.
4. Long term available flow can then be determined.

Weir sizes
For sites 1, 3 and 4, the weir should be 2 metres wide and at least 0.5 metres deep.
For site 2, the weir should be 3 metres wide and at least 0.5 metres deep.
The weirs can be built anywhere on each site that it is convenient to take daily readings, they need not be sited at the intake, as flow record adjustment can be made later.

Tips for building a measuring weir

- The approach channel should be straight and of uniform cross-section for a distance of 15 to 20 times the maximum anticipated water depth (head c.0.5metres, distance 10 metres) (H_{max}) upstream of the weir.
- The approaching flow should be sub-critical, tranquil, and be uniformly distributed across the width of the channel. The flow should not be turbulent, surging, unbalanced, or possessing a poorly distributed velocity pattern.
- Centre the weir in the flow stream.
- Set the lowest point of the crest (the edge of the weir over which flow passes) at least two to three (1.0 to 1.5m) times (H_{max}) above the channel floor
- The lowest point of the crest should be at least 50 mm above the downstream water level.
- Weirs ***MUST*** be level from front-to-back and from side-to-side. No deviation is allowed.

- The point of measurement (H_a) is three to four (2.0 metres) times H_{max} upstream of the weir. Any closer and the head reading is affected by drawdown as the flow approaches the weir.
- The zero elevation for H_a is the same elevation as the lowest point of the weir crest – this is the same as the water surface being the weir once flow over the weir has ceased.



Measuring weir outline


Measuring weir and staff gauge

Instructions for building a measuring weir and discharge table.

FLOW OVER A MEASURING WEIR

For a more accurate method the following should be applied. If there is a weir across the river or a suitable overflow from a head race, the length should be measured together with the mean depth of water flowing over the sill. this will be inaccurate if the weir is uneven, or broad section, or a sloping as opposed to a vertical wall on the down stream side, but with the table below an estimate of the flow can be obtained easily and quickly.

If the stream is small, a temporary measuring weir can be erected as indicated below. The weir should be built of timber with the edges bevelled to give a notch of sharp-edged rectangular section.

This weir is let into the stream and made watertight with clay or sods.

For accurate measuring a stake should be driven into the stream bed some feet upstream, the top of the stake being absolutely level with the crest of the river. The distance from the gap to the lower stream water level should be at least 75mm to allow aeration. The depth of water flowing over the weir is measured by taking the distance from the water level to the top of this stake. The flow can be calculated from the table below.

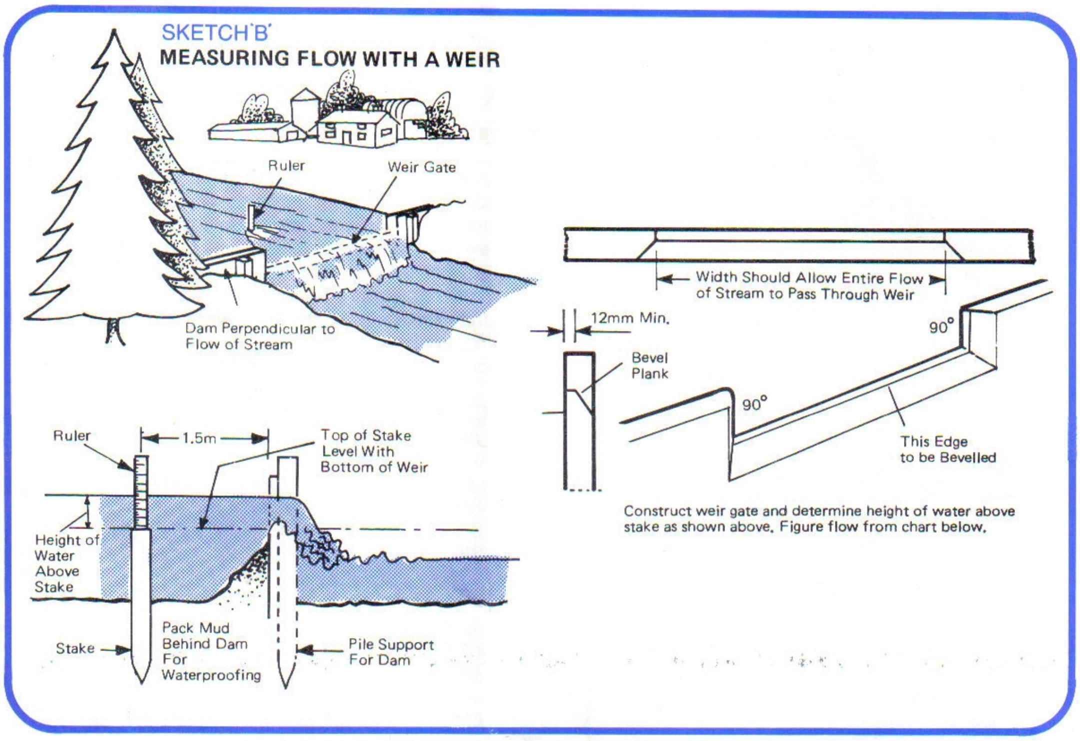


TABLE OF DISCHARGE FROM EACH METRE OF WIDTH OF SILL, IN CUBIC METRES PER SECOND

PER METRE WIDTH

Depth in mm	Litres/Sec	Depth in mm	Litres/Sec per metre width
5	0.7	125	81
10	1.9	150	107
15	3.4	175	135
20	5.1	200	165
25	7.1	225	200
30	9.5	250	225
40	14.6	300	300
50	20.5	350	380
75	38.0	400	460
100	58.0	500	640

PER FOOT WIDTH

Depth in inches	Cu. Ft/Min	Depth in inches	Cu. Ft/Min
0.25	0.6	5	53
0.5	1.7	6	70
0.75	3.1	7	88
1.0	4.8	8	108
1.25	6.7	9	129
1.5	8.8	10	151
2.0	13.5	12	198
2.5	18.9	14	250
3.0	25.0	16	305
4.0	38.0	20	427

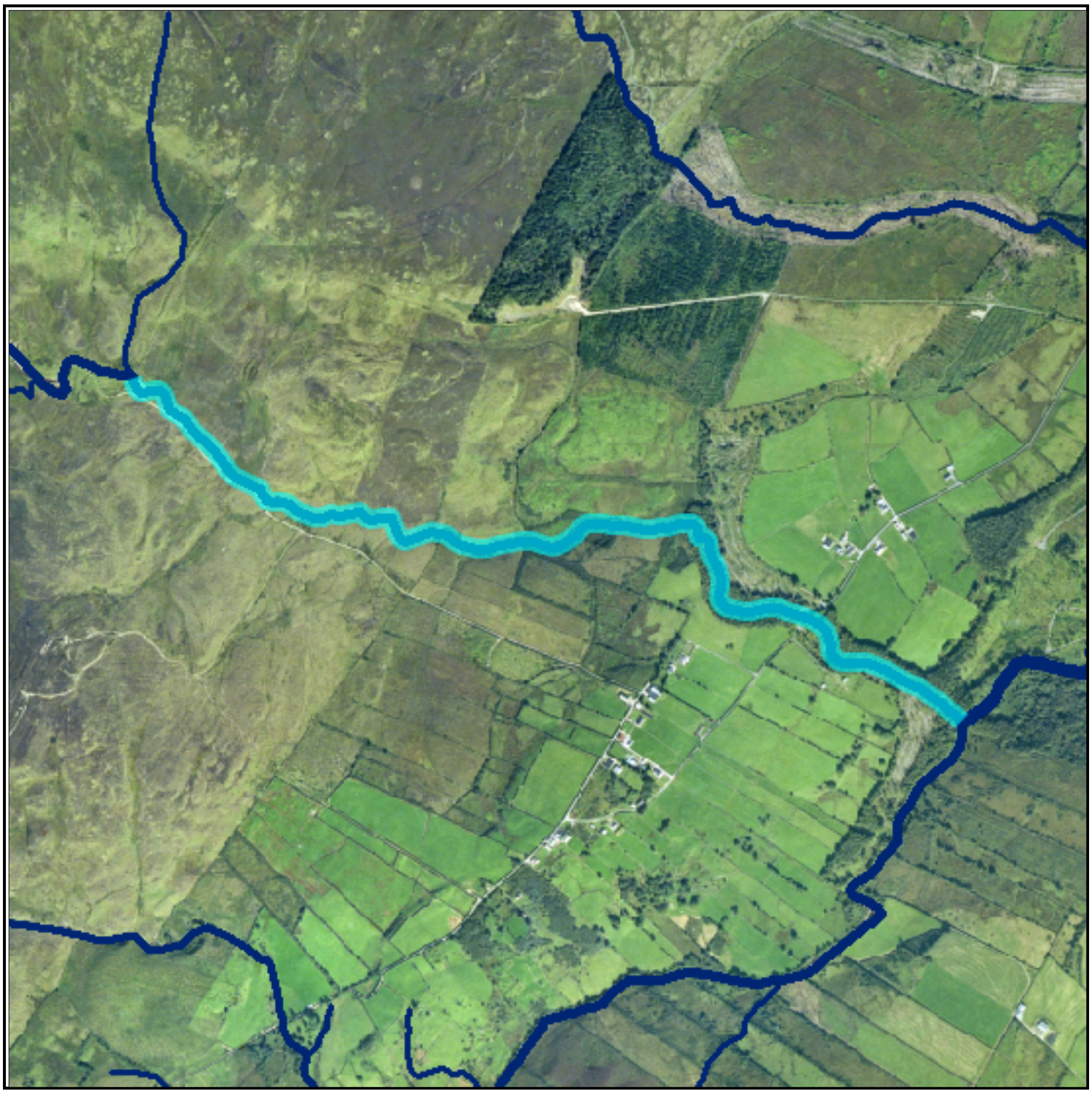
Appendix IVa

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

River Name	TUAR_MHIC_ÉADAIGH_THOIR(30_1461)
XY Location	108164,267660 (ING)

River Segment Map



Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

Disclaimer

The source of hydrometric data used to estimate the flow duration curve ordinates for ungauged catchments was obtained from (1) water level data and (2) the rating curve(s) generated for each hydrometric station. The Environmental Protection Agency and the Office of Public Works used these data, respectively, to calculate daily mean flows. The daily mean flows were then used by the Environmental Protection Agency to prepare flow duration curves for each station. Neither body accepts any liability for the subsequent handling of the data.

The user should familiarise himself/herself with the catchment being studied and confirm that the ungauged site is in a natural catchment where flows conditions are suitable for the use of the model.

It is strongly recommended that the user examine the catchment descriptors contained in the report produced and confirm that the percentages of the various constituent elements are comparable to a natural catchment.

If the flow in a catchment is not entirely natural, the estimation of flows using the model in these catchments could be affected due to:

- existence of local conduit karst within the catchment;
- the selected location itself is on local conduit karst;
- regulation of the river flow on the river channel (e.g. power station, sluice gates etc)
- impacts of abstractions upstream of the selected location or the impact of the discharge associated with the abstraction into the same/different catchment;
- estimates of flow being sought at locations effected by storage effects at, or near, lake outfalls;
- lack of similar catchments with observed flows, ie where catchment descriptors lie outside the range of available gauging station catchments (e.g. the catchment area is under 5 km^2);
- any other special circumstances that may affect river flows.

Expert judgement will be required to ensure that the estimate of flow is not unduly affected by any of these influences.

Please note that the model does not provide estimates of flood peaks and, specifically, should not be used for that purpose.

The EPA has also prepared estimates of DWF and long term 95 percentile flows which are also presented on the EPA web site. These data are presented at http://www.epa.ie/whatwedo/monitoring/water/hydrometrics/data/

The data produced by the model for specific stations should be compared to the data contained in this file of DWF and long term 95percentile flows.

Disclaimer

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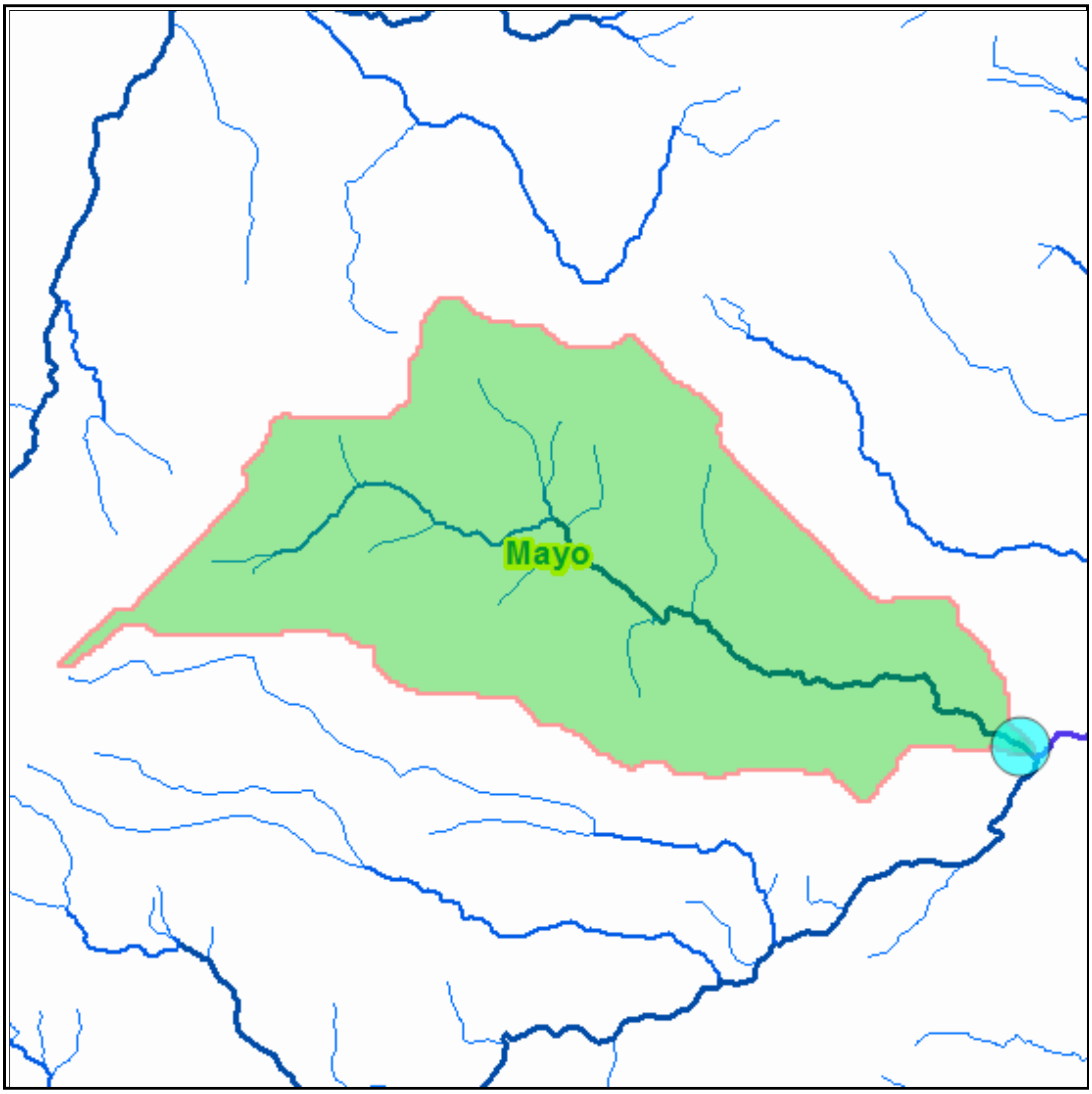
Estimation of Flow Duration Curve for Ungauged Catchment

River Name	TUAR_MHIC_ÉADAIGH_THOIR(30_1461)
XY Location	108164,267660 (ING)

Nested Catchment Map



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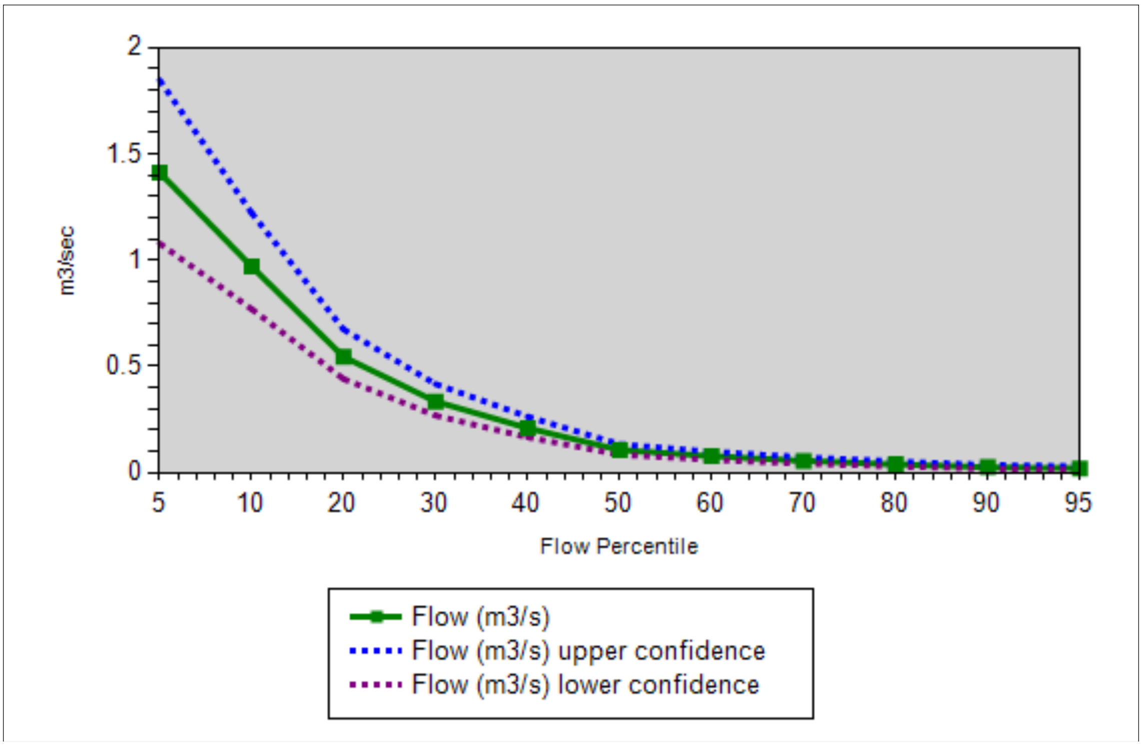
Estimation of Flow Duration Curve for Ungauged Catchment

Environmental Protection Agency

Flow Duration Curve (Flow in m3/sec)



%ile	flow(m3/sec)	upper 95% confidence limit m3/sec	lower 95% confidence limit m3/sec
5	1.412	1.847	1.079
10	0.97	1.222	0.77
20	0.545	0.674	0.441
30	0.335	0.417	0.269
40	0.21	0.264	0.167
50	0.107	0.134	0.085
60	0.078	0.099	0.061
70	0.056	0.073	0.043
80	0.04	0.054	0.03
90	0.026	0.037	0.019
95	0.021	0.031	0.014

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

Catchment Descriptors		
General		
Descriptor	**Unit**	**Value**
Area	sq km	6.2
Average Annual Rainfall (61-90)	mm/yr	1997
Stream Length	km	10
Drainage Density	Channel length (km)/catchment area (sqkm)	1.6
Slope	Percent Slope	13.2
FARL	Index (range 0:1)	1

Soil	
Code	**% of Catchment**
Poorly Drained	78.6
Well Drained	4.1
Alluvmin	0.4
Peat	16.9
Water	0
Made	0

Subsoil Permeability		
Code	**Explanation**	**% of Catchment**
H	High	0
M	Moderate	0
L	Low	4.9
ML	Moderate/Low	3.2
NA	No Subsoil/Bare Rock	91.9

Aquifer		
Code	**Explanation**	**% of Catchment**
LG_RG	LG:Locally important sand-gravel aquifer RG: Regionally important sand-gravel aquifer	0
LL	Locally important aquifer which is moderately productive only in local zones	0

LM_RF	LM: Locally important aquifer which is generally moderately productive RF: Regionally important fissured bedrock aquifer	0
PU_PL	PU: Poor aquifer which is generally unproductive PL: Poor aquifer which is generally unproductive except for local zones	100
RKC_RK	Regionally important karstified aquifer dominated by conduit flow	0
RKD_LK	Regionally important karstified aquifer dominated by diffuse flow	0

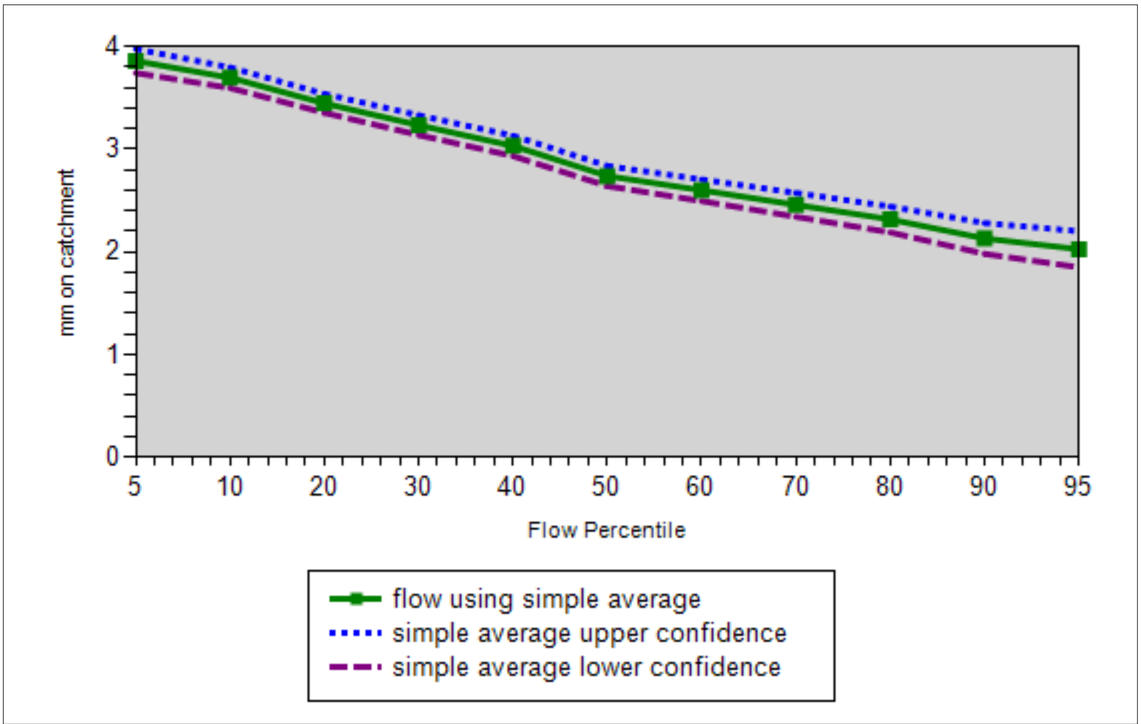
Stations in Pooling group

%ile Flow	Station 1	Station 2	Station 3
5	30033	09026	01054
10	30033	09026	01054
20	30033	09026	01054
30	30033	09026	01054
40	30033	09026	01054
50	30033	09026	01042
60	30033	09026	01042
70	30033	09026	01042
80	30033	26029	09026
90	30033	26029	09026
95	30033	26029	09026

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

Flow Duration Curve (mm on catchment)



Log Flow (mm on catchment)			
%ile	mm	upper 95% confidence limit	lower 95% confidence limit
5	3.86	3.977	3.743
10	3.697	3.797	3.597
20	3.447	3.539	3.355
30	3.235	3.331	3.139
40	3.033	3.132	2.934
50	2.74	2.838	2.642
60	2.601	2.706	2.496
70	2.459	2.575	2.343
80	2.317	2.443	2.191
90	2.132	2.282	1.982
95	2.027	2.203	1.851

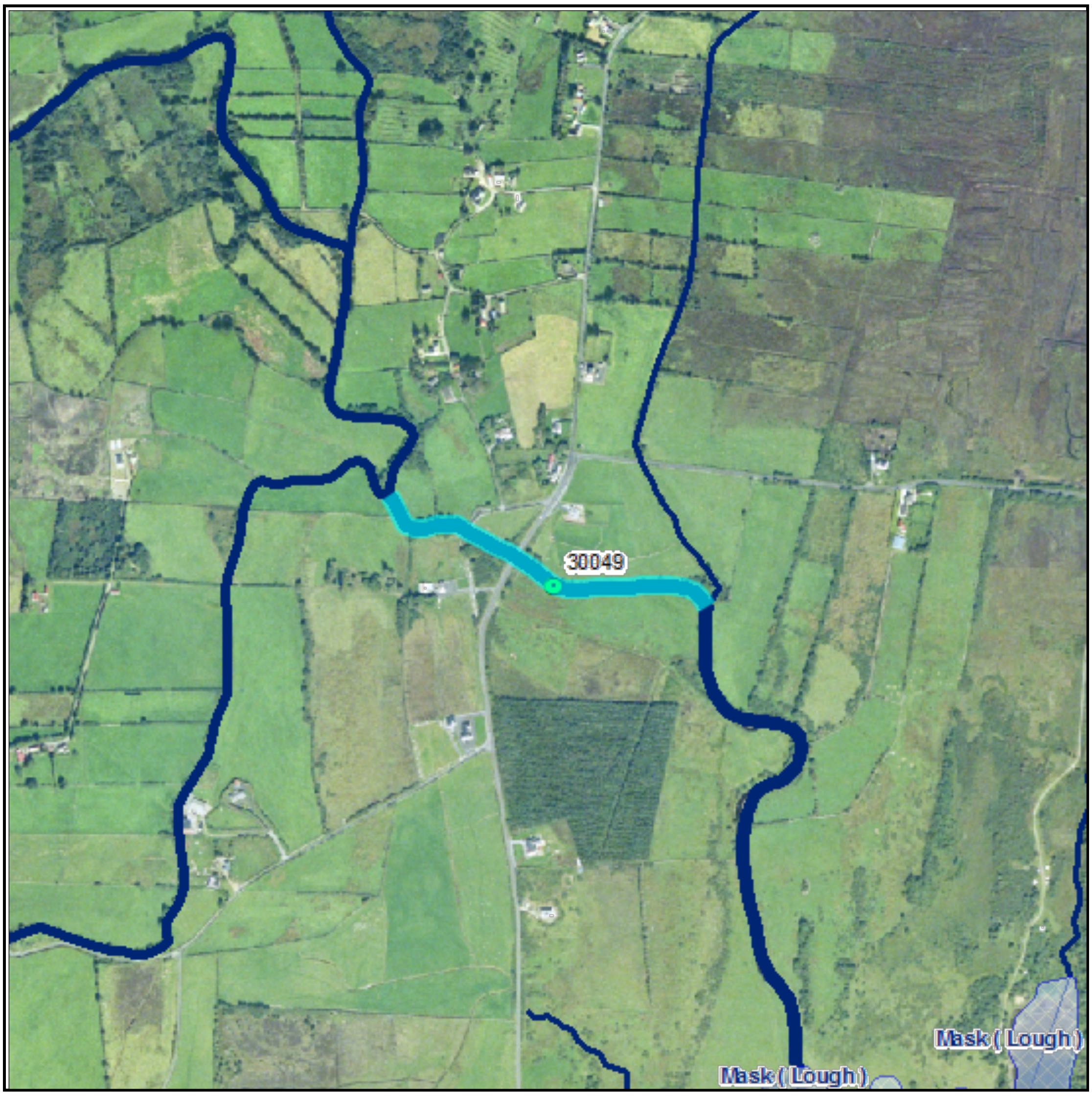
Appendix IVb

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

River Name	Srah Stream(30_1518)
XY Location	111768,272468 (ING)

River Segment Map



Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

Disclaimer

The source of hydrometric data used to estimate the flow duration curve ordinates for ungauged catchments was obtained from (1) water level data and (2) the rating curve(s) generated for each hydrometric station. The Environmental Protection Agency and the Office of Public Works used these data, respectively, to calculate daily mean flows. The daily mean flows were then used by the Environmental Protection Agency to prepare flow duration curves for each station. Neither body accepts any liability for the subsequent handling of the data.

The user should familiarise himself/herself with the catchment being studied and confirm that the ungauged site is in a natural catchment where flows conditions are suitable for the use of the model.

It is strongly recommended that the user examine the catchment descriptors contained in the report produced and confirm that the percentages of the various constituent elements are comparable to a natural catchment.

If the flow in a catchment is not entirely natural, the estimation of flows using the model in these catchments could be affected due to:

- existence of local conduit karst within the catchment;
- the selected location itself is on local conduit karst;
- regulation of the river flow on the river channel (e.g. power station, sluice gates etc)
- impacts of abstractions upstream of the selected location or the impact of the discharge associated with the abstraction into the same/different catchment;
- estimates of flow being sought at locations effected by storage effects at, or near, lake outfalls;
- lack of similar catchments with observed flows, ie where catchment descriptors lie outside the range of available gauging station catchments (e.g. the catchment area is under 5 km^2);
- any other special circumstances that may affect river flows.

Expert judgement will be required to ensure that the estimate of flow is not unduly affected by any of these influences.

Please note that the model does not provide estimates of flood peaks and, specifically, should not be used for that purpose.

The EPA has also prepared estimates of DWF and long term 95 percentile flows which are also presented on the EPA web site. These data are presented at http://www.epa.ie/whatwedo/monitoring/water/hydrometrics/data/

The data produced by the model for specific stations should be compared to the data contained in this file of DWF and long term 95percentile flows.

Disclaimer

The source hydrometric data used to estimate the flow duration curve ordinates for ungauged catchments was obtained from (1) water level data and (2) the rating curve(s) generated for each hydrometric station. The Environmental Protection Agency and the Office of Public Works used these data, respectively, to calculate daily mean flows. The daily mean flows were then used by the Environmental Protection Agency to prepare flow duration curves for each station. Neither body accepts any liability for the subsequent handling of the data.

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

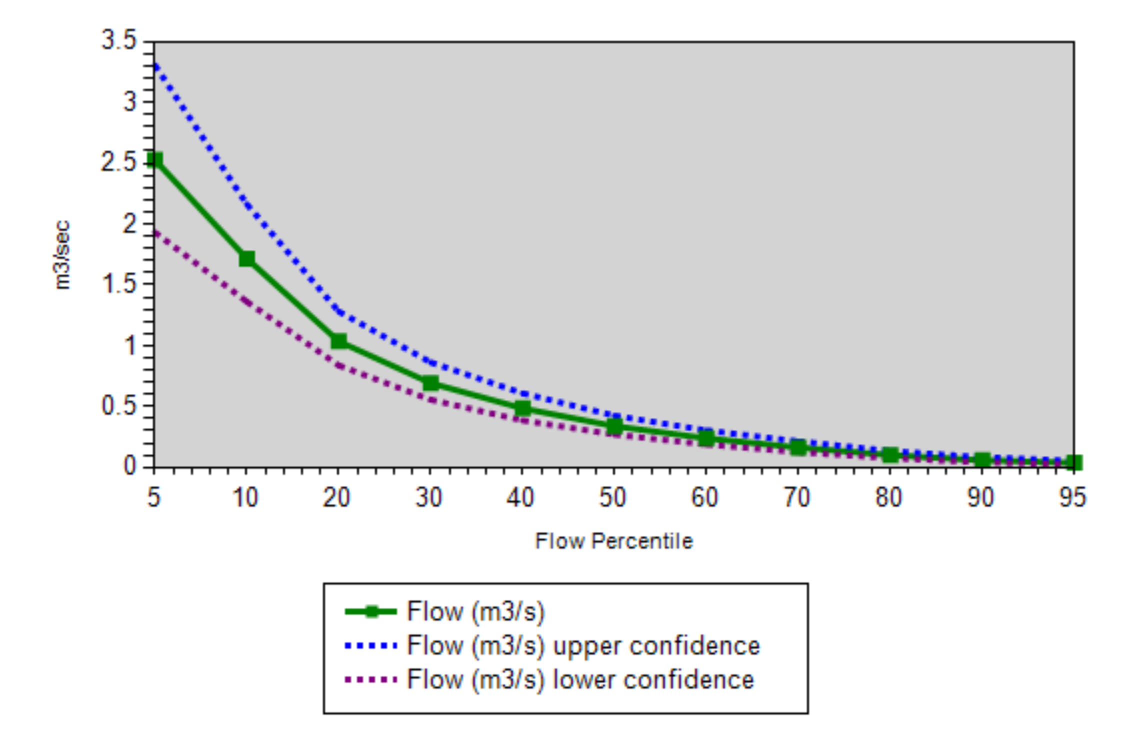
River Name	Srah Stream(30_1518)
XY Location	111768,272468 (ING)

Nested Catchment Map

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

Flow Duration Curve (Flow in m3/sec)



%ile	flow(m3/sec)	upper 95% confidence limit m3/sec	lower 95% confidence limit m3/sec
5	2.527	3.305	1.932
10	1.716	2.162	1.362
20	1.036	1.281	0.838
30	0.693	0.863	0.556
40	0.485	0.609	0.386
50	0.339	0.425	0.27
60	0.239	0.304	0.188
70	0.164	0.214	0.125
80	0.101	0.135	0.076
90	0.059	0.084	0.042
95	0.037	0.055	0.024

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

Estimation of Flow Duration Curve for Ungauged Catchment

Catchment Descriptors		
General		
Descriptor	**Unit**	**Value**
Area	sq km	14.3
Average Annual Rainfall (61-90)	mm/yr	1718
Stream Length	km	30.2
Drainage Density	Channel length (km)/catchment area (sqkm)	2.1
Slope	Percent Slope	10.3
FARL	Index (range 0:1)	1

Soil	
Code	**% of Catchment**
Poorly Drained	84.8
Well Drained	9.9
Alluvmin	0
Peat	5.3
Water	0
Made	0

Subsoil Permeability		
Code	**Explanation**	**% of Catchment**
H	High	0
M	Moderate	0
L	Low	1.5
ML	Moderate/Low	6.3
NA	No Subsoil/Bare Rock	92.1

Environmental Protection Agency

Estimation of Flow Duration Curve for Ungauged Catchment

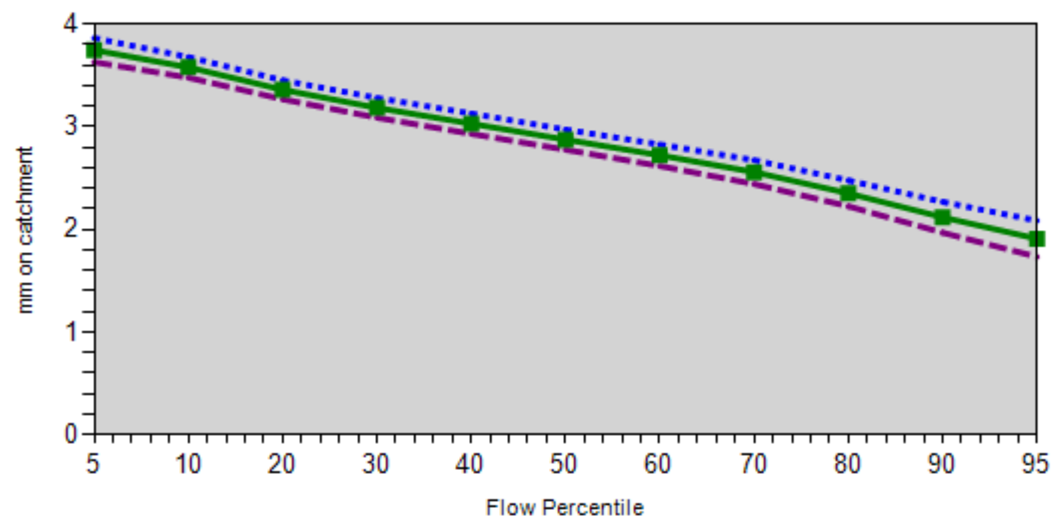
Aquifer		
Code	**Explanation**	**% of Catchment**
LG_RG	LG:Locally important sand-gravel aquifer RG: Regionally important sand-gravel aquifer	0
LL	Locally important aquifer which is moderately productive only in local zones	6.7
LM_RF	LM: Locally important aquifer which is generally moderately productive RF: Regionally important fissured bedrock aquifer	6.9
PU_PL	PU: Poor aquifer which is generally unproductive PL: Poor aquifer which is generally unproductive except for local zones	86.4
RKC_RK	Regionally important karstified aquifer dominated by conduit flow	0
RKD_LK	Regionally important karstified aquifer dominated by diffuse flow	0

Stations in Pooling group			
%ile Flow	**Station 1**	**Station 2**	**Station 3**
5	21004	32011	33006
10	21004	32011	33006
20	21004	32011	33006
30	21004	32011	33006
40	21004	32011	33006
50	32011	34014	26029
60	32011	34014	26029
70	32011	34014	26029
80	32011	34014	30033
90	32011	34014	30033
95	32011	34014	30033

Flow Duration Curve (mm on catchment)

Estimation of Flow Duration Curve for Ungauged Catchment

Environmental Protection Agency



Log Flow (mm on catchment)			
%ile	mm	upper 95% confidence limit	lower 95% confidence limit
5	3.747	3.864	3.63
10	3.579	3.679	3.479
20	3.36	3.452	3.268
30	3.185	3.281	3.089
40	3.03	3.129	2.931
50	2.875	2.973	2.777
60	2.723	2.828	2.618
70	2.559	2.675	2.443
80	2.352	2.478	2.226
90	2.119	2.269	1.969
95	1.91	2.086	1.734

Appendix V

WATER POWER SERVICES

SPECIALISTS IN DESIGN AND CONSTRUCTION OF WATER POWER SCHEMES
13 Marlboro Rd • Dublin 4 • Ireland
Phone +353 1 6680043 • Email fiaccob@iol.ie

Statement of Construction Method for Toormakeady Hydro

General
These schemes will use tributaries and mountain streams to generate electric power which will be fed into the national electricity grid. The schemes will exploit the natural renewable resource of the river flow by using the natural fall to power the turbine.

The key features of the development are as follows:

1. An intake structure will be constructed as illustrated in the attached drawings. This will have a small weir, an intake chamber and a screen to prevent trash entering the pipeline. It is proposed to carry out this work when flows are lowest.

2. There will be a sluice gate at the pipeline in-take to control water flow and provide for shut down.

3. It is proposed to use a Crossflow turbine to harness the power of the water.

Construction Phase

4. The construction phase will be undertaken in the summer months when water levels are lowest. The construction phase will be carried out over a maximum of a four month period.

5. During the entire construction phase all machinery will be kept clean of excess grease and regularly inspected to ensure that there are no oil or fuel leaks. Refuelling will take place in a controlled environment away from the water course. Work will then commence on constructing the foundation for the turbine. All this work will occur on dry-land, away from the water course, in the normal manner of a construction project.

6. Construction of the weir and intake chamber pass will be carried out in stages so that there will be no work carried out in the river. Essentially the chamber and weir will be built separately so that the water flow can be diverted around the part of the structure being worked on with the remainder staying dry.

7. Construction of the pipeline is all carried out away from the river and spoil from this will not be allowed near the river

8. The lower part of the turbine house will be constructed behind a water filled bund dam or similar so that there will be no leaching of concrete into the river.

9. The turbine, will then be brought to the site and craned into position.

10. The turbine superstructure will be completed. The building around the turbine may remain incomplete to allow easy access for engineering during the final testing of the turbine.

11. When all the building work is completed any necessary bunding will be removed and the turbine house base will be connected to the existing river course. Work will be undertaken in a careful manner to ensure that solids do not enter the main water course. In any case this work will be undertaken at a time when there is a relatively high flow in the river and a relatively high level of suspended solids in the water, therefore any solids (soil) entering the water will be indiscernible.

12. Testing of the turbine will occur during a time of relatively high flow in the river.

13. When testing has been completed the turbine will be finally commissioned by the project engineer. Following this the structure around the turbine will be completed thereby closing the entire structure inside the building. The necessary safety barriers and fencing will be completed.

14. The turbine will then come into normal operation.

15. The operation of the turbine will be fully automated with level control making sure that the head level is kept to a maximum allowed by the river flow.

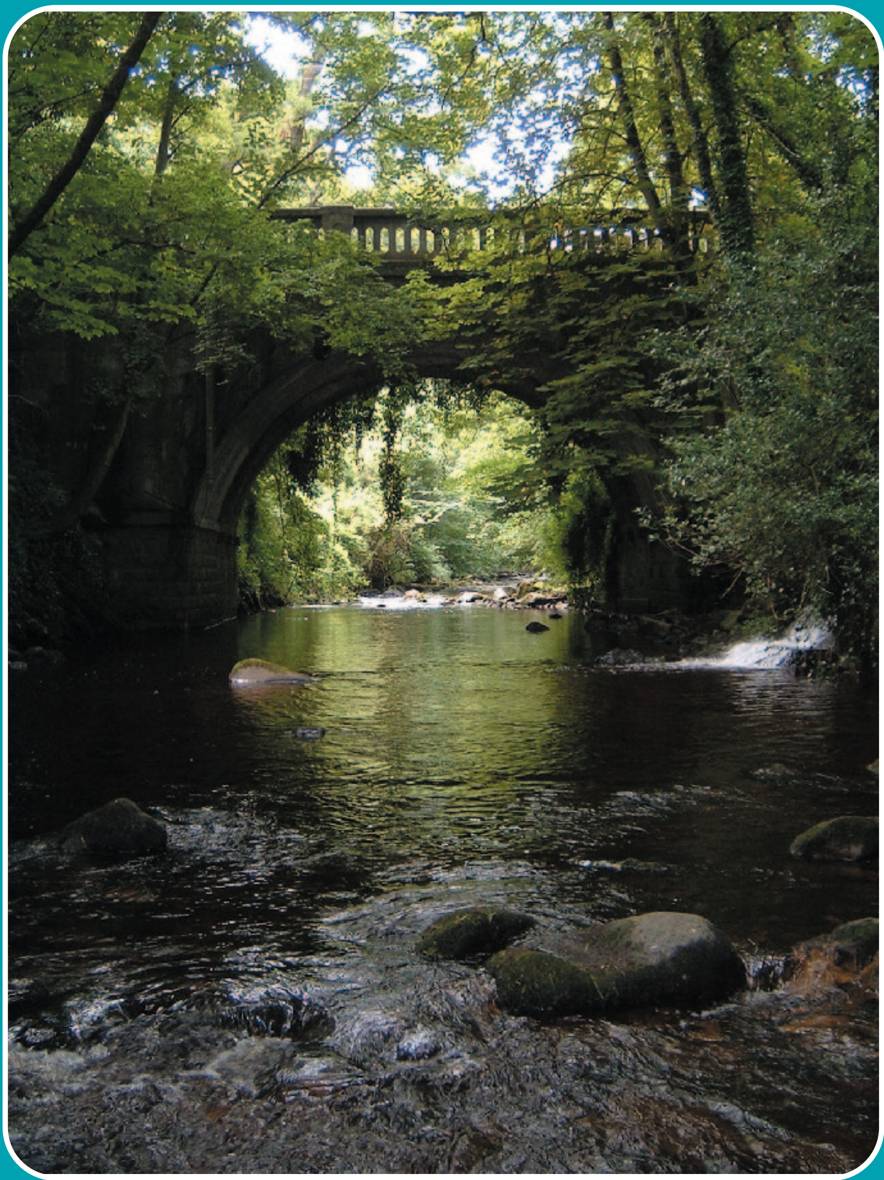
16. Health and Safety
    As required under the Safety, Health and Welfare at Work (Construction) Regulations 2006 it will be necessary to appoint a competent Project Supervisor Design Process (PSDP) to prepare a Preliminary Safety and Health Plan to identify exceptional features of design and construction activities affecting safety and health for this project from information provided by the designer and client prior to the commencement of the work on site.
    This information will be communicated to the Contractor and the Project Supervisor Construction (PSCS) when appointed to enable them to develop safe systems of work for the project.

Appendix VI

Eastern Regional Fisheries Board

Bord Iascaigh Réigiúnach an Oirthir

FISHERIES



Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites

EASTERN REGIONAL FISHERIES BOARD

Fisheries Protection Guidelines

These Guidelines were written by Mr. Donal F. Murphy, BE FIEI MIFM,
with the assistance of staff of the Eastern Regional Fisheries Board

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Introduction

The Fisheries Board is charged under the Fisheries Acts with the responsibility to protect and conserve all freshwater fisheries within its area of jurisdiction.

Every river, stream, canal, lake, pond and reservoir within this area must be regarded as constituting and/or supporting a Fishery under the meaning of the Acts unless otherwise regarded by the Boards.

The fisheries resource is also protected under national and EU legislation. Some notes on the legal protection given to fishery habitats are contained in Appendix I.

While general and specific requirements for the conservation and protection of the fisheries habitat may be set out in the planning conditions under which a project is approved, many issues regarding the timing, management, organisation, and methods of execution of the works inevitably arise during the construction phase.

These Guidance Notes are aimed to identify the likely impact on fisheries habitat in the course of construction and development work, and to outline practical measures for the avoidance and mitigation of damage.

These guidelines should not be regarded as all-embracing. Each project must be assessed on a case by case basis. It is, therefore, essential to consult with the Board. It may also be necessary to seek professional expert advice.

All information contained in these guidelines were up to date at time of print.

Fish
and Their Requirements

Fish need unpolluted water and abundant food in a habitat that provides spawning areas, shelter and freedom of movement. The bed and soil of a natural river and the associated aquatic and riparian vegetation combine to provide the food chain on which fish depend. A natural river channel is characterised by the morphological features which are vital for the life cycle of fish: gravel shoals or reed beds for spawning, pools and riffles where fish rest and feed, and turbulent reaches which enhance oxygenation.

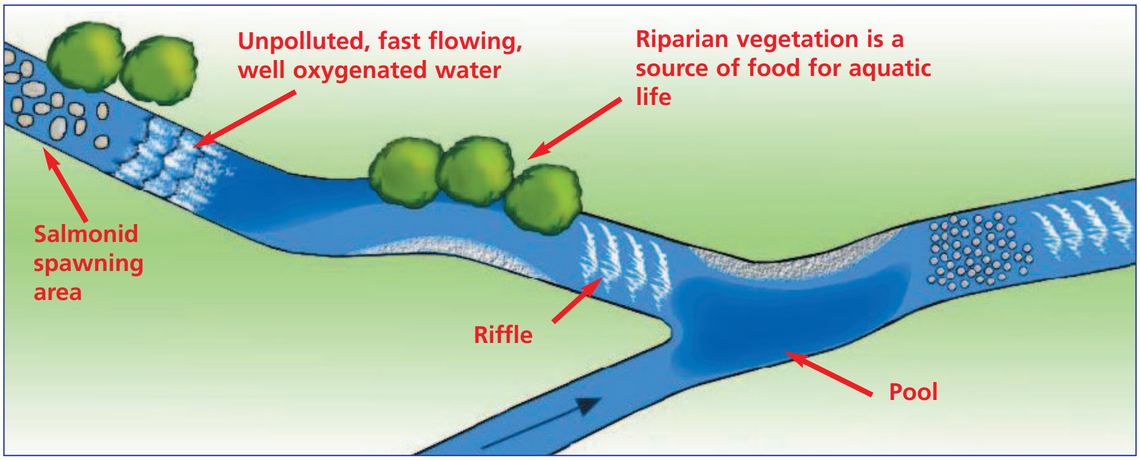

Fig. 1. Overview of River System

All elements of this natural environment must be protected. These guidance notes outline important practical measures to minimise the impact of construction and development works on fisheries habitat.

Potential Impacts on Fish and Fish Habitat from Roads and Watercourse Crossings

Barriers to fish passage	■ Blockages in watercourses – physical or hydraulic.
Water pollution	■ Sedimentation – impacts include smothering fish eggs and causing mortalities in fish of all ages, reducing abundance of food and impeding movement of fish. ■ Cement, grout and concrete – toxic to fish. ■ Oil and fuels – direct impacts on fish, fish food and fish habitats.
Removal of bed material	■ Causes loss of instream vegetation and food. May destroy spawning or nursery habitats.
Disturbance of riparian vegetation	■ Loss of shelter and cover, loss of food (plant debris and invertebrates).

Design Stage

Permanent river crossings

1. Bridges

Clear span bridging is the preferable option, causing no changes to bed and banks and no impact on fish migration. If piers are required keep them slim-line to minimise changes to the channel. Bed and bank work should be executed in natural materials.

Adequate clearance should be allowed under bridges for angler access and mammal passage, if required, particularly in the case of a motorway project.

2. Culverts

Culverts are likely to obstruct or delay upstream fish passage unless the depths and velocities of flow in them are within the swimming capabilities of the species to be catered for. Entry and exit conditions are also critical for ease of fish passage.

- Where possible, arch-type, “bottomless” units should be used so that the natural stream bed can be retained.
- The next best option is to use box culverts incorporating the design principles set out hereafter.
- The use of round/oval culverts should be limited to short runs and temporary crossing.

Design principles

1. Culvert should be as short as possible
2. Where the topography allows, they should be laid so as to remain backwatered in drought flow to a depth of not less than 500mm at the upstream invert, thereby providing a fishway over their full length.
3. In all cases, provisions must be made to ensure that the velocity of flow will be less than the swimming speed which can be comfortably maintained by the weakest upstream migrants.
4. Transition pools should be formed at each end to allow upstream migrants to enter and exit without stress or delay.
5. Culverts should be daylit over their full length: if necessary, light-ports should be provided at suitable intervals.
6. The use of trash screens should be avoided.

Fig. 2. Over-sized box culvert permanently backwatered

Design Options

1. To conform to the principles set out above, culverts always need to be oversized and, generally, laid below the river-bed grade level by about 500 mm.
2. Where the bed gradient is too steep for full backwatering, the best option for achieving low velocity and adequate fishway is to provide a fish-pass at the downstream end, as shown in Figure 3.

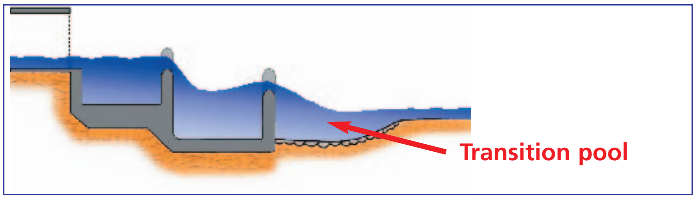

Fig. 3. Fish pass and transition pool at downstream end of culvert

3. Alternatively, the downstream water-level may be raised by providing one or more ponding weirs below the outfall. Such weirs should have fish notches to facilitate upstream movement. The pools formed by them should provide adequate resting and take-off conditions for fish.
4. In some cases it may be acceptable to use notched baffles to control the velocity and provide fishway in the culvert. As already recommended the culverts should be over-sized to compensate for flood conditions.
5. More rarely, shaping and roughening of the invert may serve to provide flow conditions suitable for fish passage, especially during low flow. The objective is to create a low flow channel along the centre of the culvert.

Permanent River Diversions and/or Realignments

While permanent diversions are not encouraged, in limited circumstances they will be permitted. The new channel should display hydraulic and morphological characteristics fulfilling the requirements of fisheries habitats. Bed and bank work should be executed in natural materials.

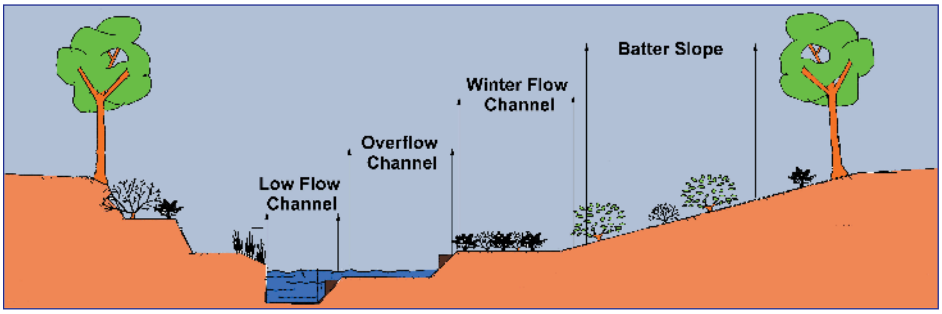

Fig. 4. Example of realignment design

Road run-off

All surface water collected from the road drainage should be treated in a sustainable manner to minimize the impact on water quality and prevent habitat degradation. Treatment should be designed with adequate storage capacity and in a manner to facilitate maintenance.

Construction Stage

Minimising impact: Site Layout and Organisation

The following measures are critical for preserving water quality and aquatic habitats.

1. Fuels, oils, greases and hydraulic fluids must be stored in bunded compounds well away from the watercourse. Refuelling of machinery, etc., should be carried out in bunded areas.
2. Runoff from machine service and concrete mixing areas must not enter the watercourse.
3. Stockpile areas for sands and gravel should be kept to minimum size, well away from the watercourse.
4. Runoff from the above should only be routed to the watercourse via suitably designed and sited settlement ponds/filter channels.
5. Settlement ponds should be inspected daily and maintained regularly.
6. Temporary crossings should be designed to the criteria laid down for permanent works.
7. Watercourse banks should be left intact if possible. If they have to be disturbed, all practicable measures should be taken to prevent soils from entering the watercourse.

Instream works

1. Instream works may only be carried out in accordance with the Board's general requirements set out below.
2. Preparatory works – such as constructing temporary crossings, forming cofferdams, creating diversions, - must be carried out in accordance with an approved Method Statement and under supervision by the Board's officers. Similar requirements apply during removal and reinstatement.
3. Instream machine works should be minimised, and any machines working in the watercourse must be protected against leakage or spillage of fuels, oils, greases and hydraulic fuels.
4. Instream earthworks must be executed so as to minimise the suspension of solids.
5. Construction works, especially ones involving the pouring of concrete, must be conducted in the dry.
6. When cofferdams are being kept dry by pumping, the discharge must be routed to an approved settlement facility before return to the river.
7. Every care must be taken to insure against spillage of concrete or leakage of cement grout within cofferdams.
8. Temporary diversions may be used to facilitate working in the dry, subject to permission by the Board. Advance notice must be given and a Method Statement must be furnished and approved. Such approval will be subject to the Board's officers being satisfied that the diversion channel can be so designed as to accommodate fish migration.
9. The diversion channel should be formed in the dry, and arrangements should be made for authorised personnel to remove all fish from the natural channel before the flow is diverted.

Summary of the Board's General Requirements:

- In salmonid catchments, all in-stream works should be carried out during the period May to September (see table on next page).
- In the event that these waters contain Lamprey it is necessary to contact National Parks and Wildlife Service for their requirements.
- No instream works shall be carried out without the written approval of the Board. A method statement must be agreed well in advance.
- The Board should be given sufficient notice before pre-approved in-stream works commence.
- If a section of watercourse is to be de-stocked work must be carried out by authorised personnel. If this work is to be carried out by Fishery Board staff, two to three weeks notice must be given and the cost will be recouped by the Board.
- There must be no discharge of suspended solids or any other deleterious matter to watercourses.
- Fish passage conditions must be maintained at all times.

MONTH	INSTREAM WORK	FISH LIFE CYCLE
January	Instream works not permitted	Some late spawning Incubation of eggs continues Kelts descending
February		Incubation of eggs continues Kelts descending Spring Salmon runs
March		Incubation of eggs continues and swim-up of young salmonids begins Spring Salmon runs Coarse fish spawning
April		Incubation ending Swim-up on-going Young salmonids dispersing Smolts migrating to sea Coarse fish spawning
May	Instream works permitted	Young salmonids migrating downstream into nursery areas Smolts migrating to sea Coarse fish spawning and fry dispersing
June		Young salmonids in nursery areas Adult Sea Trout returning to rivers Coarse fish spawning and fry feeding
July		Grilse and Set Trout moving upstream
August		Low river flows Sea Trout run tailing off
September		Low River flows
October	Instream works not permitted	Spawning run commences as flows increase
November		Spawning and incubation of eggs underway
December		Spawning and incubation of eggs continues

APPENDIX I

Some notes on the legal protection given to fishery habitats in legislation

- The enforcement authority for inland fisheries is the relevant Regional Fisheries Board and the legislation charges them with the protection of fisheries and the general enforcement of the Fisheries (Consolidation) Act 1959 (as amended).
- Since the Fisheries (Amendment) Act 1999 the Board was additionally required to have regard for the need for sustainable development. This includes:
  - the conservation of fish and other species of fauna and flora habitat.
  - biodiversity of inland fisheries and ecosystems.
  - to protection of national heritage within the meaning of the Heritage Act 1995.
- The Fisheries Act provides a wide range of measures to protect fish; however the protection of fishery habitat is limited to a number of sections of the Acts.
- Section 131 of the Fisheries (Consolidation) Act 1959 protects spawning salmon and trout and creates the offence that where any person during the annual close season:
  - *wilfully obstructs the passage of salmon or trout or the smolts or fry thereof.*
  - *or injures or disturbs any salmon or trout, or any spawn, fry or smolts thereof.*
  - *or injures or disturbs any spawning bed, bank shallow where such spawn of fry or smolts may be,.........* commits an offence with a maximum penalty of 12 months in jail and 635 fi ne may be imposed.
- Section 171 of the Fisheries (Consolidation) Act 1959 creates the offence of *throwing, emptying, permitting or causing to fall onto any waters deleterious matter. Deleterious matter* is defined as not only *as any substance* that *is liable* to injure fish but is also *liable* to injure their *spawning grounds or the food of any fish or to injure fish in their value as human food or to impair the usefulness of the bed and soil of any waters as spawning grounds or other capacity to produce the food of fish.*
- In addition to a maximum fine of €1,270 and six months imprisonment by the District Court, the full cost of the damage done and restoration is also chargeable against the offender – Section 10 of the Water Pollution Act 1977 (as amended by Section 7 of the Water Pollution Act 1990).
- Section 173 of the Fisheries Consolidation Act 1959 creates a number of offences which including that where any person:
  - *wilfully obstructs the passage of the smolts or fry of salmon, trout, or eels, or*
  - *injures or disturbs the spawn or fry of salmon, trout or eels, or*
  - *injures or disturbs any spawning bed, bank or shallow where the spawn or fry of salmon or trout or eels..........* Commits an offence as well as a penalty of €635 there is an additional provision *that any engine device used in the commission of the offence shall as a statutory consequence of conviction stand forfeit.*
- Fishery habitat protection has been further enhanced by other national and EU legislation including the provisions under the Freshwater Fish Directive and the Habitats Directive. The Planning and Development Act 2000 also affords an opportunity for the pro-active protection of fisheries and fisheries habitat.

Summary of Relevant Legislation

- The Fisheries (Consolidation) Act 1959 (as amended).
- The Fisheries (Amendment) Act 1999 (No. 35 of 1999).
- The Freshwater Fish Directive – *Council Directive on the quality of fresh waters needing protection or improvement in order to support fish life* (78/659/EC) as transposed into Irish law under the *E.C. (Quality of Salmonid Waters) Regulations 1988* (S.I. No. 293 of 1988).
- The Habitats Directive – *Council Directive on the conservation of the natural habitats of wild fauna and flora* (92/43/EEC) as transposed into Irish law under the *E. C. (Natural Habitats Regulations 1997* (S.I. No. 94 of 1997).
- The Local Government (Water Pollution) Act 1977 (as amended).
- The Local Government (Planning and Development) Act 2000 (No. 30 of 2000).

Note

Full text of the above legislation can be accessed at www.irlgov.ie

Eastern Regional Fisheries Board

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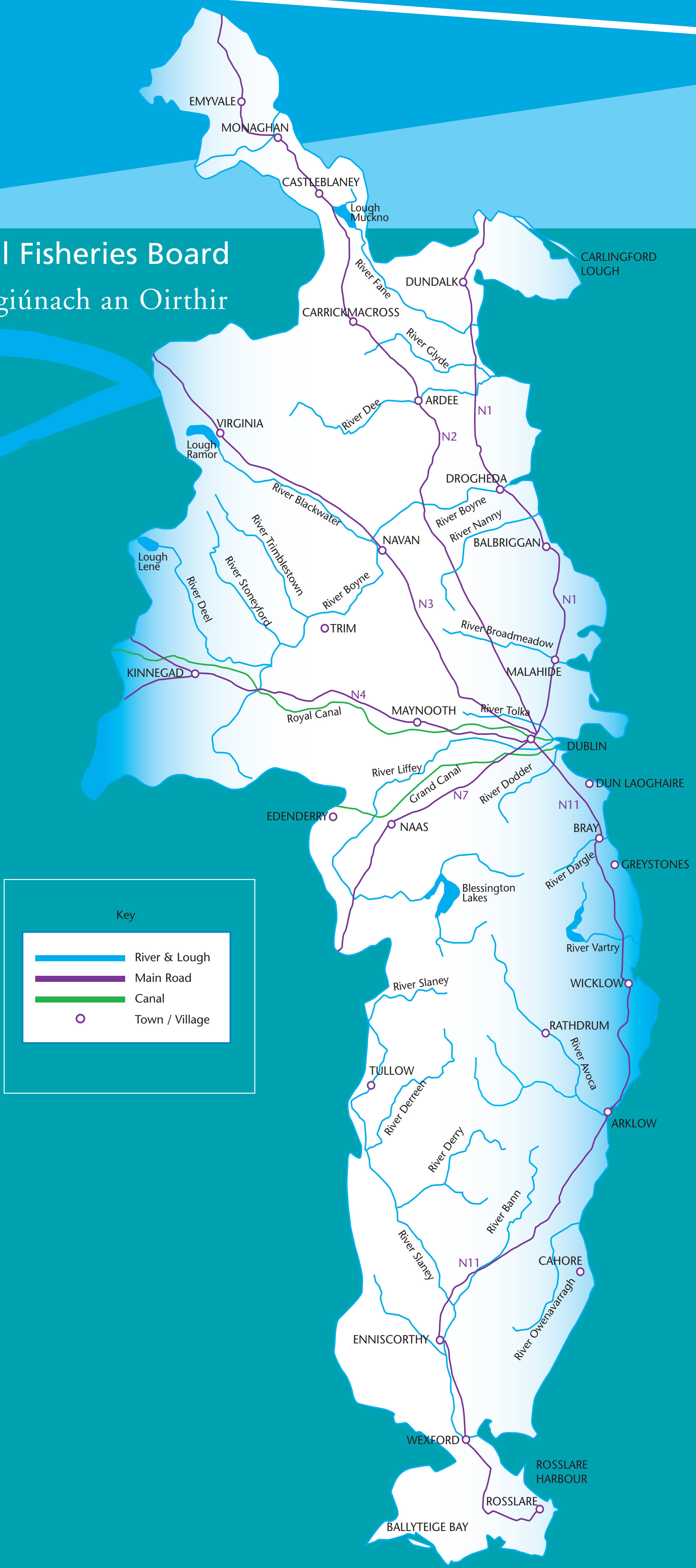
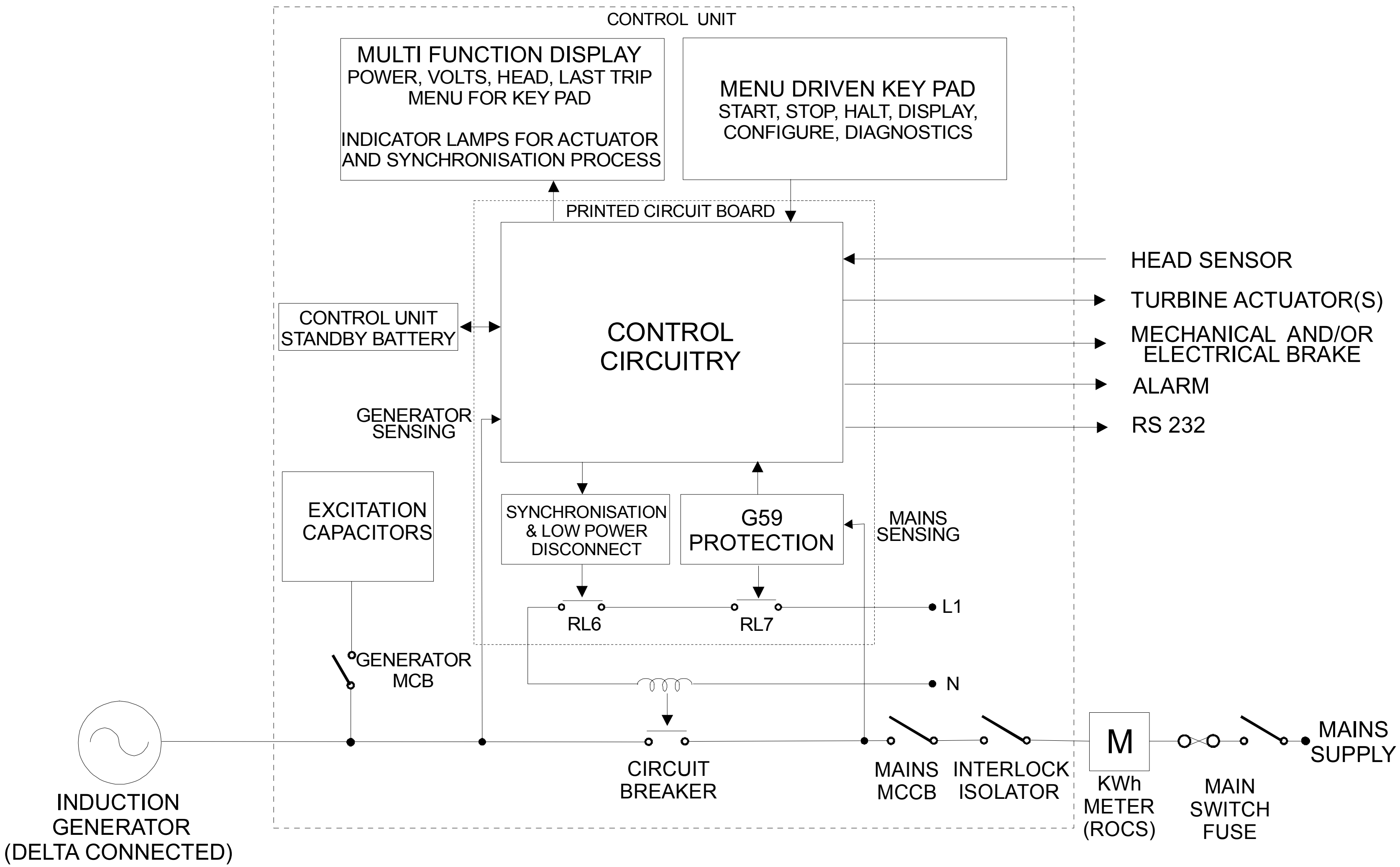


Fisheries Ireland
Our Natural Heritage

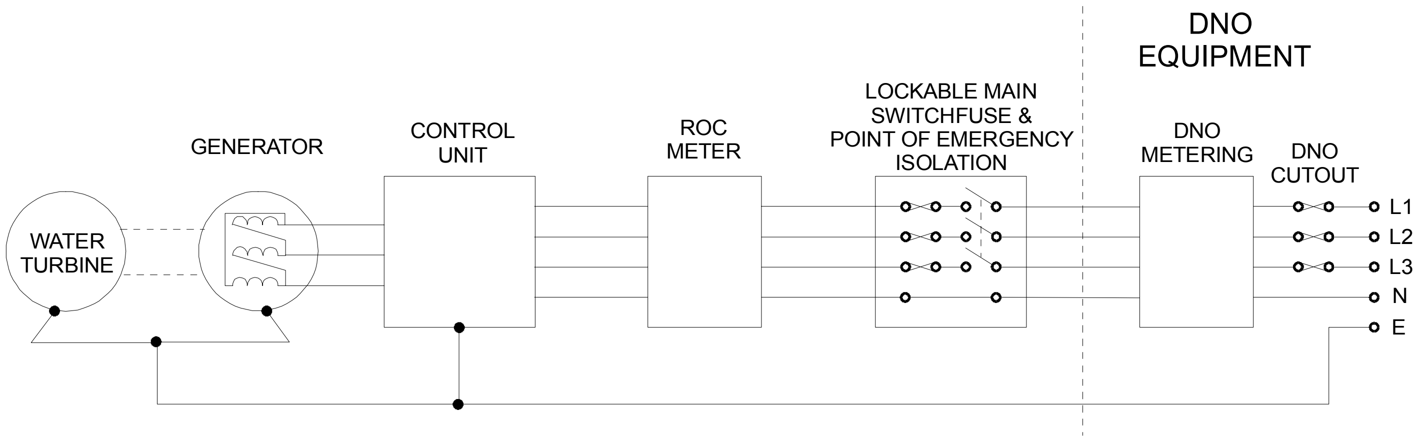
Appendix VII

CONTROL & PROTECTION SCHEMATIC DIAGRAM



Appendix VIII

EARTHING SCHEMATIC DIAGRAM



Form NC5A

ESB Networks *Serving all electricity customers*

For Official Use Only
Notification No:
MPRN:

APPLICATION FOR A NEW CONNECTION

EMBEDDED GENERATION FACILITIES

INTRODUCTION

This application form outlines the information ESB Networks requires Ltd. to progress an application for connection to the Electricity Distribution System. All applications must comply with the Distribution Code, and ESB'S Conditions Governing Connection to the Distribution System. These can be found on our website, www.esb.ie/esbnetworks.

Please note that this application form only deals with LV (230/400V), 10kV, 20kV, 38kV and in some cases, 110kV connections. If a higher connection voltage is required the applicant should contact the Customer Relations Team in EirGrid, Tel: +353 1 702 6642, info@eirgrid.com.

ESB Networks Ltd. reserves the right to request additional data if necessary and the applicant should provide such information promptly during and post the offer process.

It is ESB Networks' Ltd. responsibility to determine distribution connection method. If the applicant has a specific request this will be considered and examined in this process. The selected method will be based on the overall least cost technically acceptable solution **unless the Applicant requests otherwise or ESB Networks Ltd requires an alternative method for system reasons.**

This application form must be submitted in both **paper and electronic format** (eg. on CD). **Applications sent via email will not be accepted.** All electronic files should be approximately 2 MB or less.

Any accompanying drawings must be on A3 sized paper at <u>most.</u>

Definitions of terms used in this form can be found in the glossary of the Distribution Code.

When the application form is <u>fully</u> completed please send the form and all relevant documentation to:

Generator Application
ESB Networks Ltd
P.O. Box 29
Garrycastle
Athlone
Co. Westmeath

If any queries arise ESB Networks Ltd. can be contacted at 1850 372 757, or DSOgenerators@esb.ie

Please note that in accordance with the CER direction CER06145 some information from your completed application form will be published on the EirGrid website. The direction can be found on the CER website, http://www.cer.ie

Form NC5 should be used where an applicant considers their application is eligible for processing outside of the Group Processing Approach (GPA). Form NC5A is a shortened version of this form and may be used where the applicant considers their application will be processed inside the GPA. For more detail on which is the most suitable form please refer to our web-site www.esb.ie/esbnetworks

ALL APPLICANTS

Applicant Details:	1. Full name of the applicant: Toormakeady Sustainable Energy Community [if a company or Partnership give full Corporate or Trading Name]
	2. Address of the applicant: Toormakeady Co. Mayo [in the case of a body corporate, the registered or principal office] Full address of legal applicant required Company registration number required
	3. Telephone Number: 087 055 6630
	4. Fax Number:
	5. Email Address:
	6. Contact Person: Yvonne Finn Michael Hegarty Contact Name and Address and phone number and email required if different to the above
Site Details:	7. Site Name: Gortfree 1
	8. Site Address: Gortfree Toormakeady Co. Mayo
	9. Site Planning Permission Status: None as yet
	10. Planning Reference No.:
	11. Site Substation Co-ordinates: Easting: X508587 Northing: Y768643
General Details:	12. Projected Start-Up Date: 2020 (month and year)
	13. Target Connection Date: 2020 (month and year)
	14. Generation Export Capacity Required (MW): 0.05
	15. This project is an extension ☐ Yes ☑ No
	If "yes" please provide the existing project name
Generator Application Fees: **Details can be found in Generator Connections**	16. Please note that a deposit of 7,000 (incl VAT @21.5%) which is part of the application fee or the full application fee if the total application fee amount is less (both non-refundable) must accompany the application. Please visit our website www.esb.ie/esbnetworks for more information. Details can be found in Generator Connections Section. Payment should be made by cheque, postal order or bank draft only payable to "ESB Networks Ltd". Applications submitted without this fee will be returned. Noted * ☑
Maps and Diagrams:	**Please provide both paper and electronic copy of the following :** 17. A 1:50,000 "Discovery Series" Ordnance Survey map, with the location of the facility clearly marked with an "X". 18. A plan of the site (in an appropriate scale) of the proposed facility, indicating the proposed location of the connection point, generators, transformers, site buildings etc. 19. A draft electrical single line diagram of the proposed facility detailing all significant items of plant and their values including: -Relevant Voltage Levels -Interlocking -Earthing and Synchronising Arrangements -Relay Types -CT/VT ratios -Generator Transformer(s) -Power Factor Correction -Location of Alternative Connections (e.g. house load) -Network Connecting Transformer(s) (if applicable) Please note: we will not be able to process your application without these maps/diagrams
Site Load Data:	20. Maximum Import Capacity Required (kVA):

Independence of Contiguous Wind Farms	A Wind Farm Power Station will be deemed to be unrelated to and independent of the other Wind Farm Power Stations already present in a Contiguous Wind Farm Site ("Independent Wind Farm Power Station") if: • the Applicant, where a body corporate, is not a related undertaking of another Wind Farm Power Station already present in the Contiguous Wind Farm Site or in respect of which an application for a Connection Agreement has been made to the DSO or the TSO; • no person or body corporate holding 50% or more of the equity or voting rights in the Applicant is a person connected with any person or body corporate holding 50% or more of the equity or voting rights in another Wind Farm Power Station present in the Contiguous Wind Farm Site ("Connected Person").
	21. The Wind Farm Power Station is/will be independent from Contiguous Wind Farms
	☐ Yes ☐ No

Landowner Consent Confirmation:

1. Mobile ______________________ 2. Landline ______________________

I (Name in Block Capitals) ______________________

Position ______________________
on Behalf of (Company Name in Block Capitals as specified in Applicant Details of this application form)

____

confirm that all necessary landowner consents are in place for the substation at the coordinates as specified in Site Details of this application form and the generation site.

Signed ______________________ Date ______________________

and witnessed
by Solicitor (Name in Block Capitals) ______________________

Date ______________________

Solicitors Address ______________________

Please note the application will be returned to the applicant if submitted without a **solicitor's stamp**.

<table>
<tr><td rowspan="7">Signature of Applicants:</td><td>I/We accept ESB's General Conditions relating to the connection and all amendments, which ESB may make from time to time. I/We agree to grant ESB Networks Ltd. all necessary access to bring the network to the premises. I/We acknowledge that ESB shall be entitled to connect other customers to the network.</td></tr>
<tr><td>Signature of Applicant ______________________ Date: __________

If signing on behalf of a Partnership, Limited Company, or other Legal Entity, or as a duly Authorised Agent.</td></tr>
<tr><td>Full Name (BLOCKS): ______________________ Capacity: __________

[ESB Networks Ltd. may require the signatory to produce evidence of authority to bind the applicant by his/her signature].
Signature of Witness: ______________________ Date: __________</td></tr>
<tr><td>Address of Witness:</td></tr>
<tr><td></td></tr>
<tr><td>Note: ESB Networks Ltd. reserves the right to request additional data if necessary and the applicant agrees to provide such information promptly. The connecting party will be required at the relevant time to comply with Connection Agreement and the Distribution Code and provide information in accordance with these documents. ESB Networks Ltd. regrets it cannot accept responsibility for delays or mistakes if this application is completed incorrectly. If this application is incomplete the form will be returned to you.</td></tr>
</table>

Appendix X

Specification for the Building of the Intake and Turbine House at Toormakeady, Co. Mayo

1.0 PRELIMINARIES

1.1 Contractor to examine drawings and visit site

The Contractor tendering will be deemed to have made a thorough examination of the Drawings and Specification, the site and all features thereof with all drains, mains, adjoining premises or other matter affecting in any way the proposed works. The Contractor will be deemed to have ascertained for himself the nature and extent of the work to be carried out, the conditions under which it is to be executed, levels of the ground and facilities for delivery and storage of materials, plant etc., and to have generally obtained his own information in all matters and incidentals which could in any way influence his tender.

1.2 Satisfaction of works

The work is to be executed under the Supervision, control and to the entire satisfaction of the Engineer/Architect, and the Contractor shall give due and proper notice to the Architect and await his inspection before executing foundation or any work connected with drainage, or otherwise covering up works or proceeding with works about which there is any doubt or difficulty.

1.3 Safety Precautions

The Contractor shall take all necessary precautions for the safety of the workers and shall comply with the provisions of the current Building (safety, Health and Welfare) Regulations.

1.5 Protect

The Contractor is to permit nothing to be done calculated to injure the stability of the work or building or adjoining buildings, and no cutting through walls or floors is to be allowed, other than where required by the drawings or Specification therein without sanction of the Engineer/Architect, and the Contractor will be held responsible for all damage arising through carelessness or inadvertence in this respect.

Providing for the proper protection of water mains, gas mains sewers and other underground services, against damage by the movement of plant, vehicles or workers during the building operations. Cover trenches with hard dry material, steel chequer plates or other approved method.

1.6 Generally

The whole of the works are to be carried out in a good and workmanlike manner to the full intent and meaning of the drawings and standard, and all materials, workmanship etc., are to be of the respective kinds described in this Specification, and in accordance with the Conditions of Contract and for minor works and all to the satisfaction of the Architect.

1.7 Procedure of Work

The work shall be commenced when directed by the Engineer/Architect and shall be carried out with due diligence and with such expedition as, in the opinion of the Engineer/Architect, may be considered necessary to ensure its completion within the Contract period.

The Contractor shall submit a progress schedule for the engineer/Architect's approval within 14 days of his receipt of the order to commence, setting out a building programme.

1.8 Temporary Fence

The Contractor shall be deemed to have visited the site and examined the existing building and its surroundings, fencing etc., in order to ascertain their nature, and the extent of the work involved in their retention where shown and their removal where necessary.

1.9 Contingency Sum and Variations

Any oral instructions, directions and explanations given by the Engineer/Architect or his agent shall, if involving a variation, shall be confirmed in writing by the Contractor to the Architect within five (5) working days. If not dissented from in writing by the Engineer/Architect within five working days from the date of receipt of the written confirmation from the Contractor the variation shall be deemed to be authorised in writing. All variations ordered or authorised by the Engineer/Architect in writing or subsequently sanctioned by him in writing shall be measured and valued without undue delay by the Quantity Surveyor who shall give to the Contractor or his representative opportunity to be present with him on the works at the time and to take such notes and measurements as the Contractor may require.

2.0 EXCAVATION AND EARTHWORK

1. The Contractor shall employ only that plant which is suited to the soils to be handled. He shall not at any time use any plant which damages or reduces the natural strength of the soil either in its in-situ state or during handling and placing or in its final compacted state.
2. Any fill material used within 500 mm of concrete structures or cement bound materials shall have a soluble sulphate content not exceeding 2.5 9 per litre when tested in accordance with Test 10 of BS 1377, unless special precautions to the approval of the Engineer are taken to protect the concrete or cement bound materials.
3. The use of topsoil shall be restricted to surface layers.
4. No excavated suitable material other than surplus to requirements of the Contract shall be removed from the Site except on the direction or with the permission of the Engineer who may require material which is unsuitable only by reason of being frozen to be retained on Site when in that condition. Should the Contractor be permitted to remove suitable material from the Site to suit his operational procedure, then he shall make good any consequent deficit or filling arising therefrom.

5. If any suitable material excavated from within the Site is, with the permission of the Engineer, taken by the Contractor for purposes other than forming of embankments and other areas of fill, sufficient suitable filling material to occupy after full compaction a volume corresponding to that which the excavated material occupied shall, unless otherwise directed ‘by the Engineer, be provided by the Contractor from his own resources.
6. All unsuitable material shall, unless the Engineer permits otherwise, be run to spoil in tips provided by the Contractor.
7. Topsoil surplus to the total requirements of the Works shall not be disposed of without the Engineer’s permission.
8. The Contractor shall arrange for the rapid dispersal of water shed on to the earthworks or completed formation during construction, or which enters the earthworks from any source, and, where practicable, the water shall be discharged into the permanent outfall. Adequate means for trapping silt shall be provided on temporary systems discharging into permanent drainage systems. The arrangements shall be made in respect of all earthworks including excavations whether for pipe trenches, foundations or cuttings.
9. The Contractor shall provide, where necessary, temporary water courses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provision shall include carrying out the work of forming the cuttings and embankments in such a manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, sufficient longitudinal gradient to enable them to shed water and prevent ponding.
10. Excavations carried out in the diversion, enlargement, deepening or straightening of watercourses shall include the operations of any necessary trimming of slopes, grading of beds, disposal of excavated materials and pumping, timbering works and materials necessary for dealing with the flow of water.

3.0 DRAINAGE

3.1 Workmanship

All work to drains shall comply with SI 46 1951 for drainage.

3.2 Trenches

Excavate for all trenches to drains and for full width of bedding under to such depths as to allow for fall in drains. Consolidate bottoms, make good with hardcore, and will ram any soft places.

4.0 CONCRETE WORKS

4.1 Cement

The whole of the cement used in the construction of the works shall be of an approved brand, and shall comply with the provisions of I.S. EN 197-1:2002 for Portland Cement (normal setting).

All cement shall be in the original sealed packages of the manufacturers, each containing the same weight of cement. Each bag shall show the makers name, the type of cement and the consignment number. Each consignment shall be accompanied by a Certificate of Quality.

4.2 Aggregates

All fine sand aggregates and coarse aggregate shall be washed and well graded and conform to I.S. EN 12620: 2003, for coarse and fine aggregates from natural sources. Run of pit material will not be permitted for any reinforced or precast concrete work.

4.3 Mixing Water

The mixing water shall comply with BS EN 1008

4.4 Rejected Materials

All materials which have been damaged, contaminated, have deteriorated or do not comply with the requirements of this Specification, shall be rejected, and shall be removed immediately from this site.

4.5 Gauging and Mixing

Quantities of cement shall be measured by weight, the unit being one bag of 50 kg., and the constitution of each batch shall be such that the cement required per batch is in the units of 50 kg.

Aggregates for concrete shall be measured by weight in an approved weigh batching mixing plant.

All proportioning must be carried out in such a manner that the proportions of the materials may be easily and readily checked. The batches of concrete shall be proportions to the size of the mixer, to produce the best results. The entire contents of the hopper to be completely discharged each time a batch is mixed.

No concrete shall be mixed for more than one half hour, shall on any account be placed in permanent work without the sanction of the Architect. The cement and aggregate shall be mixed in an approved mechanical batch mixer. Mixing shall continue until the mix is uniform in texture but in any event for not less than two minutes.

Water shall be added only after the drum is fully charged with other materials. the volume of mixed materials shall not exceed the rated capacity of the mixer drum. the entire contents of the mixer shall be washed out thoroughly whenever work ceases which includes meal breaks.

4.6 “Ready Mixed” Concrete

“Ready Mixed” concrete from an approved supplier may be used provided it is equal in all respects to the concrete specification for the works, and complies with I.S. EN 206-1:2002.

4.7 Concrete Mixes

The water-cement ratio shall be kept to the minimum needed to ensure reasonable workability, but should not exceed 35 litres per 50kg of cement.

4.8 Compacting Concrete

The whole of the concrete shall be thoroughly compacted during the operation of placing, and be well packed around embedded fixtures and into corners of the formwork. All necessary rammers and spatulas shall be provided and employed to ensure compact and smooth faced work throughout.

4.9 Cold Weather

No concrete of any kind shall be placed during a falling tempreature of 4^{o} C or less or until after the rising temperature exceeds 1^{o} C. When depositing concrete at or near freezing temperatures, approved precautions shall be taken to ensure that the temperature of the concrete is maintained at above 4.5^{o} C, until it has thoroughly hardened. All concrete damaged by frost shall be removed and replaced by the Contractor.

4.10 Surface Finishes

The operation of compacting the concrete shall be conducted so as to form a compact, dense, impervious concrete which shall show a smooth face on all exposed surfaces.

4.11 Foundations

Foundations shall be to the sizes shown on drawings. Care is to be taken in depositing concrete in foundations to ensure that it is rammed closely against the face of the trenches in order that there may be no subsequent settlement or disturbance of the ground.

5.0 BLOCKWORK

5.1 Rising Walls

The external walls of the turbine house are to be 225mm thick and constructed with hollow block.

5.2 Chases

Form or leave all bonding chases, grooves for flashing, door, window and vent opes etc., holes for passage of steel beams at floor level to TBM on site and electrical supplies.

5.3 Damp Proof Courses

The damp proof courses shall comply with BS 743 1970. damp proof course to be laid on a bed of mortar on all external walls and lapped 150mm at junctions.

5.4 D.P.C. Over Lintols

A damp proof course is to be provided in external walls over door and window opes, to be bedded into blockwork a minimum of 225 mm over the top of the lintol and project a minimum of 25mm between abutting lintols of inner and outer leaf. D.P.C. to project a minimum of 150mm beyond lintol ends.

5.5 Vertical D.P.C.

Fix damp proof course, minimum 150mm wide to jambs of all windows and door opes, to be placed as blockwork proceeds between cavity block closer and outer leaf.

5.6 D.P.C. Under Cills

The damp proof course under cills to be returned at back of cills to the full height of the cill ends and to project minimum 25mm beyond face of the external blockwork.

6.0 ROOFING

6.1 Wallplates

Wallplates 44 x 75mm to be fully bedded on top course of blockwork, to be halved at angles and to be bolted down to two courses of eaves blockwork with wrought iron rag bolts 12mm diameter at 1200 centres.

6.2 Roof Timbers

Rafters shall be 50 x 150mm joists at 400 mm centres securely fixed to wall plate at eaves and fully bedded on party wall to adjoining property, spiked to ridge. Trimming rafters shall be 44 x 75mm. Ceiling (collar) joists to be 35 x 150mm at 400mm centres, spiked to rafters and built into party wall.

6.3 Eaves

Fascia 32 x 225mm wrought deal, pressure treated and secured to joist ends.

6.4 Roof deck

The roof deck shall be of 12 mm WBP ply, felted and battened for slating.

6.5 Roof Finish

The roof finish shall be of slates.

Appendix XI
Water Power Services
13 Marlborough Rd Dublin
D04 XV65

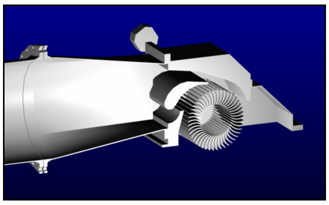
No.	Description	Unit	Quantity	Rate	Price
1	Establishment costs	item	1	€3,000.00	€3,000.00
2	Insurances	item	1	€1,500.00	€1,500.00
3	Extend Farm Roads for access incl geotextile and 0.5 m gravel	item	1	€1,000.00	€1,000.00
4	Clear scrub along pipeline route	m^2	1000	€5.00	€5,000.00
5	Excavate 600 x 1 x 1.5 metre trench for pipeline	m^3	900	€20.00	€18,000.00
6	Blinding to trench	m^3	200	€20.00	€4,000.00
7	Lay 600 metres of 0.6 dia pipe in 100 No 6 metre lengths	no.	100	€40.00	€4,000.00
8	Backfill trench with excavated material	m^3	600	€5.00	€3,000.00
9	Excave for intake	m^3	40	€20.00	€800.00
10	Excavate for turbine house	m^3	50	€20.00	€1,000.00
11	Bedding for pipe	m^3	200	€20.00	€4,000.00
12	Supply, place and compact lean mix blinding concrete at intake	m^3	10	€100.00	€1,000.00
13	Supply, place and compact lean mix blinding concrete in pit	m^3	10	€100.00	€1,000.00
14	Reinforced concrete 200mm thick unshuttered	m^2	0	€70.00	€0.00
15	Reinforced concrete 300mm thick unshuttered	m^2	13	€80.00	€1,040.00
16	Reinforced concrete 200mm thick shuttered one side	m^2	0	€60.00	€0.00
17	Reinforced concrete 300mm thick shuttered one side	m^2	0	€120.00	€0.00

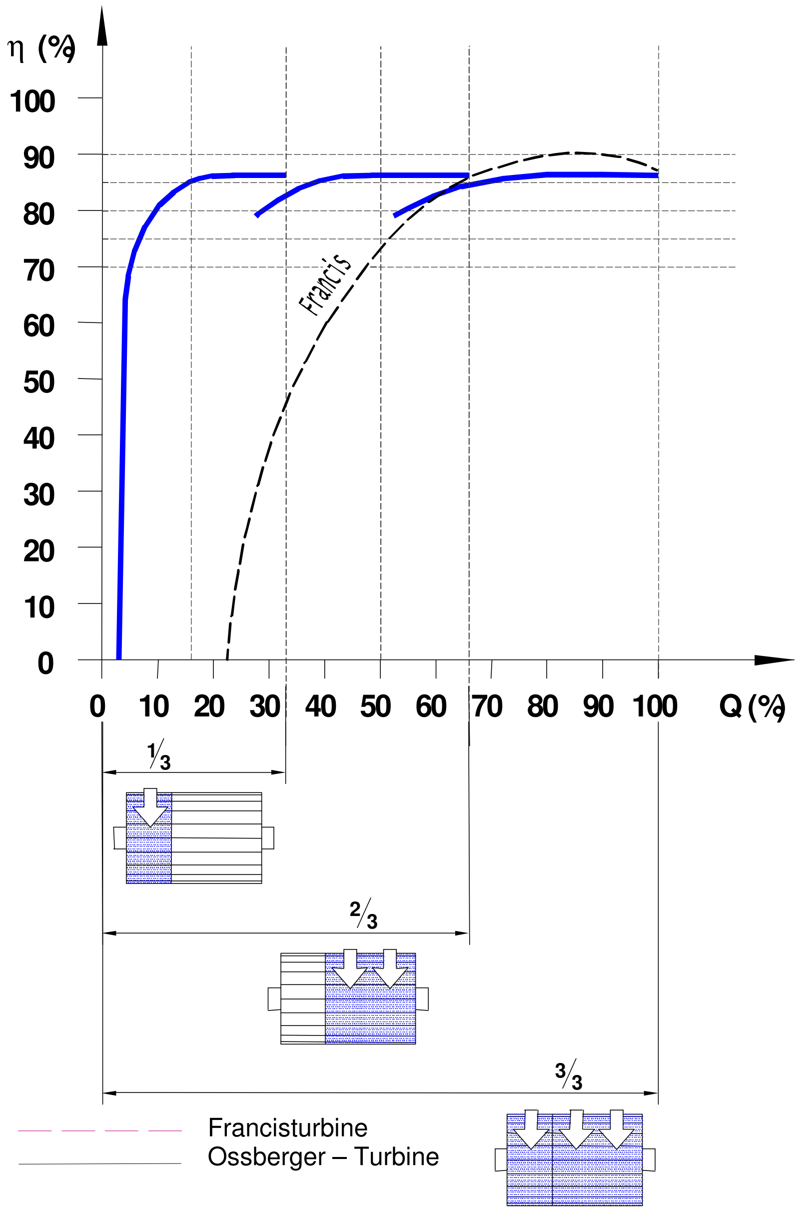
18	Reinforced concrete 300mm thick shuttered both sides	m^2	20	€150.00	€3,000.00
19	Concrete CEMII C30/35 (50% GGBS)	m^3	31	€70.00	€2,170.00
20	Grouting	m^3	3	€70.00	€210.00
21	Form rebate for baffle boards	no.	4	€50.00	€200.00
22	Trim and scabble concrete to form joint	m^3	5	€40.00	€200.00
23	Testing pipe	item	1	€1,000.00	€1,000.00
24	Supply, place and compact clause 804 in 300mm thick layers	m^2	60	€30.00	€1,800.00
25	215 hollowblock turbine house	m^2	70	€40.00	€2,800.00
26	Plaster to turbine house	m^2	130	€20.00	€2,600.00
27	Machinery floor to turbine house	item	0	€1,000.00	€0.00
28	Roof to turbine house	item	1	€6,000.00	€6,000.00
29	Door to turbine house	item	1	€1,500.00	€1,500.00
30	Trash Rack	item	1	€2,000.00	€2,000.00
	Sub total				€71,820.00
	Vat. @ 13.5%			€9,695.70	€9,695.70
	Total				€81,515.70

Good reasons for the Ossberger®-Turbine

- **Turbine:**

We shall gladly be prepared to show you our test stand on the occasion of a visit to our works. You will then get an own idea of our permanent research and development on the original OSSBERGER Turbine. As soon as the results obtained will be concrete and well tested, they will be referred to for our manufacture.





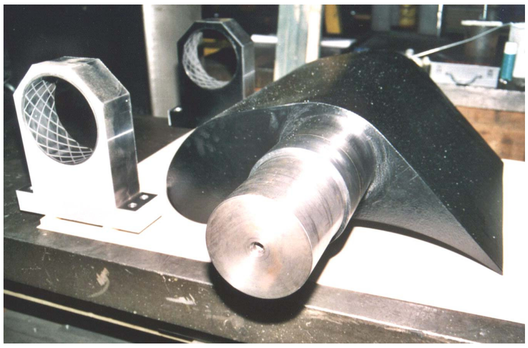
Efficiency characteristic of an OSSBERGER-Turbine compared with the Francis turbine at different admission

Your advantage:

⇒ The machine is particularly outstanding compared with imitated cross-flow turbines concerning operating and regulating behaviour as well as efficiency curve and level.

- ## Guide Vanes:

The subdivided guide vanes provide a flat efficiency curve, they need to direct the water for a jerk-free entry into the runner. As the manufacture of cast guide vanes would demand too large tolerances calibrated profiled guide vanes are referred to. Both guide vanes can be set up independently, they can easily be dismounted towards the radial direction without special tools, the corresponding forces are absorbed by maintenance-free friction bearings “brand Permaglide” with shaft protecting sleeves.



Your advantages:

⇒ No lubricants are admitted to the water
⇒ Seizing, e.g. due to negligent lubrication (e.g. in case of special steel shafts), is excluded
⇒ Only calibrated guide vanes allow for a hydraulically perfect forming; you may gladly look forward to an operation without cavitation with high efficiencies.

- ## Bearings:

The OSSBERGER turbine is equipped with standardised self-aligning roller bearings, designed for an infinite service life. The bearing casings and the bearing inserts can be considered as one unit, they are fixed in the turbine casing by a locating bunch. This will permit to dismount the runner radially without removing the bearing casings from the runner shaft. A simple readjustable gland packing arrangement with hemp tallow cord seals the shaft.

Your advantages:

⇒ No lubricants are admitted to the water
⇒ An exchange against standardised parts is possible without problems
⇒ Maintenance is limited to an annual change of grease
⇒ No monitoring of the bearing condition is required
⇒ The hemp tallow cord does not need to be lubricated.

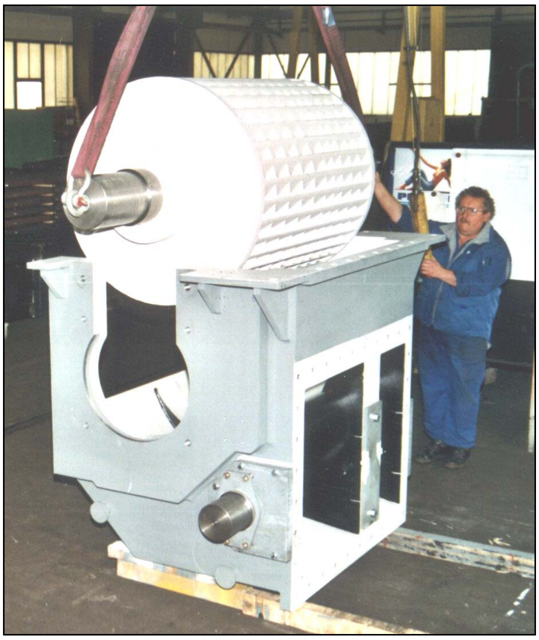
- ## Draft Tube:

The draft tube is essential for utilising the level difference between runner and downstream water level. During turbine operation the air in the casing is taken along with the discharged water. Thus a vacuum is formed; for the exterior atmospheric pressure the suction column rises. A simple venting valve which is free of own friction controls the vacuum in the turbine casing to utilise the energy potential optimally.

Your advantages:

⇒ No maintenance of the vent valve
⇒ Utilisation of the whole head which is available from the upstream to the downstream level.

• Runner:



The cylindrical runner core consists of conservatively designed cam disks and, following its width, several intermediate disks to which the profiled blades are adapted and welded. This will make the runner extremely solid by stiffening it at the same time in such a way that no vibrations are faced. The blades consisting of bright-drawn profiled steel mean an ideal solution regarding solidity and water guidance. By utilising the bright-drawn and exact blade profiles an ideal balance condition is achieved automatically, only slight corrections are required on the balancing machine. The blades bent in a linear way only do not produce any axial thrust, thus there is no need for pressure bearings. Another advantage of the flow guidance is that leaves, grass or snow, pressed between the blades when the water enters the runner, are spilled out again after a half turn by the leaving water, backed-up by the centrifugal force. Thus the self-cleaning runner is never obstructed.

Your advantages:

⇒ The runner can be dismounted without special tools nor additional axial space requirements
⇒ No axial thrust, consequently simple low-maintenance bearings
⇒ Smooth, vibration-free operation without cavitation
⇒ Self-cleaning effect, consequently no service costs due for cleaning personal nor stillstand periods
⇒ A high availability is decisive for the rentability of your investment.

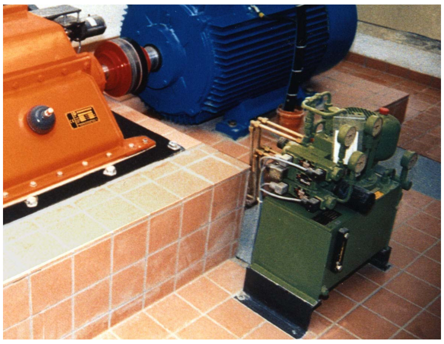
• Base Frame:

A stable base frame is provided between turbine and foundation, permitting a rapid and sure installation.

Your advantage:

⇒ Short time of erection
⇒ Maintenance and dismounting without special tools

● **Regulator:**



For an automatic operation of the machine unit and the turbine regulation in accordance with the water level an electro-hydraulic turbine controller has been foreseen. It is composed of a hydraulic unit and a control switchboard. Emergency stop in case of mains failure or generator switch release are made without any foreign energy through storage weights. The continuous water level registration by a depth gauge and the regulation which is continuous either mean a precondition for an almost constant upstream water level and thus an optimal utilisation of the existing flow. The computer capacity of the specially adapted regulator element has been overdimensioned and allows for an enlarged servicing and observance as well as for the necessary plain text display, and all this operator-controlled, at the device directly. No programming knowledge nor devices are necessary.

Your advantages:

⇒ Maximum annual production for a permanent registration and conversion of the level value
⇒ Easy mounting of the zinced sensor holder
⇒ Adjustments are made at the switchboard directly without auxiliary means
⇒ Industrial components of a long service life, no electronic elements of short lifetime
⇒ Minimum drive energy for the utilisation of a storage accumulator

● **Installation and commissioning:**

The proposed concept does not comprise any elements that need to be concreted in advance. In case of order you will be provided, apart from the plan of installation, with a plan of foundations which will enable you to prepare the site for a quick and trouble-free erection. The turbine and the base frame are lodged on the carriers laid in the primary concrete which is situated above the draft tube pit. Own bases have been foreseen for gearbox and generator. The fixation is made by means of foundation blocks.

Each plant is completely assembled prior to its dispatch and tested at the manufacturer's works. Thus it is ready for operation at site as soon as the erection work has been finished. The equipment is delivered as premounted units. Thus erection is limited to the exact alignment of the elastic couplings.

Your advantages:

⇒ Quick and consequently priceworthy erection
⇒ No demanding efforts for civil construction as only plain surfaces need to be
⇒ created.

Appendix XIII

Possible Cink Turbines

Toormakeady 2 looks like a small 2-cell Crossflow with a draft tube similar to a scheme near Glasgow. It would generate some 45 kW, i.e. about 40 kW at the generator. The whole set with controls (including remote monitoring via an internet connection) and everything as usual would cost about € 66,000. Shipping and commissioning would be about € 10,000.

Toormakeady 1 actually looks like an exact copy of Barrisdale Hydro (a recent 'Off Grid' scheme in Scottish Highlands), so the total price of the package would be about € 61,000 for a 2-cell Crossflow turbine making some 39 kW, or 35 kW at the generator. Shipping and commissioning would again be about € 10,000.

Regards

Jonathan Cox
Eur Ing C Eng B Eng (Hons) MEI FEANI
Erre Due UK Limited

We may also looking at making the turbines slightly larger. Can you outline a price for a 0.25 m3/sec on a 35 metre head and a 0.45 m3/sec on a 20 metre head. As the rainfall is high, it might be possible to justify the extra size.
Fiacc

Larger Turbines to be considered after measuring rivers

In such a case, Toormakeady 1 would cost about € 66,000 and it would generate about 70 kW of mechanical output, which means about 65 kW at the generator. The scope of supply would be similar to the previous budget quote. The shipping and commissioning would again be about € 10,000.

Toormakeady 2 (in this uprated version) would look very much like our UK scheme in Cumbria (Intake Side i.e. a 300mm runner diameter 2-cell Crossflow with draft tube, but much wider than Toormakeady 1) and it would cost about € 72,000. The turbine would make about 72 kW, and the generator – 66 kW.

Let me know, if you need anything else.

Best regards

Bc. Petr Koňata
Senior Sales & Marketing Manager

Appendix XIV

Hi Fiacc,

Many thanks again for this enquiry and I now detail out below the two options we discussed on our call.

Option one – Push Fit System with 630mm PVC-O Pipe
107 number pipes required at 5.61mtr lengths and the rate per pipe is €813.53 plus VAT at 23%. Included above is the relevant data sheet (attachment one)

Option two – Welded System with 630mm SDR17 (10 bar) PE Pipe
100 number pipes required at 6.0mtr lengths and the rate per pipe is €1,013.34 plus VAT at 23%. Included above is the relevant data sheet (attachment two)

Both of these options are readily available and could be delivered to site with 2-3 weeks from date of official order. I appreciate both are higher in terms of the operating pressure of 4 bar that you are looking for but these are the most economical way to provide you with the pipe size required as they are in general standard items. To produce a 4 bar pipe, it would require a special production run, and for 600mtrs it would not be cost effective and manufacturers won't set up a run for a low meterage volume.

As we discussed you can see there is significant savings with the PVC-O system and it does not require any specialists welding equipment that the PE system would.
That said both offer their own benefits and both will serve you very well in providing you with a secure system.

Once you've had time to review the above and attached give me a call and we can talk through in more detail.

Regards,

Keith Herbert | Director
Office: +353 (0) 1 4573900 | Mobile: +353 (0) 86 7816160 | Email: keith@total-pipeline.com
www.total-pipeline.com

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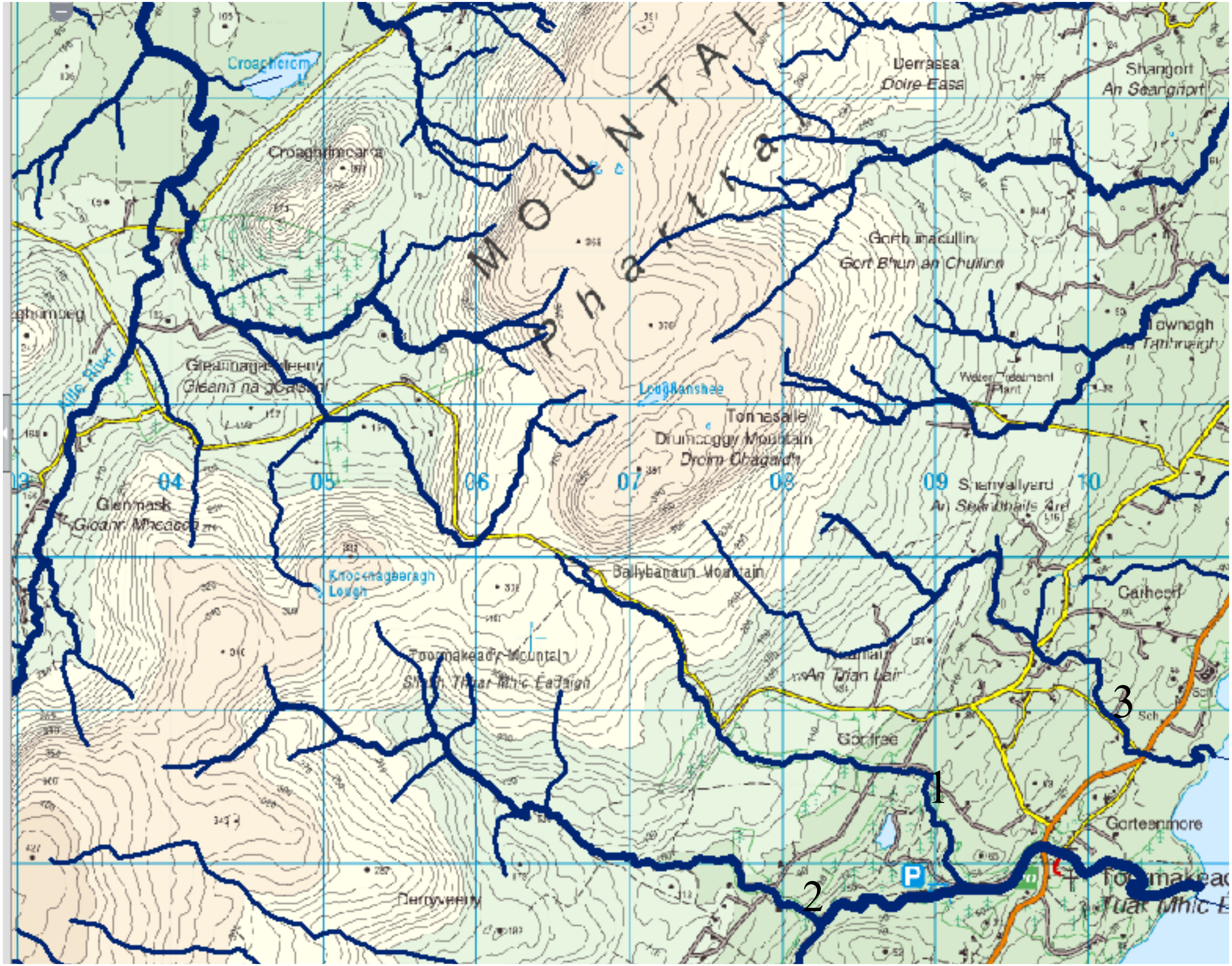
€145.01 per metre	= € 72,507	for 500 metres	Scheme 2 & 4
	= € 94,259	for 650 metres	Scheme 1
	= € 116,011	for 800 metres	Scheme 3



Derrassa
Doire Easa
Shangort
Croaghrimcarra
Glenmask
Aille River
Loughanshee
Tonnasalle
Drumcoggy Mountain
Droim Chagaidh
Water Treatment Plant
Shanvallyard
Knocknageeragh Lough
Ballybanaun Mountain
Toormakeady Mountain
Gortfree
Gorteenmore
Derryveeny
04
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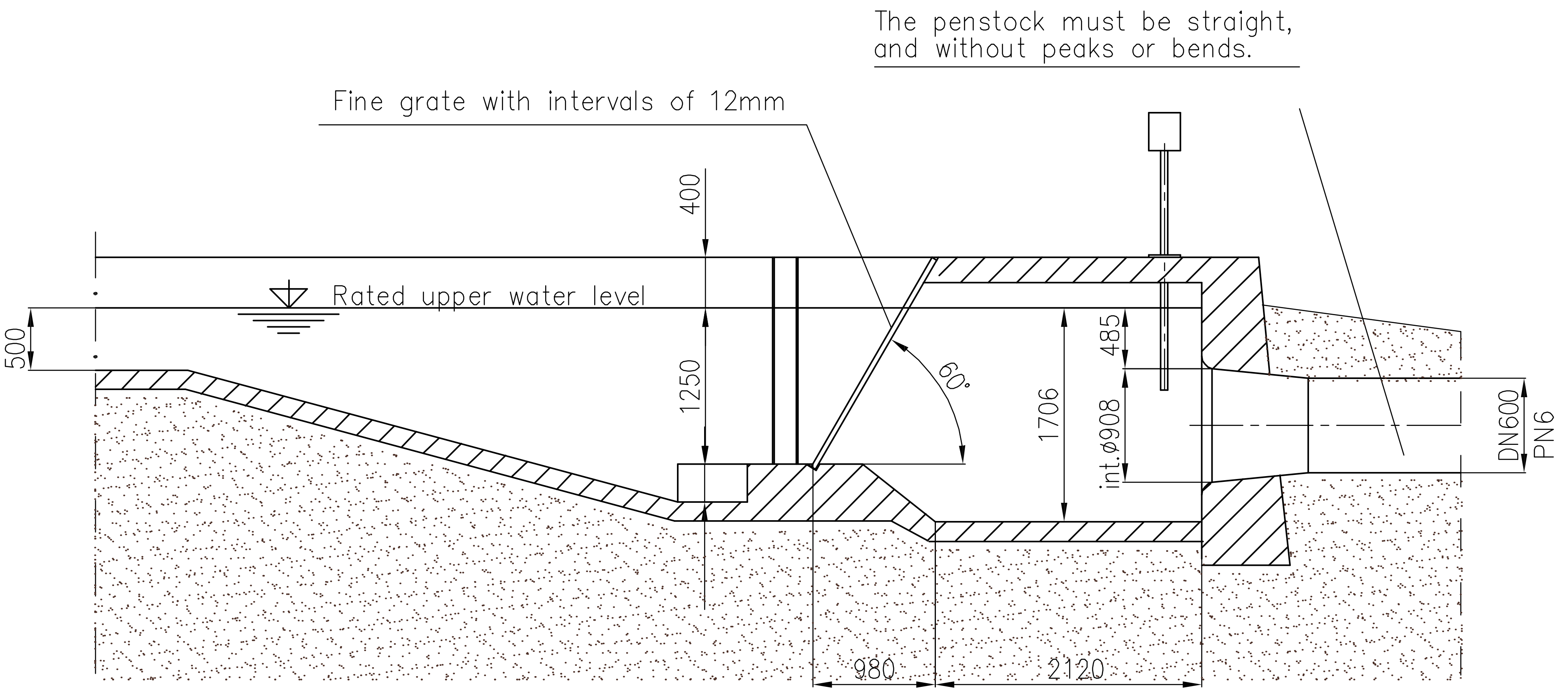
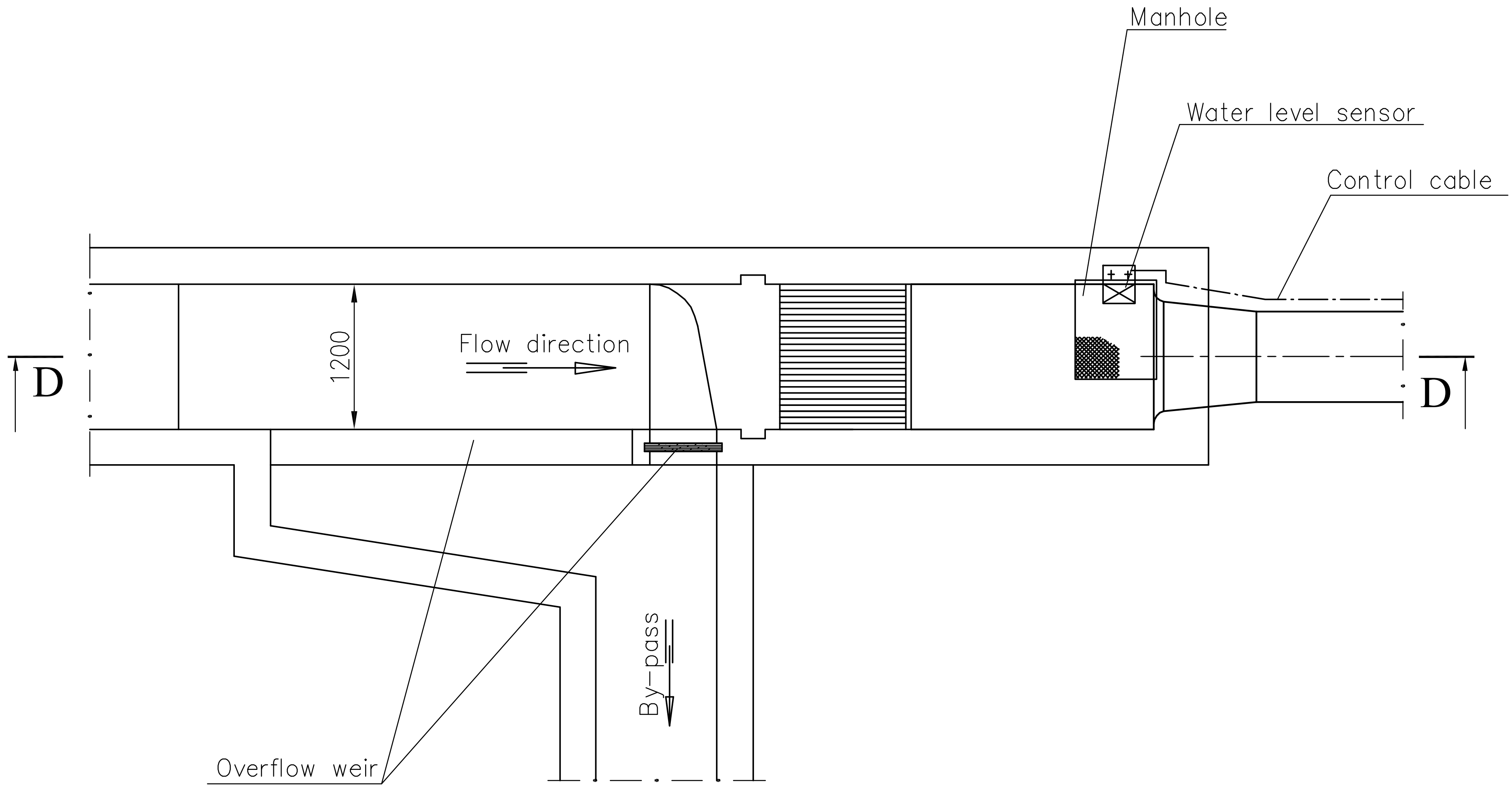
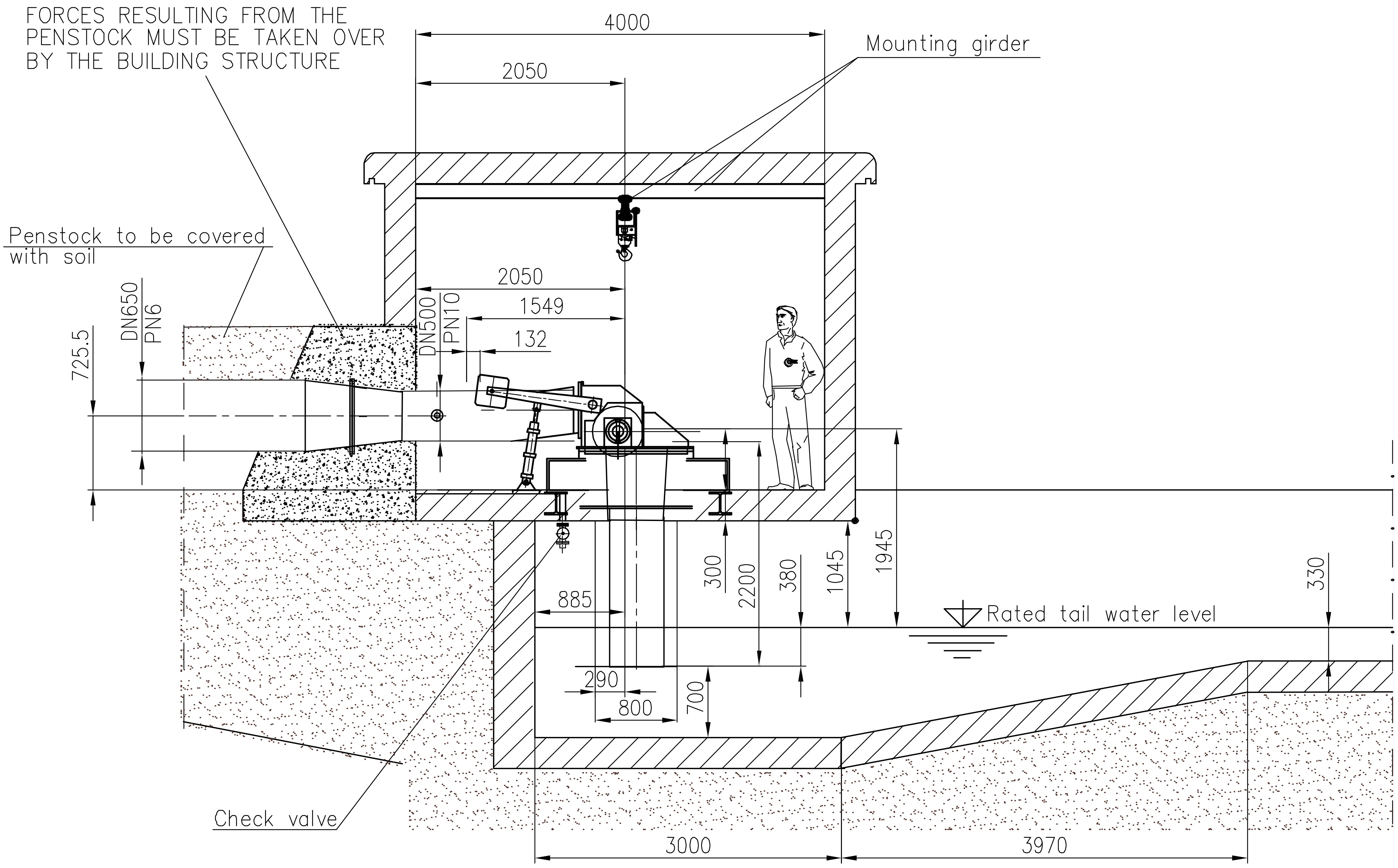


Section D - D

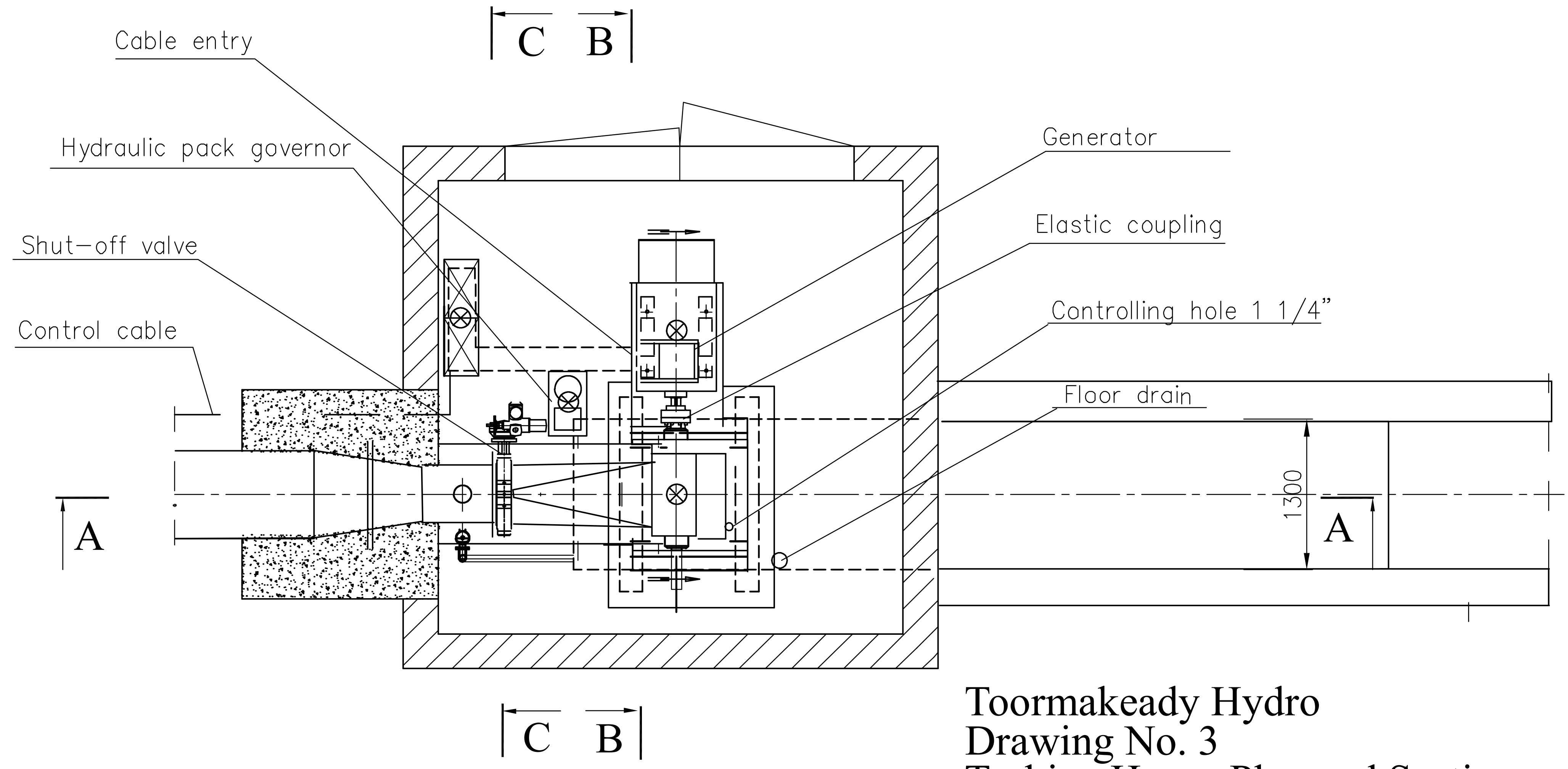


Plan of intake

Toormakeady Hydro
Drawing No. 2
Intake details Scale 1 :50
For Illustration only
February 2019
Water Power Services

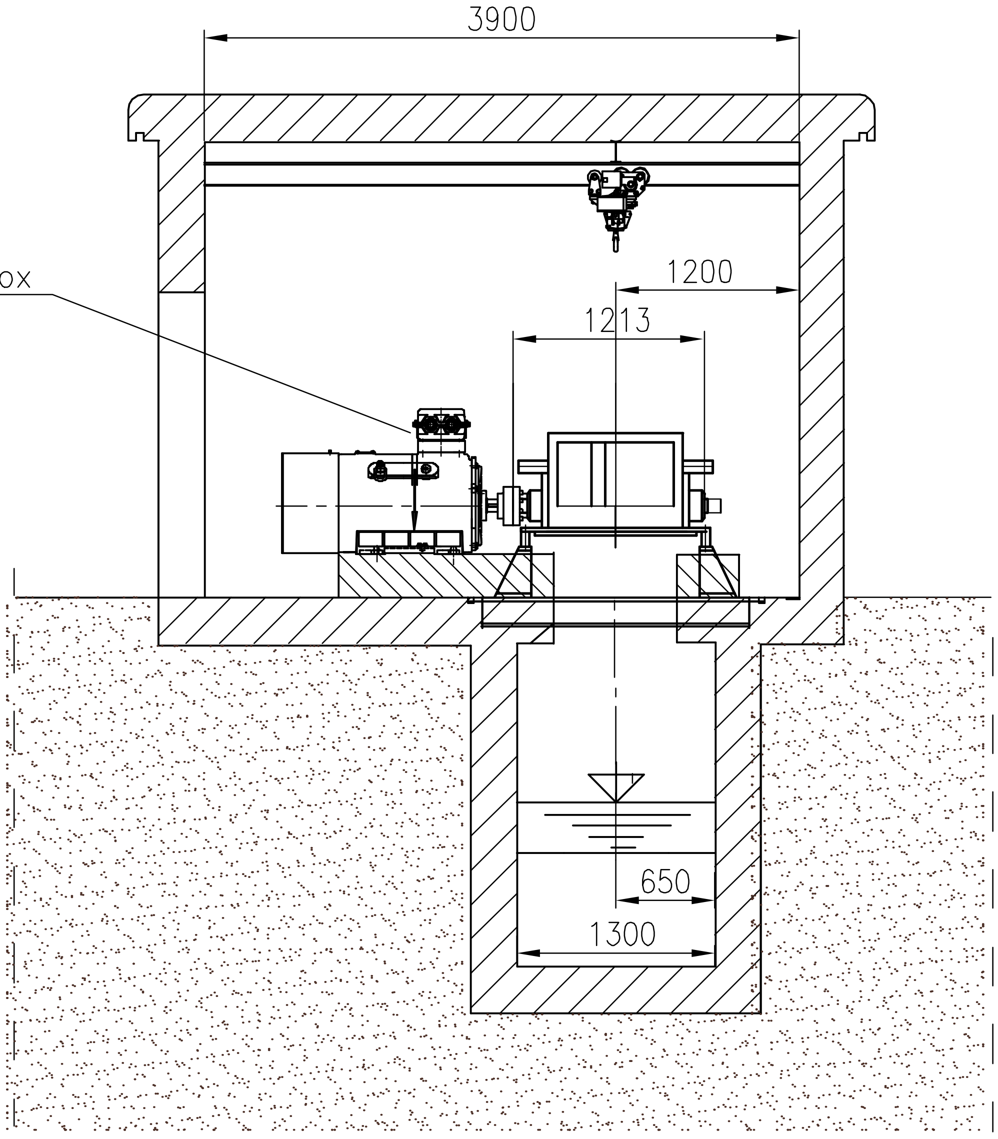


Section A - A

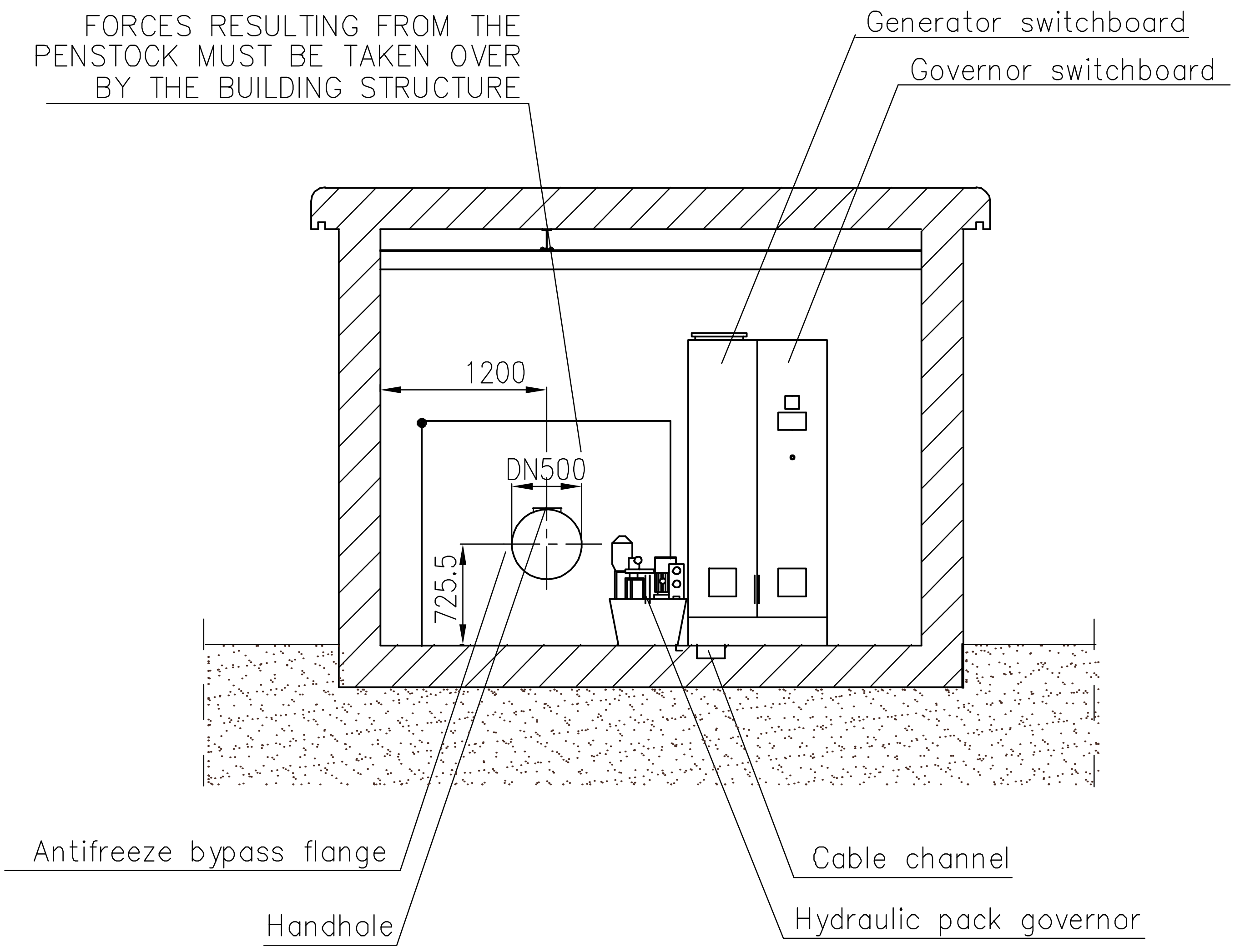


Plan

Toormakeady Hydro
Drawing No. 3
Turbine House Plan and Section
Scale 1 :50
For Illustration only
February 2019
Water Power Services

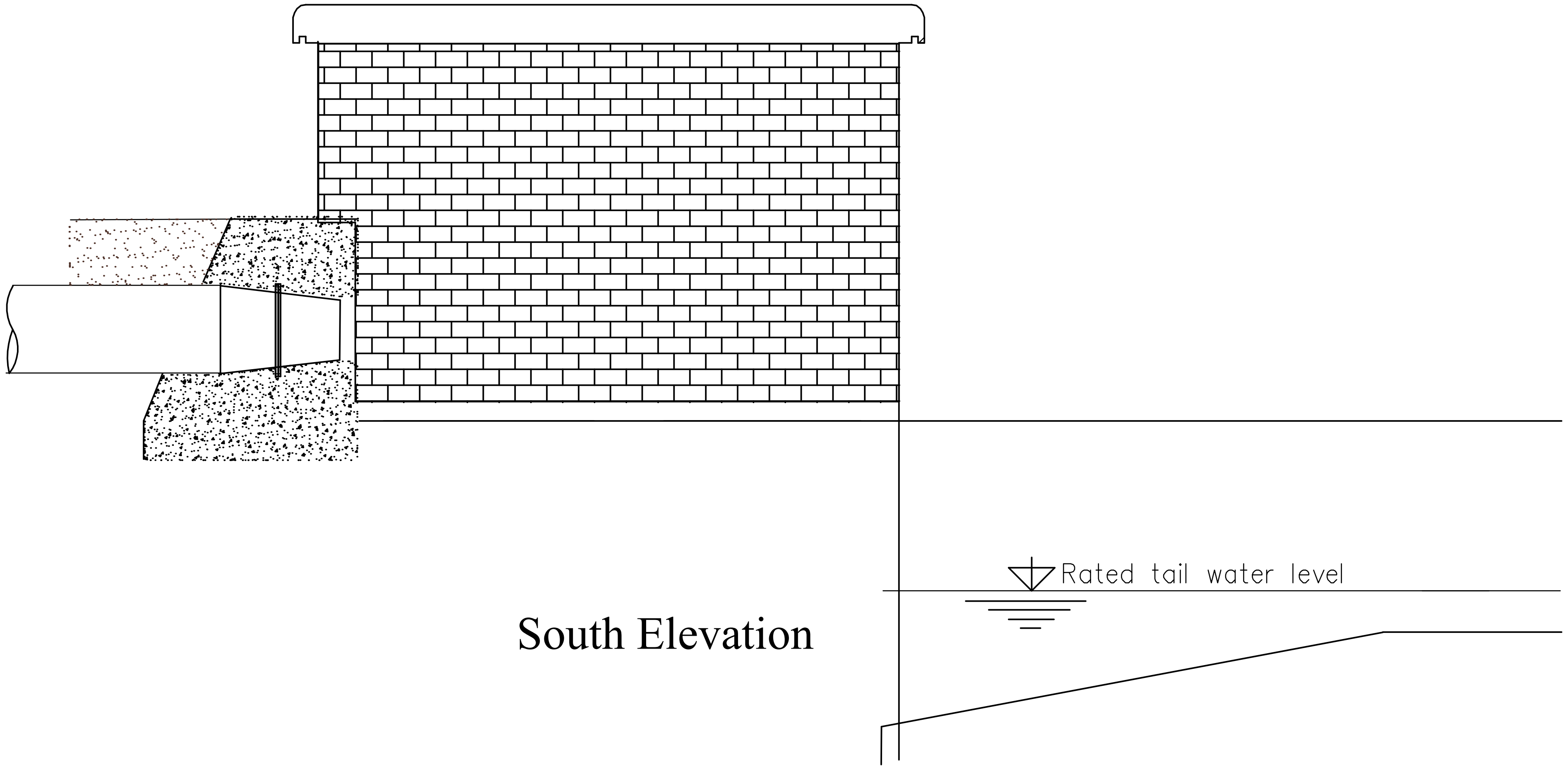


Section B - B

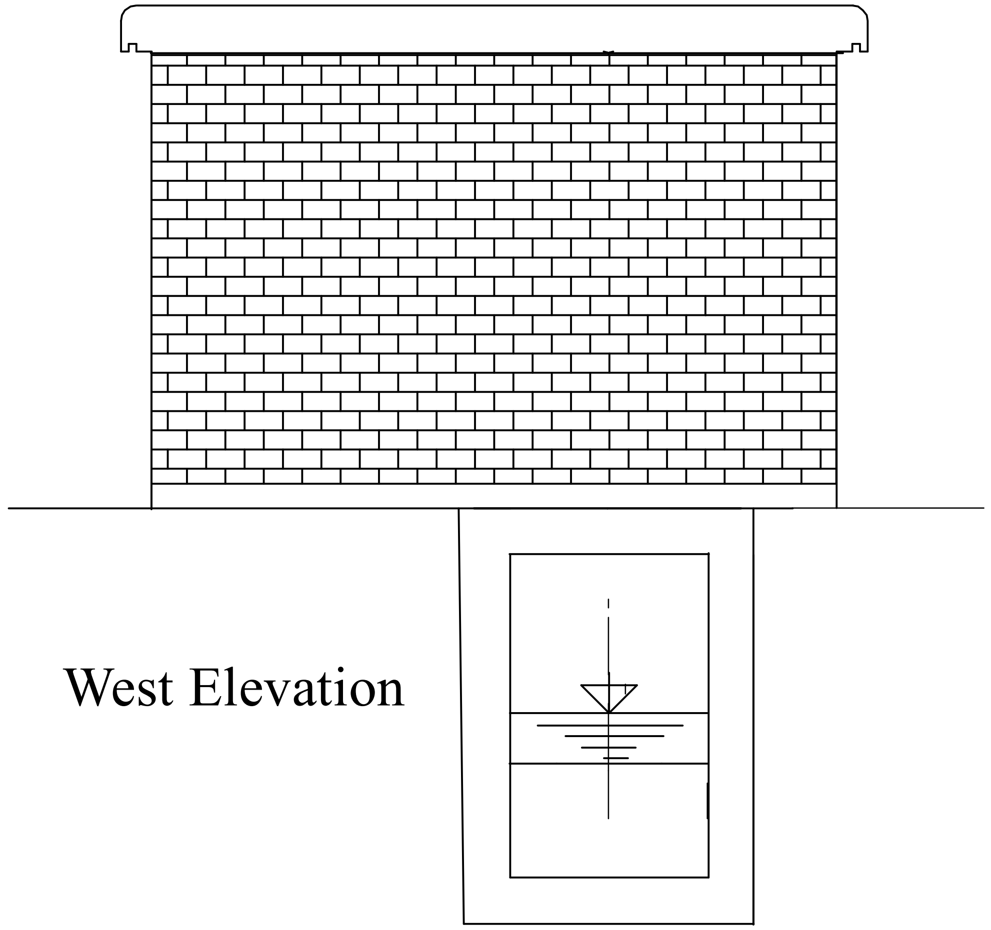


Section C - C

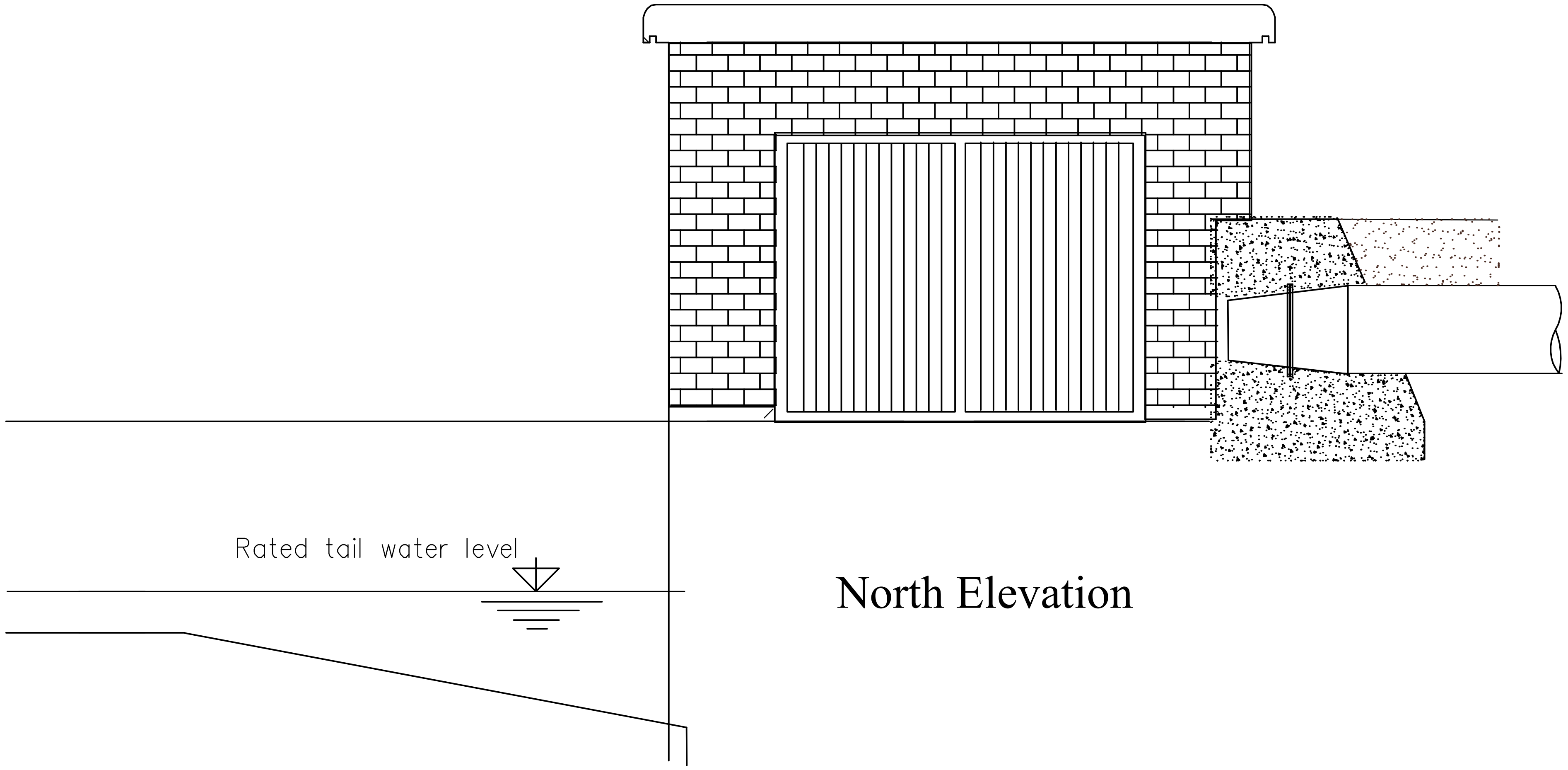
Toormakeady Hydro
Drawing No. 4
Turbine House Sections
Scale 1 :50
For Illustration only
February 2019
Water Power Services



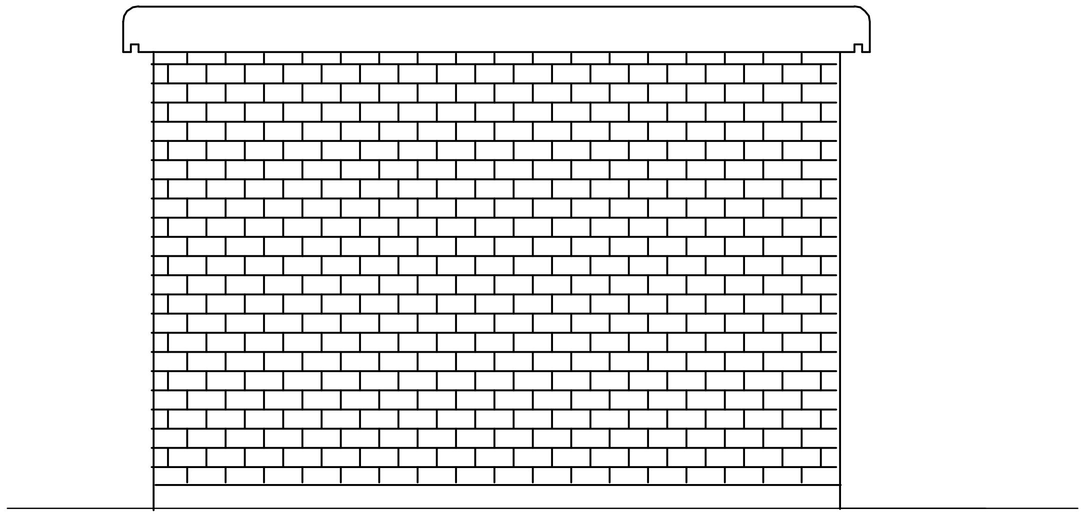
South Elevation



West Elevation



North Elevation



East Elevation

Toormakeady Hydro
Drawing No. 5
Turbine House Elevations
Scale 1 :50
For Illustration only
February 2019
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Section 2

Site 1 Gortfree

To be read in conjunction with the Summary, Appendices and Drawings common to all schemes

Contents:

WDC
WESTERN DEVELOPMENT COMMISSION
COIMISIÚN FORBARTHA AN IARTHAIR

Northern Periphery and Arctic Programme 2014-2020

EUROPEAN UNION
Investing in your future
European Regional Development Fund

Site 1 Gortfree

This site has a hydro power potential of 35kW using a fall of 35 metres over 650 metres. The power produced would reduce Irelands CO_2 output by 60 tonnes per annum.

This site is one of over 6,500 hydro power sites in Ireland, mainly mills, which operated in the 19th century. While in the main these are not in use today, there are over 60 sites in Ireland where water power is used to feed electricity into the national grid and due to the rising cost of electricity there are many more planned.

Hydro power is a clean, reliable renewable energy source, and while very site specific, as a river with a fall is necessary, it is already a significant supplier of renewable energy in Ireland.

Description

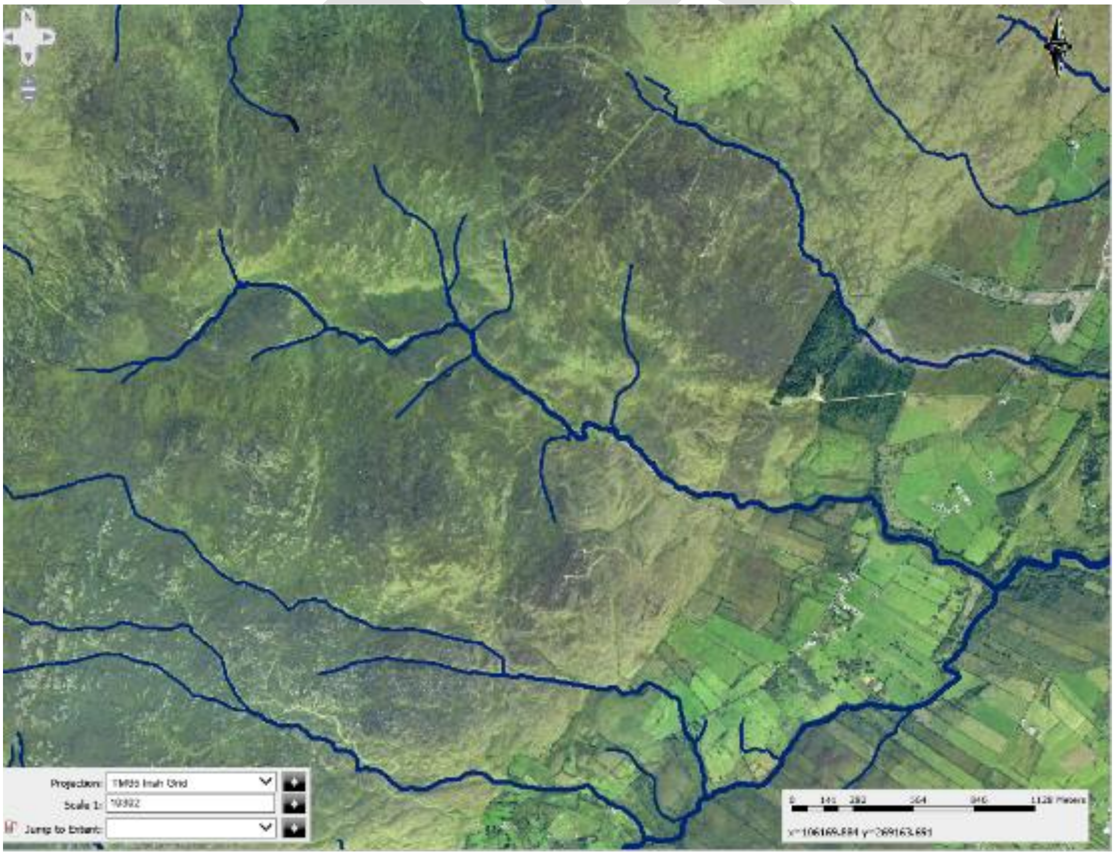
This river is a tributary of the Glensaul River which flows into Lough Mask at Toormakeady. From a position at the bridge near Derryveeney the river falls some 35 metres in 650 metres.

This scheme proposes to use this fall and the water in the river to run a water turbine that will generate electricity.

Catchment

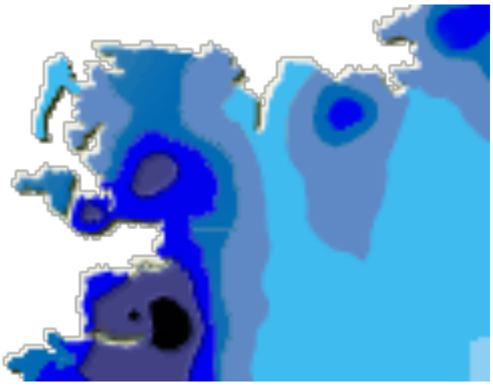
The river has its catchment on the Eastern side of the Partry Mountains. The area of the catchment above the bridge at 53.659556,-9.383025 (ITM X508587 Y768643) is about 2.5 square kilometres.

0.5 kilometres below the hydro site the river joins the Glensaul River.



EPA catchment map of Site 1

Rainfall and Flow



Irish Rainfall Records 1961 to 1990

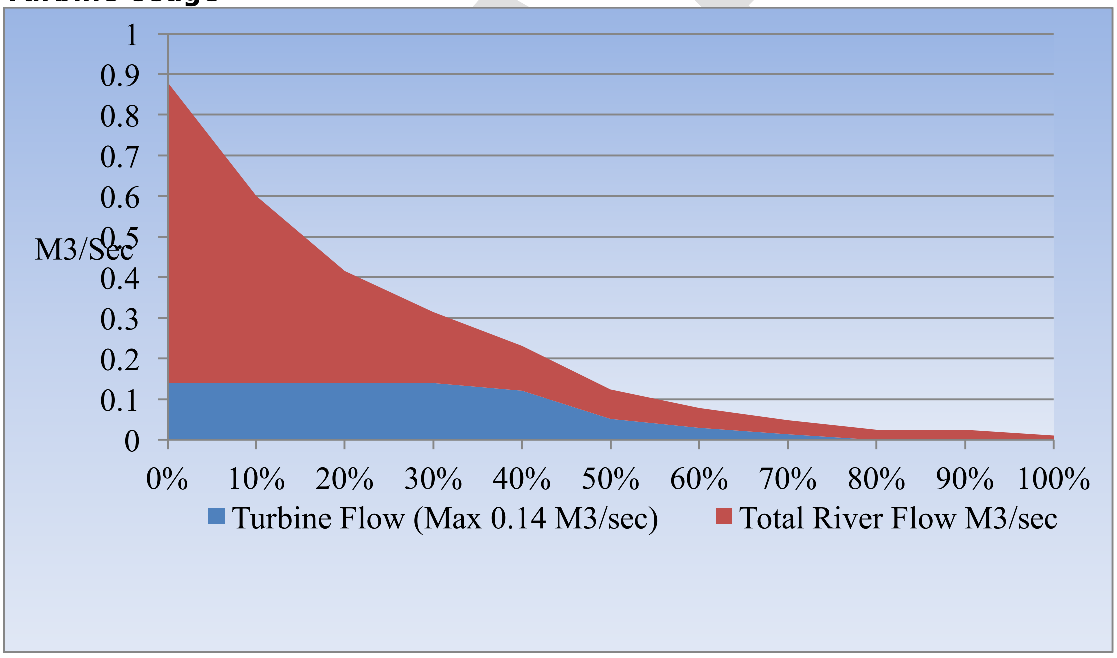
Rainfall at the site is 1,997 mm per annum. With a catchment area of 2.5 square kilometres this gives an average flow in the region of 0.14 cubic metres per second.

The flow available for these schemes was determined by using software developed by the Environmental Protection Agency (EPA) *Estimate of Flow Duration Curve for an Ungauged Catchment.*

This figure represents the 35% long term flow in the rivers and is a normal design size for small hydroelectric schemes. As the site is a mountain river and there is a high proportion of the time that there is rainfall it is possible that these design flow figures could be increased. This figure is based on the upper confidence of 95%. See Appendix IVa and IVb

It is therefore recommended that this be confirmed by using measuring weir. Details of this are included in Appendix III

Turbine Usage



Graph of total flow and turbine usage

Using the figures from the EPA *Estimate of Flow Duration Curve for an Ungauged Catchment* the above graph shows what a turbine with a capacity to use 0.14 cubic metres per second can take from the total flow available.

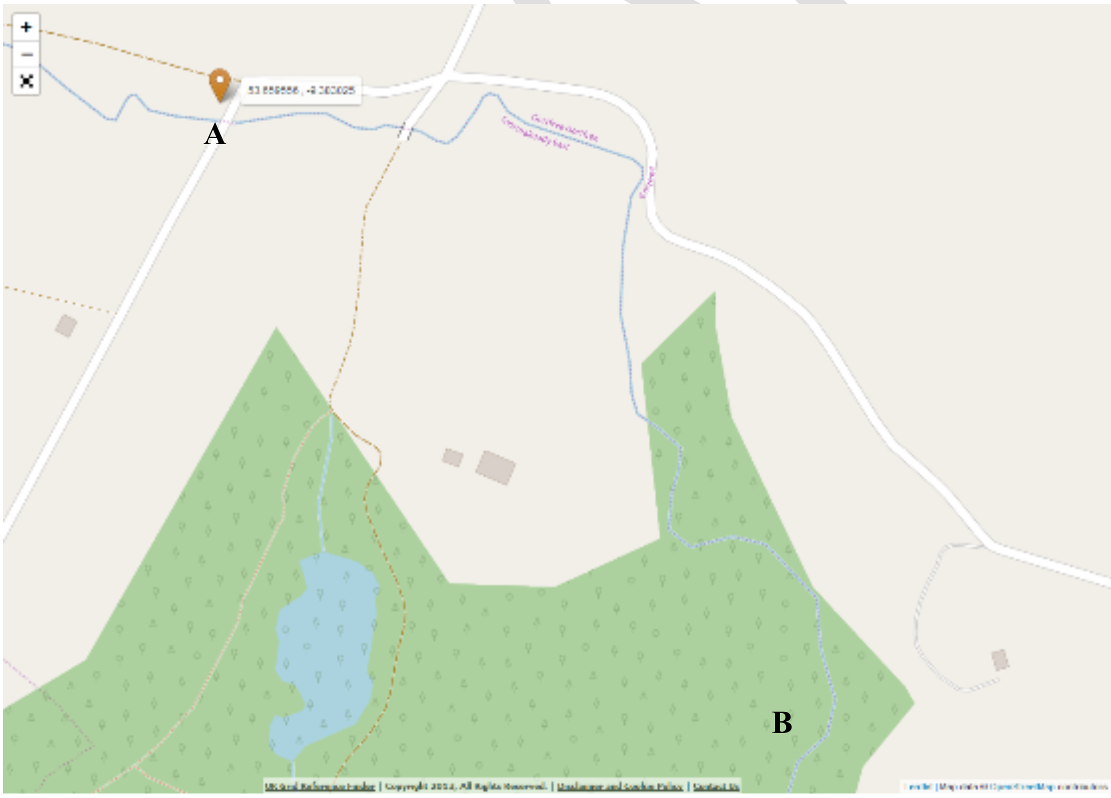
Power Output
With a design flow of 0.14 cubic metres per second and a gross head of 35 metres with a net head of 34.5 metres the power available can be ascertained as:

$P = 9.81x\ Q \times H \times n = 35kWs$
Where P = maximum power in kW
Q = Flow in m^3/s
H = Head (m)
n = efficiency (75%)

Annual Quantity of power
Because of the nature of the flow of water in the river, the turbine will operate at full or partial power about 6,000 hours per annum and will give the equivalent of full output for about 4,000 hours per annum while operating at full power for about 2,500 hours per annum. This is a total of 140 MWh per annum.

At today's prices this installation could produce just over €28,000 worth of electricity per year when purchased from the national grid. The current buying price available in Ireland is an average of 20 cent per kWh.

Headrace
In order to create a fall from the river, a pipeline 650 metres in length and 600mm in diameter will be laid. This will be buried and will follow the natural fall to give adequate cover with minimum trench depth.

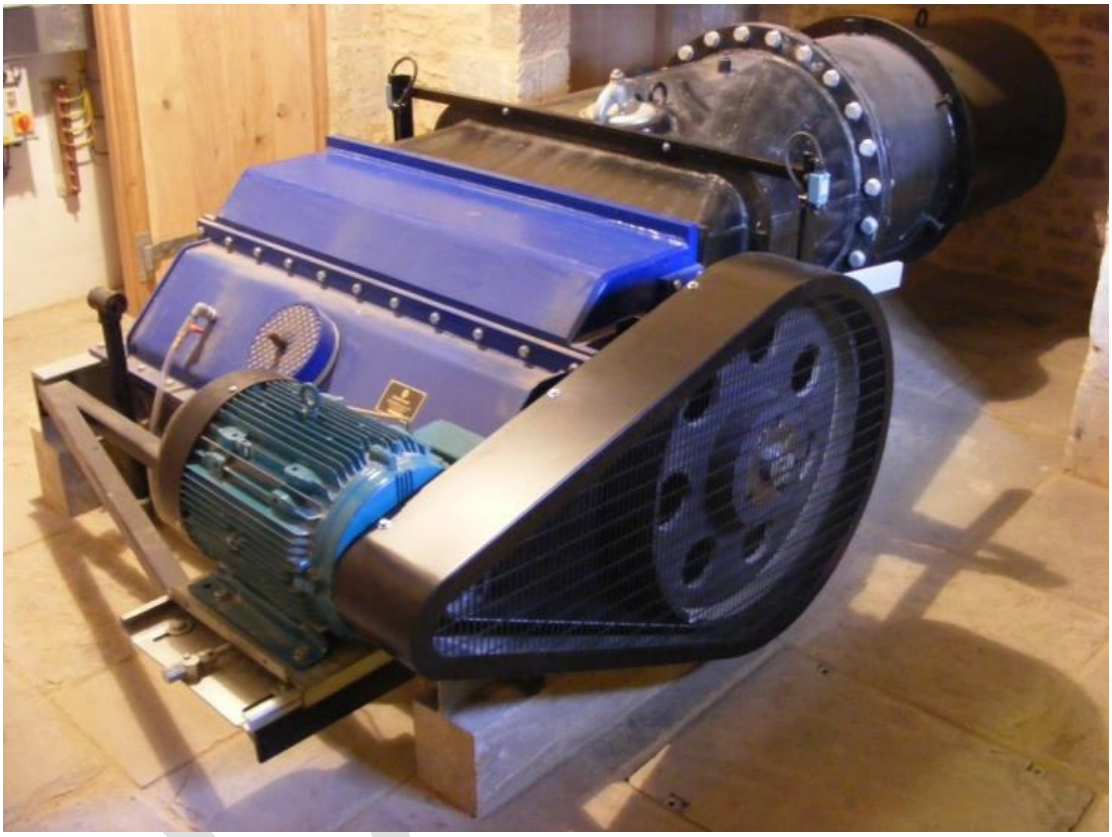


Site 1 Gortfree. The pressure pipe will run from Point A along a fall to the turbine house at B.

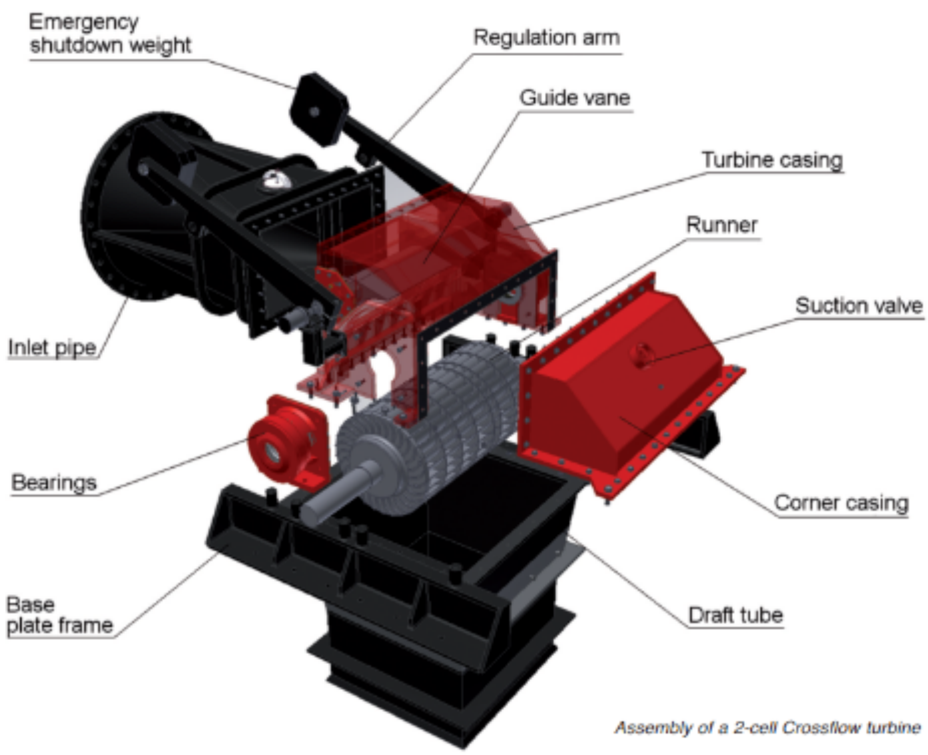
Turbine
There are several types of turbine that would suit this site. The most suitable in terms of technology and cost would be a cross flow turbine, similar to the one illustrated below. This would be connected via a belt or gearbox to an induction motor serving as a generator.

The cross flow turbine is encased in a cast steel cover, this reduces noise to a very low level. The noise from the generator and gearbox are also low. Noise is further abated by all the machinery being inside the turbine house.

An additional advantage of the cross flow turbine is that all the bearings are outside the runner casing. This means that there is no possibility of oil or grease entering the river and causing downstream pollution.



A cross flow turbine similar to the one proposed for this scheme



A blow up of a cross flow turbine

Environmental Protection

The proposed scheme has followed the Inland Fisheries Ireland (IFI) *Guidelines on the Planning, Design, Construction & Operation of Small-Scale Hydro-Electric Schemes and Fisheries.*

Any damaged vegetation will be replaced to enhance the bank resistance to erosion.

An Environmental Appraisal and Freshwater Assessment, By Dr. Brendan O'Connor of Aquafact International, is Appendix II of this report.

The minimum requirement for a 'hands off flow' is 12.5% of the long term flow which equals 0.018M^3/sec. The turbine design means that the scheme will shut down when there is less than 0.018M^3/sec in the river. This will not only preserve aquatic life but will also preserve the depleted section of the river.

Construction Method

In order not to interfere with the life in the river all construction of the scheme will take place outside of any running water.

The turbine outlet is under the machine and the discharge pit for this will be concrete lined. This will be built before the area is opened up to provide the outlet to the river. There is no need to have any concrete work in the river at this outlet point.

The Inland Fisheries Ireland publication *'Requirments for the Protection of Fisheries Habitat during Construction and Development Works at River Sites'* will be followed.

Full details of the Construction Method and the IFI Construction Guide are attached in Appendix V and VI.

Access to the site will be by the existing roads that will be extended as necessary. The extensions will be formed by striping 200mm of topsoil and placing a geotextile and a layer of gravel.

The main item to be placed on site is the pipe and this weighs 300kg per length. The heaviest item is the turbine at c2,500kg. Apart from ready mix concrete all other items will be brought on site by tractor and trailer.

Control System

The control system for the turbine is fully automatic and needs no adjustment after its initial setup.

Turbine output is based on the reading obtained from a head level sensor that is placed in the intake chamber. The sensor will be calibrated so that the 12.5% Qmean available flow is maintained at all times in the channel below the weir and so that the turbine will shut down when the water levels drops to 12.5% Qmean ($0.017M^3$/sec). This will be done by calibrating the controller to limit the turbine output based on the water level above the intake.

The control system has a battery back-up which operates in a failsafe method, in case of grid outage or other system failure, the governor shuts down the turbine and ceases generation. The level sensor accuracy is+/- 3mm for 300mm range.

The schematic for the control panel is Appendix VII.

Interconnection

This scheme would be interconnected with the national grid. This is done by using an induction motor as a generator that gets its excitation from the grid and provides power as long as the grid is in operation. The benefit of this is that the grid acts as a governor. At this site the grid is no more than 200 metres away from the turbine.

Finance

At this stage in this project it is difficult to be precise as to final costs. This is due to the costs varying between now and the actual building of the project and the possible restrictions put on the project during the licencing process.

That being said the projected total cost of this project is c€287,000 and it has an ability to generate €28,000 worth of electricity per annum.

Quotations

In Appendixes XIII and XIV there are quotations for a turbine and for pipe from one manufacturer.

Gortfree Hydro will cut CO_2 emissions by 60 tonnes per annum

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Section 2

Site 2 Above Derryveeney Bridge towards waterfall

To be read in conjunction with the Summary, Appendices and Drawings common to all schemes

Contents:

Site 2 Above Derryveeney Bridge towards waterfall

This site has a hydro power potential of 40kW using a fall of 20 metres over 500 metres. The power produced would reduce Irelands CO_2 output by 70 tonnes per annum.

This site is one of over 6,500 hydro power sites in Ireland, mainly mills, which operated in the 19th century. While in the main these are not in use today, there are over 60 sites in Ireland where water power is used to feed electricity into the national grid and due to the rising cost of electricity there are many more planned.

Hydro power is a clean, reliable renewable energy source, and while very site specific, as a river with a fall is necessary, it is already a significant supplier of renewable energy in Ireland.

Description

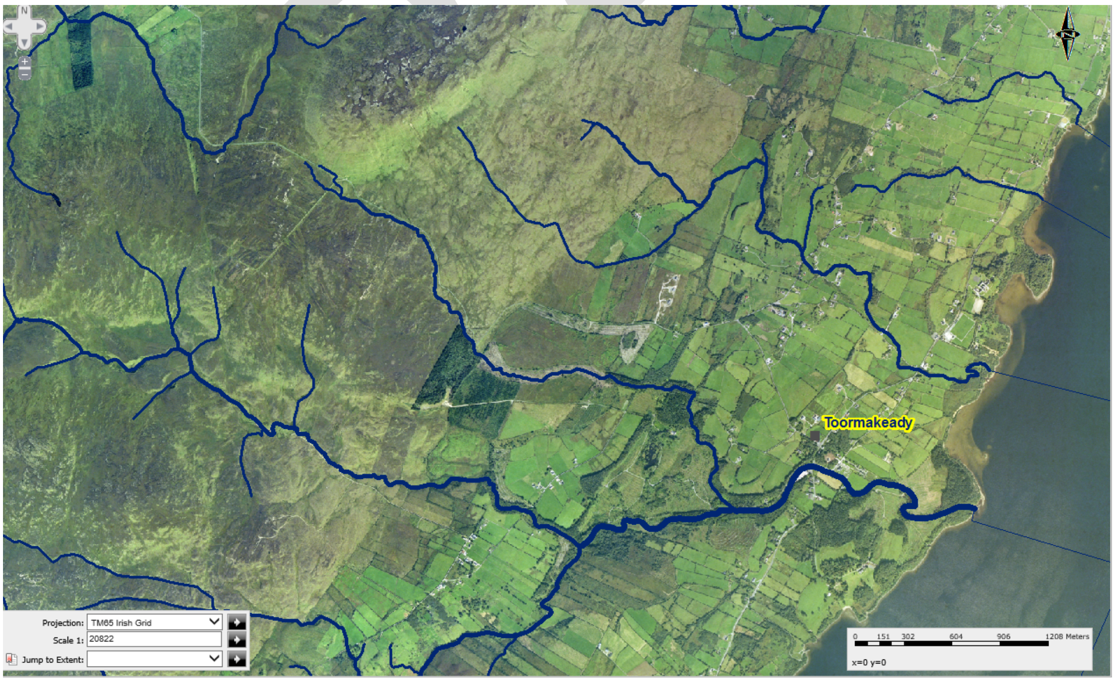
This river is a tributary of the Glensaul River which flows into Lough Mask at Toormakeady. From a position 300 metres upstream of the bridge at Derryveeney the river falls some 20 metres in 500 metres.

This scheme proposes to use this fall and the water in the river to run a water turbine that will generate electricity.

Catchment

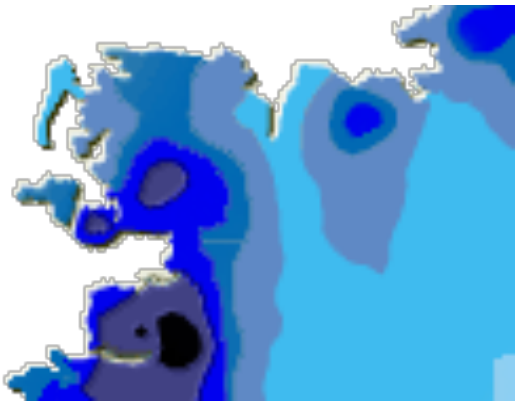
The river has its catchment on the Eastern side of the Partry Mountains. The area of the catchment above the bridge at 53.652086,-9.393718 (ITM X507864 Y767862) is about 5 square kilometres.

The Falls are just below the proposed hydro site. Under 200 metres below the falls the river joins the Glensaul River.



EPA catchment map of Site 2

Rainfall and Flow



Irish Rainfall Records 1961 to 1990

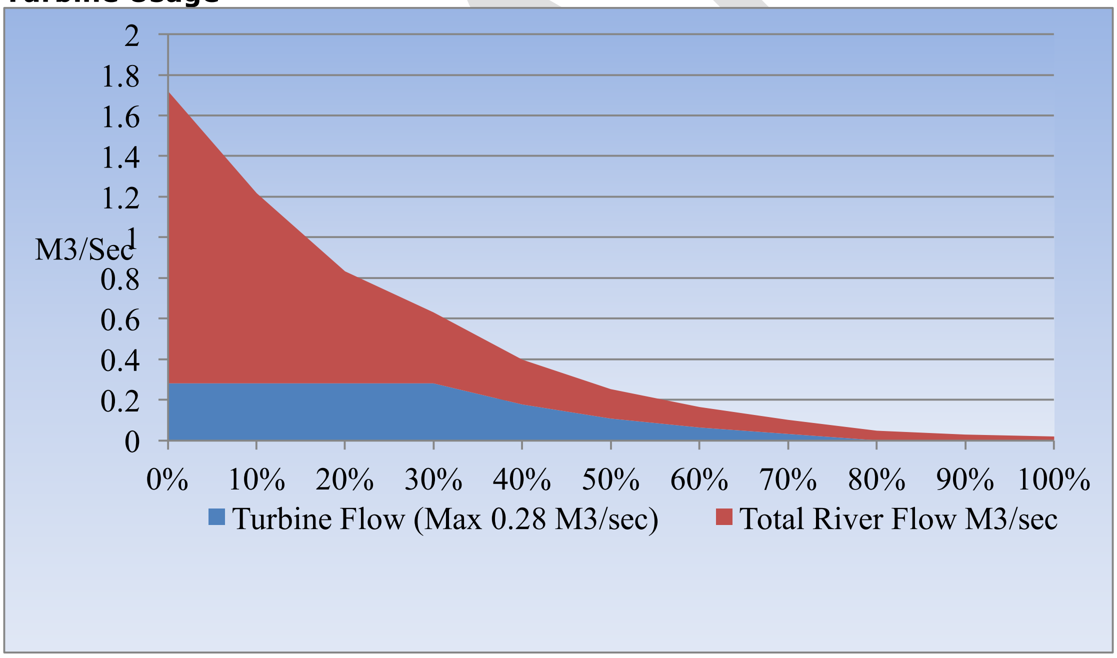
Rainfall at the site is 2,312 mm per annum. With a catchment area of 5 square kilometres this gives an average flow in the region of 0.28 cubic metres per second.

The flow available for these schemes was determined by using software developed by the Environmental Protection Agency (EPA) *Estimate of Flow Duration Curve for an Ungauged Catchment.*

This figure represents the 35% long term flow in the rivers and is a normal design size for small hydroelectric schemes. As the site is a mountain river and there is a high proportion of the time that there is rainfall it is possible that these design flow figures could be increased. This figure is based on the upper confidence of 95%. See Appendix IVa and IVb

It is therefore recommended that this be confirmed by using measuring weir. Details of this are included in Appendix III

Turbine Usage



Graph of total flow and turbine usage

Using the figures from the EPA *Estimate of Flow Duration Curve for an Ungauged Catchment* the above graph shows what a turbine with a capacity to use 0.28 cubic metres per second can take from the total flow available.

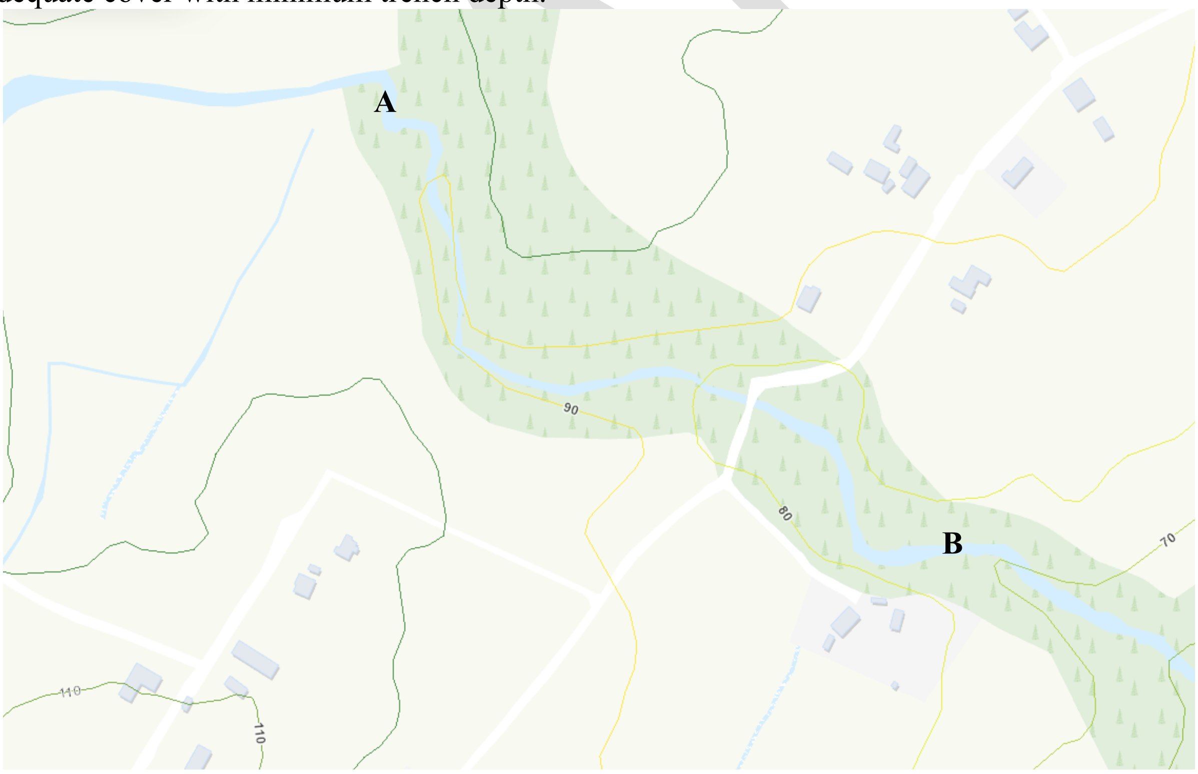
Power Output
With a design flow of 0.28 cubic metres per second and a gross head of 20 metres with a net head of 19.5 metres the power available can be ascertained as:

$P = 9.81x\ Q \times H \times n = 40kWs$
Where P = maximum power in kW
Q = Flow in m^3/s
H = Head (m)
n = efficiency (75%)

Annual Quantity of power
Because of the nature of the flow of water in the river, the turbine will operate at full or partial power about 6,000 hours per annum and will give the equivalent of full output for about 4.000 hours per annum while operating at full power for about 2,500 hours per annum. This is a total of 160 MWh per annum

At today's prices this installation could produce over €32,000 worth of electricity per year when purchased from the national grid. The current buying price available in Ireland is an average of 20 cent per kWh.

Headrace
In order to create a fall from the river, a pipeline 500 metres in length and 650mm in diameter will be laid. This will be buried and will follow the natural fall to give adequate cover with minimum trench depth.



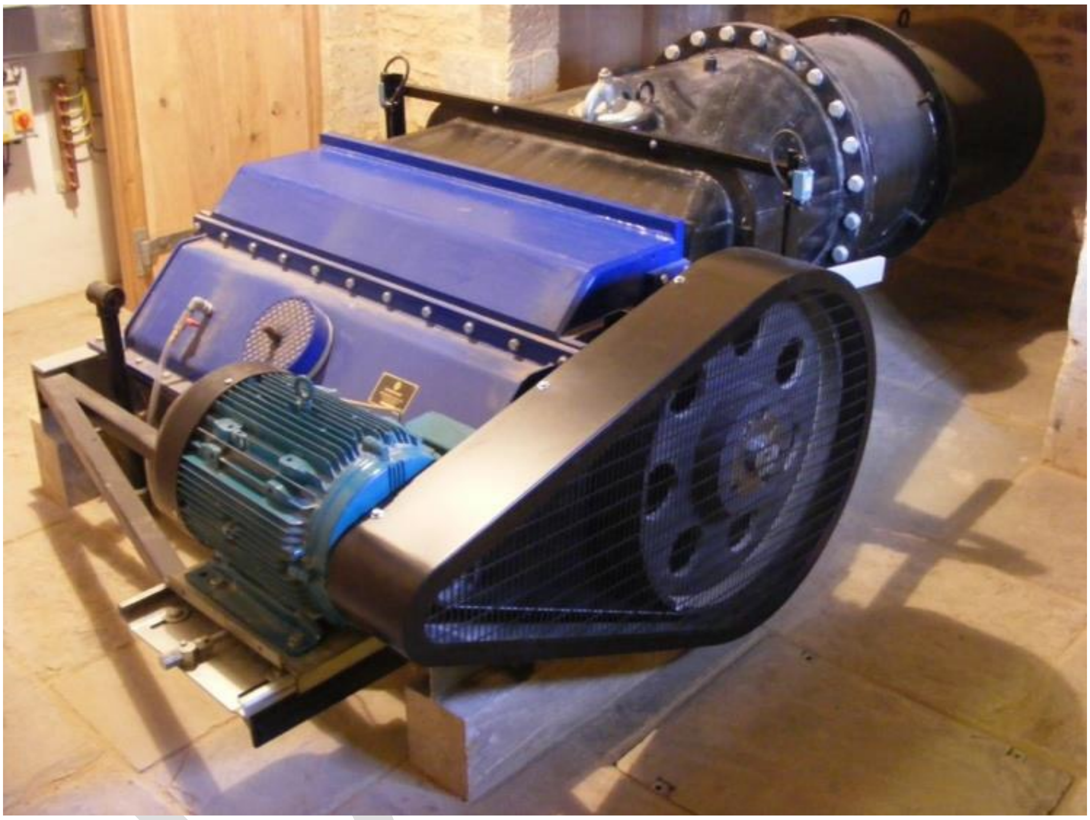
Site 2 Derryveeney. The pressure pipe will run from Point A along a fall to the turbine house at B.

Turbine

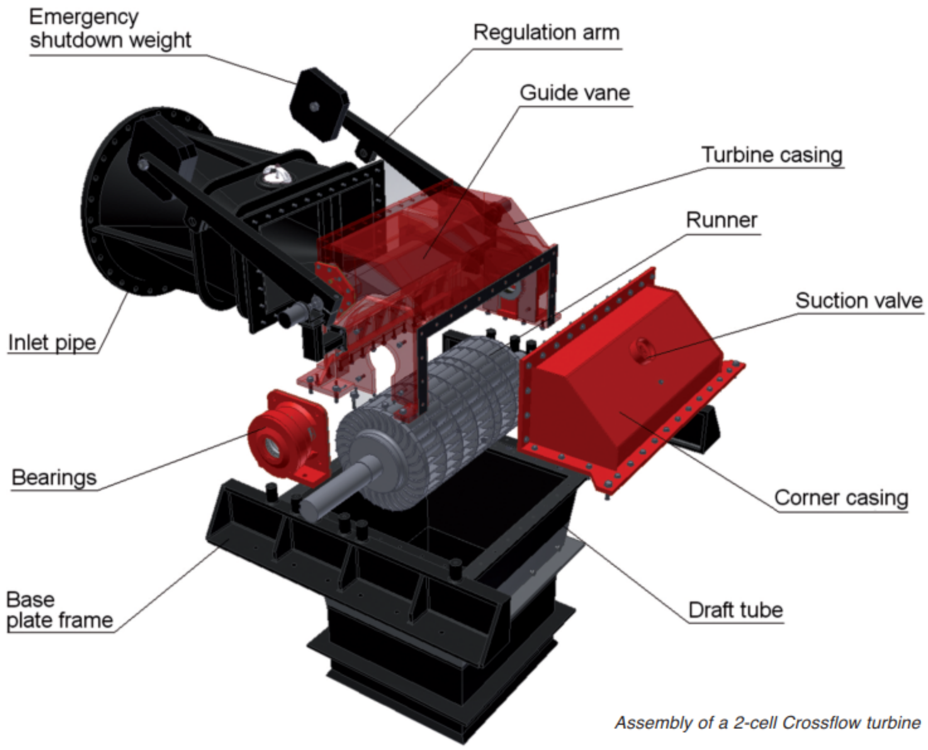
There are several types of turbine that would suit this site. The most suitable in terms of technology and cost would be a cross flow turbine, similar to the one illustrated below. This would be connected via a gearbox to an induction motor serving as a generator.

The cross flow turbine is encased in a cast steel cover, this reduces noise to a very low level. The noise from the generator and gearbox are also low. Noise is further abated by all the machinery being inside the turbine house.

An additional advantage of the cross flow turbine is that all the bearings are outside the runner casing. This means that there is no possibility of oil or grease entering the river and causing downstream pollution.



A cross flow turbine similar to the one proposed for this scheme



A blow up of a cross flow turbine

Environmental Protection
The proposed scheme has followed the Inland Fisheries Ireland (IFI) *Guidelines on the Planning, Design, Construction & Operation of Small-Scale Hydro-Electric Schemes and Fisheries*.

Any damaged vegetation will be replaced to enhance the bank resistance to erosion.

An Environmental Appraisal and Freshwater Assessment, By Dr. Brendan O'Connor of Aquafact International, is Appendix II of this report.

The minimum requirement for a 'hands off flow' is 12.5% of the long term flow which equals $0.035M^3$/sec. The turbine design means that the scheme will shut down when there is less than $0.035M^3$/sec in the river. This will not only preserve aquatic life but will also preserve the depleted section of the river.

Construction Method
In order not to interfere with the life in the river all construction of the scheme will take place outside of any running water.

The turbine outlet is under the machine and the discharge pit for this will be concrete lined. This will be built before the area is opened up to provide the outlet to the river. There is no need to have any concrete work in the river at this outlet point. The Inland Fisheries Ireland publication *'Requirments for the Protection of Fisheries Habitat during Construction and Development Works at River Sites'* will be followed.

Full details of the Construction Method and the IFI Construction Guide are attached in Appendix V and VI.

Access to the site will be by the existing roads that will be extended as necessary. The extensions will be formed by striping 200mm of topsoil and placing a geotextile and a layer of gravel.

The main item to be placed on site is the pipe and this weighs 300kg per length. The heaviest item is the turbine at 2500kg. Apart from ready mix concrete all other items will be brought on site by tractor and trailer.

Control System

The control system for the turbine is fully automatic and needs no adjustment after its initial setup.

Turbine output is based on the reading obtained from a head level sensor that is placed in the intake chamber. The sensor will be calibrated so that the 12.5%Qmean available flow is maintained at all times in the channel below the weir and so that the turbine will shut down when the water levels drops to 12.5% Qmean ($0.017M^3$/sec). This will be done by calibrating the controller to limit the turbine output based on the water level above the intake.

The control system has a battery back-up which operates in a failsafe method, in case of grid outage or other system failure, the governor shuts down the turbine and ceases generation. The level sensor accuracy is+/- 3mm for 300mm range.

The schematic for the control panel is Appendix VII.

Interconnection

This scheme would be interconnected with the national grid. This is done by using an induction motor as a generator that gets its excitation from the grid and provides power as long as the grid is in operation. The benefit of this is that the grid acts as a governor. At this site the grid is no more than 200 metres away from the turbine.

Finance

At this stage in this project it is difficult to be precise as to final costs. This is due to the costs varying between now and the actual building of the project and the possible restrictions put on the project during the licencing process.

That being said the projected total cost of this project is €271,000 and it has an ability to generate €32,000 worth of electricity per annum.

Quotations

In Appendixes XIII and XIV there are quotations for a turbine and for pipe from one manufacturer.

Derryveeney Hydro will cut CO_2 emissions by 70 tonnes per annum

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Section 2

Site 3 Treanlaur

To be read in conjunction with the Summary, Appendices and Drawings common to all schemes

Contents:

WDC
Northern Periphery and Arctic Programme 2014-2020
EUROPEAN UNION
Investing in your future
European Regional Development Fund

Site 3 Treanlaur

This site has a hydro power potential of 40kW using a fall of 35 metres over 800 metres. The power produced would reduce Irelands CO_2 output by 70 tonnes per annum.

This site is one of over 6,500 hydro power sites in Ireland, mainly mills, which operated in the 19th century. While in the main these are not in use today, there are over 60 sites in Ireland where water power is used to feed electricity into the national grid and due to the rising cost of electricity there are many more planned.

Hydro power is a clean, reliable renewable energy source, and while very site specific, as a river with a fall is necessary, it is already a significant supplier of renewable energy in Ireland.

Description

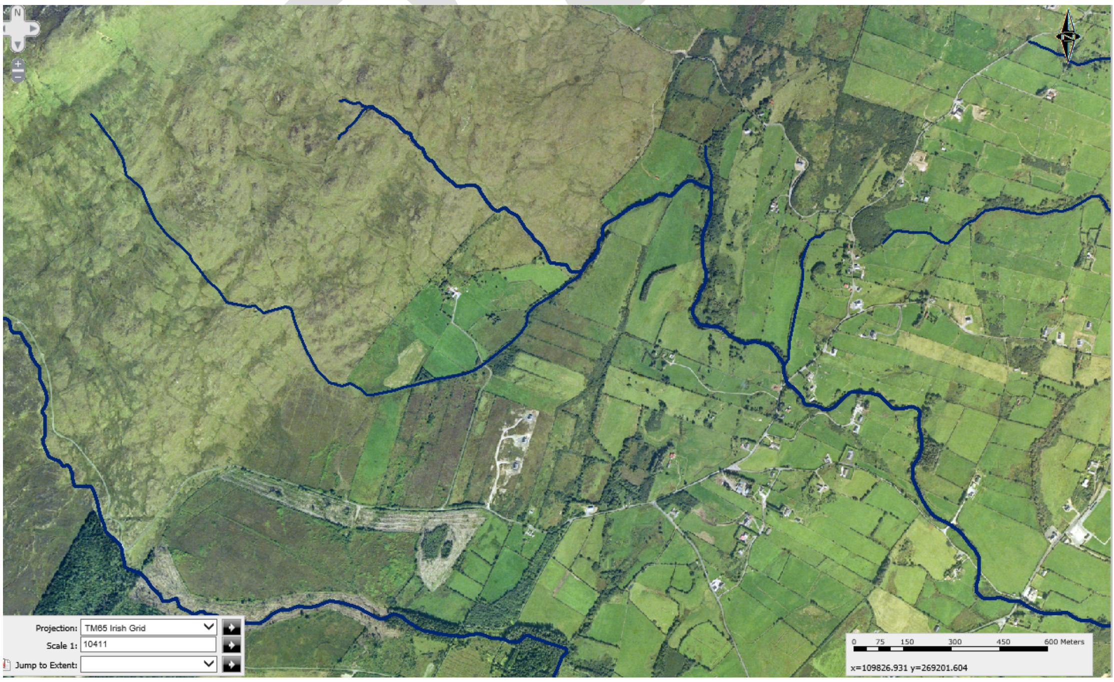
This river is the Ballybannon River which flows into Lough Mask just north of Toormakeady. From a position just upstream of the bridge on the upper road at Treanlaur the river falls some 35 metres in 800 metres.

This scheme proposes to use this fall and the water in the river to run a water turbine that will generate electricity.

Catchment

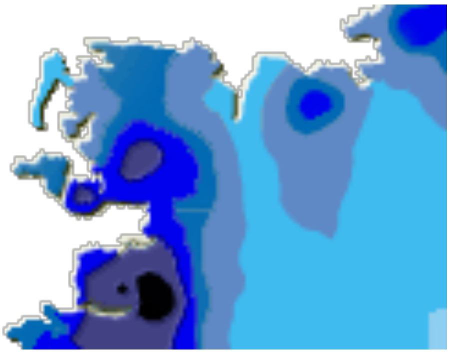
The river has its catchment on the Eastern side of the Partry Mountains. The river rises on the south-eastern slopes of Droim Chagaidh. The area of the catchment above the bridge at 53.666521,-9.365808 (ITM X509740 Y769396) is about 3 square kilometres.

c.1.0 kilometres below the hydro site the river joins Lough Mask.



EPA catchment map of Site 3

Rainfall and Flow



Irish Rainfall Records 1961 to 1990

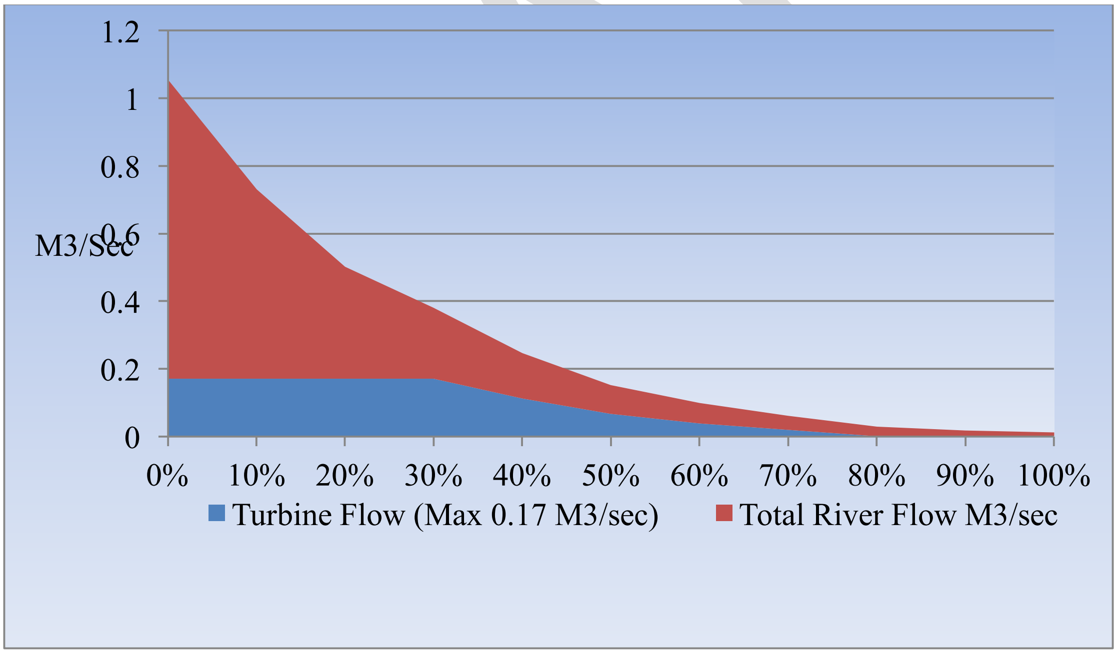
Rainfall at the site is 1,718 mm per annum. With a catchment area of 3 square kilometres this gives an average flow in the region of 0.166 cubic metres per second.

The flow available for these schemes was determined by using software developed by the Environmental Protection Agency (EPA) *Estimate of Flow Duration Curve for an Ungauged Catchment.*

This figure represents the 35% long term flow in the rivers and is a normal design size for small hydroelectric schemes. As the site is a mountain river and there is a high proportion of the time that there is rainfall it is possible that these design flow figures could be increased. This figure is based on the upper confidence of 95%. See Appendix IVa and IVb

It is therefore recommended that this be confirmed by using measuring weir. Details of this are included in Appendix III

Turbine Usage



Graph of total flow and turbine usage

Using the figures from the EPA *Estimate of Flow Duration Curve for an Ungauged Catchment* the above graph shows what a turbine with a capacity to use 0.17 cubic metres per second can take from the total flow available.

Power Output

With a design flow of 0.17 cubic metres per second and a gross head of 35 metres with a net head of 34.5 metres the power available can be ascertained as:

P = 9.81x Q x H x n = 43kWs

Where P = maximum power in kW

Q = Flow in m^3/s

H = Head (m)

n = efficiency (75%)

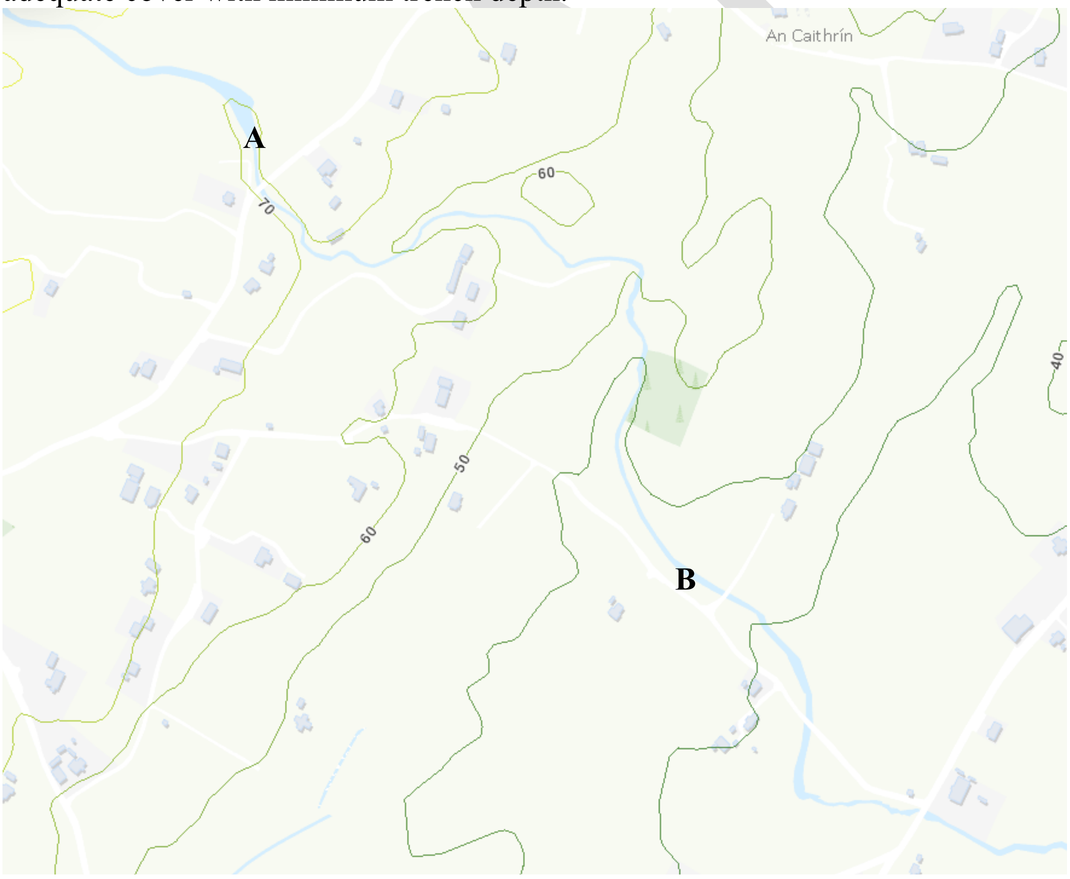
Annual Quantity of power

Because of the nature of the flow of water in the river, the turbine will operate at full or partial power about 6,000 hours per annum and will give the equivalent of full output for about 4,000 hours per annum while operating at full power for about 2,500 hours per annum. This is a total of 170 MWh per annum.

At today's prices this installation could produce over €34,000 worth of electricity per year when purchased from the national grid. The current buying price available in Ireland is an average of 20 cent per kWh.

Headrace

In order to create a fall from the river, a pipeline 800 metres in length and 600mm in diameter will be laid. This will be buried and will follow the natural fall to give adequate cover with minimum trench depth.



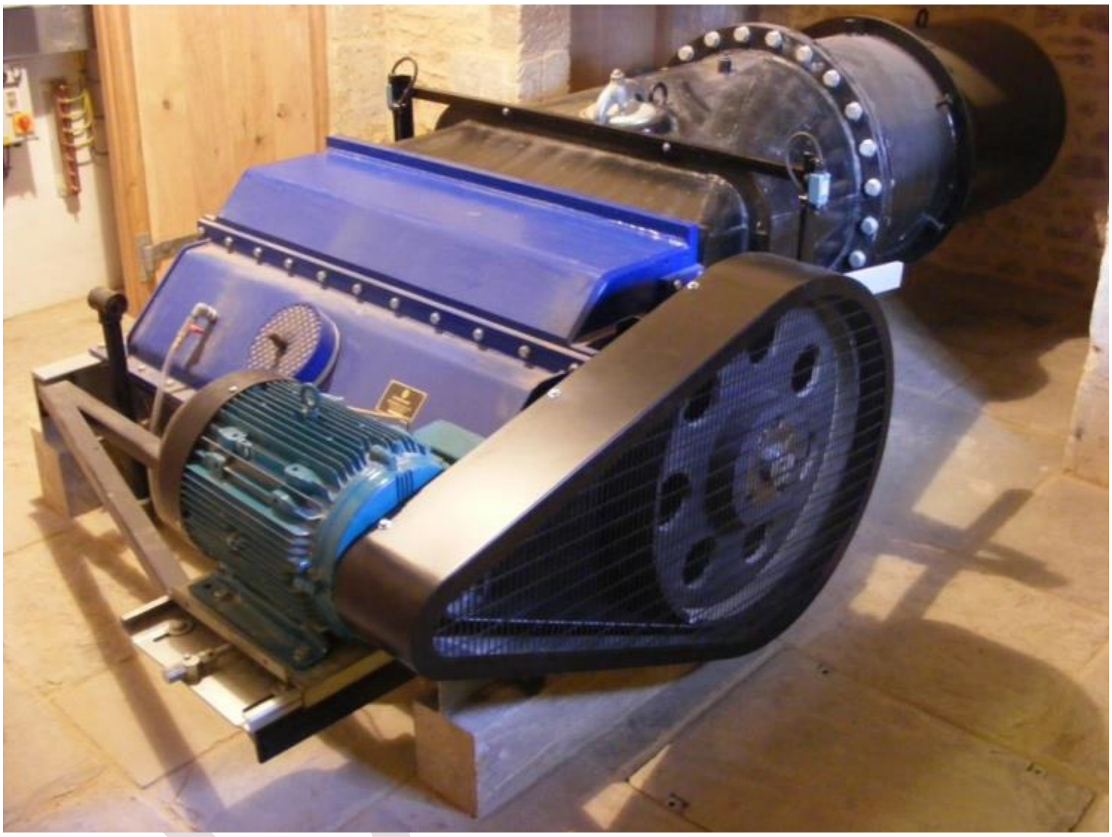
Site 3 Treanlaur. The pressure pipe will run from Point A along a fall to the turbine house at B.

Turbine

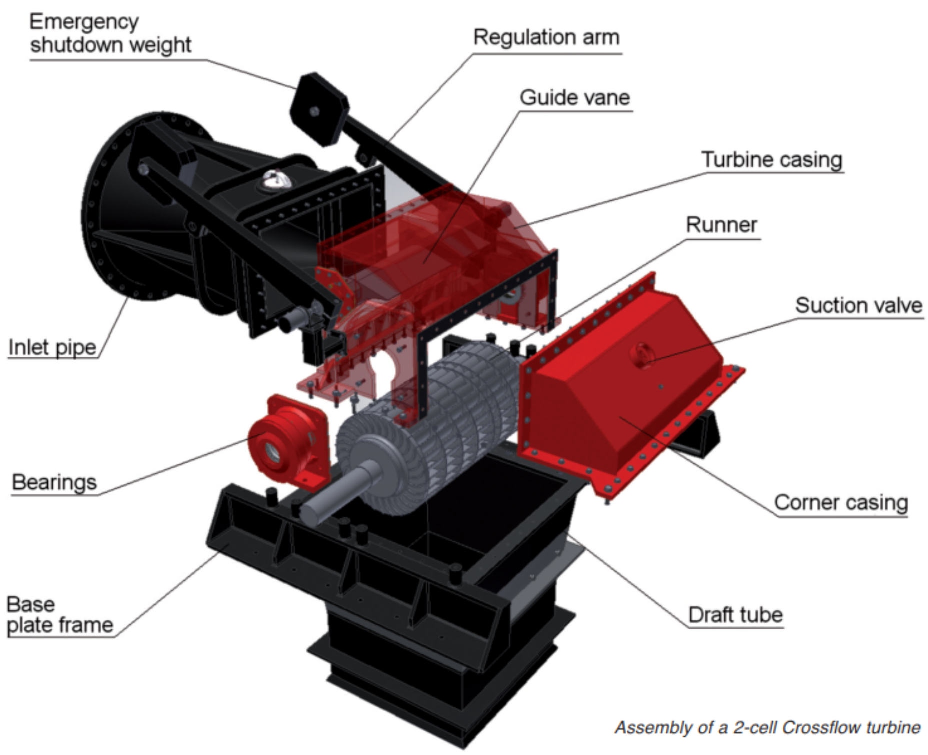
There are several types of turbine that would suit this site. The most suitable in terms of technology and cost would be a cross flow turbine, similar to the one illustrated below. This would be connected via a gearbox to an induction motor serving as a generator.

The cross flow turbine is encased in a cast steel cover, this reduces noise to a very low level. The noise from the generator and gearbox are also low. Noise is further abated by all the machinery being inside the turbine house.

An additional advantage of the cross flow turbine is that all the bearings are outside the runner casing. This means that there is no possibility of oil or grease entering the river and causing downstream pollution



A cross flow turbine similar to the one proposed for this scheme



A blow up of a cross flow turbine

Environmental Protection

The proposed scheme has followed the Inland Fisheries Ireland (IFI) *Guidelines on the Planning, Design, Construction & Operation of Small-Scale Hydro-Electric Schemes and Fisheries*.

Any damaged vegetation will be replaced to enhance the bank resistance to erosion.

An Environmental Appraisal and Freshwater Assessment, By Dr. Brendan O'Connor of Aquafact International, is Appendix II of this report.

The minimum requirement for a 'hands off flow' is 12.5% of the long term flow which equals $0.02M^3$/sec. The turbine design means that the scheme will shut down when there is less than $0.02M^3$/sec in the river. This will not only preserve aquatic life but will also preserve the depleted section of the river.

Construction Method

In order not to interfere with the life in the river all construction of the scheme will take place outside of any running water.

The turbine outlet is under the machine and the discharge pit for this will be concrete lined. This will be built before the area is opened up to provide the outlet to the river. There is no need to have any concrete work in the river at this outlet point.

The Inland Fisheries Ireland publication *'Requirments for the Protection of Fisheries Habitat during Construction and Development Works at River Sites'* will be followed.

Full details of the Construction Method and the IFI Construction Guide are attached in Appendix V and VI.

Access to the site will be by the existing roads that will be extended as necessary. The extensions will be formed by striping 200mm of topsoil and placing a geotextile and a layer of gravel.

The main item to be placed on site is the pipe and this weighs 300kg per length. The heaviest item is the turbine at c2,500kg. Apart from ready mix concrete all other items will be brought on site by tractor and trailer.

Control System

The control system for the turbine is fully automatic and needs no adjustment after its initial setup.

Turbine output is based on the reading obtained from a head level sensor that is placed in the intake chamber. The sensor will be calibrated so that the 12.5%Qmean available flow is maintained at all times in the channel below the weir and so that the turbine will shut down when the water levels drops to 12.5% Qmean ($0.017M^3$/sec). This will be done by calibrating the controller to limit the turbine output based on the water level above the intake.

The control system has a battery back-up which operates in a failsafe method, in case of grid outage or other system failure, the governor shuts down the turbine and ceases generation. The level sensor accuracy is+/- 3mm for 300mm range.

The schematic for the control panel is Appendix VII.

Interconnection

This scheme would be interconnected with the national grid. This is done by using an induction motor as a generator that gets its excitation from the grid and provides power as long as the grid is in operation. The benefit of this is that the grid acts as a governor. At this site the grid is no more than 50 metres away from the turbine.

Finance

At this stage in this project it is difficult to be precise as to final costs. This is due to the costs varying between now and the actual building of the project and the possible restrictions put on the project during the licencing process.

That being said the projected total cost of this project is c€309,000 and it has an ability to generate €34,000 worth of electricity per annum

Quotations

In Appendixes XIII and XIV there are quotations for a turbine and for pipe from one manufacturer.

Treanlaur Hydro will cut CO_2 emissions by 70 tonnes per annum

WATER POWER SERVICES
SPECIALISTS IN DESIGN AND CONSTRUCTION OF WATER POWER SCHEMES
13 Marlborough Rd • Dublin D04 • Ireland
Phone +353 1 6680043 • Email fiaccobr@gmail.com

Section 4

Site 4 An Tamhnaigh

To be read in conjunction with the Summary, Appendices and Drawings common to all schemes

Contents:

Site 4 An Tamhnaigh

This site has a hydro power potential of 50kW using a fall of 40 metres over 700 metres. The power produced would reduce Irelands CO_2 output by 85 tonnes per annum.

This site is one of over 6,500 hydro power sites in Ireland, mainly mills, which operated in the 19th century. While in the main these are not in use today, there are over 60 sites in Ireland where water power is used to feed electricity into the national grid and due to the rising cost of electricity there are many more planned.

Hydro power is a clean, reliable renewable energy source, and while very site specific, as a river with a fall is necessary, it is already a significant supplier of renewable energy in Ireland.

Description

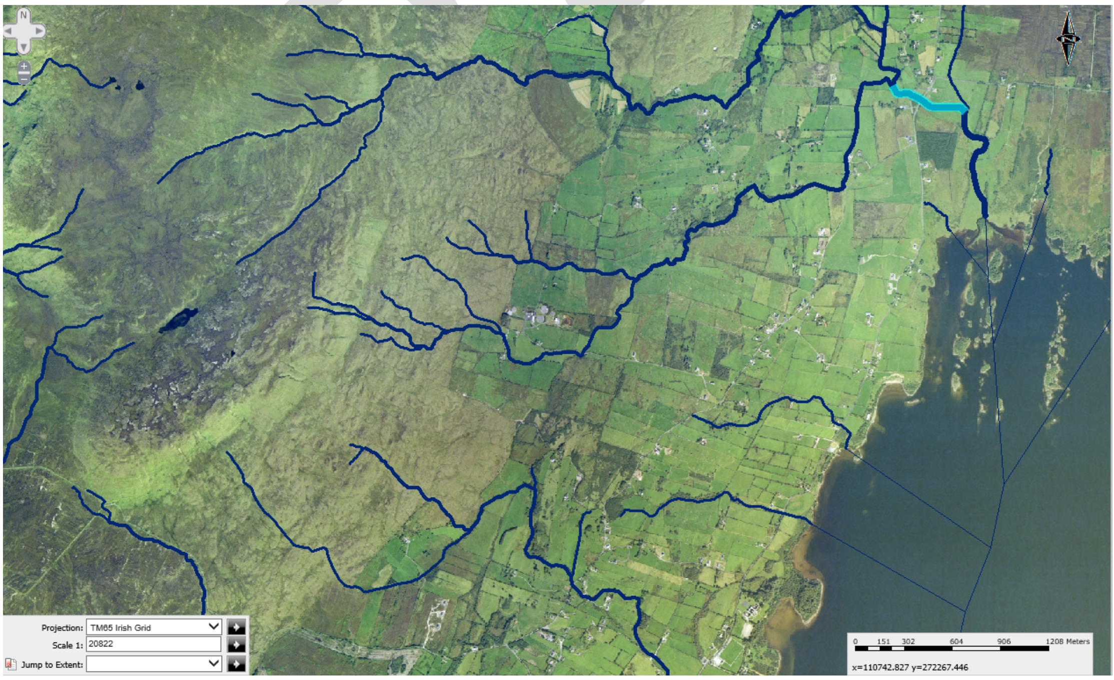
This river is the Ballybannon River which flows into Lough Mask just north of Toormakeady. From a position just upstream of the bridge on the upper road at Treanlaur the river falls some 35 metres in 800 metres.

This scheme proposes to use this fall and the water in the river to run a water turbine that will generate electricity.

Catchment

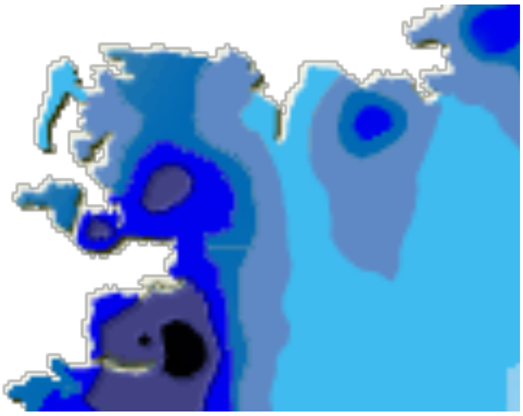
The river has its catchment on the Eastern side of the Partry Mountains. The river is a tributary of the Srah Stream that rises in Tonnasaile. The area of the catchment above the bridge at 53.689215,-9.3477694 (ITM X510980 Y771899) is about 3 square kilometres.

2 kilometres below the hydro site the river joins Lough Mask.



EPA catchment map of Site 4

Rainfall and Flow



Irish Rainfall Records 1961 to 1990

Rainfall at the site is 2312 mm per annum. With a catchment area of 3 square kilometres this gives an average flow in the region of 0.17 cubic metres per second.

The flow available for these schemes was determined by using software developed by the Environmental Protection Agency (EPA) *Estimate of Flow Duration Curve for an Ungauged Catchment.*

This figure represents the 35% long term flow in the rivers and is a normal design size for small hydroelectric schemes. As the site is a mountain river and there is a high proportion of the time that there is rainfall it is possible that these design flow figures could be increased. This figure is based on the upper confidence of 95%. See Appendix IVa and IVb

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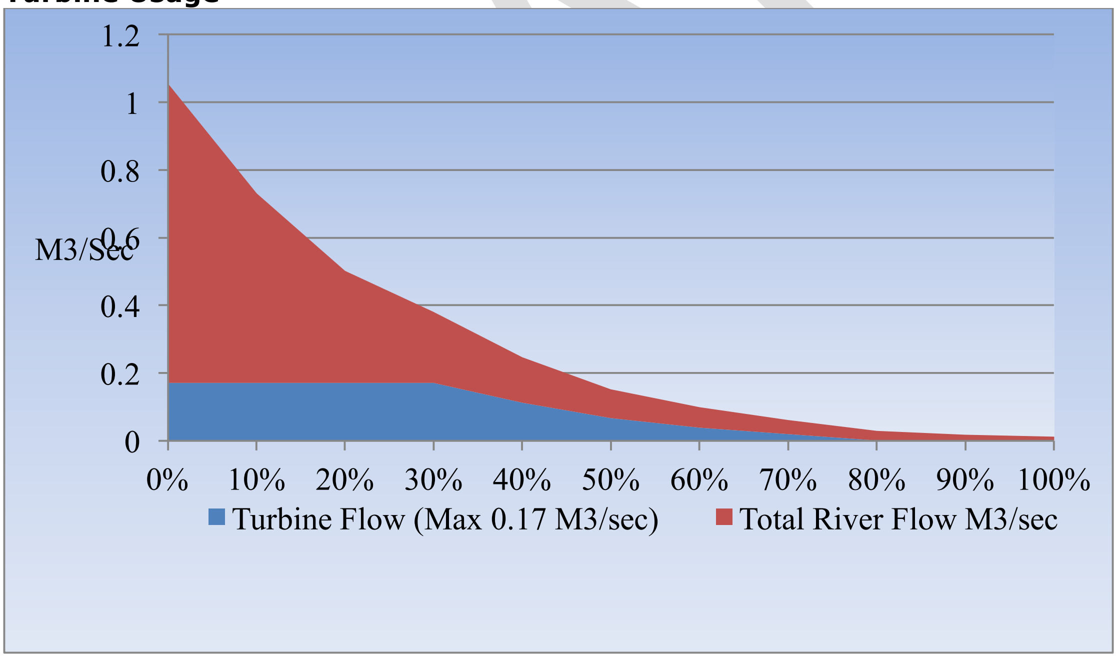
Turbine Usage



Graph of total flow and turbine usage

Using the figures from the EPA *Estimate of Flow Duration Curve for an Ungauged Catchment* the above graph shows what a turbine with a capacity to use 0.17 cubic metres per second can take from the total flow available.

Power Output

With a design flow of 0.17 cubic metres per second and a gross head of 40 metres with a net head of 39.5 metres the power available can be ascertained as:

$P = 9.81 \times Q \times H \times n = 50$kWs

Where P = maximum power in kW

Q = Flow in m^3/s

H = Head (m)

n = efficiency (75%)

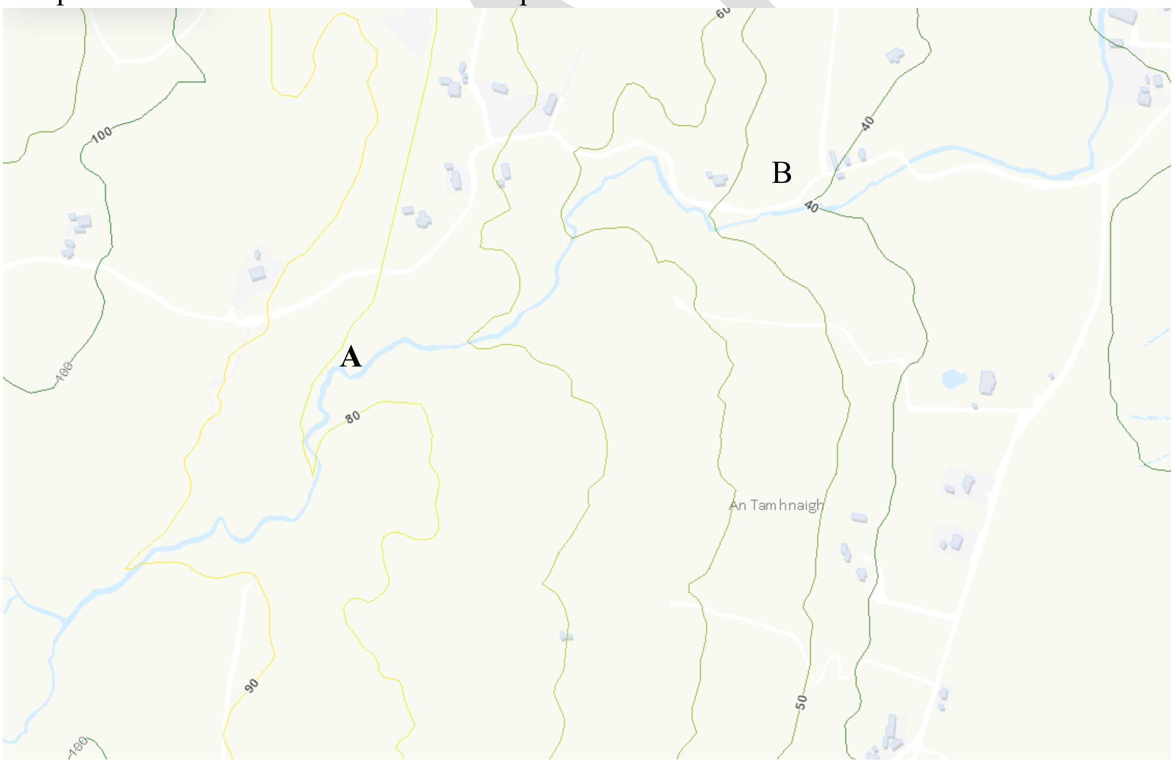
Annual Quantity of power

Because of the nature of the flow of water in the river, the turbine will operate at full or partial power about 6,000 hours per annum and will give the equivalent of full output for about 4,000 hours per annum while operating at full power for about 2,500 hours per annum. This gives a total of 200 MWh per annum.

At today's prices this installation could produce over €40,000 worth of electricity per year when purchased from the national grid. The current buying price available in Ireland is an average of 20 cent per kWh.

Headrace

In order to create a fall from the river, a pipeline 500 metres in length and 600mm in diameter will be laid. This will be buried and will follow the natural fall to give adequate cover with minimum trench depth.



Site 4 Tamhnaidh. The pressure pipe will run from Point A along a fall to the turbine house at B.

Turbine

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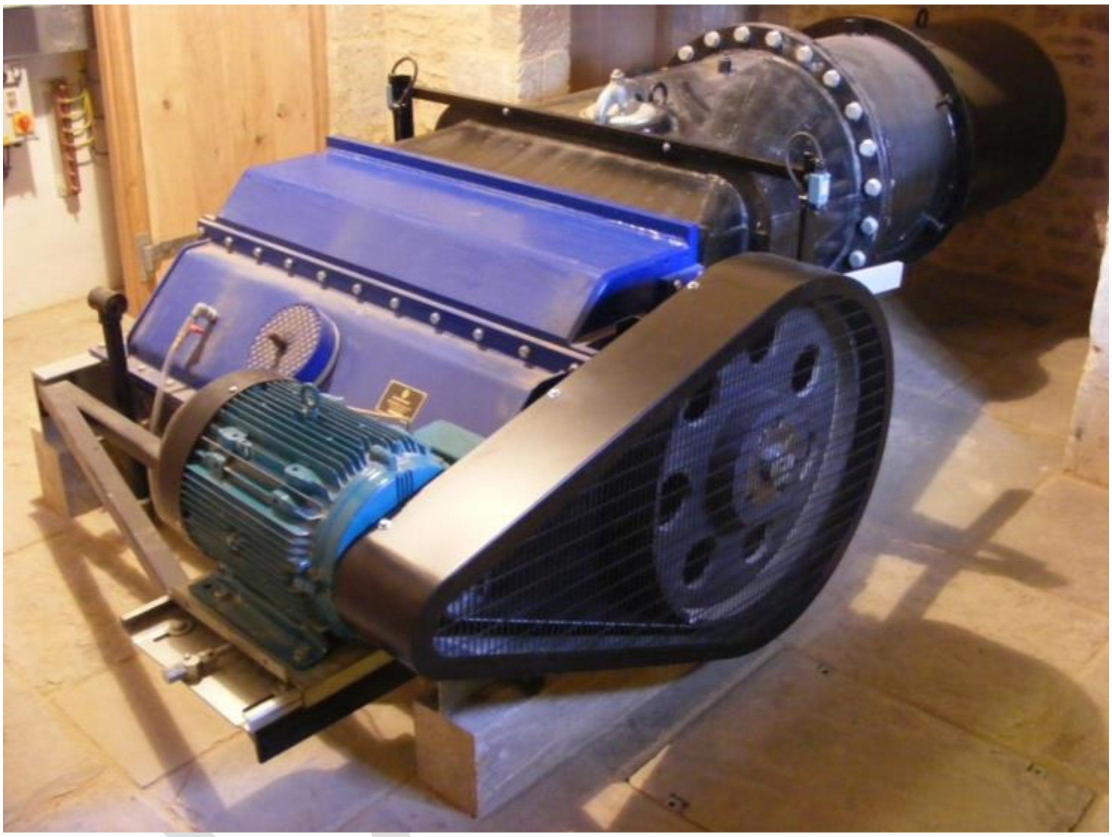

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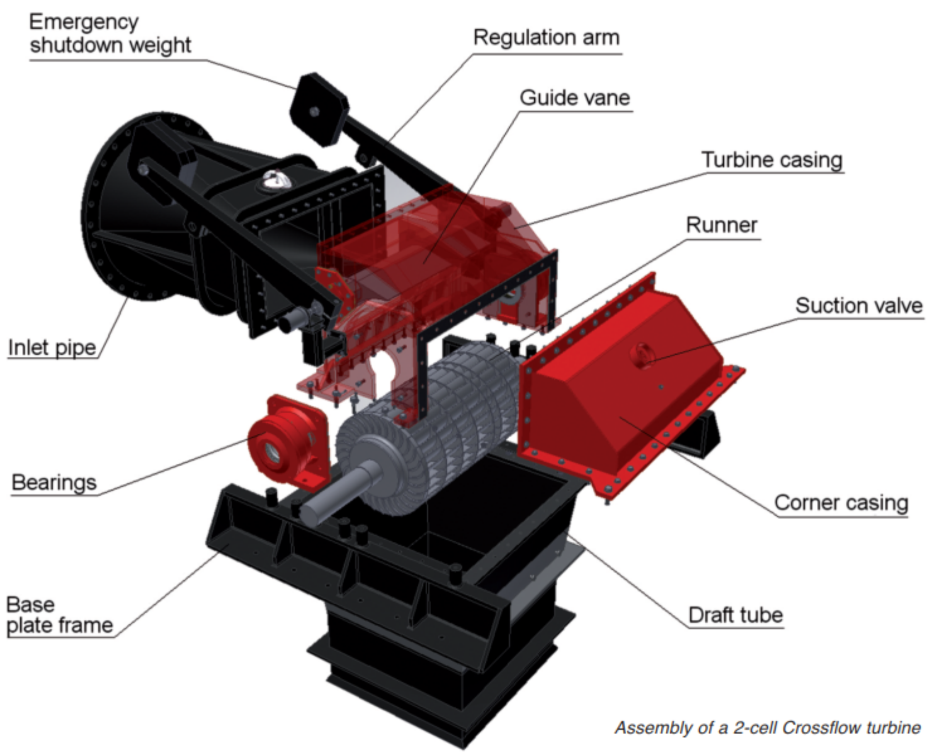

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Construction Method

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The turbine outlet is under the machine and the discharge pit for this will be concrete lined. This will be built before the area is opened up to provide the outlet to the river. There is no need to have any concrete work in the river at this outlet point. The Inland Fisheries Ireland publication *'Requirments for the Protection of Fisheries Habitat during Construction and Development Works at River Sites'* will be followed.

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Control System

The control system for the turbine is fully automatic and needs no adjustment after its initial setup.

Turbine output is based on the reading obtained from a head level sensor that is placed in the intake chamber. The sensor will be calibrated so that the 12.5%Qmean available flow is maintained at all times in the channel below the weir and so that the turbine will shut down when the water levels drops to 12.5% Qmean (0.017M^3/sec). This will be done by calibrating the controller to limit the turbine output based on the water level above the intake.

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Finance

At this stage in this project it is difficult to be precise as to final costs. This is due to the costs varying between now and the actual building of the project and the possible restrictions put on the project during the licencing process.

That being said the projected total cost of this project is €295,000 and it has an ability to generate €40,000 worth of electricity per annum

Quotations

In Appendixes XIII and XIV there are quotations for a turbine and for pipe from one manufacturer.

Hydro will cut CO_2 emissions by 85 tonnes per annum