Archimedean Screw
Hydropower scheme at
Guyzance Meander

DESIGNER'S ENVIRONMENTAL SUSTAINABILITY ASSESSMENT

31st October 2018

Mann Power Hydro Ltd
Barton Cottage
York Road
MALTON
North Yorkshire
01653 619968
info@mannpower-hydro.co.uk
www.mannpower-hydro.co.uk

Version control

18.10.2018	first issue, for EA licensing application & planning
20.10.2018	updated with minor amendments for planning
31.10.2018	updated with minor amendments for EA licensing and Env Permitting

Author: Adrian Clayton MSc, engineer, Mann Power Hydro Ltd

31.10.2018

Reviewer: David Mann, director, Mann Power Hydro Ltd

31.10.2018

Executive summary

The design of the proposed scheme has taken account of the latest regulatory guidance for best practice hydropower schemes. Consideration is given in turn to those areas of greatest interest in EA licensing. An operating regime is proposed which has been intentionally designed so as to have least environmental impact while still allowing a viable hydropower scheme. The proposed regime is as protective as EA default guidance, or more so, and significantly exceeds guidance in terms of minimum residual flow. This regime seeks to minimise change to the natural environment. Other aspects of scheme layout and technical design are detailed to minimise or mitigate environmental detriment.

Introduction

Renewable energy developments benefit the environment through carbon emissions reduction, but must also demonstrate sustainability in wider environmental terms. The present document summarises how the proposed scheme addresses environmental considerations as noted in the Environment Agency (EA) Good Practice Guidelines (2009) on environmental assessment of low-head hydropower, as modified in guidance to 2016.

Using an Archimedean screw turbine is identified as having low negative impact on fish. This is recognised in latest EA guidance, where the default position is that screws meeting standard criteria are considered for implementation without any fish exclusion screening.

This document is laid out with respect to areas of principal interest to the EA, but serves as a summary of relevant environmental issues and how the project design addresses these.

EA licensing and consents

The applicant and agents have had informal discussion with EA Newcastle during 2018 with regard to issues which will be considered by the EA during licensing.

The Coquet is a main river, therefore Environmental Permits for the works in the river will be required from the EA as Lead Local Flood Authority. Planning permission is being sought from Northumberland County Council.

Application is made to the EA for grant of licence to change the status quo, as follows:

- Build a new intake structure at the riverbank, to act as a new point of abstraction
- Admit agreed amounts of flow - by gravity fall - through this intake via a new buried pipe, this inflow to be admitted or prevented by a hydraulic vertical sluice gate. The undershot gate will in principle normally operate fully open (drawn up above water level), and will close to exclude all flow when abstraction is not permitted or not required or when there is a fault (failsafe closure: gravity fall when positive signal lost).
- Control the flow rate of this abstraction by managing the rotation speed of an Archimedean screw turbine – by means of a variable-speed control system and its software parameters - allowing the water to fall back to the river via the screw and thereby generating electricity.

- Maintain an acceptable residual flow in the main channel at all times. The proposed regime is for (Q75 HOF + 50/50 proportional take) – this is designed to preserve an unusually conservative minimum residual flow to maintain necessary services (fish passage) and also to preserve an acceptable degree of flow variation in the main channel.
- Condition these changed flows based on continuous recorded input from a level sensor at the intake, and a proportional-take equation. This will be calibrated in the field, but stage-discharge data can be provided as the basis for this method.
- (Potentially – subject to discussion with authorities and agreement of weir's landowner:) contribute marginal improvements to the passability of Guyzance Mill Weir, such as by superficial addition of substrates, if the weir is to be retained.

The EA will consider whether these proposals meet is definitions to be conditioned as an Impoundment licence or a Full Abstraction Licence for the hydropower system as a whole. The abstracted flow here will be used for hydropower, therefore this does not seem to meet the definition of "without intervening use" which defines a Transfer licence. A unit charge is inapplicable for hydropower abstraction.

In the event that any time-limited form of licence were to be required, it is foreseen that the licence review date may be the next CAMS end date. However, if the environmental risk of this proposal is considered to be low, the EA is invited to exercise its discretion (as explained when time-limited licences were introduced) to grant a "long-term" licence to the subsequent CAMS end date.

EA PLEASE NOTE: If the EA decides to issue an abstraction licence WITHOUT an impoundment licence, or vice versa, **the EA is asked to supply a formal letter stating that whichever licence type is NOT issued is (in the EA's opinion) formally "NOT required".** The issue of such a letter in this case is required by OFGEM as a prerequisite (as proof that no further application is outstanding for another type of licence) before it will consider the hydropower scheme as eligible to receive income.

Environmental Impact Assessment (EIA)

For hydropower schemes which are less than 0.5 MW (5 times larger than proposed here), statutory EIA is only invoked where there is also a concern the scheme must demonstrate no significant risk of environmental damage to designated protected sites such as a SSSI.

The applicant is submitting an Environmental Statement for EIA in the light of the Coquet designations. On the basis of the evidence submitted, and subject to the regulatory conditions which will be imposed by the EA and planners on any areas of specific concern, the designer considers that the present project will not be found to pose significant risk to designated features. The ES will be available to the EA via planning, or can be provided on request. (Specialist reports used as sources to the ES have been submitted to the EA.)

Water Framework Directive

In considering a proposal for a hydropower scheme, the EA will have regard to the EU Water Framework Directive (WFD). The EA has a legal duty to ensure that all existing and new modifications do not risk preventing the waterbody achieving its status objective, nor causing a deterioration in its current status. The submission is therefore expected to make a case for how this scheme design complies with the intent of the WFD, in the light of criteria in 2012 EA GPG Appendix 2.

The relevant waterbody is GB103022076693 – Coquet from Forest Burn to Tidal Limit. Details were viewed (Oct 2018) on the EA's Catchment Data Explorer: http://environment.data.gov.uk/catchment-planning/WaterBody/GB103022076693

The Coquet has Good Ecological Status at present (as of 2016), and is targeted to have Good Ecological Status by 2027.

By following latest EA guidance for hydropower schemes, and as detailed in this and supporting documents, the current proposal takes reasonable practical steps to mitigate its negative impact, and will have no detrimental impact on the WFD status of the Coquet. The EA typically considers that the significance of impact on WFD quality elements should be assessed at a waterbody scale (except for critically sensitive habitats). As considered below, quality impact is unlikely to be significant even locally, and its significance at a waterbody scale low or zero.

Hydromorphology and geomorphology

See Hydromorphology and Hydrology assessments for detail.

Rivers act as a conduit not only for water, but also for gravels and sediment. The river has evolved in response to a combination of natural and anthropogenous processes. The point

at which the Coquet's channel deviates to form Guyzance Meander has been created and held in relative stasis for centuries by the hard landform.

The proposed scheme is not anticipated to have any significant impact on bedload gravel or sediment movement through the catchment. The proposed abstraction of a minority of the river's flow during medium flow conditions will not reduce the river's ability to mobilise and propel bedload material along the gorge-like channel during those high flows in which this process occurs. Suspended sediment will continue to move through the natural channel and in future through the hydropower intake channel in proportion to the flow of water in each case. Sediment will not be screened or settled out of the hydropower intake channel and will remain within the water column to pass freely through the Archimedean screw turbine.

Coarse woody debris and leaf material likewise will not be screened out at the entrance to the hydropower intake. Only the largest sticks and branches will be stopped at the debris screen and will then be fended off into the natural channel or withdrawn by the operator at cleaning intervals - a maintenance activity whose continuance is assured by the need to maintain the efficient operation of the system. The smaller elements of materials that pass into the intake with abstracted flows will pass on through the hydropower intake and pass safely through the screw. The majority of flow does not approach the hydropower intake, and material borne in rest of the river will pass on down the natural channel as at present.

While weirs form an obstruction to natural processes, having persisted for many years this in itself can contribute locally to the variety of form in a river. The weir at Guyzance Meander is such a case, with a slow pool upstream and more turbulent flow downstream adding to other natural riffles

River restoration for ecological purposes may sometimes favour the removal of a weir to create a specific benefit, and in some cases the absence of other drivers to retain the weir could make it possible now or in future to make the case for removing the weir. A hydropower scheme creates a new licence or permission to make use of the river in its current form. This has potential implications in terms of an expectation or a right of continued use of the weir. This use may then become a new material consideration when authorities wish to weigh the evidence for possible removal of a weir as part of a programme of renaturalisation works in a river catchment.

In the present case, the weir is not in the same ownership as the proposed hydropower scheme, and the applicant is not entitled to decide future maintenance or fate of the weir.

The form and scale of this weir are the result of its purpose in creating a limited fall in height in order to operate medieval mill-wheel technology on the site of Guyzance Mill. However, the topography of the river channel along the meander includes significant gradients in the channel, giving a total fall in height such that a modern hydropower scheme across the neck of the meander (as proposed) can be designed to operate even if the weir were not present (subject to suitable recalibration of the hydropower control logic).

This has allowed the proposed scheme intake to be positioned and designed in such a way that it is not, in fact, critically dependent on the continued existence of the weir. It is therefore important that the potential for the proposed scheme to complicate the arguments for weir removal should not form a consideration in consenting the proposal.

Flow Regime

See Hydrology and Fisheries assessments for detail.

The project fisheries consultant proposed a minimum residual flow of Q90 and a flow split of 50/50 thereafter. This is what SEPA in Scotland typically licence for a depleted-reach Archimedean screw scheme on a salmon river with a semi-passable weir and no co-located fish pass. This minimum of Q90 allows more flow than the EA's default guidance of Q95 in the same circumstances.

This project instead proposes to agree a yet more conservative position, to ensure that there is no residual concern that conditions in the depleted reach will be detrimentally impacted. The proposal is to agree a minimum residual flow of Q75 and a flow split of 50/50 thereafter. Q75 conditions were witnessed by the fisheries consultant, and were deemed at all points in the affected reach to create suitable conditions to preserve fish habitat and movement. A 50/50 proportional take on top of a Q75 minimum flow will give a variable flow which will provide a more favourable regime for fish movement than the EA's default guidance, because it will better augment lower depleted flows rather than higher depleted flows where passage is more challenging.

No water will be taken before the river reaches its Q75 condition. Above this, 50% of additional flows may be taken, up to a maximum abstraction of 2.90 m3/s. All other flows will remain in the main channel.

The proposed abstraction would create reductions in flow from Q75 upwards, as follows:

Flow	BEFORE	AFTER	Proposed regime:		
Q%	Total site flow	Depleted site flow	Actual abstraction	% abstracted	% left in river
1	60.30	57.40	2.90	5%	95%
5	28.28	25.38	2.90	10%	90%
10	18.24	15.34	2.90	16%	84%
15	13.71	10.81	2.90	21%	79%
20	11.00	8.10	2.90	26%	74%
25	9.23	6.33	2.90	31%	69%
30	7.82	5.00	2.82	36%	64%
35	6.81	4.50	2.32	34%	66%
40	5.97	4.07	1.89	32%	68%
45	5.19	3.69	1.51	29%	71%
50	4.57	3.37	1.19	26%	74%
55	4.00	3.09	0.91	23%	77%
60	3.47	2.83	0.65	19%	81%
65	2.98	2.58	0.40	13%	87%
70	2.54	2.36	0.18	7%	93%
75	2.18	2.18	0.00	0%	100%
80	1.90	1.90	0.00	0%	100%
85	1.66	1.66	0.00	0%	100%
90	1.43	1.43	0.00	0%	100%
95	1.18	1.18	0.00	0%	100%

This has been designed as the most favourable regime for the river that can be proposed for a viable hydropower scheme at this site.

Effect on the depleted reach

The reach which would be depleted by the proposal is a meander of some 1750m, following a roughly square course (south-west-north-east) around Whirleyshaws Hill. At its western corner, the meander turns to fall over Guyzance Mill Weir, a diagonal weir of some 1.3m height (as measured 24th Sept 2018 by fisheries consultant in approx. Q75 state) pointing downstream at the former Guyzance Mill on the left bank, with an unfurnished fish slide or easement at centre-right of the weir (towards Whirleyshaws side). At the northern corner of the meander, the Coquet is joined by a tributary stream from the north (Quarry Burn including Westwood Burn).

The proposed point of abstraction is on the right or east bank, outside of the reflex bend westwards where the meander begins. This is a sharp change in direction at a longstanding relative hardpoint of higher bank which has caused the meander to form. The point of discharge is on the right or west bank as the river returns southwards.

The proposed abstraction regime has been designed to have the least impact on flow variation while allowing abstraction for a viable hydropower scheme. Specifically this means having allowed for the highest levels of non-abstraction and leaving the most possible water in the depleted reach, having particular regard to lower flows where the free movement of fish may become most difficult.

Difficulty for fish movement, in particular at low flows, is principally due to the weir which present the key obstruction to free passage. The project may be able to facilitate the superficial addition of eel or lamprey substrate to the weir or its fish easement if this is concluded to be a desirable outcome, subject to consent of the applicant's neighbour who owns the weir. As noted elsewhere, the scheme is designed to be able to continue to operate even in the future absence of the weir, so does not create a dependency on this.

Water quality

As noted above, quality is among elements assessed for compliance with the Water Framework Directive (WFD), and the Coquet has good ecological and chemical status. It is anticipated that present information will be sufficient to conclude that this scheme design does not prejudice the attainment of water quality objectives.

The proposal will redistribute some flows away from the depleted reach as described, this being subject to a licensed regime derived specifically to protect rivers from abstractions of this sort based on best-available knowledge of impacts. All water will remain available in the catchment, depleting only the meander. Oxygenation continues to take place, now at the screw as well as the weir. Sediment, not screened out, is allowed to move through the system as before.

Where there are existing wastewater discharges into a depleted reach, there is potential for a new abstraction to reduce the dilution of these discharges. EA records locally show six current (non-revoked) licensed discharges:

EA EP reg#	Type	Premises	Grid ref#
NE/223/A/1018/001	Private sewage	(GUYZANCE HALL) WEST LODGE	NU2077003760
NE/223/0913/001	Private sewage	GUYZANCE HALL / BARNHILL FM	NU2128003700
NE/223/0913*/001	Private sewage	GUYZANCE HALL / BARNHILL FM	NU2150003600
NE/223/0634/001	Private sewage	GUYZANCE VILLAGE	NU2110004000
NE/223/0930/001	Private sewage	BANKHOUSE FARM	NU2095005050
NE/223/F/0446/001	Private sewage	BRAINSHAUGH FARM	NU2025003250

The first three are small consents operated by the applicant. The other three discharge to tributaries which are not being depleted: hence these tributaries continue unchanged as the bottleneck constraint on dilution of those discharges. Pending the EA responding to a request for confirmation by providing the detailed data of these discharges, it is understood that all are small-volume discharges, which will continue to be satisfactorily diluted by the comparably larger main river flows vouchsafed by the proposed flow regime, even where it deviates most greatly from the status quo (for % deviations, see previous table above). The proposal therefore has no negative impacts on the dilution of discharges.

No detrimental impacts on water quality have been reported by the EA from around a hundred similar micro-hydropower sites operating under the EA's regulatory guidance for Archimedean screws. Several hundred other small hydropower schemes have been in operation on watercourses in England, over an increasing depth of time, with no evidence of negative impacts on water quality. Impact of the present scheme is unlikely to be significant even locally, and its significance at a waterbody scale is low or zero.

Water resources

Pending the EA responding to a request for confirmation, it is understood that there are no competing licensed abstractions in this area that will be derogated or otherwise disadvantaged by this proposal. The proposal poses no detriment to wells or boreholes. No flow gauging sites or flow measuring structures are present within the area affected. A requirement to maintain suitable main-channel flow is met by an agreed residual flow. This scheme has no effect on distribution of flow in the wider catchment, beyond the intake and outflow, and hence also no impact on the Morwick gauging station or others.

The applicant is confident that the other riparian landlord at this site has no intention of proposing a competing application for this reach such as might complicate EA licensing.

The volumes of water licensed for use by the system will be measured as per EA WR standard conditions for hydro schemes, by calculation from generation output using a conversion factor which is derived at commissioning and advised to the EA.

For national water management purposes, under an abstraction licence the EA seeks to apply a maximum limit to the quantity of water that may be abstracted per year – the "annual quantity" - as well as the instantaneous flow. At this site there is no particular reason to cap the annual quantity to less than 365 days' equivalent of maximum design flow, but any reasonable amount will be acceptable. The key result is that any proposed arbitrary administrative cap on the annual quantity must not prevent the scheme from using its agreed daily quantity if that agreed quantity happens to be available on any day. EA Hydropower specialists have previously assured us that this is not the intention of the annual quantity, and the value of annual quantity should not be set so as to cause a conflict. (If the scheme is to be licensed with an impoundment licence only, it is not necessary to specify this notional limit at all.)

Environmental Management

An Environmental Management System is now a requirement when obtaining an EA Environmental Permit to construct the scheme. This has been submitted to the EA as part of the application, and covers all areas of environmental risk during works.

Responsibility for running the scheme on a day-to-day basis, and any maintenance program for the site, will lie with the applicant. Their personnel or contractor will maintain the system on a regular basis in the interests of maintaining their income to recoup their capital investment. This scheme does not have unusual technical complexity – i.e. its operation does not necessitate integration with other sluice gates or channel controls - therefore a formal management plan for the hydropower scheme does not seem to be a proportionate requirement, as all relevant conditions can simply be included in the licence.

Whatever residual flow is agreed will be calibrated and set by an equation in the control software, which takes as its input the river level at the intake. This is the method successfully used at other proportional-take screw sites such as those regulated by SEPA in Scotland. The software will control the turbine speed to govern abstraction to be no more than the agreed proportion of river flow, controlling the water level at the intake to maintain a given Qn condition which represents what has been agreed as the "depleted" condition, using an agreed lookup table of field measurements of level vs gauged flow.

The contents of this lookup table and equation can be calibrated during commissioning of the scheme, and written approval of the method can be a condition on the licence as a prerequisite to operation. A representative table of stage-discharge data will be provided.

The system's operation "fails safe" – i.e. when the relevant level threshold cannot be maintained, or in a fault condition, the hydropower sluice closes passively on loss-of-signal and abstraction to the turbine ceases.

If the scheme is to be licensed with a full Abstraction licence, the standard EA hydropower conversion sheet will be completed to ensure correct reporting of abstracted flows; even with an Impoundment licence - where the legislation itself does not require annual reporting - the same effect can be achieved via licence a condition, if there is a particular concern to monitor this. Equipment calibration documents, efficiency specifications, etc can be supplied upon installation. If the EA wishes to make visual inspections of compliance with a minimum water level, installing a visible staff gauge close to the the relevant level sensor (typically at the intake) is often conditioned in the licence. The foregoing standard provisions are typically deemed adequate to meet requirements of EA Environmental Management (Enforcement).

Ecology

Refer to Ecological Appraisal report.

The scheme is designed with features and a proposed flow regime which are intended to minimise detriment to local ecology and nearby designations and their features of interest.

Specific aspects of potential interest include:

- Fish, including salmon, trout, eels and lampreys: see Fisheries section, below. Proposed changed flow regime is designed with specific regard to mitigating impact for fish and their habitat, with concomitant similar mitigated impact (via limited flow reductions) on other species.
- crayfish: no impact anticipated. Found likely absent.
- benthic macroinvertebrates: no significant impact anticipated – bed conditions unchanged (except for small works footprints at intake and outflow). Standard silt and pollution control conditions for river works to be followed during construction.

- aquatic macrophytes: no impact anticipated – depths and flows are not being modified to such an extent that local aquatic plant assemblages likely to deprived. Plants further afield are not impacted by the changed regime.
- otters:
    - potential for transit – small areas of riverbank are implicated, passage around these changed areas remains open for transit, opposite banks are not affected
    - holts and lay-up areas – not found at initial survey, site checked again before works, any new holts managed with mitigation plan and contractors made aware
    - risk to individuals during works – all open excavations will be provided with exit ramp or slope
    - risk to individuals during operation – intake screens minimum 100mm spacing, sufficient to prevent entrainment
- badgers: no setts found, but locally present - similar mitigations will be followed
- water vole: no impact - likely not present:
    - Water level variation will be slightly moderated during scheme operation, but will continue to vary, so habitat implications are not changed.
- nesting birds: relevant tree/habitat clearance outside of March-August (or only after ecologist checks for nests) will avoid any detriment.
- bats: low roost potential in all the trees in working area, and a further aerial check will be made for roosts prior to works. Conditions for daytime working / lighting during works will avoid any detriment to foraging.
- other vegetation: no significant impact anticipated – loss of locally typical bank vegetation within a small footprint – footprint of works is mostly grass / some scrub.
- invasive species: River works contractors follow standard guidance and standard methods for dealing with the most common invasives, as per EMS.
- Designated sites: Coquet SSSI/SAC and interest features thereof. For specific detail, refer to Ecological Appraisal (and EIA Environmental Statement).

The potential presence of protected species is not only seasonally-determined but can change from year to year. Ecology assessment identifies a need to check for specific species prior to construction, and provide mitigation measures as appropriate. Due consideration will be given to the protection of wildlife during works and to the appropriate eradication of any undesirable invasive flora and fauna discovered.

Fisheries

Refer to Fisheries technical assessment and to Hydrology assessment for flow regime. The scheme is designed with features and a proposed flow regime (Q75 HOF plus 50/50 flow split) which are intended to minimise detriment to fisheries in the Coquet.

Habitat

Fish habitat quality impacts are anticipated to be low. Changes to oxygenation or temperature are negligible. The proposed flow regime deducts only an agreed proportion from medium flows, maintaining an occurrence of relative peaks, and not modifying spate events which move vegetation and bedload and which thus refresh bed habitats. Limited modification of the flow regime to an extent which does not greatly reduce natural variation likewise minimises the potential for impacts on channel depths, widths and form. The proposed regime prevents abstraction during all flows up to Q75 which prevents any net impact during low water conditions. If this flow regime is agreed it will not significantly impact habitat in terms of passage, residence or spawning.

Sediment release from the construction works is minimised by working within the cofferdam and filtering all pumped water back to the river.

Downstream passage / Intake screening

The proposed proportional-take flow regime maintains downstream passage over the weir and through the depleted reach. It causes a proportional (minority) reduction at higher flows than Q75, and causes no reduction in weir flow or main channel flow in conditions below Q75, in which condition the technical assessment indicated that the weir and channel are concluded to contain sufficient water to maintain downstream passage for all fish species.

EA guidance allows that it is not necessary to exclude fish from an Archimedean screw turbine, provided that the screw complies with a guidance matrix based on research evidence, which sets limits on blade tip speed (a function of rotation speed, number of blades, and diameter) and on minimum diameter; and which requires that it is equipped with correctly affixed and maintained compressible rubber bumpers on the leading edges.

Larger-diameter screws such as proposed here comply with EA guidance thresholds. Where – as proposed here - larger-diameter screws are implemented with steel troughs

(rather than rough or erosible concrete troughs) and are operated under a variable-speed control system (which keeps all chambers full of water at all times), the risk of damage to fish is logically less likely than in other cases (where smaller quantities of water are injected into screws at higher fixed speeds and/or with more irregular trough surfaces.

Research has been carried out regarding potential damage to fish passing through Archimedean screw turbines. Most of this research has considered salmonid smolts which move downstream through the screw. Potential differences in the implementation of different screws, such as those above, may help to explain the variation in the low incidence of scale loss which is attested in some research on live smolts passing through screw turbines. The system proposed for this site adopts all the above known measures to minimise this impact while still permitting that smolts may pass through the screw. This remains in keeping with EA national licensing practice at the present time.

The proposed proportional-take flow regime is designed such that the hydropower intake will never admit more than a minority of river flow and will therefore not be predominantly attractive as the downstream route. This represents the best available mitigation which the flow regime can be made to provide while still accommodating a hydropower scheme.

The intake structure is designed to accommodate a screen of vertical 25mm round bars at 100mm spacing. This will admit fish which opt to enter the screen to follow this route, but will ensure that inflow velocity at the screen is low enough to remain escapable across the flow regime. A screen of 4m overall width will keep average escape velocities below a maximum of 0.5 m/s (when the full abstraction occurs) if measured through the screen aperture. (A lower velocity would require a wider screen with greater footprint and visibility in the landscape.)

In practice, due to proportional take, all increases in abstraction are accompanied by a rise in water level. Full abstraction does not occur until a water level is reached which is higher than the screen soffit, above which condition, the level continues to rise. Therefore attraction velocities at a short distance before the screen aperture will slightly diminish. (Status-quo Qn water levels are to be calibrated on site upon construction of the intake, and the operating regime conditioned accordingly.)

It is proposed that the intake screen and aperture are opaquely roofed over, which thus presents a dark route in comparison with the main river channel. It is anecdotally

understood that smolts presented with a choice of downstream flow route options of equal depth do not preferentially enter dark grated intakes rather than the open river.

Seasonal suspension of operations is not normally proposed in assessing screw schemes, and it is unlikely that this would be a viable option for this scheme, as it has proposed a conservative flow regime which is already very conservative. Seasonal screening may also prove difficult to agree in this location.

If regulators in this case depart from established EA regulatory precedent and are able in this case to cite compelling reasons why they must instead propose an unusual condition which permanently excludes smolts from the intake, then regulators will present specifications of evidence required to demonstrate that the scheme as proposed poses no unacceptable risk. Any such further evidence may form a condition on a licence or planning consent. Typically, where there is such residual concern, there is widespread regulatory precedent for a suspended condition to require retrospective exclusion screening in the event of future developments emerging from monitoring, wider research, or in forthcoming changes to regulation or legislation.

Upstream fish passage

The proposed proportional-take flow regime causes no reduction in weir flow or main channel flow in conditions below Q75, when assessment indicated that the weir easement is suitably passable to migrating salmonids, the weir is wetted to allow the passage of juvenile eels, and that all other parts of the depleted reach are passable in general. At flows above Q75, the proposed regime marginally reduces flows in the deleted reach, which assessment indicated was unlikely to cause detriment to passage. Specifically this also marginally reduces flow in the weir fish easement, reducing overcharging, making it less challenging to ascend for those fish which attempt this, especially in higher flows.

It is unlikely that a new co-located fish pass would be agreed acceptable at this site, as it would bring upstream migrants out of the designated main natural channel and instead into a pipe. With no pass nearby, a deep pool will be provided so that screw discharge loses its velocity sufficiently that it does not predominate as at attraction to fish. The proposed flow regime will permanently provide significant attraction in the adjacent onward river channel.

The weir is not part of the applicant's property, is difficult to access for large works, and cost of installing a pass there would be disproportionate even if it were desired. Subject to

agreement with the neighbouring landowner, minor manual work to add lamprey or eel substrate at the existing fish easement or weir face might be possible, if agreed to be a desirable improvement.

Timing of works

The EA prefers that works within the river should if possible be carried out outside of the main migratory period for relevant fish populations. Works for this project will take place within dewatered cofferdams and/or will then proceed behind a closed sluice. The EA is invited to indicate any ecological “best season” to minimise river impacts in the Coquet, so contractors can consider how works might be scheduled around this.

Trees

Implications have been considered in a dedicated report for planning, finding no likely significant impacts. Removals are of semi-mature trees in two small areas, locally common species, mostly replanted beech, of low bat roost potential. Replanting is recommended and will be conditioned in planning.

Noise

Implications have been considered in a dedicated report for planning, finding no likely significant impacts.

Recreation and amenity

Operational impacts of the proposed development are limited to the watercourse of the Coquet in the depleted reach of the meander. No rights of way are affected.

Third-party recreational or amenity interests are affected only insofar as the development will reduce river flow, within that reach of the river only, during some parts of the flow regime as described. The system cannot operate at all in the lowest 25% of river conditions.

The intake is in deep water and is screened to exclude human access. The intervening channel is culverted and not accessible (except via the security hatches for maintenance). The discharge point is also in deep water. As is typical for Archimedean screw hydropower schemes, the discharge is not screened. When the screw is operating, the release of large volumes of water repels swimmers or canoeists from the immediate vicinity of the screw.

Potential environmental risks in construction

Ecological risk from pollution of the watercourse is managed by precautions during works. The following risk factors have been identified and clear prevention and mitigation measures are contained in the project construction method statement.

- Fuel/Oil Spillage resulting in soil contamination
- Fuel/Oil Spillage resulting in contamination of water course
- Contamination of watercourse with cementitious material
- Contamination of watercourse with chemicals
- Contamination of watercourse with sediments due to run off from excavations

These risks are familiar to construction contractors using construction materials and manual or mechanical plant in rivers. Clear prevention and mitigation measures compliant with EA guidance are put forward in a project outline Construction Method Statement (CMS) which will be the model for Method Statements (MSs) required from contractors.

During works, water flow through the works will be excluded by piled or bagged cofferdamming below, and by closing off the intake above, removing connection to the watercourse. Where oils are required for operation, PANOLIN environmentally low-impact products are used.