Hydropower installation at Little Paxton, St Neots

HYDROLOGY ANALYSIS: UPDATED / REVISED Aug 2023

6th September 2023

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Version

1.0 for EA licensing application
1.1 data table expanded
1.2 updated to support licensing design
1.3 minor updates / clarifications

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Background

A Hydrology Summary for this proposed hydropower scheme site was presented in March 2022 by consultants Hydroplan. That report is reproduced as an Appendix at the end of the present document (Hydroplan 2022a) and is replaced in full by the present document.

The present document revises and updates a hydrological description of the proposed hydropower site, using a fuller set of evidence, and incorporating responses to questions and issues raised by Environment Agency's Hydrology team during the EA WR Licensing pre-app and the internal consultee phase of the formal licence application.

Purpose of this document

Energy can be extracted from falling water and harnessed to provide mechanical or electrical power. The theoretical amount of energy available from any given site is directly proportional to two factors: the actual volume of water available to hydro, of that which passes the site (the flow), and the height through which water falls at the site (the head).

In order to assess the hydropower potential of the site, it is necessary to have measurements of both the changing flow and head over the course of several years. This will determine what can be expected to be the average annual energy capture.

This hydrological information is of equal interest to the developer in evaluating the scheme, and to regulators in determining that the scheme will not cause unacceptably detrimental impacts to the river environment.

NOTE (2023:) In an amendment from the original submission, we now propose the licence should allow a design flow of up to the site's Qmean 16.190 m3/s (and all dependent values etc), in case the choice of turbine technology available and offered to us in the tendering phase allows us to efficiently pass this amount through the works. (We foresee unlikely that the larger max flow of 1.3x Qmean provided for in EA guidance can be exploited in available space, so we do not seek this.) If a lower cap on flow is imposed by the machine/s finally selected, this will then be a slight reduction in net impact on site flow distribution, and that only in a small subset higher up the hydrograph: any such adjustment can be handled via a minor licence variation. Likewise, final number and spec of turbines.

Environment Agency – Hydrology Team comments

These comments were provided by the EA to the present author in November 2022 and are taken as representing the EA's latest know position on Hydrology aspects of the hydropower proposal. The EA Hydrology comments are reproduced in full in boxes, with relevant responses if necessary. (Grey framework & green replies require no response.)

I. Please give some background information describing the catchment that this application falls within. I.e., is it natural or influenced and the type of geology? Is the surface water in continuity with the ground water at the abstraction point?

Please note – the AP should be AP3 Offord.

The application point at Mill Lane in Little Paxton is just downstream of the confluence of the river Kym with the river Great Ouse. The river Ivel joins the Great Ouse approximately 10km upstream of the application point. There are a number of groundwater and surface water abstractions that influence the hydrology as well as discharges such as sewage treatment works.

The underlying geology in the area consists of Oxford Clay, mostly covered by glacial till or fluvial deposits. Sands and gravels are found along the course of the river and these will have continuity with the groundwater, including at the abstraction point – the Groundwater team would need to be consulted specifically about this if required.

The above observation is noted and no specific response action is anticipated to be necessary. The project will not reduce water levels below existing normal low water levels (see further below for detail).

II. Please confirm the ASB for the site.

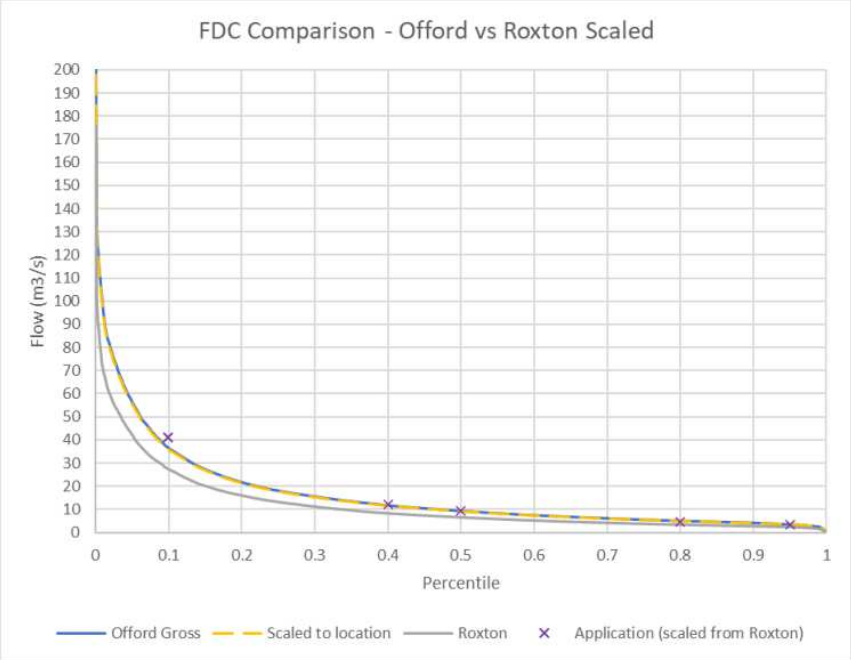
ASB 1

N.B. Allowable abstraction as % QN95: ASB1 = 20%

The proposed design is based on EA hydropower guidance, as a non-consumptive abstraction, which identifies no such limit on abstraction in ASB1 waterbodies. If such a limit were imposed on hydropower schemes in England, they could not be licensed or operate. Comment is inferred not to apply. (See further below for proposed detail.)

III. Is the flow data flow data provided acceptable? If not, please provide guidance as to what statistics to use and from where. What support information is required to validate/support this data, i.e., what level of detail is required (number of spot flows etc)? Please confirm if you need flow split.

The applicant (in Hydroplan 2022a) has used Roxton to estimate the flows when scaled up. The graph below shows the Flow Duration Curves for Roxton, Offord (Gross) and then the scaled data from the application and scaled data for Offord for comparison. Whilst the shapes are not too dissimilar overall, there is discrepancy in the higher flows and as flows from Offord (Gross) include additional tributaries such as the Kym which join the main river before the application point I feel that the Offord data would be more appropriate. As such I have used the data from Offord (Gross) for the flow calculations required.



Acknowledged. Our revised report (below) now instead uses Offord Gross DMF data, as recommended above, when making application for the licensed flow regime. The 30-year

data period now used is 01/10/1992-30/09/2022. Previously, no catchment-area reduction factor was applied. We calculate 98.56% at site, and apply this.

IV. Do we agree with the applicant's HoF? Please confirm the proposed HOF, or suggest a suitable alternative, with justification, for the site.

Applicant should be using Table A "Design Flows for Hydropower Schemes" from the Hydropower Guidance document as whilst the application is based around an existing weir, there would be a short depleted reach created.

As such calculations should be as follows:
River Type = High Base Flow
Q95/Qmean value = 0.2 & Above = 0.22
HOF = Q97 = 3.2 m3/s
Maximum Abstraction = 1.3 x Qmean = 1.3 x 16.3 = 21.19m3/s
Proposed 11.7m3/s due to site constraints
% take above HOF = 45% = 45%

In addition (to) the HOF the following restrictions need to be taken into account:
- A flow over the weir needs to be maintained at all times
- The retention level upstream of St Neots Sluice needs to be kept for navigation purposes. The retention level is set to 13.56 mAOD and maintained by operating the sluices automatically.
- Minimum residual flows (MRF) that might be needed through the sluice.

I am unsure how the applicant had calculated the HOF as they have stated Q77 where we would have expected it to be Q95 if following the rest of their calculations. However the value they have proposed is neither Q77 or Q95 so I would like to know how they have come to their HOF/what it was intended to be.

As previously explained above I have also used data from Offord rather than the scaled Roxton flow to calculate the HOF.

It may be that they can apply for more than 45% of the take above the HOF – the 100% they have applied for is based on the guidance below for Table B. *"These are schemes with turbines sited at or alongside an existing weir where there will be no significant flow depletion within the natural watercourse. These schemes discharge water back into the weir pool. Based on your environmental assessment and any mitigation measures you propose, we may allow abstraction as shown in Table B."*
However, discussion with A&R (Analysis & Reporting) raised concerns about the 50m depleted reach between the intake and the weir, so this would have to be considered, hence why I have gone with the standard application amount of 45%.

NB: Hydroplan 2022a assumed some values of unclear provenance which may relate to SEPA Scotland regulation, e.g. 80% of mean flow; and assumed High Sensitivity rather than ASB1 as here. Re HOF, EA guidance allows Q95-Q97, but the amounts previously proposed may also have been taking account of the inability of particular machines to start until a Qn condition somewhat higher than Q95, which may be the origin of an inferred "Q77". We use a new dataset as advised, and present new proposed values. This fully addresses the EA's previous uncertainty as to how the HOF is calculated.

The proposed design is based on the EA's standard guidance for hydropower, in which TABLE B deviations are justifiable on the merits of the case - having *"turbines sited at or alongside an existing weir [with] no significant flow depletion within the natural watercourse [and which] discharge water back into the weir pool."* As Hydrology notes above: **yes, we propose to deviate from 45% to 100% on the evidence presented for no detriment** - as is conventional for on-weir schemes such as this, which in practice usually involve such a short, albeit non-zero, depleted reach. Hydrogeomorphology evidence is presented in support of no unacceptable impacts. (See further below for other detail.) After receiving the evidence requested by EA at pre-app, **if EA Analysis & Reporting have any residual concerns about 100% take at this site**, we ask them now by reply to set out in terms the actual concerns so that we can consider and address them.

Using the agreed new dataset, EA Hydrology calculations above are reviewed as follows:

River Type = High Base Flow -	**confirmed**
Q95/Qmean value = 0.2 & Above =	0.23 (Offord Gross DMFs 9/92-8/22)

HOF = Q97 = 3.35 m3/s (Offord Gross DMFs 9/92-8/22)
Maximum Abstraction = 1.3 x Qmean = 1.3 x 16.19 = 21.06m3/s (Offord Gross 9/92-8/22)
(i.e. Maximum Abstraction which might potentially be licensed by EA under its guidance)

We revise the proposal to take a maximum of Qmean 16.190 m3/s rather than 11.87 m3/s previously proposed. (NB: Both amounts are below EA guidance limit for maximum abstraction for hydropower: our proposed maximum relates to site constraints other than licensable water.) **Note also:** Q97 3.35m3/s exceeds Q97 3.2m/3 accepted at EA pre-app.

% take above HOF = we propose 100%.
Hydrogeomorphology evidence is presented in support of this.

Also, as recommended, we have designed to ensure:
- A flow via the sluices at all times, satisfying EA A&R concern for ecological services MRF
- The retention level upstream to be maintained at a minimum level (HOL) of 13.56 mAOD *(or thereabouts: if parallel discussions with EA Assets/MEICA confirm different real target.)*
- Retention level is maintained automatically: a) by the HEP, operating automatically; b) if the HEP is not operating: by the sluices activating as at present. This dependency must be failsafe - likely subject to an operating agreement between the licence holder and the EA (conditioned in the licence). *(method subject to parallel discussion with EA Assets/MEICA.)*

V. Will a derogation be required for this proposal? If so, please give high level details.
Yes according to the Derogation advice document.
Details to follow after discussion with IEP and PO.

Acknowledged. EA WR is invited to add a Derogation condition in the licence, modelled on similar proportionate standard conditions in many other low-head HEP licences in England.

VI. Do we require any further hydrological assessment from the applicant? If yes, please be as specific as possible.
No - but please note additional measurement required in point IX (below – re HOF).

VII. Please liaise with H&T / A&R, Asset Performance, PSO and Estates Teams colleagues where necessary on the EA asset issue.

The asset is not owned by Hydrology and we have no direct input into its use.

Acknowledged. No further action needed.
(Parallel discussions are ongoing with EA Assets/MEICA re any operating dependencies.)

VIII. What information/data do you need regarding possible impacts of the scheme on the asset? Please be as specific as possible.

From a hydrology perspective we need to ensure that flow is maintained over the weir into the main channel. Discussion with A&R (Analysis & Reporting) reinforced the idea that flow must be maintained over the weir to avoid DO (Dissolved Oxygen) depletion between the abstraction point and the weir. NB: The applicant has included maintaining a flow over the weir within the application form.

Acknowledged. A minimum flow past the weir (sluices) will be conditioned. DO levels will in the weirpool are unlikely to be significantly reduced given that the turbine discharge and any fish pass discharge will also continue to emerge not far off in the same weirpool zone. A&R have called for post-operational monitoring: if, in light of hydrogeomorphology report, this is maintained still to be a necessary response, then a licence condition may impose a proportionate form of monitoring to confirm no detriment or require amended operation.

IX. Is there any other information you would require in an Application?

The applicant would need to consider how to accurately and reliably measure the HOF required for the operation of the scheme at the site. This could relate the equivalent level at Offord when flows are at the proposed HOF Q97 to the level at the site of the sluice or be based on a direct flow measurement downstream of the intake.

Acknowledged. Standard local methods are used, as typical of EA-licensed low-head HEP schemes in England. A licence condition may be included which requires, subject to agreement by EA Assets/MEICA, either: a) an undershot gate discharge equation to be presented, demonstrating what gate opening position is required to deliver the agreed HOF beneath (e.g. one of) the sluices; or: b) a narrow-crested weir equation to be presented, demonstrating what proxy HOL or water level at the sluices must be maintained as a minimum by the hydropower control system, in order to ensure that the agreed HOF delivered when all sluices are fully closed. The EA response seems alternatively to accept

that a one-time flow measurement in the agreed correct HOF QN condition (here Q97) would confirm that the agreed HOF is then delivered. Whether this is finally achieved by setting a minimum aperture beneath one or more gates, or allowing spill over the top of any of the gates, will require the assent of EA Assets/MEICA, having taken into account their preferred gate operating methods, agreement as to invert elevation value of the gate tops when closed, preference for ecological value of a small pressurised flow beneath the gates vs passage value of a small free spill over the gates, etc. In either case, further opening of any gate by any amount will deliver more undershot flow beneath than overshot flow is lost above for the same distance of gate travel. Therefore the proxy HOL in any event will represent a gate flow which meets or exceeds the HOF at the sluices whatever the status of the gates. Whenever a level equal to or exceeding the licensed HOL cannot be maintained, the HEP control system causes it to cease operation.

Alternatively, or additionally, it is also possible to install some form of telemetry connection to an EA flow gauging station, in order to stop the HEP abstracting when flows drop to HOF equivalent (here Q97), regardless of gate status. However, if the EA has no appetite for collaborative telemetry between an EA station and a third-party system, public API service must now be used (not real-time; potentially intermittent), then this could be a less-accurate and less-immediate response to conditions at site than agreeing a simple local geometry relationship. But, if still an option, an apparent closer time-event match with Roxton (see below) than with Offord recommends that the former would be the best proxy.

Thanks for arranging with Claire Leivers to come [to] telecall regarding derogation – …really helpful to get an idea of how it works with the pre-app/full application differences…
Following that, I think the pre-app response I sent is fine to stand as it is, that there will need to be derogation agreement in place, but will look at the details at the point of full application.

Further correspondence:
Please can you populate the FDC table, I seem to be unable to lift any sensible figures out of the programme! By lunchtime tomorrow (Friday)?! Please.

Offord Data:

Q95	3.58
Q80	5.11
Q50	9.37
Q40	11.8
Q10	36.4
QMean	16.19

Many thanks, Niky

From: Morris, Rebekah <Rebekah.Morris@environment-agency.gov.uk>
Sent: 09 February 2022 14:49
Subject: RE: Little Paxton Weir HEP Pre-App Consultation AN/033/0022/009 by Monday 31 January please.

Hi Niky, They would be able to use the data from Hydrology Data Explorer (Offord Gross).
Thanks, Beki

From: Drewett-Copp, Niky <Niky.Drewett@environment-agency.gov.uk>
Sent: 09 February 2022 14:06
Subject: RE: Little Paxton Weir HEP Pre-App Consultation AN/033/0022/009 by Monday 31 January please.

Hi Beki, please can you confirm where the applicant at Little Paxton can access the Offord Flow data for revising their flow stats and FDC.

Many thanks, Niky

EA expectations of hydrology assessment – *addressed in the sections below:*

- An overview of the catchment hydrology, Hydrometric data (current meter gaugings, gauging station data, model data, rainfall data)
- Flow duration statistics (flow duration curve, Qmean, Q95, prescribed flows)
- A pre-scheme assessment (flow survey) of all channels included within the scheme
- Assessment of the change in flow regime within all channels affected
- Seasonal variation in flows, Base flow/run-off comparison
- Assessment of high flow events (management of structures, relief channels)
- Reduction in downstream levels
- Raising of upstream levels
- Residual flows downstream of intake needed to safeguard river interests

Catchment hydrology and hydrometric data

Great Ouse catchment hydrology is well-understood. Upstream of the site, river flow is measured by EA gauging stations on the three main tributaries upstream of this site: the Ouse at Roxton, the Ivel at Blunham, and, closer to the site, the Kym at Meagre Farm. Long-term flow data series are available for these stations as daily mean flow (DMF) values and at 15-minute intervals. Downstream of the site, river flow is measured by the EA gauging station at Offord Ultrasonic on the Ouse. NRFA's online database describes status and context of each of these stations, catchment, and historic record. Because the Offord station is located downstream of a significant drinking water abstraction for Anglian Water, the EA also derives a virtual record entitled Offord Gross which recalculates a total river flow more representative of what the catchment delivers just before that abstraction. The EA has asked that the Offord Gross dataset be used in this application. The EA has further confirmed (May 2023), after some uncertainty, that the Offord Gross dataset is available only as daily mean flow (DMF) values and not as a 15-min series.

Rainfall

As is typical in the licensing of hydropower schemes, rainfall data is not directly presented or considered further. Hydropower submissions take into account catchment rainfall and geology only in terms of complying with EA guidance on hydrometry and sensitivity bands.

Flow duration curve and hydropower design flow

As is conventional, this licensing application uses the latest available complete 30-year data period, following the EA's licensing year from October to September: this is the DMFs dataset for 01/10/1992-30/09/2022 inclusive, from Offord Gross as the EA has directed. This data is used to produce a flow duration curve of the expected flows at Little Paxton by adjusting for the difference in catchment sizes. A catchment-area reduction factor of 98.56% has been applied to represent the smaller catchment area at the site of interest

The flow duration curve is calculated by analysing the data statistically and breaking it down into different flow bands, each occurring for >X% of the year. In this presentation, bands at 5% intervals are used. Each band then represents the percentile flow available, or the minimum flow that is in the river for that percentage of the year. For example, Q90 flow means that for 90% of the year, flow will exceed this amount.

This presentation of data serves several purposes, one of which is to predict the average annual energy capture by one or other design of hydropower scheme. Where curves of hydropower output are superimposed, they rise from right to left with rising river flows, but then peak and/or ebb again at higher flows, after the maximum capacity of the chosen turbine limits the flow which can be exploited for generation.

Key site values from the current dataset:
Qmean = 16.190 m3/s
Q95 = 3.696 m3/s
Q97 = 3.351 m3/s

The maximum rate at which water may be abstracted by a hydropower scheme is referred to as the design flow. In accordance with the EA's current hydropower guidance, the maximum design flow likely to be permitted by the EA is usually constrained to the mean flow rate in that river (Qmean). At this site, Qmean from the current dataset is 16.190 m3/s. The present application therefore proposes this as the design flow for the scheme.

Flow survey

The large majority of the site flow passes via the triple EA sluice gates at Little Paxton. The exception is a small flow via the navigation lock branch to the north. The constant flow via this branch is a sweetening overflow via a culvert beneath the former mill site, via an overspill crest at channel right, set with respect to the navigation's retention level. This was observed as a small flow emerging from the culvert at its downstream headwall to the tailpond, judged to be in the region of ~30 l/s. Small leakage flows which may occur past the lock are unquantified. During conditions when boats are moving on the navigation, there are also lockage flows. These are intermittent, occasional and short-term, they occur mainly in relatively dry conditions, and occur passively by gravity without derogation by any other use of water provided that the minimum navigation level is maintained. As both lockages and minor leakage flows can neither be measured or controlled by the proposed scheme, they cannot be conditioned in the licence; so the impact of their respective unavailability to the HEP and continued availability to the navigation channel must remain an unquantifiable net non-detriment to status quo of conditions in the local river system.

Proposed flow distribution including minimum residual flow

A residual flow must always be left to bypass the hydro scheme, to serve the bypassed part of the river channel, however short. At a site with only a limited reach of river being depleted by the proposed non-consumptive abstraction, as in the present proposal, EA guidance considers a flow of Q97 to be an acceptable level of residual flow, and here this would be some 3.35 m^3/s. It is proposed that this amount is shared between:

- an assumed existing nominal 30 l/s for the navigation lock channel sweetening overflow via the mill culvert; NB: Lockage flows, as occasional short-term demands, are not calculated; these are in no way derogated by the proposal – the hydro scheme responds passively to slow or stop its abstraction in the event of any perceived falling water level, whether due to lock filling or other causes;
- a minimum design flow of 1320 l/s at HOF for a new Larinier fish and co-located eel pass. A minimum ~20 l/s is suitable for co-located eel pass baseflow. The remainder is at least 8% of maximum turbine discharge (if 16.190 m3/s ultimately used by the selected turbine) or up to 10% (if a figure closer to 13 m3/s is ultimately exploited by the selected turbine). NB: 10% (relaxed down towards 5% in some instances) of maximum turbine flow has been an EA guidance minimum design flow for a Larinier fishpass; and:
- the remaining 2 m3/s of the above HOF to be left to pass the EA sluice gates – either to overtop them in their fully-closed position, or, if so preferred by EA Assets/MEICA, to pass beneath the sluices by a position setting to be agreed. This seems a reasonable minimum flow to ensure continuity of ecological and amenity services in the immediate area between the hydropower intake and discharge, given that all flows then recombine in the sluices' weir pool as at present.

The agent has initiated contact directly with local EA Assets/MEICA (January-August 2023) to comment on this proposal, in order to reach a mutually-agreeable technical solution, either directly or via the licensing process. An operating protocol is likely to be necessary which agrees that the hydro scheme will work to control upstream water level within a certain agreed range of limits, such that the sluices are not also competing to control that same range.

In summary: as the site level is already principally controlled by the EA sluices subject to a minimum upstream level, and continues to be so controlled by a combination of the new hydropower system operation and the EA sluices, the redistribution of flows at this site consists mainly of the permanent movement of a smaller baseflow from the EA sluices to the new fishpass, and the intermittent movement of flows across the middle of the hydrograph from the EA sluices to the hydropower scheme, to discharge within some metres of where they do at present. River interests in the depleted reach are maintained by the proposed regime, insofar as a flow is maintained to mobilise silt and prevent siltation, and refresh the weirpool, as described in the Hydrogeomorphology report.

The flow distribution is to be agreed by the EA during the application for the abstraction or impoundment licence. The regime is stipulated within the licence/s granted for the scheme.

Seasonal variation, and flexibility to be expected around a start-up condition

All changed behaviour depends upon river flow state, whose variation can occur in any season. Perhaps most constructive is to represent that in rising flows below some Q75-Q80 (greater precision to be determined only by the performance quality of the machine eventually selected), the hydropower scheme will not be able to commence operating; so that, in those conditions, there will be no change from present except for the bypassing flow in the permanent new fishpass. Once commenced, then in falling flows in the same range, the hydro may continue operation for a little longer, though will almost certainly stop by around Q85. Those conditions include all summer low-flow conditions.

Furthermore, at this site, a programme of levels monitoring discovered that there is an observable deviation of pool tailwater level behaviour between rising events and falling events, possibly influenced in part by operations of the EA sluices, but also likely by the downstream reach. While monitored values allowed deriving projections for average conditions, the variation seen may exacerbate the above divergence between precise start-up and shutdown points of a selected machine in rising and falling flows respectively.

The above subtleties help explain why the applicant seeks a licence with a defensible and permissible agreed low guidance value of HOF which does not at all constrain efficient operation of the chosen equipment or capriciously put the applicant in breach of a fixed

condition; but, that conditions may also frequently occur in the band ~Q80-97 where operation of the HEP will in practice not deprive the river of everything above agreed HOF.

In higher conditions, up until the hydropower scheme is running at full capacity, the immediate area of the EA sluices between hydro intake and discharge will experience only the residual flow. At highest flows with the turbine sated, all additional flow will cause variation to re-augment the depleted flow in that area. This re-augmenting effect will begin occur above ~Q25 if max abstraction if a turbine of were to take no more than 13 m3/s, but with the proposed 16.190 m3/s, is unlikely to contribute to the sluice route until around Q2 (see bold values in table at end). Conversely however, a machine taking 16.190 m3/s will tend to surrender more to re-augment the HOF in the sluices route in conditions around its start-up in lower conditions than a machine taking 13 m3/s which can start up on less flow.

High-flow events

The scheme is designed in principle to pose no unacceptable detriment to handling of flood flows, and is resilient to foreseeable events, as set out in due course in Flood Risk Assessment in the context of EA EP Flood Risk Activity permitting and Planning consent. If the screening equipment finally selected necessitates the inclusion of the depicted bywash channel to assist with the automatic cleaning of in-river woody debris from intake screens, the bywash may in practice be available to help increase conveyance by a small net amount in the worst events, albeit designed rather to retain minimum navigation level and not classed as a passive structure for flood relief.

Inclusion, use, and licensing status of a bywash flow

If the screening equipment finally selected necessitates the inclusion of the depicted bywash channel to assist with the automatic cleaning of in-river woody debris from intake screens, the proposed use of the bywash is to open when the HEP shuts down and thus make alternative use of that same flow which the HEP is licensed to abstract. This use of that same flow is a technical alternative to using a hypothetical alternative hydropower device which works in itself less efficiently in order to also process its own debris directly, thus diverting some unquantifiable portion of the energy of the water abstracted expressly for the production of electricity to facilitate the continued production of electricity at a tolerable efficiency. For a HEP such as that currently proposed which is required to protect

and screen out eels, the cleaning of the screening system is a completely analogous functional aspect of the production of electricity, likewise diverting a portion of the energy of the abstracted water to facilitate the continued production of electricity at a tolerable efficiency, albeit having to do this by diverting that water outside the intake screening from the same point of abstraction and delivering it to an identical point of discharge. In this sense, it is logical that the bywash flow is to be classed among the water used for the production of electricity, and not separately licensed or indeed charged for. However, if a bywash flow is to be separately licensed, a transfer licence is an acceptable instrument. In this regard, please note also that: the turbine will never abstract in flood conditions, in which a bywash might conceivably be opened to serve to help alleviate flood conveyance; and also that, in practice, the turbine will typically be slowed or stopped during any operation to use the bywash to flush large debris from the intake screen. Hence the bywash and turbine flows are complementary uses of the same water; so a condition worded to ensure that their combined total flow at any time must not exceed the maximum turbine abstraction would be acceptable.

The applicant favours that the wording of licensing conditions around a bywash are contingent on the applicant's suspended decision on whether to include the depicted bywash in the scheme as finally built. Since the benefit of including any such bywash in the scheme depends upon the results of a technical selection and procurement process for screening and turbine which is yet to be made, while its omission is conversely of arguably minor net impact to environmental interests (as situated closely adjacent to existing sluices with comparable and equivalent equal potential impacts), a simple means of licensing to provide for its eventual inclusion or omission would be of interest.

Inclusion and licensing status of fishpass and eel pass flows

While the community applicant is in principle positively disposed to the inclusion of a fishpass in this HEP scheme, the EA has advised the applicant at pre-app that there is no legislative driver to construct a fishpass at this site:

There is no legislative driver for a fish pass, the site is also not "frequented by", so I have "requested" not conditioned. If a fish pass isn't going to be part of the scheme, we would request to retain 10% of the flow for future opportunities to install fish passage.

In that context, given the net additional expense of the construction of a fishpass at the outset of a costly project and before the scheme has earned any income with which to pay back its investment and pursue its founding aim of helping fund projects of community benefit, the applicant favours wording the licence to allow, if possible, omitting or suspending any obligation to construct the depicted fishpass, while initially progressing the functional HEP scheme itself into licensed operation. The fishpass as depicted in outline is of an approvable design for the site and the HEP, and the depicted footprint is sufficient for this and approximately for any similar design to be included or retrofitted.

If the licence tolerates that the fishpass may not be constructed as part of the initial development, the reservation for future use of a fishpass flow as proposed here – i.e. 10% of the maximum turbine flow, this amount to be confirmed upon commissioning - would be an acceptable licence condition; and the provision of footprint sufficient to accommodate in future such a pass, co-located as depicted, would be an acceptable reciprocal element for inclusion in the necessary property lease agreements to be finalised for use of the site.

In the absence of a legislative driver in EA licensing to require construction of a fishpass, allowing the licence to give latitude to suspend fishpass construction does not prejudge the outcomes of other processes such as Planning, which might impose other obligations.

In the event that a multi-species fishpass were not made an obligatory part of the licensed development, it is possible that the EA would conclude that an approved upstream eel pass would still be an obligatory element. In that event, that pass could proceed in the location depicted in current design, if there were not strong grounds for its repositioning. Such change would typically occur during post-licensing detailing if not in a minor variation.

A fishpass or eel pass flow for environmental purposes should not be made subject to a subsistence charge at the cost of the HEP licence holder. Where such flows are to be licensed distinctly from hydropower abstraction, a transfer licence is the acceptable instrument for this. An alternative could be to grant an impoundment licence without subsistence charge for the passive effect of a new pass as a spill crest around the sluices.

Minimal alteration to water levels

Retention levels will not be increased. It is expected that the Hands-off Level (HOL) of 13.56 at the upstream sensor, or an equivalent agreed by EA Assets/MEICA subject to the gate operation protocol, will be conditioned as proxy for the agreed residual flow condition. A licence condition would be suitable in a form which set the HOL to 13.56 mAOD initially or to another level subsequently agreed by the EA subject to commissioning.

The large majority of the site flow passes via the triple EA sluice gates at Little Paxton. The exception is a small flow via the navigation lock branch to the north. In terms of water levels, it is not proposed to raise the crest of the sluices or lock or make any other structural changes which could result in increased water levels above or below.
The presence of a new spill in the form of the new fishpass will direct baseflow around the sluices. Normal operation of the sluices will continue to respond to maintain the minimum upstream retention level responsively in any conditions when it would otherwise be threatened by this or other perceived signal of low levels. In conditions where dry weather would pose a risk to minimum level, the hydropower scheme will already be shut down on its failsafe level control to maintain the agreed HOL as above.

During the upper end of the range of turbine operation, in non-dry river conditions, a slight drawdown effect may occur which will marginally lower the water level immediately upstream of the intake as water flows into the turbine. This effect will be taken into account at commissioning when setting the water level sensor in relation to the measured turbine flows and licence conditions, guaranteeing maintenance of the HOL as a proxy for the agreed residual flow condition, so that any drawdown does not cause any net detriment.

Downstream levels are unaffected: as the same water continues to arrive in the pool downstream of the EA sluices.

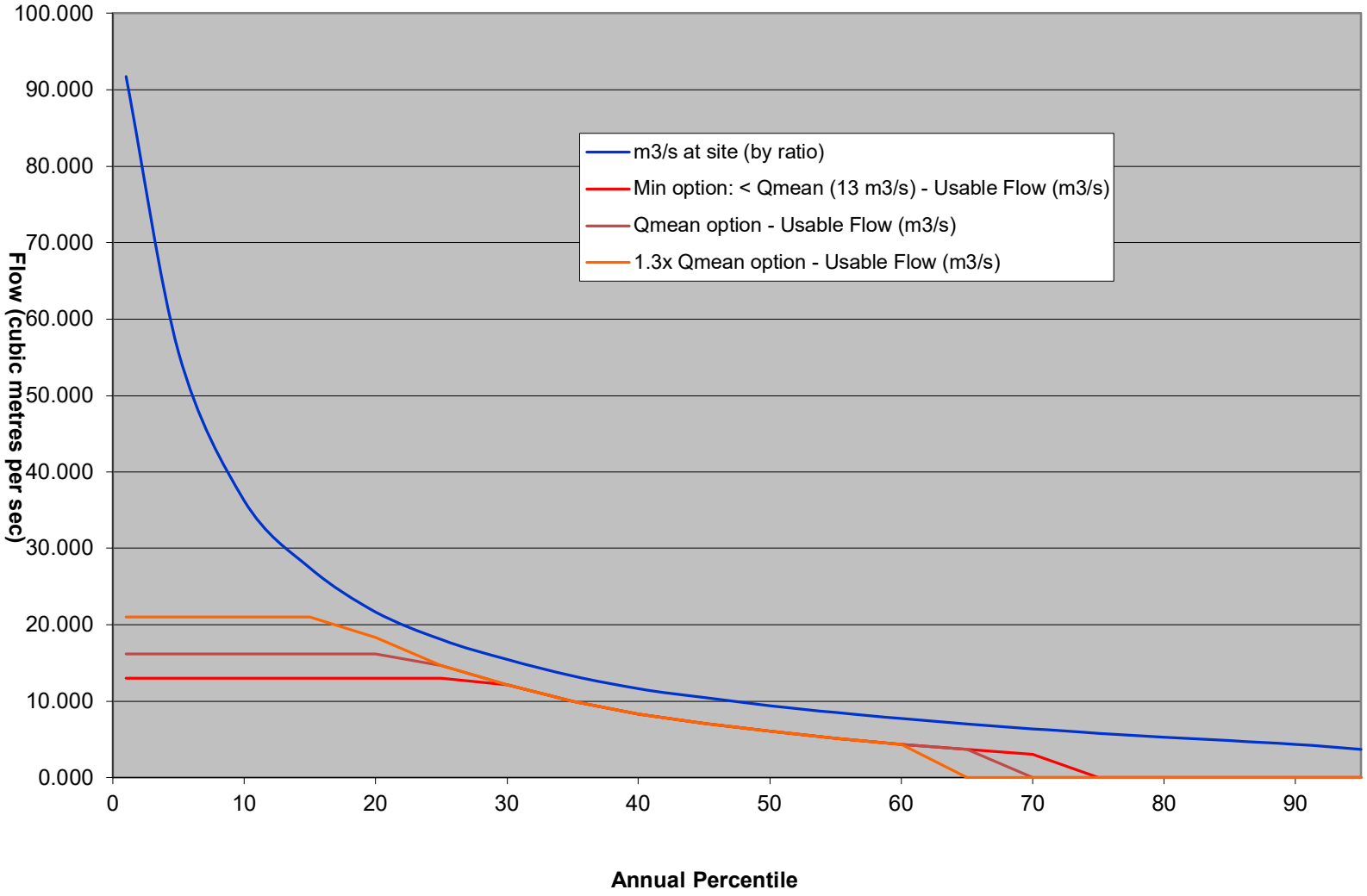
Subject to maintaining agreed upstream minimum level suitable to protect the navigation lock branch, the proposed flow changes do not implicate any other interests upstream or downstream, as the water is diverted above the weir and returned immediately adjacent to the weir toe. Please also refer to the Environmental Sustainability Assessment for further consideration of the proposed distribution of flows in terms of ecology and flood risk.

Quantities (for EA WR purposes)

While the design flow described is an instantaneous maximum (i.e. per second), the EA will also impose in its licence a maximum volume per-hour, per-day and per-annum. The per-hour and per-day rates are usually equivalent to the instantaneous rate. However the EA has often made a default assumption that the maximum volume per-annum is set on the basis of 220 days' design flow. Via precedent and via repeated confirmation from the EA in response to enquiries, we have established that the 220 days figure is a guideline only. Where the applicant can demonstrate (e.g. from historical gauged data or other evidence) that the design flow is likely to be present at the site more often than 220 days in the year, the 220 days limit will be relaxed to allow the design flow to be taken for a more reasonably foreseeable number of days. The final value agreed is then influenced by river baseflow characteristics and by the sizing of the scheme in relation to local mean flow.

At the present site, having regard to flows in the wettest rolling year in the gauged dataset used (~2012), and allowing an additional 10% for a foreseeable possible increase due to climate change, a reasonable value would seem to be 250 days: this amount is applied for. As this refinement serves only to govern whether normal licensed operation may continue as normal on all wet days if the year is a particularly wet one, it should not raise a concern.

Flow Duration Curve



Head duration – lower water level variation

The height that the water falls over the site is known as the head, and varies with the flow in the river. Site measurements indicated that a gross head of over 2.3m could be achieved when the flow is low. When the flow is high, the tail water naturally rises due to channel constraints, which reduces the effective head across the site. This reduces the output of a generator, and will cause it to cease completely at the point that the head is too small for the system to function effectively. The magnitude of this problem is highly site-specific, depending on the width of the weir and on the nature of the downstream channel. An estimate can be determined from the flow data and past observation or data.

Data loggers were deployed in winter 2022, and the 15-min data recorded has been used to produce a curve of tailwater (LWL) variation at the sluices, in relation to corresponding Qn river flow conditions. As the Offord Gross data source does not provide 15-min data, two alternative methods were used:

a) LWL measurements were graphed against Offord Gross DMF data for the same period. Because this data greatly simplified real river events, it was necessary to average the water levels at site to make a matching dataset. A rolling averaging period of 6h was applied as retaining some variation which tracked the shape of the DMF flow events. A trendline of the LWL data against Offord Gross DMF was derived, which can be presented against Qn percentile values for use at the site.
b) LWL measurements were graphed against a 15-min flow data series for the same period, obtained by summing 15-min flow data from the three upstream gauging stations and increasing this by a catchment ratio of 106.4%. This method of obtaining site flow data was previously deprecated by EA Hydrology for flow regime purposes, in favour of Offord Gross. However, the increased granularity of its 15-min data enables a much more compelling overlay to be made with the recorded time-series river events. A trendline of the LWL data against the site's Summed 15-min flow data can be presented against Qn percentile values for use at the site.

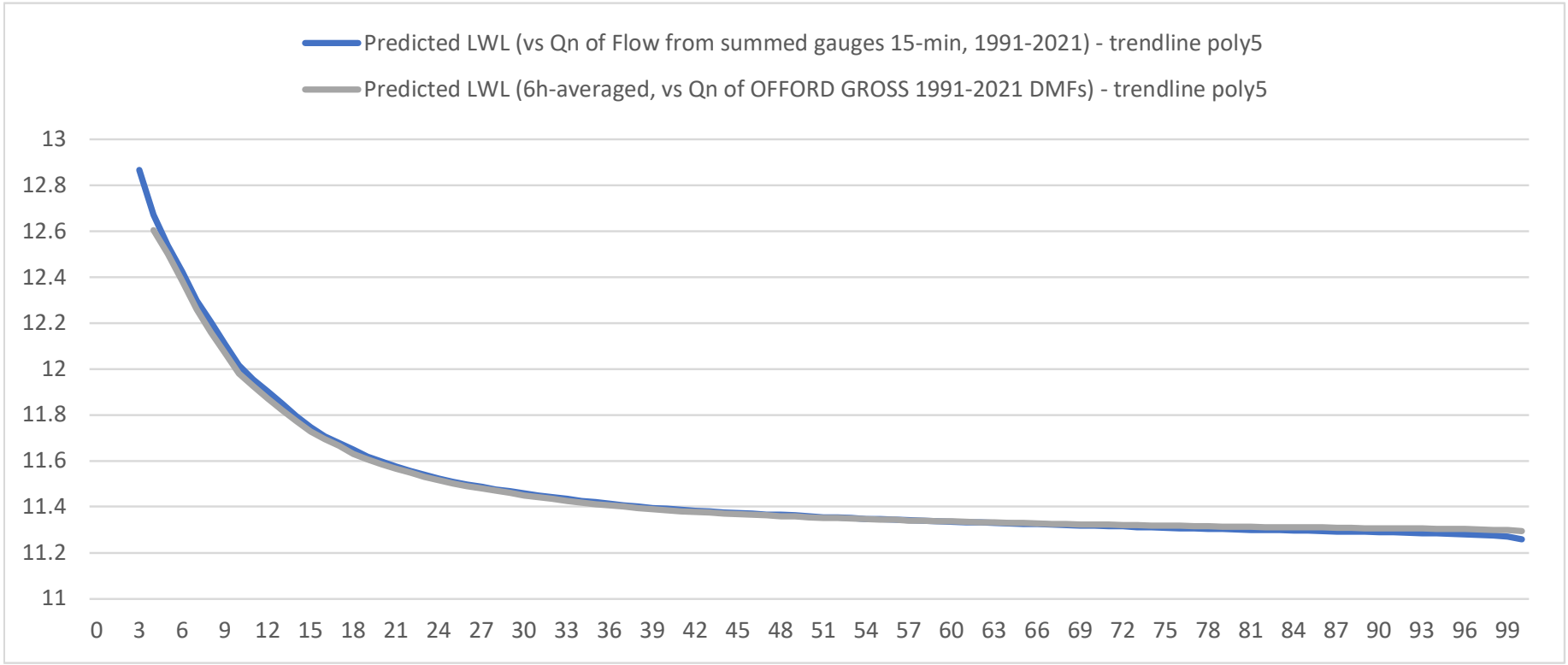
The two methods gave a quite close match, with the Summed 15-min data predicting slightly lower levels per Qn flow (in theory, more favourable to hydro generation) in lowest flow conditions (when hydro NOT able to operate, so no predicted benefit), while predicting slightly higher levels per Qn flow in elevated flow conditions (i.e. conservative as to hydro

output in these conditions when it would be operating). The lower levels predicted in lowest flows also support anecdotal information which was not captured during the period of data logging. Pending any further evidence which emerges, the project therefore provisionally uses tailwater behaviour modelled by method b) e.g. in its hydropower output calculations.

While average tailwater values derived from this monitoring programme per Qn condition were considered the best-available representation of conditions for likely average energy capture, it was noted that the source data points revealed an observable deviation of pool tailwater level behaviour between rising events and falling events, possibly influenced in part by operations of the EA sluices, but also likely by the downstream reach.

Additional head will be lost due to friction, as the water moves through the intake and outflow channels and past the screens at the entrance, so the net head available for generation will be reduced. An estimate of up to 100mm is assumed based on the shape and dimensions of the structures proposed and calculations for proprietary intake screens with a good screen-cleaning mechanism.

Lower water level variation



% of Year	Offord Gross DMFs 1992-2022	Site flow m3/s x98.56% ratio from Offord Gross DMFs 1992-2022	Site flow m3/s (SUM Ouse+Ky m+Ivel x106.44% ratio), Oct1991-Sept2021	Predicted LWL (vs Qn of Flow from summed gauges 15-min, 1991-2021) - trendline poly5	If Hydro 13m3/s + fishpass 1.3 - proposed new channel discharge	If Hydro 13m3/s + fishpass 1.3 - proposed EA sluices discharge	If Hydro 16.2m3/s + fishpass 1.62 - proposed new channel discharge	If Hydro 16.2m3/s + fishpass 1.62 - proposed EA sluices discharge
0	201.000	198.106	198.320	14.000	0.000	198.106	0.000	198.106
1	93.090	91.750	95.999	13.400	14.300	77.450	17.820	**73.930**
2	79.092	77.953	80.192	13.100	14.300	63.653	17.820	**60.133**
3	70.282	69.270	71.779	12.865	14.300	54.970	17.820	**51.450**
4	62.792	61.888	64.457	12.673	14.300	47.588	17.820	**44.068**
5	56.445	55.632	57.748	12.536	14.300	41.332	17.820	**37.812**
6	51.300	50.561	52.355	12.421	14.300	36.261	17.820	**32.741**
7	46.800	46.126	47.255	12.297	14.300	31.826	17.820	**28.306**
8	43.000	42.381	43.850	12.206	14.300	28.081	17.820	**24.561**
9	39.600	39.030	40.410	12.107	14.300	24.730	17.820	**21.210**
10	36.800	36.270	37.338	12.016	14.300	21.970	17.820	**18.450**
11	34.905	34.402	35.264	11.954	14.300	20.102	17.820	**16.582**
12	33.000	32.525	33.500	11.901	14.300	18.225	17.820	**14.705**
13	31.100	30.652	31.767	11.850	14.300	16.352	17.820	**12.832**
14	29.400	28.977	29.870	11.795	14.300	14.677	17.820	**11.157**
15	27.800	27.400	28.212	11.748	14.300	13.100	17.820	**9.580**
16	26.500	26.118	26.754	11.708	14.300	11.818	17.820	**8.298**
17	25.300	24.936	25.647	11.678	14.300	10.636	17.820	**7.116**
18	24.000	23.654	24.550	11.649	14.300	9.354	17.820	**5.834**
19	22.900	22.570	23.273	11.617	14.300	8.270	17.820	**4.750**
20	22.000	21.683	22.408	11.596	14.300	7.383	17.820	**3.863**
21	21.200	20.895	21.514	11.575	14.300	6.595	17.820	**3.075**
22	20.400	20.106	20.692	11.556	14.300	5.806	17.820	**2.286**
23	19.700	19.416	19.967	11.540	14.300	5.116	17.672	**1.744**
24	18.900	18.628	19.252	11.524	14.300	4.328	16.805	**1.823**
25	18.300	18.036	18.566	11.510	14.300	3.736	16.154	**1.882**
26	17.720	17.465	17.967	11.498	14.300	3.165	15.525	**1.940**
27	17.200	16.952	17.376	11.486	14.300	2.652	14.961	**1.991**
28	16.700	16.460	16.869	11.476	14.300	2.160	14.419	**2.040**
29	16.200	15.967	16.420	11.467	13.877	2.089	13.877	2.089
30	15.700	15.474	15.934	11.458	13.335	2.139	13.335	2.139
31	15.200	14.981	15.441	11.449	12.793	2.188	12.793	2.188
32	14.800	14.587	14.997	11.442	12.359	2.227	12.359	2.227
33	14.300	14.094	14.569	11.434	11.817	2.277	11.817	2.277
34	13.900	13.700	14.099	11.426	11.384	2.316	11.384	2.316
35	13.500	13.306	13.746	11.420	10.950	2.356	10.950	2.356
36	13.100	12.911	13.333	11.413	10.516	2.395	10.516	2.395
37	12.700	12.517	12.944	11.407	10.083	2.434	10.083	2.434
38	12.400	12.221	12.623	11.402	9.757	2.464	9.757	2.464
39	12.000	11.827	12.251	11.396	9.324	2.503	9.324	2.503
40	11.800	11.630	11.922	11.391	9.107	2.523	9.107	2.523
41	11.500	11.334	11.629	11.387	8.782	2.553	8.782	2.553
42	11.200	11.039	11.377	11.383	8.456	2.582	8.456	2.582
43	11.000	10.842	11.145	11.380	8.240	2.602	8.240	2.602
44	10.800	10.644	10.906	11.376	8.023	2.622	8.023	2.622
45	10.600	10.447	10.664	11.372	7.806	2.641	7.806	2.641
46	10.400	10.250	10.485	11.370	7.589	2.661	7.589	2.661
47	10.200	10.053	10.290	11.367	7.372	2.681	7.372	2.681
48	9.972	9.828	10.124	11.365	7.125	2.703	7.125	2.703
49	9.750	9.610	9.917	11.362	6.884	2.725	6.884	2.725
50	9.550	9.412	9.682	11.359	6.668	2.745	6.668	2.745
51	9.360	9.225	9.483	11.356	6.462	2.764	6.462	2.764
52	9.189	9.057	9.301	11.353	6.276	2.781	6.276	2.781
53	9.000	8.870	9.123	11.351	6.071	2.799	6.071	2.799
54	8.810	8.683	8.960	11.349	5.865	2.818	5.865	2.818
55	8.620	8.496	8.774	11.346	5.659	2.837	5.659	2.837
56	8.480	8.358	8.599	11.344	5.508	2.850	5.508	2.850
57	8.310	8.190	8.433	11.342	5.323	2.867	5.323	2.867
58	8.130	8.013	8.303	11.340	5.128	2.885	5.128	2.885
59	7.980	7.865	8.123	11.337	4.965	2.900	4.965	2.900
60	7.840	7.727	7.941	11.335	4.814	2.913	4.814	2.913
61	7.681	7.570	7.805	11.333	4.641	2.929	4.641	2.929
62	7.530	7.422	7.664	11.331	4.478	2.944	4.478	2.944
63	7.410	7.303	7.505	11.329	4.348	2.956	4.348	2.956
64	7.261	7.157	7.371	11.328	4.186	2.971	4.186	2.971
65	7.130	7.027	7.233	11.326	4.044	2.983	4.044	2.983
66	7.000	6.899	7.116	11.324	3.903	2.996	3.903	2.996
67	6.870	6.771	6.982	11.322	3.762	3.009	3.762	3.009
68	6.740	6.643	6.845	11.321	3.621	3.022	3.621	3.022
69	6.610	6.515	6.715	11.319	3.480	3.035	0.000	**6.515**
70	6.480	6.387	6.586	11.317	3.339	3.047	0.000	**6.387**
71	6.367	6.275	6.458	11.316	3.217	3.058	0.000	**6.275**
72	6.220	6.130	6.348	11.314	3.057	3.073	0.000	**6.130**
73	6.110	6.022	6.201	11.312	2.938	3.084	0.000	**6.022**
74	6.000	5.914	6.078	11.311	0.000	5.914	0.000	5.914
75	5.890	5.805	5.963	11.309	0.000	5.805	0.000	5.805
76	5.770	5.687	5.863	11.308	0.000	5.687	0.000	5.687
77	5.630	5.549	5.749	11.307	0.000	5.549	0.000	5.549
78	5.530	5.450	5.599	11.305	0.000	5.450	0.000	5.450
79	5.430	5.352	5.493	11.303	0.000	5.352	0.000	5.352
80	5.340	5.263	5.403	11.302	0.000	5.263	0.000	5.263
81	5.250	5.174	5.299	11.301	0.000	5.174	0.000	5.174
82	5.150	5.076	5.213	11.300	0.000	5.076	0.000	5.076
83	5.060	4.987	5.120	11.298	0.000	4.987	0.000	4.987
84	4.970	4.898	5.026	11.297	0.000	4.898	0.000	4.898
85	4.880	4.810	4.938	11.296	0.000	4.810	0.000	4.810
86	4.800	4.731	4.851	11.295	0.000	4.731	0.000	4.731
87	4.700	4.632	4.759	11.294	0.000	4.632	0.000	4.632
88	4.610	4.544	4.669	11.293	0.000	4.544	0.000	4.544
89	4.510	4.445	4.581	11.291	0.000	4.445	0.000	4.445
90	4.420	4.356	4.487	11.290	0.000	4.356	0.000	4.356
91	4.300	4.238	4.393	11.289	0.000	4.238	0.000	4.238
92	4.200	4.140	4.277	11.287	0.000	4.140	0.000	4.140
93	4.080	4.021	4.183	11.286	0.000	4.021	0.000	4.021
94	3.920	3.864	4.069	11.285	0.000	3.864	0.000	3.864
95	3.750	3.696	3.926	11.283	0.000	3.696	0.000	3.696
96	3.590	3.538	3.754	11.281	0.000	3.538	0.000	3.538
97	3.400	3.351	3.615	11.279	0.000	3.351	0.000	3.351
98	3.122	3.077	3.432	11.276	0.000	3.077	0.000	3.077
99	2.606	2.568	3.094	11.272	0.000	2.568	0.000	2.568

Table – Qn flow and level values discussed

Both sources of flow data presented, showing how closely the summed gauges match the Offord Gross DMFs.

Assuming hydro max flow of Qmean (16.190 m3/s), **bold values** show how HOF left to EA sluices is further modified vs a lesser abstraction of 13 m3/s (further reduced > Q28; less reduced, Q73 to Q69). The turbine finally selected will use no more than 16.190 m3/s, but smaller options may be considered.

Extrapolated LWL values: highlighted orange

Passive minor/leakage/lockage flows for navigation channel not separately quantified; assumed +/-50 l/s.

Appendix: HYDROLOGY summary by Hydroplan - to March 2022 (Hydroplan 2022a)

3no pages - as reproduced below – for reference only *(no longer used in submission)*

Mill Lane Hydro Scheme

Hydrology

Report No: P847 / Hydrology R0

March 2022

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Water & power engineering

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1 Introduction

Waterside Green Energy Ltd (WGE), a Community Benefit Society, are keen to develop a hydroelectric scheme at Mill Lane Weir on the River Great Ouse. Their aim is to help achieve the targets set at national and local level to reduce carbon emissions to net zero. They also hope to set a precedent for community based schemes and use the income generated from energy sales to fund other renewables and carbon reduction projects and initiatives aiming to reduce fuel poverty.

The Mill Lane site has been found to be suitable for a hydroelectric scheme and the preferred option would see the installation of three Kaplan turbines producing up to 200kW and generating 860MWh of renewable energy per year.

This report shows Mill Lane FDCs scaled from the Offord daily mean flows and Roxton 15 minute flows. Though the EA consider Offord to be a more suitable analogue for the Mill Lane site, the DMF data will not accurately relate the extreme of the range.

2 Hydrology

Scaled FDCs, based on stage flow data from Roxton and Offord, are shown in Figure 1 and mean flows, abstractions flows and the HOFs are given in Tables 1 and 2.

Overall the flows derived from Roxton and Offord show a good level of agreement though the Roxton produces larger extremes compared with a slightly flatter flow profile from Offord. This flatter profile from Offord, that is to say slightly reduced high and elevated low flows is perhaps due in part to the use of daily average flow data, which would tend to average out the extremes, and refinements using a 15 minute data series would be useful if such data were available.

Table 2 shows the proposed abstraction and HOF regimes The proposed abstractions are set at 80% of the mean flow and the HOF at the Q_{95} in accordance with EA requirements for watercourses with high sensitivity to abstractions.

Table 1 – Mill Lane Flows scaled from Roxton and Offord data, flows in m^3/s.

	Q_{mean}	Q_{10}	Q_{40}	Q_{50}	Q_{80}	Q_{95}
Roxton	17.05	40.46	12.01	9.35	4.66	3.00
Offord	15.97	35.29	12.48	9.69	5.12	3.55

Note: Roxton uses 15min time series data and Offord uses daily average flows.

Table 2 – Mill Lane Abstraction and HOF derived from Offord data, flows in m^3/s.

Q_{mean}	Q_{95}/HOF	Min scheme Q	Design scheme Q
15.97	3.55	0.975	12.87*

**An additional 10% over the expected abstraction has been added to allow for final turbine design.*

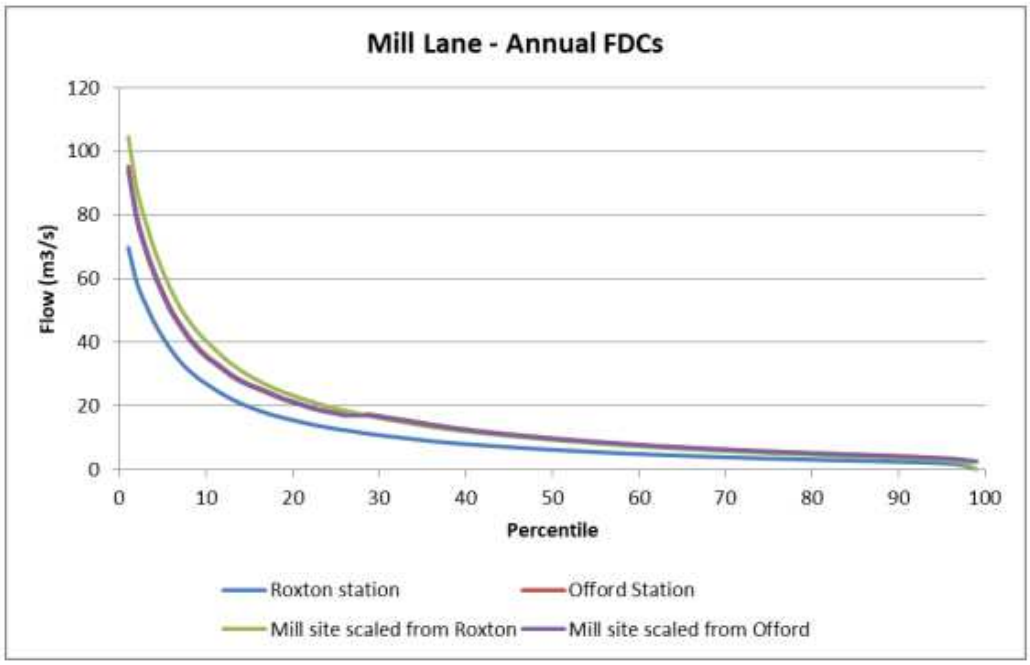

Figure 1 – Derived Flow Duration Curves for Mill Lane

Hydropower installation at Little Paxton, St Neots Project Number 753

ENVIRONMENTAL SUSTAINABILITY ASSESSMENT

Including compliance with EA pre-app advice and other aspects of interest to EA Licensing

6th September 2023

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Revision history

31/05/2023	v1.0	DPP (to support EA licensing)
04/08/2023	v1.1	DPP (updated, first release - draft)
06/09/2023	v1.2	DPP (updated, second release – to EA)

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Introduction

This document relates to a proposal to install a hydro-electric power (HEP) scheme at Little Paxton Sluices, St Neots, in a field just to south of these EA sluices on Mill Lane. Drawings, forms and other supporting documents are submitted. EA ref# AN/033/0022/009

Renewable energy developments benefit the environment through carbon reduction, but must also demonstrate sustainability in wider environmental terms. This document summarises how the proposal addresses considerations noted in Environment Agency (EA) past best practice for the design of schemes "not expected to pose environmental problems" and EA guidance online to date. This project has been submitted to the EA for licensing pre-app, so has had the benefit of relevant pre-app scrutiny and advisory comment from EA internal consultees in its various specialisms. The 2023 update to the application simply adds fuller detail to what is essentially the same scheme design as previously presented and must satisfy the same requirements, All requirements raised by the EA (11/02/2022) are fulfilled as follows:

Summary of additional supporting information required	
• Geomorphological walk-over survey	HYDROGEO report submitted
• Re-confirmation of Hands-off Flow (HoF) using Offord data.	HYDROLOGY document submitted
• Analysis of the existing flow data to understand how the turbine may impact the regularity the sluice movements.	EA Assets - section below
• Further ecological assessment – Phase 1 Habitat Survey, Protected Species surveys.	PEA submitted *(successor to these)*
Additionally, you should:	
• Continue to consult with our Estates Team regarding the Little Paxton Weir Agency Asset.	EA Assets - section below

EA WR licensing

Finalised licensing forms and supporting documents are now submitted to EA Licensing, with a view to satisfying the above and informal feedback from all EA internal consultees for issue of licence/s. Formal application is made for licences, which might include both:

- *(From EA confirmation to date that the proposed new works are an abstraction)* A full abstraction licence – to regulate abstraction into the hydro plant bypassing the weir. EA has confirmed at pre-app (email 28/11/2022) that a licence granted now is expected to skip the next Common End Date in 2028 and be renewable in 2040.

and:

- *(if the EA now views any part of the revised layout as an impoundment, AND/OR now requires any licensable modifications adding to an existing impoundment* – an impoundment licence for a new impoundment or for any licensable modifications to be made to an existing impoundment. (NB: no Form D is submitted unless advised)

- *(possibly, in the event that the EA now decides that any non-hydropower flow must be licensed and cannot suitably be conditioned within the full licence)* a transfer licence, to regulate any non-hydropower transfer flow without incurring unit charge.

This application does not propose to depart from current EA HEP guidance Table B. The EA at pre-app has considered that this is a river "not frequented" by migratory salmon and trout, so brown trout recorded higher in the catchment are inferred resident not migratory.

For grant of the full abstraction licence, it is a legal requirement that a right of access to the point of abstraction must be established by the time of determination. The sole location likely to be considered the point of abstraction is the meadow belonging to Huntingdonshire District Council (HDC). The applicant obtained agreement in principle (HoTs) to make use of this land, and these are currently being renewed. The EA is invited to specify any further formal evidence the applicant must submit by date of licence issue.

In terms of competing abstractions: the only implication of the proposed scheme is for interoperation with the nearby navigation channel (Figure 13), and this flow is vouchsafed by gravity whenever the lock is operated, plus a small sweetening flow via its gravity-fed bypass sluice through a culvert beneath the old mill site (Figure 15). The applicant has no control over these flows, except by collaborating to maintain the common navigation level set by the EA sluices (Figure 3). In the event of lock operation, any temporary reduction in levels perceptible in the south branch, if not immediately corrected by the EA sluices, will cause the hydropower scheme to slow or stop to maintain an agreed minimum level. This proposed gravity abstraction cannot derogate from any pumped abstraction.

Regarding potential for another *competing hydropower scheme* to be proposed at this site, the only potential points of abstraction which would support hydro are via the EA land north of the sluices, or around the navigation lock. It is anticipated that the EA does not regard the likelihood of competition as a risk to licensing at this site.

Regarding a recent regulatory concern to take into account whether existing in-river instructions might preferably be reduced or removed rather than utilised as the basis for hydropower developments, this site is an example of an obstruction whose other existing functions are likely to override or rule out significant alteration or removal. The EA sluice array is required to maintain a retention level for navigation, therefore is unlikely to be removed or significantly reduced, and the EA has not advised of any plan to do so.

EA Environmental Permitting (FRAP)

A Flood Risk Activities Permit will be sought from the EA in due course, at the appropriate point in the project, having finalised any other relevant changes (e.g. due to planning concerns including those not material to the river environment). Relevant contact for FRAP is inferred to be EA Partnerships & Strategic Overview team (PSO) at Peterborough – the EA is asked to confirm this.

A significant input into the FRAP application as well as the planning process will be a Flood Risk Assessment (FRA), proportionate to the proposed scheme and context. This will consider the risk of any net detriment arising to third parties from the proposed works, as well as demonstrating how design has taken account of flood risk to the scheme itself. FRA is not a prerequisite to the EA Licensing process.

FRAP consent at least for the permanent works is likely to be able to be sought in the first instance alongside the planning application, prior to a tender for construction, to ensure the acceptability of the design. Refinement of temporary constructional details of works often cannot be completed until a later stage, when the scheduling of works is clear and when a contractor has been selected and has confirmed proposed methods.

Works in the river will be scheduled in the appropriate season as advised to minimise risk. EA Fisheries & Biodiversity are invited to state preferred seasonal constraints, if any, on works, with regard to migratory windows or other key periods.

EA fish pass approval

Any licence condition which requires the mandatory inclusion of a technical fish pass will require the design of such a pass to be subjected to approval in detail by the EA National Fish Pass Panel at the appropriate stage in the project. All EA internal consultees will by then have already had the opportunity to review any proposed solutions and to raise and allay any other relevant concerns during the licensing process.

The Planning process (and EA as statutory consultee)

Planning will be applied for in due course, from Huntingdonshire District Council as local planning authority (LPA), when design aspects affecting the watercourse are nearing completion. That application will be supported by the same document set as for EA Licensing, plus proportionate FRA, Design & Access information, finishes, listed building/heritage reports or other assessments as called for which are relevant to planning.

Water Framework Directive

In considering a proposal for a hydropower scheme, the EA (and in due course other LPA consultees) may currently continue to have regard to UK standards applied under the EU Water Framework Directive (WFD). Principal concerns are that the scheme should not prevent the waterbody achieving Good Ecological Status (or Good Ecological Potential, for heavily modified waterbodies) nor cause a deterioration in its status. The scheme design must not conflict with the intent of the WFD, in light of criteria in 2012 EA GPG Appendix 2.

The abstraction falls within WFD waterbody GB105033047921: “Ouse – Roxton to Earith” https://environment.data.gov.uk/catchment-planning/WaterBody/GB105033047921

The following text is provided as a compliance assessment with these requirements under WFD. This waterbody is classified as heavily-modified and of Moderate ecological status due principally to chemical aspects. The status objective is ‘Good' for Fish by 2015, achieved 2013-2019; ‘Supports Good’ for Hydrological Regime and Hydromorphological Supporting Elements, achieved 2009-2019. These statuses do not reflect the absence of morphological continuity or upstream fish passage (other than via lockages and high spates) at sites such as Little Paxton. Overall, certain chemicals are marked as (possibly, obligatory technical) Fails or below Moderate and likely to remain no more than Moderate for the foreseeable future, likewise Macrophytes. Abstraction Sensitivity Band (ASB) is 1.

The EA has a legal duty to ensure that proposed modifications do not risk reducing the ecological WFD status of this river or prevent it reaching its overall WFD status or potential objectives. Concerns for WFD status include assessing the impact of proposed works on potential changes in the shape (geomorphology) and flow (hydrology) of the watercourse, and potential effects on fish populations, invertebrate communities and aquatic plant habitats (the biological indicators of WFD status) and water quality. Outline details of design and mitigation specifics relevant to the WFD metrics are to be found set out among the headings in the present document. If the project can add or facilitate an effective new fishpass, this will improve obstruction of the river. A hydropower scheme which is designed to co-work with a fish or eel pass will not detract from the pass but complement it. It will not affect e.g. chemical stressors, so on balance is a neutral to positive influence on status.

As the physical implications are similar to those in other on-weir hydropower applications licensed by the EA in all regions, it is anticipated that consideration of these aspects will be

sufficient to conclude that this scheme design likewise complies with the intent of the WFD and does not prejudice the attainment of its objectives.

Considerations regarding fish and fisheries are addressed here in outline. These may be subject to specialist assessment if the EA finds ground for residual concern and raises a requirement for this. Information known to date is set out in sections below. On this and on other aspects affecting WFD impacts, the EA is invited at pre-app to provide the applicant with any further relevant data on this site, and explain need for further assessments if any.

Hydrology

See separate accompanying Hydrology Assessment. Present document also makes some comment on details of local river system, proposed redistribution, compliance with Table B.

Fluvial geomorphology

Rivers act as a conduit not only for water, but also for gravels and sediment. The point at which the river passes this site is dynamic, and has evolved in response to a combination of natural and anthropogenous processes. The EA sluices form an obstruction to natural processes, albeit through long presence this has contributed to variety of form in the river.

Even where a new hydropower scheme is screened against the passage of coarse bedload, introducing any form of fishpass or bywash will involve creating a new channel past the obstruction, potentially increasing passage of flotsam otherwise trapped or passed by the undershot sluices. High-flow spate conditions may be powerful enough to mobilise additional sediment as well as flotsam. In such conditions, as net head over the weir will be reduced to zero, the hydropower scheme will shut down, so will not be deducting from mobilising flows. A bywash can be set to a spill level which promotes conveyance, or be actively opened. The scheme therefore poses no detriment to transport in such conditions.

The area downstream of the sluices and adjacent to the proposed turbine outflow is a concrete splay built as part of the sluice installation, terminating in an upstand to ambient bed level. The weirpool below is fed by continuous flows via the sluice and likely modified by high flows. It is proposed to leave the residual flow via the sluices as a continued baseflow to that area. **A specialist report has been commissioned** to assess the net impact of diverting the majority flow path away from the toe of the sluice itself and instead to the nearby turbine discharge into the same pool. The conclusion finds low risk of

materially degrading hydrogeomorphological conditions or status in this reach, causing any detriment to oxygenation levels, or having any potential to cause detriment to well-aerated gravel shoals utilised for spawning, as no such habitat was detected to be present.

The hydropower system must be screened to exclude fish suitably for the chosen turbine type. For Kaplan turbine/s here, intake screen bar spacing of 9mm proposed by the EA at pre-app will exclude small adult eels. Detailed design will await procurement; the chosen form will incorporate suitable debris impact protection, exclusion in all normal river levels, and cleaning mechanism. Where the final design of intake screen does not follow a bank line, a boom across the intake, if desired, can fend off larger debris to pass the weir at next high flows; here, a screen in line with the bank is proposed. For Kaplan/s here, the EA pre-app proposes 40mm dissuasive tailrace screening; this is depicted applied as close as possible to the turbine discharge, oriented at an angle towards an upstream eel pass. If choosing a screw or Kaplan equivalent deemed fish-safe, fish screening would be omitted.

All areas where excavation will take place in the river will be within dewatered cofferdams, pumped out through filters, and the turbine channel will be formed from sheet-piled or concrete facing structures. The form of the outflow has large dimensions to manage velocity, and is oriented to direct the flow downstream and back into the natural river channel, without risk of erosion on the opposite bank. These measures help minimise any increased siltation from the construction or operation of the scheme itself.

Proposed flow redistribution / depleted reach

The depleted reach in terms of a route between the new intake and the outflow consists only of the immediate environment of the adjacent sluices, a short length of ponded channel above the sluices, and the hard apron and weirpool between the existing and new discharges below. Baseflow into the weirpool immediately adjacent will be maintained by the hydro plant in most conditions, plus the discharge of any fishpass in other conditions, as well as any minimum residual flow earmarked as continuity baseflow at the EA sluices. It is not proposed to physically modify the sluice gates themselves, as the scheme is designed around their existing retention level. Collaborative operation is to be discussed.

Control of minimum flow distribution, i.e. where and how much residual flow must be retained before hydro operation may occur, depends here on gravity flow via any new fishpass, plus the existing structures which will remain unmodified - the lock, its bypass culvert, and the sluices as set to pen the minimum level. At this site, the EA's pre-app

responses have not requested further representations of flows, recognising pragmatically that the changed distribution of flows will be determined only by the agreed operating regime of the EA sluices together with the crest dimensions of any fishpass subsequently to be approved to jointly deliver an agree minimum residual flow at a single agreed proxy level value, that being the minimum value of upstream river level required by EA Assets for retention of minimum navigation levels (provisionally 13.56 mAOD). **Hydrology report gives full details of proposed flow regime. Hydrogeomorphology report, requested by the EA at pre-app, confirms proposed regime is unlikely to cause detriment.**

In recognition of adding a permanent benefit of safe otter transit and upstream eel passage and potentially also facilitating an upstream fish pass to transcend the obstruction formed by the EA sluices, the scheme proposes a deviation from EA Table A to EA Table B, to abstract 100% of available flow, above the agreed minimum residual amount, up to agreed maximum abstraction. In moderation, the proposal opts NOT to seek the maximum deviation permissible abstraction of 1.3x Qmean, but instead only an amount of Qmean or less. While the value of licensed HOF sought is Q97 for reasons of operational practicality, operating circumstances will frequently supplement this HOF (see Hydrology document)**.**

If the EA were to set out conclusive reasons why it will **not** accept this qualified deviation from Table A to license an abstraction of 100% of available flow, any hydropower scheme at this site is highly likely to become unviable, and its accompanying benefits lost.

The foregoing provides a reasonable basis on which the EA can confirm that this flow regime can be considered acceptable at this site, or what if any specific further additional evidence must be submitted to demonstrate this acceptability - given that the current proposal closely follows current EA published guidance, in that it does:

- not prevent the achievement of Water Framework Directive objectives at water body level *(= confirmed and/or to be demonstrated as set out above and below)*
- maintain or improve fisheries and fish passage *(= confirmed in design)*
- not have unacceptable impacts on protected sites or species *(= demonstrated as set out below)*
- not have unacceptable impacts on the rights of other water users, including anglers *(= mitigation for any minor amenity loss to be addressed in Planning)*

…and that the proposal merits 100% flow as per EA Table B, deviating from Table A, based on having sought to minimise:

- the potential risk to the environment *(= all measures above)*
- the mitigation measures proposed to avoid environmental damage *(= proposed licence constraints / new passage inclusion)*

…by incorporating mitigation measures stated in EA guidance as including:

- increasing the HOF *(= Q97 and operational uplifts, rather than Q97 alone)*
- reducing the maximum abstraction level or the percentage abstraction above HOF *(= less than a permissible 1.3x Qmean)*

Hydrometry

The proposed site does not host or have implications for EA hydrometry assets, unless the feedback monitoring of the EA sluices is included among those. Impacts on the latter must be taken into account in parallel discussions ongoing with EA Assets/MEICA regarding an operating regime for the hydro to collaborate with EA gate control and reporting.

Water quality

The scheme will not lower levels or reduce flows at any point other than immediately above the weir itself. Water is not held back in the upstream ponded reach any more than at present, and thus there is no increased potential for algal growth. There is no evidence of detriment arising from chemical or temperature impacts due to low-head hydropower.

When in operation, there may be some increase in consistency of flotsam transport past the weir. This is because any new through route (eel pass, fishpass, bywash) may convey flotsam in additional to or in different conditions from the existing undershot sluices.

The proposed scheme location falls, on the map, within a groundwater Source Protection Zone 1 (Inner Zone), being a circle centred some 150m-200m away on the mill island, which is inferred to be a current or historic borehole. The source location is effectively upstream of the proposed site in terms of surface water. No “subsurface activity” protection zone is marked for this SPZ. Any risk of impact would depend on aquifer continuity from the site to the borehole, and the depth of the aquifer. The EA is invited to provide any known details to further assess risk, to be clarified in due course by ground investigation.

https://data.catchmentbasedapproach.org/datasets/theriverstrust::source-protection-zones-england-1/explore?location=52.242063%2C-0.264403%2C16.00

Environmental Management

Responsibility for running the scheme on a day-to-day basis, and any maintenance program for the site, will lie with the applicant or the applicant's chosen contractor. Their personnel will maintain the site and the system on a regular basis in the interests of protecting what is a significant capital investment. If the EA believes that it is a proportionate requirement in WR licensing terms to impose a formal requirement for a management plan, this may be made a condition on the licence. Provision of the plan should however not be a prerequisite for grant of a licence, unless the EA has reason to require specific clauses to be included in the plan. Most such licences simply include suitable conditions with no additional benefit to having a separate plan.

The agreed level ensuring the hands-off flow (HOF) is safeguarded by an electronic control system. This "fails safe" – i.e. when the HOF threshold is threatened or when the system encounters a fault condition, the sluice gates close and abstraction to the hydro plant ceases. This method is invariably managed via a suitable condition in the licence.

Visible gauge boards will be installed where control level sensors are located. The standard EA hydropower conversion sheet will be completed to ensure correct reporting of abstracted flows calculated from electrical output. The turbine specification declares the maximum flow which the machine is designed to take at its declared maximum rotation speed, and will confirm the maximum abstraction required to be licensed. Equipment calibration documents, efficiency specifications, etc will form part of the handover documentation retained on site after commissioning, and can be provided for inspection if so conditioned in the EA licence. The foregoing standard provisions are typically deemed adequate to meet the requirements expressed by EA Environmental Management (Enforcement) in licensing pre-apps for low-head schemes of this character.

Fisheries

The online EA Ecology & Fish Data Explorer shows numerous coarse species recorded in the Ouse at and close to Little Paxton, and some eels nearby. Salmon and lampreys are not recorded as having been present locally. Brown/sea trout are not recorded locally, but copiously recorded higher up the catchment e.g. at Brackley. While these may be resident brown trout, their presence may imply potential for some upper catchment habitats to support migratory sea trout whenever the catchment is or becomes accessible to these. EA records in this part of the catchment do not include lamprey species as being present.

EA Fisheries confirmed the above characterisation, in terms of "coarse fish both juvenile and mature, and eel – [with] potential for sea trout and lamprey". Pre-app further advised:

> "There is no legislative driver for a fish pass, the site is also not "frequented by", so [we] have "requested" not conditioned. If a fish pass isn't going to be part of the scheme we would request to retain 10% of the flow for future opportunities to install fish passage."

Such a condition would be acceptable.

Downstream fish passage and screening

Such a site would be technically suitable for an Archimedean screw hydropower plant compliant under EA guidance, without any fish or eel exclusion screening. Parameters of a screw for this site would be 4-bladed, 5000mm-diameter, with maximum rotation speed of 21 RPM. Free selection of technology at procurement stage would allow the project to opt to use a screw, in which event, a licence scheduled or varied to allow this would simply omit screening conditions and area labelled "finely screened intake" in drawings Sheet 7.

The present application is depicted as a Kaplan turbine or equivalent similar low-head reaction device, for which the EA at pre-app has advised a requirement for 9mm-spaced intake screens, based on its guidance matrices, principally to exclude small adult eels. The intake exclusion screening must seal fully to exclude eels in all operating conditions, and must be kept clear of debris, so will incorporate a form of automated screen-cleaning.

Further EA advice at pre-app was to fully blank off any apertures in the lowest 90mm of the intake screening array where it meets the bed slab, in order to dissuade bullhead from entering (citing *Heuer and Tomljanovich (1979)*). Intake screen design will ensure this, and it may be conditioned in the licence. If helpful, a further condition would be acceptable to also incorporate a rebate or trough of 300mm (w) x 200mm (d) in the bed slab immediately upstream of and parallel to the toe of the exclusion screen, as a refuge via which bed-oriented eels may seek the ends of the screened area where other routes may be sought.

Upstream fish passage

The site's obstruction to the upstream movement of fish, since at least the 1930s, and presumably prior, by any pre-existing weir, would be significantly improved by installing new eel and/or fish passage here. Provided that minimum depth in such structures is maintained by the default automated operating regime, a hydro scheme offers potential to optimise any upstream pass, both by suppressing level rise upstream and its challenges for such pass/es, and by augmenting a co-located attraction signal at the pass entrance.

The plan layout of the sluices here makes it impracticable to co-locate a pass entrance with the “weir toe” at this site. The best available alternative is a proposal to co-locate optimally with the turbine discharge and to minimise distraction flow via the sluice across as much of the flow regime as possible. This is achieved by agreeing the lowest-possible residual flow via the sluices, to the extent acceptable having allayed other concerns.

Any proposal to install a technical fish pass must seek prior formal approval from the EA’s National Fish Pass Panel. No difficulty is anticipated with this in principle. Lariniers are a well-understood design of technical pass which are routinely investigated and approved by the EA’s specialists, and, like brush- or tile-formed eel passes, widely installed in the UK.

Even where a Larinier pass is installed, this in itself is not greatly suitable for eels, so in any event it is inferred that some form of provision of eel climbing substrate will be called for. At this site, the layout will accommodate wall-mounted brush cassettes, a brush substrate ramp, or side-angled ramp of plastic peg tiles as currently depicted in drawings.

While the co-location of any passes and a hydro does need to be established in advance of licensing, it is usual for the licence to be issued in advance of (and condition upon) the final EA approval of any pass design details. Where a pass is mandatory, we have typically received pre-app advice that a licence can be issued in advance of fish pass approval, with a condition to this effect. This helps offset sometimes long delays in the approval process.

When EA approval is sought for a pass, detailed drawings of the pass will be provided at the approval stage. As approval requires signoff on details dependent on other aspects of technical design, dimensioned pass drawings are not anticipated to be finalised until all other substantive licensing questions are resolved. The key requirement of licensing is simply to allow footprint space for a pass which will take a flow sized appropriately to the hydro and will suitably span the existing head.

The footprint which has been allocated here in design for fish and/or passage facilities has been designed to accommodate pass structures which are approvable by the EA (able to comply with EA guidelines on sizing and orientation and to provide correct performance across a range of flows up to at least Q10, along with attraction to the pass).

As the EA has advised at pre-app that a fish pass is not mandatory at this site because there is no legislative driver, and will thus request rather than condition a fish pass, we anticipate that the EA can word the relevant licence condition to allow that: a) the hydropower scheme may operate without construction of a fishpass; b) provided that, in

the future event of a fishpass being installed, the licence holder and the EA will collaborate to modify agreed controls so that part of its HOF will always provide a minimum amount which is 10% of the licensed maximum turbine flow, for correct operation of the fish pass. The licence may most easily be conditioned so as to allow the hydro to passively benefit from this flow in the meantime. Otherwise, if the interim operating regime requires the reserved fishpass flow to accompany the HOF via the EA sluice gates until a fishpass is constructed, distracting from the eel pass attraction, then an interim modified gate position regime may have to be temporarily adopted by EA Assets to manage this (see Hydrology).

If, as is assumed, the EA requires a condition that an upstream eel pass must be included as a condition of operation of the hydropower scheme, the necessary minimum flow of 20 l/s for this (or another suitable amount if required by the EA) will be found from the HOF.

Habitat

Fish habitat quality impacts are anticipated to be small and any such impacts would be confined to the immediate vicinity of the site. Oxygenation caused by turbulence now taking place below the sluice apron will be partly relocated to the new discharge flow. Temperature change in such installations is negligible. The necessary land footprint in bankside meadow ground, roadway and made ground, between ponded channels, does not significantly detract from habitat value or uniqueness. Tree loss is small, restricted to perhaps 4-5 pre-standard trees at the tailwater, of locally-common riparian species. During construction, sediment release is minimised by excavating within cofferdams, filtering all pumped water, and by finishing newly excavated areas with concrete or piling.

Other aspects of ecology and biodiversity

All species for which legal protection is afforded must be considered, which includes:

- Habitats Directive (92/43/EEC)
- Freshwater Fish Directive (EC/659/EEC)
- Salmon and Freshwater Fisheries Act (1975 as amended)
- EU Eel Protection Policy (1100/2007)
- The Water Framework Directive (2006/60/EC)
- Wildlife and Countryside Act (1981 as amended)
- Countryside and Rights of Way Act (2000)
- Protection of Badgers Act (1992)

Enquiry via DEFRA's online MAGIC portal identifies that the site lies within the impact zone of a SSSI named St Neots Common, in unfavourable/recovering condition at last assessment (2012). The SSSI's main interest features (wetter flood meadow grassland) are stated as being at the western end of the SSSI. The eastern end of the SSSI adjacent to the proposed site consists of willow carr, listed as Deciduous Woodland in the Priority Habitat Inventory. The SSSI's interest features are wet meadow plant assemblages and amphibians, to which there are no risk pathways from the development downstream in the impact zone, provided that the scheme is conditioned (as is foreseen throughout the scheme design) to maintain minimum water levels at the riverbank upstream as the sluices do at present. The territory of the SSSI is not modified by the development, which can be physically demarcated from the SSSI's interest features by temporary boundary fencing during construction as required; and the prevailing wind here is south-westerly, which is optimal for risk of construction noise to the SSSI.
Citation: https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1002239.pdf

The River Great Ouse County Wildlife Site and Little Paxton Pits SSSI, and other designated sites further afield relying on water proximity, are similarly not at risk from the development, provided that the scheme is conditioned to maintain minimum water levels as the sluices do at present, and subject to mandatory controls on river works during construction. Little Paxton Woods SSSI is not within any impact vector.

Within the construction site itself, the upstream meadow owned by HDC falls within an area listed as Lowland Fens in the Priory Habitat Inventory and is subject to a "Higher Level" Environmental Stewardship Scheme (AG00683035, 2013-).

Notwithstanding the observations above, such a development could theoretically have potential to impact on flora and fauna including the following:

- All fish, particularly migratory species such as salmonids eels and lampreys
- Otters
- Bats
- Amphibians and reptiles
- Breeding birds
- Water voles
- White-clawed crayfish
- Freshwater pearl mussel
- Invertebrates

- Aquatic macrophytes
- Badgers
- Bryophyte mosses

The online EA Ecology & Fish Data Explorer contains no local records of salmonids or lamprey species, but plentiful survey catches of coarse fish species, notably roach and perch. In previous years, eels ~250mm-500mm have been found present in tributaries upstream of the site including the Kym nearby at Hail Weston. Aquatic macrophyte records are copious from surveys of the Ouse close downstream of the site, which are at low risk from the proposed local redistribution of flows to the sluices' tailwater pool upstream. A survey point on the same tailwater stream has also been found to host a varied population of invertebrates. However, *Aeshnidae* spp (potentially including Norfolk Hawker dragonfly mentioned at pre-app by EA Ecology as potentially locally present) were not recorded here since 1999 nor the next nearest survey point nearby on the Kym since 2001.

The applicant therefore follows standard good practice by undertaking a Preliminary Ecological Assessment (PEA), submitted at formal licence application. (This subsumes the EA's advice to provide a Phase 1 Habitat Assessment.) The list above served as a point of departure for the ecologist. Risk here to species lower down the list is more immediately resolved, with recommendations for those species earlier in the list. Measures for otters can include non-disturbance during works and ensuring continuity of transit routes; for birds and bats, non-disturbance, roost potential, and seasonal working on trees whose removal is found to be necessary.

The PEA submitted with the licence application was conducted in summer 2022 and addresses all of the items raised by EA at licensing pre-app. The ecologist's conclusions led to the following amendments to the submitted design and the project schedule:

The licensed design includes provision for a permanent alternative safe transit route for otters. Further detailing of this will be elaborated in consultation with Huntingdon DC and Cambridgeshire Wildlife Trust.

For the construction phase, the project will budget for, and construction-phase working methods will specify, that:

- a project ecologist will be engaged to undertake search/rescue for Great Crested Newt and Grass Snake immediately prior to commencement of works
- a Preliminary Bat Roost Assessment will be undertaken for any trees which will be felled or pruned (i.e. of those downstream of road, and one on bankside upstream).

- a check for nesting birds will be conducted prior to any tree work, which will occur outside the nesting season
- the creation of any excavated areas during works will include the provision of temporary escape ramps for otters
- invasive Himalayan Balsam was present in the nearby ditch and thus may be present on site: instructions for management will be included in working methods
- invasive Floating pennywort may be present (pre-app advice of EA ecologist): instructions for management will be included in working methods

Provided that due care is taken during construction, as below - the proposal to excavate land to locally divert water seems unlikely to have significant implications for plant or animal populations or valuable habitat beyond the water zone, therefore no unacceptable impacts on biodiversity outside the river. Compliance with recommendations of the proposed PEA will minimise long-term impact on local ecology.

Presence of the above species is not only seasonally-determined but can change from year to year. In the construction phase, method statements must be produced by the contractors engaged on the scheme which will incorporate identified needs to assess any impact on wildlife prior to construction. Due consideration will be given to wildlife protection and the appropriate eradication of any undesirable invasive species if found present on site. This together with any pre-construction wildlife survey actions will inform a Construction Environmental Management Plan submitted in the FRAP consent application.

The present document and the submitted PEA demonstrate that protection of wildlife has duly been taken into account by the applicant.

Trees

A small number of trees will need to be removed to clear the construction site footprint. This loss is around 4-5 pre-standard trees at the tailwater, of locally-common riparian species. The significance of the trees to be removed in this riverside context is likely to be assessed as small, and if found necessary at Planning, their numbers may be replaced with same species or others, within the applicant's landscape stewardship. Assessment for bat roosts and nesting birds will be done on trees prior to their removal in suitable season.

Noise

Noise is generated in the machinery housing due to the rotation of the gearbox, drive and generator. This noise is similar to other rotating machinery such as motors or fans. Generators of the size proposed may have a noise rating (SPL) of ~73dB(A). Housing the

equipment within a hard built structure or acoustically-insulated tank or shed greatly reduces the externally perceptible noise and brings it within acceptable limits. Water noise is created by fishpasses, and potentially at the point of discharge, depending on design; but this replicates or replaces the noise of the turbulent flow via the sluices immediately adjacent. Studies of noise impacts carried out in relation to similar installations identified no cause for concern. Where there is concern for particular nearby receptors, acoustic impacts may be subject to a planning condition. At this site, an acoustic assessment has been commissioned to ensure no unacceptable impact on nearby residential properties.

Potential environmental risks in construction

The following potential risk factors are acknowledged, and clear prevention and mitigation measures will appear in method statements and Construction Environment Management Plan submitted with the FRAP application:

- 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 other building chemicals
- Contamination of watercourse with sediments due to run off from excavations

Recreation and amenity

The site is used by local anglers and the applicant group includes a representative of anglers' interests. Construction will interrupt bank access along the entire footprint length, and the completed scheme incurs minor permanent loss of angling amenity in terms of one currently demarcated fishing spot. Provision of fish or eel passage however will enable locally present species to move up- and downstream, inferred to contribute to a long-term net benefit for the resilience of fish populations and sustainability of angling. The proposal has no significant impacts on river access for other established uses, nor upon moorings or slipways. Navigation rights and access are unaffected. The route of an unmarked informal riparian access via the field will be practically formalised by the perimeter of the new elements, but any right of way across the field will not be significantly deviated. EA personnel will retain foot access to the south riverbank at the sluice. The applicant may consult locally interested parties if any other likely impacts on rights / usage are confirmed.

Heritage, archaeology, and visual amenity of the site can also feature in a planning application, where pertinent; but these fall outside the scope of the present document. No statutory designations or protections are present in this regard.

Environmental Impact Assessment (EIA)

Statutory EIA is not called for in hydropower projects of this size (<5MW) unless there is significant risk of specific environmental damage e.g. to features of designated protected sites. The proposed design has regard to best practice and no such significant risk is foreseen to receptors such as designated sites (as considered above). In an experience of many such low-head hydropower schemes, it is extremely rare that LPAs decide this test is met. The applicant may opt to obtain a screening opinion from the LPA.

Ecology & biodiversity in local planning

Huntingdonshire District Council issues a Biodiversity checklist form for developments which invites a PEA to be submitted in the case of riverbank developments and those potentially affecting protected species. The checklist result, the PEA which has been conducted, and supporting documents including this one will be submitted at planning.

Natural England

Natural England will be a consultee of the EA and via the planning process with regard to the protection for example of designated habitats and protected species. The foregoing characterisation of the site, description of the potential impacts of the scheme and of mitigation measures will be of interest to Natural England. The likelihood of additional unforeseen significant issues being raised by Natural England is inferred to be low. Insight into Natural England's response at this location may be gained from nearby applications such as 17/00108/OUT (2017: for a bankside development of 199 houses 500m distant at Riversfield) to which Natural England concluded no unacceptable risk to sites of statutory nature conservation, including the closest SSSIs and the river as a County Wildlife site.

For the low likelihood of potential impacts on SSSIs from the current proposal, including SSSI immediately upstream, see above section *Other Aspects of Ecology and Biodiversity*. As regards protected species and their habitats of interest to NE, evaluation of potential for impacts or their avoidance is found in relevant named sections of the present document.

Design principles

As “water-compatible development”, the new structures will be located within the flood corridor, are at risk from flooding, and will be designed in detail to be resilient to all predicted flood levels. Flood Risk Assessment of proportionate scale has been commissioned from a specialist and will be submitted for FRAP and Planning Application.

The design situates the hydro plant in a new excavation forming an additional bypass channel descending alongside the existing sluices. Where provision for a fishpass is to be included, there are strong EA preferences for co-locating the turbine discharge with the fishpass discharge (so that the former acts as an attraction flow, signalling to fish the position of the pass), and this preference is respected to the extent permitted by the downstream constraint on the overall width of the outflow channel. The design shows how this coincides with directing the outflow in a downstream direction and as far as possible aligning the hydro plant with river flow, while minimising obstruction to oncoming flood flows. The proposed plan alignment is the best to reconcile potential fish-passage needs and inflow to the hydro scheme with leaving a margin of undisturbed ground to reduce structural impacts to the integrity of the existing sluice array.

At its downstream end, the turbine flow and other potential new channel flows emerge back into the same pool in the river’s normal channel as the current sluice discharge. The discharge channel bed is located within new excavation which will constitute net additional river capacity over present. This offsets the marginal reduction in out-of-bank cross-section caused at one point by the presence of the new powerhouse to the side of the river channel above bank level. The powerhouse acts to secure and protect the electrical equipment by elevation and by waterproofing. Its dimensions are the minimum necessary to safely house the plant equipment and facilitate attendance. FRA is likely to demonstrate that, on balance, there is no significant net reduction in flood storage or conveyance.

Crest levels of the sluices appear sufficiently regular that no raising or straightening is anticipated to be a prerequisite of the project.

During normal operation (i.e. in conditions above the agreed HOF), the system will allow water from the river upstream to enter the additional new deep invert into the turbine intake, and return it to the main river channel close to the existing sluice apron. The abstracted flow will therefore simply bypass the EA sluices. The residual flow not entering

the hydro will be split between any new fish and/or eel pass and the existing sluices, with the navigation channel to the north passing only leakage or intermittent lockage flows at the lock itself and its sweetening baseflow via the former mill culvert. The licensed HOF will be protected by a level sensor and automated intake sluicegate/s (with failsafe operation). A prerequisite of design of any new fish and/or eel pass will be that the desired minimum operating flow must be maintained in the pass during any turbine operation, so that fish passage conditions are maintained. This will be verified during the approval of the design of any approved pass, and is then ensured by automating turbine operation to maintain the agreed upstream water level and/or total HOF conditioned in the licence.

Any higher flows (in excess of the residual flow plus the maximum abstracted flow) will also augment the residual flow via sluices and any fishpass, distributed simply by gravity according to the water level which that condition causes to occur, under the further control of any response by the EA sluices to suppress the level. The impact on variability in terms of spate flows over the weir at migration times and maintenance of the weir pool will be only slight, in that all flows will still be returned preferentially into the tailwater pond in all conditions, and in high spates there will also still be a relative peak via the sluices themselves, even if the hydro plant is then still able to convey its maximum flow. All the more so in flood conditions where the tailwater reaches the EA sluice crests, as the hydro plant will shut down automatically when such high conditions occur (see below).

With the turbine intake sluices closed, the system does not change flow paths except for admitting any agreed new permanent minimum flow via a fishpass rather than via the EA sluices. With the turbines sluice open, the hydro plant itself provides an additional new route to allow flows past the weir, though this will close off in higher flows as the head over the site tends towards zero (likely: when head less than 700mm). Under all conditions, water recombines below the weir as at present.

Downstream of the sluices, the proposed scheme has no detrimental implications for water levels. Operating the hydropower system before a flood event could tend to very slightly smooth the flood peak, by passing the first part of the rising flows more quickly (by way of its deeper invert). This could result in bringing forward the onset of a given level downstream, which in theory could increase the period of detrimental levels. However, in practice, the hydropower scheme will cease operation (once head difference at the weir tends towards zero) while still within in-bank conditions, well in advance of detrimental

flood levels. While this is not anticipated to incur risk at this site, there is precedent from another licence for the EA to condition a high tailwater level at which operation ceases.

The hydro plant will create new open channels in a riverside field where there is potential for public access and fall risk to water. Subject to any planning conditions, it is proposed to install steel or GRP mesh decks across the channels and/or to install security paling fencing as a locked site perimeter and tube-clamp fencing as edge protection where necessary, methods which are widely used including at the adjacent EA sluices. The EA asked for access to its sluices to be maintained. Inclusion within or across the new works of suitable load-bearing areas for potential future EA crane access to the EA sluices was initially considered; but, on balance, this was eliminated as disproportionately costly, given also that existing ground at that location is currently soft and not suited to such lifting operations. Crane pad provision for future lifts is therefore included only at the south bank of the scheme as depicted (where hardstanding is shown), though the applicant welcomes a licence or FRAP condition to give the EA right of access to this base for long-reach lifts. Likewise a FRAP condition would be acceptable to allow placing temporary spans across the new works to facilitate lighter lifts in such a future event. Foot access to the south bank of the EA sluices from all parking locations remains available as at present via the road.

Electrical services to the mains grid will be via armoured cables, to be run via buried ducts along the new works, then buried in the road to regulation depths and suitably marked. These are likely to run to the nearest UKPN substation behind Mill House on the island; or, if not, then to a different connection point beyond the sluices bridge, likewise accessed via the public highway network with similar environmental implications.

There is no proposed raising of water levels at this site, unless EA Assets prefer to agree an operating regime which tolerates a minor upwards adjustment in default level (within minor normal variation) to facilitate mutual control of normal river levels.

There will be no detriment to any land drainage to the river which is present. Local land drainage via the ditch which currently passes through the site will be improved, as the current terminal headwall and small-bore culvert through which the ditch discharges to the river will be replaced by a larger diameter exit culvert through the hydro channel retaining wall and equipped with a coarse debris screen. This is a net benefit, as obstruction of this drainage ditch at its outflow culvert in high water conditions is observed to be the source of overland flood flow which discharges across Mill Lane and can block this route to all traffic.

Furthermore, if the local authority wishes to pursue this measure, there is scope for the project also to facilitate a localised raising of the road level here to prevent overland flow in future. Both improving the ditch drainage and, if desired, raising the roadway level are measures likely to gain community approval in Little Paxton, as residents here currently find their main traffic and pedestrian route into St Neots blocked in flood conditions. There is synergy for any such carriageway raising works to be carried out during a temporary closure which will be necessary when forming the new channel beneath the road and path. Local anecdotal evidence suggests that flood flows across the road result from the ditch flows alone, rather than from the river upstream. If this assertion is confirmed, such road raising would not be a detriment to flood water handling in the main river corridor section. Proposals for any road level adjustment lies outside the hydropower project's permissions.

There are no cumulative development impacts, as the river corridor is unsuited to any further development other than for purposes relating directly to the riverbank as part of the functional flood plain. There is no likelihood of competing or immediately adjacent hydropower developments which could pose a risk of cumulative negative impact. Flood or drainage impacts cannot logically arise cumulatively from this proposal in combination with other hydropower schemes on ponded reaches which are yet further afield. Thus there are no cumulative adverse effects upon any third party or property.

Forming the hydro discharge channel beneath the road and footway bridge will require a road closure during works. It is desirable to minimise the period and scale of disruption to through traffic (vehicular and pedestrian). Methods to minimise this disruption are being sought in collaboration with local authority Highways in light of mutually-agreed methods of forming the road crossing. Proposals for a road crossing form a separate related project to be managed by or for Highways, so the construction aspects of the discharge channel are to be treated as a separable element of works. The culvert structure is to be designed to Highways standard specifications, and is depicted only as a functional internal space at the stage of acquiring hydropower permissions, assuming box-culverts dimensioned as drawn.

The proposed channel layout plan is in part determined by land ownership boundaries. Subject to further discussion or changes to agreements, minor displacement of the proposed footprint could result, with, if anything, slight widening of the outflow towards the north. Regarding electrical grid connection, the applicant is proceeding on the basis of grid connection enquiries to date with the local DNO; options for connection may subsequently change, but it is not anticipated that a connection larger than 250kW will be obtainable.

Integration with EA Assets

The EA is understood to be the asset owner and is the operator of the river control sluices at Little Paxton. The current sluices originated in flood alleviation programs of 1930-1960 as an improvement on traditional structures (inferred to have been wooden hatches or traps) at what was then a working industrial mill site. The EA may be investigating options for future operation of its structures, planning for their end-of-life replacement, and/or considering how facilitating potential for fish passage at this site will sit within such plans.

The EA is invited to update the applicant of latest status of any internal or external discussions relating to the current and future status of the sluices, and any provisional proposals for their management or fish passage at this site. EA licensing is invited to provide information from other EA teams, e.g. Assets & MEICA with whom parallel enquiries have been opened. Discussion will be necessary to agree an operating protocol to ensure that operation of the sluices continues to protect the minimum navigation level and release high flows while not acting to prevent licensed operation of the hydro.

It is not necessary to finalise the terms of an interoperating agreement prior to issue of licence, but it is valid to consider some likely content of the interoperation. The hydropower scheme operating to maintain the HOL, thus the navigation level, ensures the HOF – but this relies upon ensuring that EA Assets/MEICA do not shut their gates down to zero while the hydro is operating. This can be ensured, for example, by the hydro control system sending a flag signal to EA gate control: when on/high (Hydro OPERATING), this causes the EA gates not to close below agreed HOF setting AND not to open except at a danger level (to be agreed: set somewhat above navigation level, but a value with which the EA is comfortable); or: when off/low (Hydro NOT operating, OR comms lost), loss of flag signal causes EA gates to operate as at present.

The existing EA boom at the sluices may remain in place unaffected, or: depending upon its precise location, the boom's south anchor pile may have to be slightly relocated during construction of the scheme, albeit without significant impact on the function of the boom.

A parallel enquiry was opened in early 2023 with an invitation to EA Assets & MEICA to engage collaboratively on this project, prompting some exchange of partial data; but has not yet progressed to any bilateral meetings or substantive collaboration enabling any progress on the above questions. It is understood that discussions with Assets & MEICA

may proceed outside formal licensing, if these teams are not given the usual status of internal consultees within a licensing determination. The applicant is however reliant on the outcome of discussions with EA Assets & MEICA to author draft text of any operating agreement, so the **licensing officer is urged to confirm the status of this discussion**.

Pending this discussion, an interim proposal for interoperation is as follows. **Final agreed level values etc should appear in an operating agreement rather than the licence.**

Currently –

Upstream water levels measured at EA gates level sensor.

EA sluice gates automatically operate to trim level to ~13.560 mAOD - in practice +/- ~75mm.

When flood flows occur, gates open to fully open.

Navigation lock spills in raised levels and/or fully opens (guillotine gate downstream) in flood conditions after a certain trigger level is reached.

Proposed -

Upstream water levels will be measured at a point TBC (at new sensor for hydro, or at EA gates level sensor, or both, subject to calibration of that relationship and to any agreed telemetry or API interconnection).

Navigation lock – no change: responds (?last) as above.

EA sluice gates must NO LONGER simply always trim to 13.560 mAOD - as the hydro relies upon diverting most of their flow in normal conditions.

EA sluice gates must instead be set open by a small amount to permanently deliver an agreed portion (2 m3/s proposed) of the agreed residual flow, calibrated to deliver this minimum across all non-high conditions when hydro is operating (calibrated either at aim level 13.56 mAOD or at minimum of an agreed range as below).

Hydro software will continuously attempt to maintain the level at 13.56 mAOD, but experience has shown that a buffer range should be tolerated to allow this to happen smoothly and efficiently in falling flows. It is anticipated that a “low trigger” buffer level of say 13.52 mAOD will be programmed, below which attempts to correct to 13.56 will cease and the hydro will completely stop. Such levels currently occur frequently due to gate operation in falling flows, so this is not a detriment over the status quo.

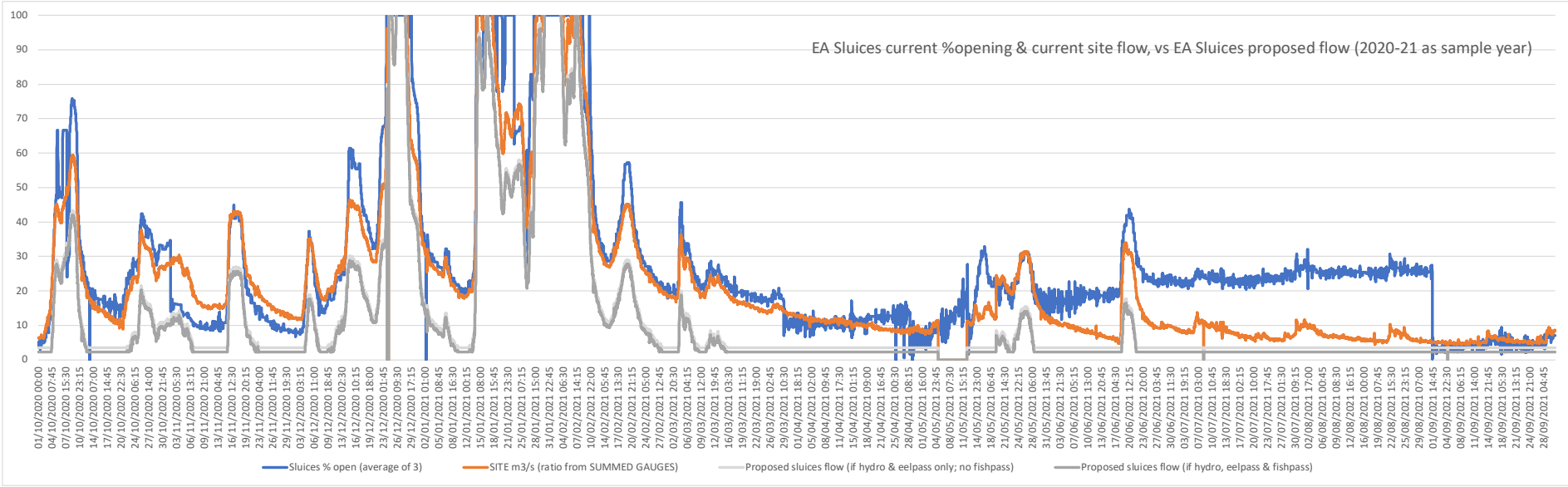
A “high trigger” value of the upstream water level is to be agreed above which the EA Gates will open further: ideally, as high as the EA is comfortable to allow to occur: provisionally this could be say 13.64 mAOD.

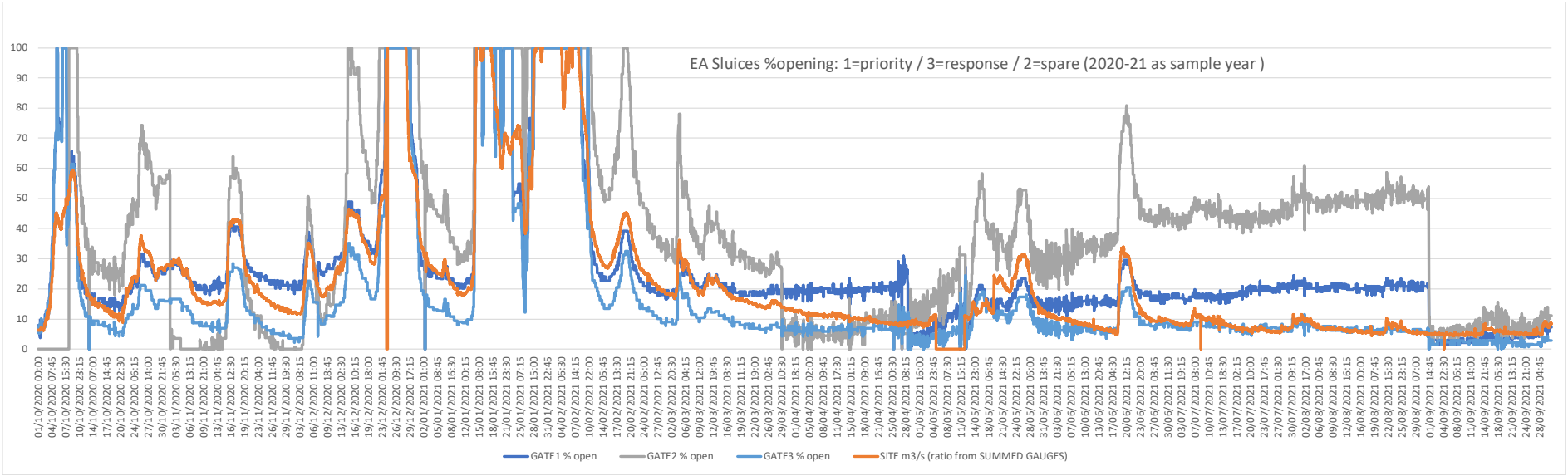
Above the agreed “high trigger” value, the EA Gates will open further - to maintain either that level, or 13.56 mAOD (whichever the EA is most comfortable with upon calibrating the system and testing its response). Provided that the EA gates do not take the level down below 13.56 mAOD in non-flood tailwater conditions in which the hydro can otherwise successfully operate, there is no detriment to the anticipated operation of the hydro; whereas trimming instead to any higher value will benefit the hydro.

The hydro software’s decision to take more or less flow is based on maintaining the minimum level, and then, once minimum levels are well exceeded, on maximising output based on all other parameter feedback.

The method of taking more or less flow is typically both an increase/decrease in rotation speed of the turbine (controlled by software) and the opening/closing of mechanical elements in the turbine (controlled by software).

One question already addressed was to what extent hydro operation would reduce amount of gate movements needed. Likely net effect is shown in upper graph on next page. Lower graph indicates how the gates currently respond: but this EA dataset has been questioned.


EA Sluices current %opening & current site flow, vs EA Sluices proposed flow (2020-21 as sample year)
Sluices % open (average of 3)
SITE m3/s (ratio from SUMMED GAUGES)
Proposed sluices flow (if hydro & eelpass only; no fishpass)
Proposed sluices flow (if hydro, eelpass & fishpass)


EA Sluices %opening: 1=priority / 3=response / 2=spare (2020-21 as sample year)
GATE1 % open
GATE2 % open
GATE3 % open
SITE m3/s (ratio from SUMMED GAUGES)

Licensing for the potential use of novel or variant hydropower devices

Novel Kaplan-like turbine devices such as a NATEL RHT or Fairbanks Nijhuis turbine are becoming available which each have a different proprietary design which claims to be compatible with the passage of fish. The project is investigating procuring such an innovative machine, but this is not certain prior to the project's procurement phase.

EA licensing responses are therefore expected currently to be similar as for a conventional Kaplan, for so long as it is understood to be the case that the fish-compatible claims of these new device designs have not yet been tested in the UK. However, this state of affairs might evolve between a licence being issued and the scheme being constructed.

To make the licence supplier-neutral in this respect, the applicant would favour the EA using any available wording, option, or variant schedule in the licence, which would allow the use of an innovative machine to be accompanied by the relaxation of the exclusion screening constraint without further variation to the licence, if that machine has by then gained a certain fish-compatible status; or, if that is not yet the case, then subject to the potential imposition of a monitoring programme to be agreed in writing by the EA, allowing temporary and/or permanent removal of fish screens, which must demonstrate an acceptably low level of risk to fish. Pending such testing (and as long as testing were negative or inconclusive), the EA would likely require the same provision as a conventional Kaplan, here being 9mm screens to exclude eels and fish, and 40mm tail screening.

If a Kaplan-like device agreed at that date to be fish-compatible, or a compliant single Archimedean screw, were chosen, the licence could simply be scheduled/varied to omit screening and "finely screened intake" area in drawings Sheet 7, and instead only >=150mm-spaced vertical-bar intake debris screens to be installed. Any required fish or eel pass would then be adjusted to the necessary length of the new shorter works by omitting length from its exit channel and relocating its exit confluence close to its entrance. Licence schedule/s to **allow either agreed fish-compatible Kaplan/s or a compliant single Archimedean screw** would be welcome. However, if the EA is unable to manage this conditionality, and prefers to manage such technical eventualities via a later licence variation, the EA is asked to confirm that discretionary fee reductions for such variation would be applicable if the impacts were no greater or incurred workload was minor. Likewise for any **variation between single and twin Kaplan devices**, which remains a question of technical product selection to be decided only in the procurement phase.

Site photographs

Figure 1: Proposed site – view upstream along footprint of new works

Figure 2: Proposed site – view across river onto footprint of new works

Figure 3: EA sluices – view downstream from north bank, with bridge and footway

Figure 4: EA sluices – view downstream from south bank, with bridge and footway

Figure 5: EA sluices – view from site on south bank, with bridge and footway

Figure 6: EA sluices – view upstream from road, at south bank of road bridge

Figure 7: EA sluices – view upstream across road bridge, from footway

Figure 8: EA sluices – view to proposed site, across road bridge, from footway

Figure 9: EA sluices – discharge splay, view upstream from south bank of sluices

Figure 10: EA sluices – discharge splay, view across from south bank of sluices

Figure 11: EA sluices – discharge viewed from south / from proposed new discharge

Figure 12: EA sluices – tailwater pool, view downstream from south bank of sluices

Figure 13: Navigation branch – lock, viewed upstream (no impact)

Figure 14: Navigation branch – bridge and lock downstream gate, viewed upstream

Figure 15: Navigation branch - intake of sweetening flow via former mill (no impact)

Figure 16: Navigation branch - sweetening flow discharge via former mill (no impact)

Alternative options assessed

Alternative locations

The sluice channel and lock channel at Little Paxton run parallel around the former mill island which has since been rebuilt as a residential area. A similar fall in river level, suitable for hydropower, can be found in both channels. Former use of hydropower by the mill may well in its later phases have taken place via the lock channel. However, the sluice channel is favoured over the lock channel for two reasons:

- the fall at the lock channel is physically closely constrained by adjacent buildings and would be more complex to build and to integrate with current use of the lock
- the river's main flow currently passes the sluices, and the two channels are sized accordingly; so locating hydropower at the lock would mean a far greater change to the distribution of flows, hydrogeomorphology, and conditions for navigation.

At the sluice channel, hydropower must bypass the fall at the sluices. Either on the left or the right bank, this means bypassing the road and footway. The left bank is closer to residences, the relevant area is more densely occupied by roads and services, and land ownership or lease is not available. The right bank is open space, more distant from the residential area, contains no service routes, and use of this area is able to be made by subject to agreement with the landowners. The right bank has therefore been selected.

The layout of the scheme assumes one of a number of conventional forms of hydropower intake and powerhouse best suited to a previously unused site. The discharge zone however requires some more bespoke detailing due to interface with the road crossing and land boundaries. The current proposal is designed to maintain separability of works at the interface with the road crossing, so that the hydropower works can be constructed separately to design and progress of the Highways works. This also has the consequence that the fall in levels at the hydropower channel occurs upstream of the roadway and allows the hydro works to potentially add to flood conveyance. It would be theoretically possible instead to position the hydro works at the point of discharge, downstream of the road, but this is not anticipated to be possible in practice due to property boundaries, and separability of detailed hydropower works and road crossing would be difficult to achieve. A further option would be to duplicate the EA's sluice array at a point 20m downstream, penning in the headwater river level beneath the road bridge, and install the hydro in a new mid-river pool below the bridge. This potentially higher-risk option has not been developed.

Alternative turbine types

A number of quite different types of machinery can be used to generate hydroelectricity at a site such as this, each having certain advantages and disadvantages. All systems have some kind of transmission or gearing mechanism that drives a generator, but where they differ is in the method used to convert the power of falling water to mechanical rotation.

All turbine types will require a failsafe means of stopping the equipment. For low-head equipment this typically consists of a valve or inlet sluice gate that can fall by gravity to stop the flow of water; a drum or disk brake is added to some devices to stop rotation. All types will require a trash/debris screen, with a bar spacing sufficient to keep out any size of debris that could be potentially damaging to the turbine type in question. Fish exclusion screening is type-specific and is mentioned below.

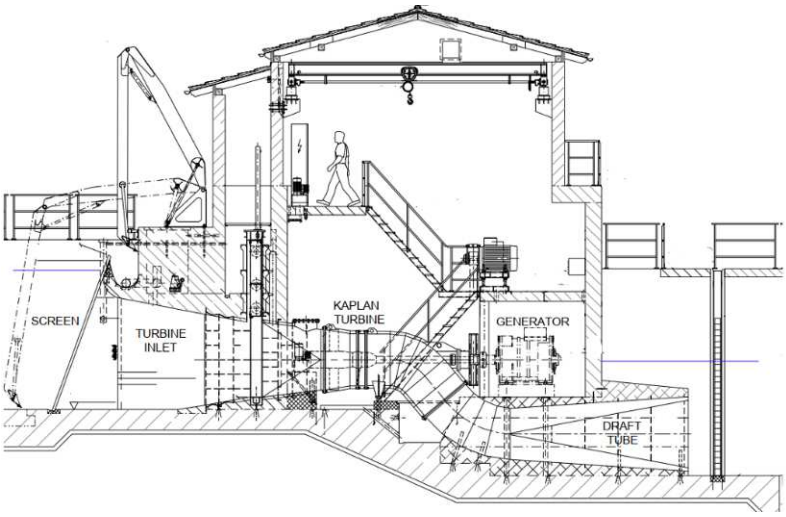
Archimedean screws were originally considered for this site, but had been deselected in favour of Kaplans on account of their visible presence and a need to suppress water noise potentially audible at the residential area upstream. One or more suitable variable-speed screws of the relevant capacity would meet EA guidance in all parameters, requiring only coarse debris screening according to the guidance. A single screw of the largest available diameter 5000mm can be accommodated in the same channel width, and in a much smaller overall footprint due to the omission of the finely-screened intake and its long bay. On grounds of capital cost, therefore, there may still be a case for using such a screw.

Other types of device can be used, subject to the addition of fine screening to exclude fish and finer debris. When using conventional Kaplan turbine/s instead of screw/s, EA licensing considerations are generally similar except for the question of fish screening. The EA's advice is that the intake must be fully equipped with very fine screens to exclude eels, which will likely require some form of automated screen-cleaner to be installed. The tailrace may also be equipped with dissuasive screening if the EA so specifies. One benefit of using Kaplans is that a greater comparative flow could be taken in a narrower turbine footprint than a screw, though the intake would be no narrower and (as above) a fine-screened intake must be much wider. Kaplans are more efficient at peak, but will suffer losses or stop sooner in rising tailwater, and also may start up later in the hydrograph.

Below are summaries of the types described above as technically suitable for this site.

Kaplan turbine

This consists of a rotating blade, rather like those used for aeroplane propellers, located within a sealed tube. It is a reaction turbine, relying on pressure differences to turn the blades. This machine operates most efficiently at a fixed design flow, so for sites with variable flows, a Kaplan system is used. Angle of the blades changes in response to the flow conditions.



Advantages

- At design flow no other system is as efficient when comparing peak turbine efficiency.
- Higher turbine speed reduces losses introduced by speed increasers.
- More discreet, as the turbine machinery is encased in concrete below river levels

Disadvantages

- Fine fish screening is required, which will increase the maintenance overhead / reduce flow available to fish.
- Head loss is introduced by the fine screens and in pressure pipes, reducing the overall net head available for generation.
- Efficiency at partial flow rates and partial heads may be poor when compared with an Archimedean screw.
- Complex control system - requires either manual adjustment with varying flow or expensive automation.
- Typically high capital cost and cost for precision parts.

NB: NATEL's RHT model of turbine is among proprietary variants having novel blade profiles which have been tested as preventing damage to fish. (Pending tests in the UK?)

Archimedean screw

This consists of an Archimedean screw, designed so as to reverse its original concept as a pump. The water is allowed to fall into and turn the screw, which in turn drives a generator.

Advantages

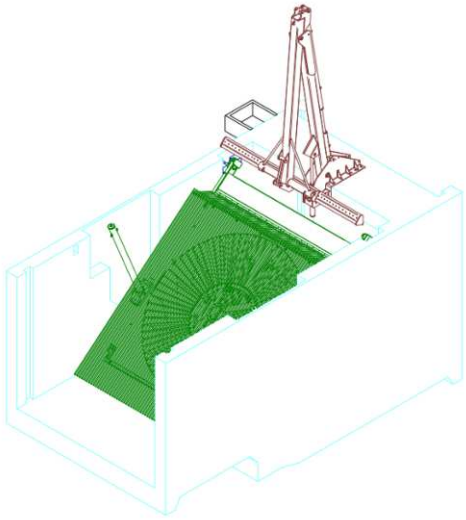
- Typically nowadays controlled to operate at variable speeds, screws turn quite slowly (typically <24 rpm), minimising injury risk to fish from contact with moving blades.
- Large chambers of water are maintained at all times, allowing fish and debris to pass slowly down through the machine.
- The swim bladders of fish are not affected, as the water pressure remains constant.
- No fine screening is therefore required, reducing installation and maintenance cost.
- Leaves and debris can simply pass through the screw, reducing need to clear a screen.
- No head loss is caused by fine screening or pressure pipes, so the highest net head is available for generation.
- No draft tube is required, reducing the civil costs of deeper excavation.
- High efficiency is maintained over a wide variation of flows, in particular for low flows.
- On environmental and fish-protection grounds, the Archimedean Screw has in the past been singled out as a preferred technology in EA recommendations. Hence some of our projects have appeared as case studies in EA and DECC literature.
- For educational and promotional purposes, turbine is exposed to view when operating *(photo above shows a screw before installation of the typical mesh safety cover)*

Disadvantages

- Kaplan systems operating in optimum conditions have slightly higher turbine efficiency.
- Low turbine speed requires use of a speed-increasing gearbox to drive the generator
- Ecological benefits of an open turbine mean a larger size and more evident presence.
- Noise above water level may be more evident than with a fully-submerged device
- ONLY where support structures are still present for a waterwheel of sufficient size, installing a waterwheel may be easier than bespoke works for an equivalent screw

VLH turbine ("Very Low Head" turbine)

This consists of a rotating bladed hub like a Kaplan, but in principle, having a wider diameter per flow, slower rotation, and larger number of blades; and set in a large flat inclined cassette without pressure pipes.



It can operate down to a part-flow - 50% has been seen, and less may be possible. Like a Kaplan, it has higher flow / power per unit width than a screw, at a higher rotational speed.

However, its civil works are simpler than a conventional Kaplan, being only a stepped plain channel (similar to that for a screw, but deeper per unit width).

Advantages

- Claimed fish-friendly (but not fully proven - see below – so likely to require screening)
- Simplicity of civils construction is similar to a screw
- Unit is hinged up out of water for inspection and maintenance – fuller inspection
- Small superstructure, so may offer a lower-profile obstruction to flood flows

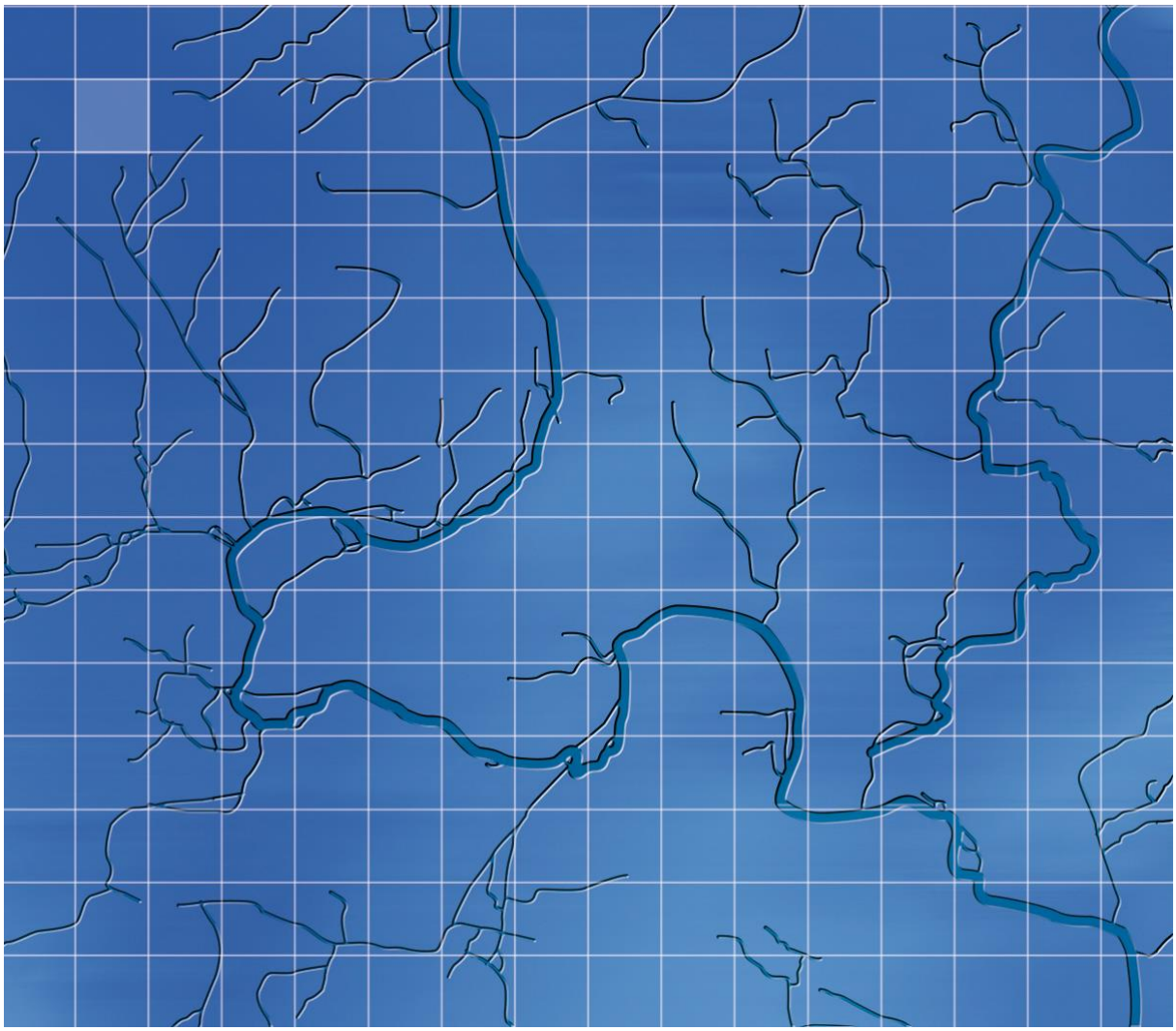
Disadvantages

- Not yet installed in UK or confirmed as fish-friendly by UK regulators – early installations will be pioneering proofs-of-concept which may require provision of additional research evidence and/or precautionary measures (extra costs; output constraints).
- This may impose an unknown extent of tailrace screening to prevent attracting fish
- Deep open channels required
- Noise above water level may be more evident than with a fully-submerged device
- Turbine efficiency curves requested - not yet available.

TLS Energy

July 2023

St. Neots Geomorphology Assessment



TLS Energy

St. Neots Geomorphology Assessment

Document issue details

WHS10058

Version	Issue date	Issue status	Prepared By	Approved By
2.0	31/07/2023	Draft	Joel Leyshon-Jones (*Senior Consultant*)	Daniel Hamilton (*Principal Consultant*)

For and on behalf of Wallingford HydroSolutions Ltd.

The WHS Quality & Environmental Management system is certified as meeting the requirements of ISO 9001:2015 and ISO 14001:2015 providing environmental consultancy (including monitoring and surveying), the development of hydrological software and associated training.

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Contents

1 Introduction

TLS Energy has contracted Wallingford HydroSolutions Ltd (WHS) to undertake a geomorphology assessment of the River Great Ouse at Mill Lane Weir, St. Neots, Cambridgeshire (NGR: 518673, 261789) as part of an ongoing planning application for a low-head hydro scheme. The location of the scheme is shown in Figure 1.

The purpose of this assessment is to identify the baseline flow regime and key geomorphological characteristics of the channel prior to construction of the scheme. From this information the assessment considers the potential impacts of the scheme once it is operational on sediment transport and the geomorphology of the channel. In this context, appropriate recommendations for mitigation to ensure compliance with the EA and WFD objectives are put forward.

Figure 1 Scheme Location

2 Proposed Scheme

2.1 General Layout

A hydropower scheme of up to 200kw capacity, is proposed on the River Great Ouse abstracting water upstream and bypassing the existing sluice gate at NGR: 518673, 261789. The scheme will consist of a turbine and housing, screened intake bay and fish pass. The scheme is outlined in Figure 2.

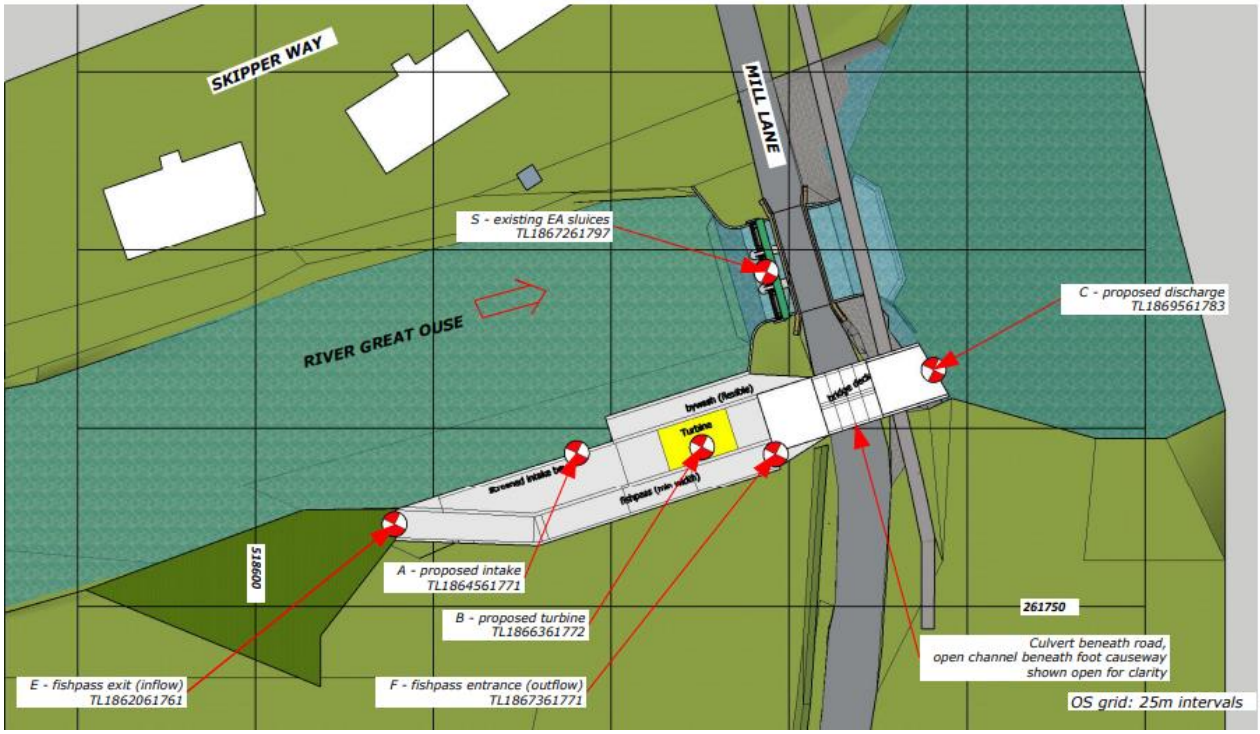

Figure 2 Scheme outline[1]

2.2 Intake Location

There is proposed to be a screened intake upstream of the Mill Lane Sluice. The channel at the location of the intake is deep as a result of the sluice gates immediately downstream and the associated backwater effect of this structure. Bathymetry data collected in 1956[2] and in 1994[3], suggest a channel depth of around 3m immediately upstream of the sluice gates. The intake's location on the River Great Ouse is approximately 500m downstream of its confluence with the River Kym.

In terms of design, the proposed intake structure consists of a wide concrete basin, with a screen to filter any debris. A photograph of the intake location is shown in Figure 3.

[1] TLS Energy. 2023. St Neots 101 V01 Hydro Scheme Concept.
[2] Great Ouse River Board. 1956. River Ouse Furlong Sections.
[3] National Rivers Authority Anglian Region. 1994. River Great Ouse St, Neoats 3 Sluices Backwater and Riverside Park Backwater Long Sections.

Figure 3 Intake location

2.3 Outfall

The abstracted water would pass through the turbine to an open pool and then be culverted beneath Mill Lane (B1041) to an outlet basin adjacent to the proposed sluice outfall, a total distance of approximately 80m. A photograph showing the outfall location is shown in Figure 4 and Figure 5.

Figure 4 Outfall location

Figure 5 Culverted reach beneath Mill Lane

2.4 Abstraction terms

The proportion of flow that can be abstracted at the intake, will be determined by flows in the River Great Ouse. The terms are not yet agreed, however the proposed abstraction for the scheme is given in Table 1 below. The information below uses data from the Offord gauge, located 5.4km downstream of the proposed scheme, to produce a flow duration curve (FDC) from the gauge's Daily Mean Flow (DMF) dataset. This is then adjusted based on the relative catchment size at the scheme's location.

The proposed maximum abstraction is proposed to be a figure which is below the expected Qmean at the site, set at 13m³/s (Qmean is calculated as 16.19m³/s). It is proposed that a minimal residual flow of 3.35m³/s is retained in the watercourse (a proposed Hands Off Flow) which equates to Q97 including both channels. From Q97 rising to approximately Q75 conditions (to be determined during commissioning), it is likely that the hydro will have insufficient flow to start up, so will not abstract. Likewise, as flows fall below again, the hydro will close down again at some condition closer to Q75 than Q97 (to be determined during commissioning). Under moderate flow conditions, only a diminishing amount of flow will be taken, and in low flows below perhaps Q80 (TBD) the hydro is unlikely ever to be abstracting.It is noted that in addition to flow through the triple sluice gates, which are to be bypassed by this scheme, a small sweetening flow also occurs past the navigation channel to the north, in the order of 30l/s (see location of this bypass in Figure 6).

Although a maximum abstraction of 13m³/s is herein assumed and assessed in this report, the client has outlined the possibility of an application which instead increases the upward limit to 16m³/s. This scenario is briefly assessed in Appendix 3, relative to the conclusions of this report assuming the 13m³/s maximum.

Table 1 Proposed abstraction

% of Year	*Offord Gross DMFs 1992-2022*	*m3/s at site (by ratio)*	*(Minimum residual flow)*	*Available flow*	*Chosen option - Usable Flow (m3/s)*	*Depleted flow*
0	201.000	198.106	3.351	194.755	13.000	185.106
5	56.445	55.632	3.351	52.281	13.000	42.632
10	36.800	36.270	3.351	32.919	13.000	23.270
20	22.000	21.683	3.351	18.332	13.000	8.683
30	15.700	15.474	3.351	12.123	12.123	3.351
40	11.800	11.630	3.351	8.279	8.279	3.351
50	9.550	9.412	3.351	6.061	6.061	3.351
60	7.840	7.727	3.351	4.376	4.376	3.351
70	6.480	6.387	3.351	3.036	3.036	3.351
80	5.340	5.263	3.351	1.912	0.000	5.263
90	4.420	4.356	3.351	1.005	0.000	4.356
95	3.750	3.696	3.351	0.345	0.000	3.696

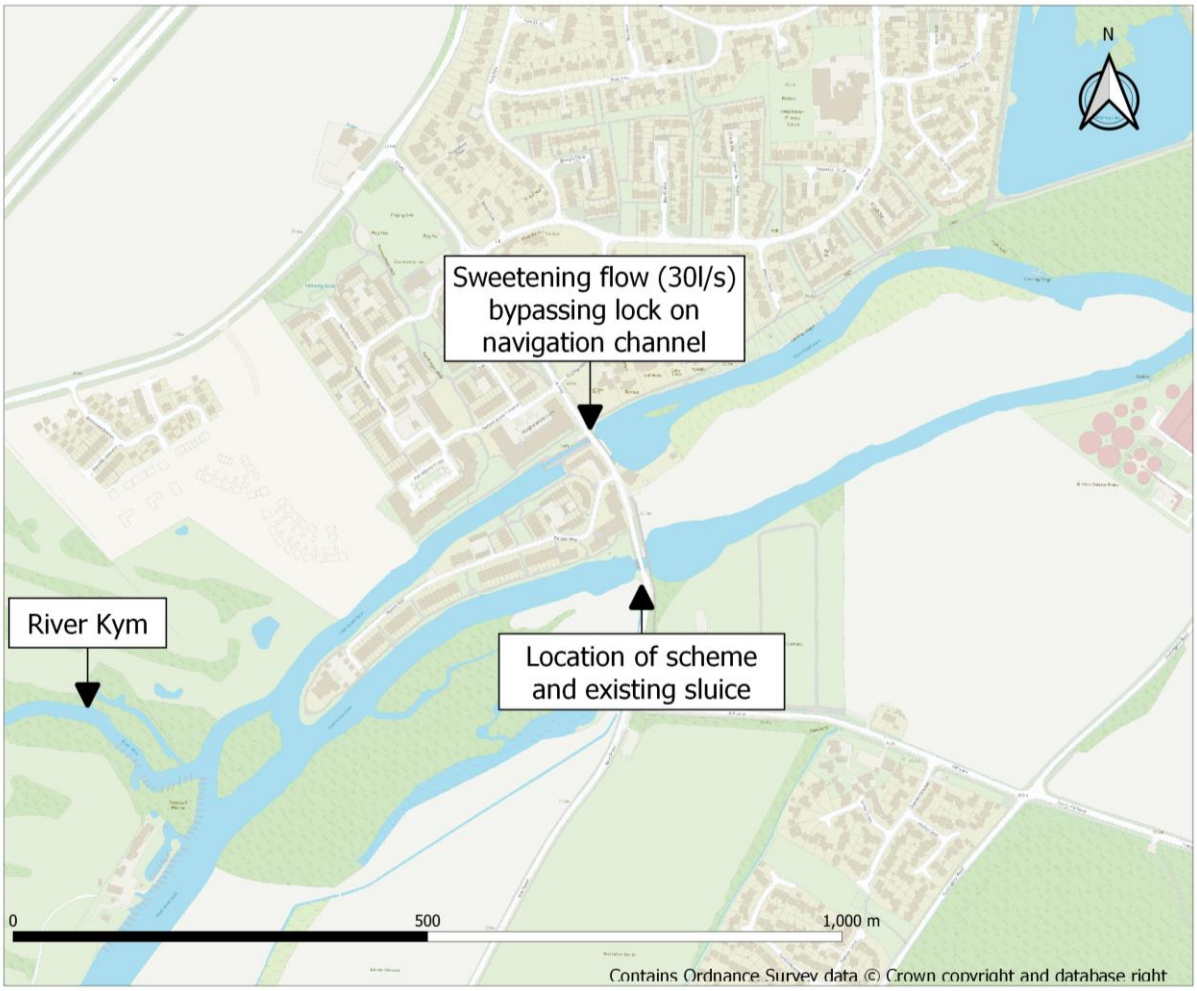

Figure 6 Location of bypass on navigation channel

3 Desk Based Assessment

3.1 Catchment Overview

The River Great Ouse catchment covers an area of approximately 2527km²[4] at the intake structure. The catchment includes major urban centres such as Milton Keyes and Bedford and is located to the south-west of St. Neots.

The river at the location of the scheme is typical of a lowland watercourse it is characterised by a very shallow gradient, gentle meanders and wide channel form. The channel bed (where visible) consists of mainly fine silt deposits, with some small pebbles downstream of the sluice gates.

[4] Flood Estimation Handbook Web Service. UK Centre for Ecology & Hydrology. Accessed at: https://fehweb.ceh.ac.uk/Map

3.2 Geology and Soils

A review of the BGS 1:50k[5] Bedrock geology map indicates the bedrock geology in this area is largely comprised of sedimentary bedrock. The Oxford Clay formation underlays the majority of the area – a sedimentary bedrock of mudstone.

In terms of superficial deposits, alluvium deposits comprised of clay, silt, sand and gravel, are recorded immediately adjacent to the watercourse across the floodplain. River terrace deposits are shown to overlay bedrock further out from the river channel, comprised of sand and gravel. Diamicton deposits then overlay much of the lower catchment area, with various instances of sand, silt and clay deposits in the upper catchment, generally in proximity to tributaries of the Great Ouse.

The overlaying soils close to the watercourse through the lower catchment are classified as 'Freely draining slightly acid loamy soils', whereas further from the channel, they become lime-rich, loamy and clayey soils, with impeded drainage. This is based on the Soilscapes 1:250k scale soils map[6].

3.2.1 Channel Gradient

The Great Ouse close to the location of the scheme has a gently sloping gradient, not averaging more than 1:3000. Given the existence of the sluice gates at the site, the upstream reach is backed up by this structure, resulting in a near horizonal water profile. Water level monitoring carried out at this location by Wallingford Hydrosolutions (November 2022-January 2023) showed there to be a head drop of between 0.8-2.3m across the sluice gates, which currently serve to maintain upstream water levels (to roughly between 13.5-13.6mAOD).

Figure 7 shows the channel gradient from upstream of the intake location to downstream of the outfall location.

[5] BGS (2023) *Geology of Britain Viewer*, https://mapapps.bgs.ac.uk/geologyofbritain/home.html
[6] Cranfield Soil and Agrifood Institute (2023) *Soilscapes map*, http://www.landis.org.uk/soilscapes/

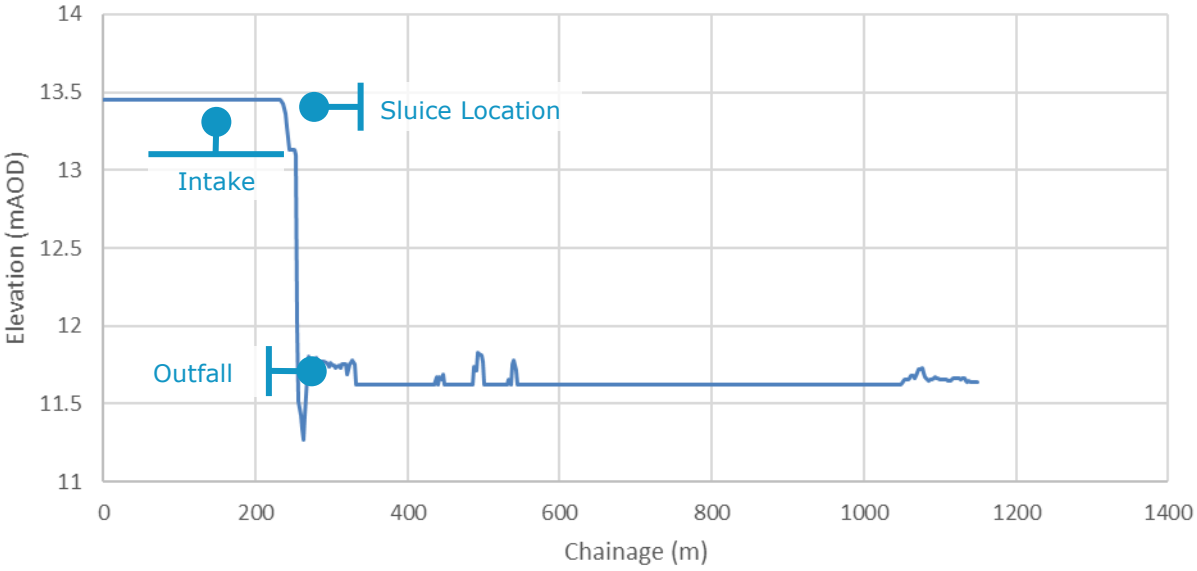

Figure 7 Channel gradient long profile

3.3 WFD Waterbody Classification

The EU Water Framework Directive was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date. Table 2 shows the current waterbody classification and objectives for the River Great Ouse.

Table 2 Waterbody Classification of the River Great Ouse (Roxton to Earith)

River Great Ouse (Roxton to Earith)	
Waterbody ID	GB105033047921
Hydromorphological designation	Heavily modified
2019 Cycle 3 Ecological Classification	Moderate
2019 Cycle 3 Chemical Classification	Fail
Ecological Objectives	Moderate by 2015
Chemical Objectives	Good by 2063

The watercourse currently has Fail Status for the Chemical Classification due to unacceptable amounts of Perfluorooctane sulphonate (PFOS) and Polybrominated diphenyl ethers (PBDE). The chemical objective is set at 2063, due to the expected environmental recovery time.

4 Walkover Survey

4.1 Survey Methodology

A 0.4km walkover survey was conducted on the 8th July 2023, extending from approximately 200m upstream of the intake location and 200m downstream of the outfall location. Representative locations were selected along the reach where access was possible. At each of these locations, georeferenced photographs were taken of the river channel and key features within the floodplain. Photographs were also taken of the dominant bedload where access was possible. All photographs are provided in Appendix 1. Due to access issues, information for the left hand bank was limited to

only a 50m stretch downstream of the sluice (though some aspects were characterised and inferred from cross river photos taken from the right hand bank).

The weather conditions during the site walkover were dry and overcast, following a period of moderate rainfall, as such, flows within the channel were low to moderate. The extent of the walkover survey is shown in Figure 8.

Figure 8 Walkover survey extent

5 Geomorphological Assessment

5.1 Baseline characteristics

5.1.1 Intake location

The proposed intake location is at approximately NGR: 518624, 261759. This is 55m upstream of the sluice gates on the right bank, as indicated in Figure 9.

Figure 9 Channel characteristics at the intake location – aspect looking downstream from the left bank.

The water profile at this location is effectively flat, with little discernible flow, a result of the backwater effect from the sluice gates. The channel width at this location is estimated to be approximately 30m. No clear evidence of bank erosion is evident at the proposed intake location. Moving downstream the river bed is likely to be increasingly deep approaching the sluice gates, with some scouring occurring to the bed as subsurface velocities increase (likely to approach supercritical), as water is drawn under the gates.

On the right bank where the intake is to be sited, dense vegetation at the intake location is evident up to the waters edge, with some areas of reeds ingressing into the channel. The bank rises no more than 0.5m from the waters edge, to a large, undeveloped floodplain area. The bank is made up of fine sediment (silt), though due to the dense vegetation this is largely unexposed and is densely

populated by reed species. Further inland there is a large expanse of grassland, extending up to 100m inland. Assessing a timeseries of photographs of this area, it is apparent that the grassland area is rarely maintained, and at the time of survey was over 1m in height. This area sits within the functional floodplain of the Great Ouse and is likely to be fully submerged during higher river levels.

The left bank is far less naturalised, and is instead maintained as a mixture of grass and planted beds alongside a pedestrian walkway which runs along the top of bank (upstream from the sluice gates). The bank rises more steeply on this side of the river, by over a meter from the waterline (at time of survey). The beds, comprise more formalised low level planting near the path, though contain dense brambles, bushes and then reeds towards the bottom of the bank. Some trees also occur in the planted beds. The bank material along the left bank is soil, covered by either bark or grass where there is no vegetation.

At the time of survey (8th July 2023), the river level was within the typical range for the 'St. Neots' river gauge[7]. The gauge is located on the bypass channel for the Great Ouse, where a lock is situated to allow boats to navigate the river. A bypass also exists at this location, providing a sweetener flow to the downstream reach in this channel, in the order of 30l/s (a relatively insignificant amount in the context of total flows in the Great Ouse).

[7] https://riverlevels.uk/river-ouse-little-paxton-st-neots. Date: April 5th 2023.

Figure 10 River Great Ouse banks, clockwise from top; right bank material, left bank planting area, left bank pedestrian walkway (with planting on left), right bank floodplain.

5.1.2 Sluice gates and outlet location

The hydro scheme will bypass an existing flow control system on the river, which are the Mill Street (Little Paxton) sluice gates. This consists of three sluice gates, owned and operated by the Environment Agency, which serve to regulate upstream water levels. The upstream and downstream channel is contracted towards the sluice gates by concrete encased, corrugate metal wing walls, with the each sluice being approximately 3.7m across. At the outlet the wingwalls extend out to 17m at which point there is a transition to unfinished concrete, set around large boulders which retain earth further up the bank towards the road. Bridge piers from the pedestrian footbridge also fall within the bank at this location.

The water is highly turbulent at the proposed outfall, creating waves which reach either side of the channel beyond the wingwalls. The channel downstream of the sluice gates is show in Figure 11.

Figure 11 Downstream of Mill Lane sluice

The proposed outlet location for the scheme is adjacent to the existing sluice gates on the right bank. The width of the outfall is yet to be determined, but is likely to span across both the rough concrete area next to the wingwalls and earth bank next to this. At the least, the internal width of the outfall is to be 6m.

In terms of vegetaion, trees and low level shrubs line the top of the banks. There is also vegetation growing on the banks which due to their steepness tend to be climbing plants, brambles and moss.

Soils are relatively coarse here and are interbedded with small stones. There is evidence of erosion to the banks which is likely in part a combination of wave buffering from the sluice outfall. The channel broadens out moving downstream to a maximum width of approximately 65m. Though there is significant wave energy at the outfall of the sluice gates, the channel velocity close to the banks was very low on the day of survey.

Figure 12 shows concrete and large rock material to the right of one of the footbridge pillar (left image) and part of the steep soil bank (right image). These two images are considered representative of the outfall location.

Figure 12 Outfall location, left showing bank material near wingwalls, right showing natural bank material (soils) further out from wingwalls

6 Potential Impacts of the Proposed HEP Scheme

The scheme has the potential to cause direct and indirect impacts on the watercourse, these need to be assessed to determine if there are any adverse effects. The main points to be considered are:

- Will the intake structure have any impact on upstream flows and sediment transport?
- Will the new abstraction impede sediment transfer?
- Will the outfall cause increased erosion risk?

To determine this, the potential impacts from i) the concrete intake basin, ii) the abstraction/fishpass and iii) the turbine/outfall basin have been independently assessed.

6.1 Intake

The intake location is situated at a relatively deep channel section. The intake is to be built into the right bank, perpendicular to the river's flow. Plans for the scheme indicate there will be minimal constriction to the existing channel. The existing sluice gate arrangement immediately downstream of this location already causes a significant backwater effect and increased river levels for a significant distance upstream of this location. The relative backwater effect of the intake structure is therefore expected to be negligible in comparison, with no further impoundment of flows. River velocities at

this location are generally expected to be low, and are unlikely to support any significant erosion, entrainment or suspension of material.

In summary, the intake structure is not expected to lead to a significant change in deposition due to increased pooling of flows upstream or in erosion through the constriction acceleration of flows downstream.

6.2 Abstraction

An increase in deposition rates caused by the reduction in flow along the depleted reach is assessed here. In this case, the depleted reach is minimal, comprising a reach of no more than 50m from the intake of the proposed scheme to the sluice gates. Current proposals suggest a maximum abstraction of 13m³/s across much of the FDC, rather than a percentage of flow. This means that at higher flows (where sediment transport will be greatest) the proportion of flow abstracted by the scheme will be far less (see Table 2-1), amounting to 23% at Q5, relative to a peak of 78% at Q28. In this regard, the impacts on entrainment and the transfer of sediment downstream are expected to be limited.

While the Hands-off-Flow (HOF) indicated by current proposals is set at EA guidance Q97, this is in practice augmented in all conditions when the chosen turbine cannot start up or maintain operation; so that a larger flow up to perhaps Q75 may in practice be left unabstracted in such conditions . This should mean that deposition rates at low flows remain similar to baseline levels. It also ensures that low seasonal flows will continue within the existing watercourse as before, supporting any existing habitats along the reach.

As noted within Section 5.1.1, the in-channel velocities at the location of the intake, up to the entrance to the sluice gates and for someway upstream (as indicated by the slope gradient of the watercourse) are generally expected to be very low, indicating relatively low baseline levels of erosion and entrainment. Overall relative changes to deposition rates across the FDC within the depleted reach are therefore considered to be minimal.

6.3 Outfall

The abstracted water from the River Great Ouse passes through a screened intake bay, before passing through the turbine. This will pass through a culvert under the road and elevated footpath before the abstracted water re-enters the River Great Ouse though the concrete outfall basin.

According to proposals, at Q28, maximum turbine flow is reached, at which point 14.3m³/s (a combination of 13m³/s passing through the turbine and 1.3m³/s from the fish pass) will be flowing from the outfall. Using the initial design width of the outfall chamber (6m) and the calculated water depth at this location (approximately 2.5m), velocities are likely to around 0.95m/s.

The velocities will peak at Q28, with tailwater levels then increasing beyond this percentile (see Appendix 2) as more water flows through the sluice gates and causes downstream levels to increase. These velocities from the scheme are likely far less than those created at the sluice gates, thus the impact on surrounding bed and bank is likely to be far less by comparison. The potential for scour on the banks is further limited by the concrete outfall basin, with straight concrete wing walls, which provides additional protection.

Nonetheless, despite relatively low velocities expected at the outlet, it is possible that the scheme in its early stages, may serve to mobilise fine sediment built up in this location. An amount of sediment build-up is likely to have accumulated in this area (at the sides of the sluice gates), as current velocities reduce towards the banks. Any mobilised sediment may then be transported downstream and potentially 'blind' downstream spawning habitats as a result of the scheme. It is therefore advised that prior to operation of the scheme, a small amount of dredging take place at, and

immediately surrounding the proposed outfall location to remove fine sediment, to ensure that this can occur in a controlled manner. The dredged sediment will be deposited in an appropriate location to avoid remobilisation.

7 WFD Geomorphological Assessment

This assessment considers any potential impacts to the hydromorphological elements of the waterbody against the main objectives of the WFD. Any hydropower scheme should demonstrate that the proposal will not:

- **Objective 1:** Contribute to a deterioration in the current status or potential of the waterbody or water bodies affected by your scheme
- **Objective 2:** Prevent the achievement of objective set for the waterbody or water bodies affected by your scheme

Currently the ecological status of the River Great Ouse surface waterbody is Moderate. As the current published objectives are to retain this status, this assessment will consider if any impacts of the scheme do not align with these objectives. As discussed in section 6 above, the scheme is not envisaged to have any significant impact on the geomorphological processes along the reach. This is primarily due to the significant impact of the existing sluice gates in terms of backwater effect, such that the impounding of flows and backwater from the scheme required for abstraction, will be insignificant relative to the baseline. Also due to the generally low flow velocities upstream of the sluice gates, there is unlikely to be significant sediment transport during most parts of the year. Whilst at high flows sediment may be mobilised and carried downstream, the relative abstractions of the scheme diminish, meaning its impact is limited during these events also.

With regard to fish passage, a fish pass has been designed into the scheme. This represents an improvement from the existing scenario, where no pass around the sluice gates is currently provided.

Overall, it is thought that the scheme will not cause detrimental effect to the WFD status or prevent the future objectives of the waterbody from being achieved.

8 Conclusions

The conclusions and recommendations from this study are as follows:

- A geomorphology walk over survey was completed in July 2023 to assess the potential impacts of a proposed hydro power scheme on the River Great Ouse at Little Paxton, St.Neots, Cambridgeshire.
- The River Great Ouse catchment covers an area of approximately 2527km² at the intake structure. The catchment includes significant urban centres such as Milton Keynes and Bedford.
- The river at the location of the scheme is significantly impacted by the existing sluice gates, which have a backwater effect for some distance upstream. Downstream the river channel is also of a very shallow gradient, gentle meanders and wide channel form. The channel bed where visible, consisted of mainly fine silt, with some small stones deposited along the bank sides.
- There was no significant bedload identified either up or downstream of the sluice gates, with only very fine sediment likely to be supported by the low velocities in this region.
- Given the nature of the existing channel, the intake is not expected to significantly impact the hydraulic nature of the watercourse upstream, due to its position perpendicular to river flow and water already backed up by the sluice gates.
- The nature and characteristics of the depleted reach are unlikely to be heavily influenced by the proposed scheme given that seasonal low flows should still be maintained.
- Sediment transport in the depleted reach will be negligibly affected since this is expected to occur at high flows. The proposed abstraction rates mean that high flows will not be significantly reduced by the proposed abstraction.
- Discharged water from the turbine will be relatively slow (expected to peak around 1m/s) and is thus expected to have far less of an impact on bed and banks than the sluice gate discharge (potential for scour to banks is further limited by the concrete wingwalls). It is though concluded that there may be some mobilisation of existing sediment at this location during early stage of operation. It is advised that this should be anticipated and a small amount of dredging take place to manage this dissipation in a controlled way.
- The scheme is not expected to impact upon the current or potential future WFD status of the watercourse.

Appendix 1 Site walkover photos

Appendix 2 Proposed Percentile Flow Values

% of Year	Offord Gross DMFs 1992-2022	m3/s at site (by ratio)	Min residual flow	Available flow	Chosen option - Usable Flow (m3/s)	Depleted flow	Weir Upper Water Level	Sluice Upper Water Level	Turbine Upper Water Level	Turbine Lower Water Level
0.0	201.0	198.1	3.4	194.8	13.0	185.1	13.6	13.5	13.5	**14.0**
1.0	93.1	91.8	3.4	88.4	13.0	78.8	13.6	13.5	13.5	**13.5**
2.0	79.1	78.0	3.4	74.6	13.0	65.0	13.6	13.5	13.5	**13.1**
3.0	70.3	69.3	3.4	65.9	13.0	56.3	13.6	13.5	13.5	12.9
4.0	62.8	61.9	3.4	58.5	13.0	48.9	13.6	13.5	13.5	12.7
5.0	56.4	55.6	3.4	52.3	13.0	42.6	13.6	13.5	13.5	12.5
6.0	51.3	50.6	3.4	47.2	13.0	37.6	13.6	13.5	13.5	12.4
7.0	46.8	46.1	3.4	42.8	13.0	33.1	13.6	13.5	13.5	12.3
8.0	43.0	42.4	3.4	39.0	13.0	29.4	13.6	13.5	13.5	12.2
9.0	39.6	39.0	3.4	35.7	13.0	26.0	13.6	13.5	13.5	12.1
10.0	36.8	36.3	3.4	32.9	13.0	23.3	13.6	13.5	13.5	12.0
11.0	34.9	34.4	3.4	31.1	13.0	21.4	13.6	13.5	13.5	12.0
12.0	33.0	32.5	3.4	29.2	13.0	19.5	13.6	13.5	13.5	11.9
13.0	31.1	30.7	3.4	27.3	13.0	17.7	13.6	13.5	13.5	11.9
14.0	29.4	29.0	3.4	25.6	13.0	16.0	13.6	13.5	13.5	11.8
15.0	27.8	27.4	3.4	24.0	13.0	14.4	13.6	13.5	13.5	11.7
16.0	26.5	26.1	3.4	22.8	13.0	13.1	13.6	13.5	13.5	11.7
17.0	25.3	24.9	3.4	21.6	13.0	11.9	13.6	13.5	13.5	11.7
18.0	24.0	23.7	3.4	20.3	13.0	10.7	13.6	13.5	13.5	11.6
19.0	22.9	22.6	3.4	19.2	13.0	9.6	13.6	13.5	13.5	11.6
20.0	22.0	21.7	3.4	18.3	13.0	8.7	13.6	13.5	13.5	11.6
21.0	21.2	20.9	3.4	17.5	13.0	7.9	13.6	13.5	13.5	11.6
22.0	20.4	20.1	3.4	16.8	13.0	7.1	13.6	13.5	13.5	11.6
23.0	19.7	19.4	3.4	16.1	13.0	6.4	13.6	13.5	13.5	11.5
24.0	18.9	18.6	3.4	15.3	13.0	5.6	13.6	13.5	13.5	11.5
25.0	18.3	18.0	3.4	14.7	13.0	5.0	13.6	13.5	13.5	11.5
26.0	17.7	17.5	3.4	14.1	13.0	4.5	13.6	13.5	13.5	11.5
27.0	17.2	17.0	3.4	13.6	13.0	4.0	13.6	13.5	13.5	11.5
28.0	16.7	16.5	3.4	13.1	13.0	3.5	13.6	13.5	13.5	11.5
29.0	16.2	16.0	3.4	12.6	12.6	3.4	13.6	13.5	13.5	11.5
30.0	15.7	15.5	3.4	12.1	12.1	3.4	13.6	13.5	13.5	11.5
31.0	15.2	15.0	3.4	11.6	11.6	3.4	13.6	13.5	13.5	11.4

32.0	14.8	14.6	3.4	11.2	11.2	3.4	13.6	13.5	13.5	11.4
33.0	14.3	14.1	3.4	10.7	10.7	3.4	13.6	13.5	13.5	11.4
34.0	13.9	13.7	3.4	10.3	10.3	3.4	13.6	13.5	13.5	11.4
35.0	13.5	13.3	3.4	10.0	10.0	3.4	13.6	13.5	13.5	11.4
36.0	13.1	12.9	3.4	9.6	9.6	3.4	13.6	13.5	13.5	11.4
37.0	12.7	12.5	3.4	9.2	9.2	3.4	13.6	13.5	13.5	11.4
38.0	12.4	12.2	3.4	8.9	8.9	3.4	13.6	13.5	13.5	11.4
39.0	12.0	11.8	3.4	8.5	8.5	3.4	13.6	13.5	13.5	11.4
40.0	11.8	11.6	3.4	8.3	8.3	3.4	13.6	13.5	13.5	11.4
41.0	11.5	11.3	3.4	8.0	8.0	3.4	13.6	13.5	13.5	11.4
42.0	11.2	11.0	3.4	7.7	7.7	3.4	13.6	13.5	13.5	11.4
43.0	11.0	10.8	3.4	7.5	7.5	3.4	13.6	13.5	13.5	11.4
44.0	10.8	10.6	3.4	7.3	7.3	3.4	13.6	13.5	13.5	11.4
45.0	10.6	10.4	3.4	7.1	7.1	3.4	13.6	13.5	13.5	11.4
46.0	10.4	10.3	3.4	6.9	6.9	3.4	13.6	13.5	13.5	11.4
47.0	10.2	10.1	3.4	6.7	6.7	3.4	13.6	13.5	13.5	11.4
48.0	10.0	9.8	3.4	6.5	6.5	3.4	13.6	13.5	13.5	11.4
49.0	9.8	9.6	3.4	6.3	6.3	3.4	13.6	13.5	13.5	11.4
50.0	9.6	9.4	3.4	6.1	6.1	3.4	13.6	13.5	13.5	11.4
51.0	9.4	9.2	3.4	5.9	5.9	3.4	13.6	13.5	13.5	11.4
52.0	9.2	9.1	3.4	5.7	5.7	3.4	13.6	13.5	13.5	11.4
53.0	9.0	8.9	3.4	5.5	5.5	3.4	13.6	13.5	13.5	11.4
54.0	8.8	8.7	3.4	5.3	5.3	3.4	13.6	13.5	13.5	11.3
55.0	8.6	8.5	3.4	5.1	5.1	3.4	13.6	13.5	13.5	11.3
56.0	8.5	8.4	3.4	5.0	5.0	3.4	13.6	13.5	13.5	11.3
57.0	8.3	8.2	3.4	4.8	4.8	3.4	13.6	13.5	13.5	11.3
58.0	8.1	8.0	3.4	4.7	4.7	3.4	13.6	13.5	13.5	11.3
59.0	8.0	7.9	3.4	4.5	4.5	3.4	13.6	13.5	13.5	11.3
60.0	7.8	7.7	3.4	4.4	4.4	3.4	13.6	13.5	13.5	11.3
61.0	7.7	7.6	3.4	4.2	4.2	3.4	13.6	13.5	13.5	11.3
62.0	7.5	7.4	3.4	4.1	4.1	3.4	13.6	13.5	13.5	11.3
63.0	7.4	7.3	3.4	4.0	4.0	3.4	13.6	13.5	13.5	11.3
64.0	7.3	7.2	3.4	3.8	3.8	3.4	13.6	13.5	13.5	11.3
65.0	7.1	7.0	3.4	3.7	3.7	3.4	13.6	13.5	13.5	11.3
66.0	7.0	6.9	3.4	3.5	3.5	3.4	13.6	13.5	13.5	11.3
67.0	6.9	6.8	3.4	3.4	3.4	3.4	13.6	13.5	13.5	11.3
68.0	6.7	6.6	3.4	3.3	3.3	3.4	13.6	13.5	13.5	11.3
69.0	6.6	6.5	3.4	3.2	3.2	3.4	13.6	13.5	13.5	11.3
70.0	6.5	6.4	3.4	3.0	3.0	3.4	13.6	13.5	13.5	11.3

71.0	6.4	6.3	3.4	2.9	2.9	3.4	13.6	13.5	13.5	11.3
72.0	6.2	6.1	3.4	2.8	2.8	3.4	13.6	13.5	13.5	11.3
73.0	6.1	6.0	3.4	2.7	2.7	3.4	13.6	13.5	13.5	11.3
74.0	6.0	5.9	3.4	2.6	0.0	5.9	13.6	13.6	0.0	11.3
75.0	5.9	5.8	3.4	2.5	0.0	5.8	13.6	13.6	0.0	11.3
76.0	5.8	5.7	3.4	2.3	0.0	5.7	13.6	13.6	0.0	11.3
77.0	5.6	5.5	3.4	2.2	0.0	5.5	13.6	13.6	0.0	11.3
78.0	5.5	5.5	3.4	2.1	0.0	5.5	13.6	13.6	0.0	11.3
79.0	5.4	5.4	3.4	2.0	0.0	5.4	13.6	13.6	0.0	11.3
80.0	5.3	5.3	3.4	1.9	0.0	5.3	13.6	13.6	0.0	11.3
81.0	5.3	5.2	3.4	1.8	0.0	5.2	13.6	13.6	0.0	11.3
82.0	5.2	5.1	3.4	1.7	0.0	5.1	13.6	13.6	0.0	11.3
83.0	5.1	5.0	3.4	1.6	0.0	5.0	13.6	13.6	0.0	11.3
84.0	5.0	4.9	3.4	1.5	0.0	4.9	13.6	13.6	0.0	11.3
85.0	4.9	4.8	3.4	1.5	0.0	4.8	13.6	13.6	0.0	11.3
86.0	4.8	4.7	3.4	1.4	0.0	4.7	13.6	13.6	0.0	11.3
87.0	4.7	4.6	3.4	1.3	0.0	4.6	13.6	13.6	0.0	11.3
88.0	4.6	4.5	3.4	1.2	0.0	4.5	13.6	13.6	0.0	11.3
89.0	4.5	4.4	3.4	1.1	0.0	4.4	13.6	13.6	0.0	11.3
90.0	4.4	4.4	3.4	1.0	0.0	4.4	13.6	13.6	0.0	11.3
91.0	4.3	4.2	3.4	0.9	0.0	4.2	13.6	13.6	0.0	11.3
92.0	4.2	4.1	3.4	0.8	0.0	4.1	13.6	13.6	0.0	11.3
93.0	4.1	4.0	3.4	0.7	0.0	4.0	13.6	13.6	0.0	11.3
94.0	3.9	3.9	3.4	0.5	0.0	3.9	13.6	13.6	0.0	11.3
95.0	3.8	3.7	3.4	0.3	0.0	3.7	13.6	13.6	0.0	11.3
96.0	3.6	3.5	3.4	0.2	0.0	3.5	13.6	13.6	0.0	11.3
97.0	3.4	3.4	3.4	0.0	0.0	3.4	13.6	13.6	0.0	11.3
98.0	3.1	3.1	3.4	0.0	0.0	3.1	13.6	13.6	0.0	11.3
99.0	2.6	2.6	3.4	0.0	0.0	2.6	13.6	13.6	0.0	11.3
100.0	0.0	0.0	3.4	0.0	0.0	0.0	13.6	13.6	0.0	11.3

Appendix 3 Increased Abstraction Option Assessment

A Preliminary Ecological Appraisal and scoping report of an area of land off Mill Lane, Little Paxton.

Author: **Richard Lawrence MCIEEM**

Date: **August 2022**

Ecological Consultancy Services

For Bedfordshire and neighbouring counties

Beds RCC

Bedfordshire Rural Communities Charity

Contents

2 Introduction

2.1 Background

BedsRCC was commissioned by Hydroplan Ltd to undertake a Preliminary Ecological Appraisal (PEA) and protected species scoping report at Little Paxton Mill, herein referred to as 'the site'.

This report has been produced to inform the client and the design team of the key ecological constraints and opportunities associated with the project, possible mitigation measures and to detail any further survey requirements considered necessary.

2.2 Site Location and Description

The site was located to the south of Little Paxton at central Ordnance Survey Grid Reference: TL186617.

The site totals 0.4ha, comprising a variety of habitats. The site is within a countryside setting situated on the edge of an urban location and surrounded by residential buildings to the north, road to the west and countryside sites to the south and east.
The wider area comprised urban settlement, agricultural land, allotments, hedgerows and watercourse, and pockets of deciduous woodland.

2.3 Development Proposal

It is proposed to create a Hydropower scheme on the site.
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2.4 Scope of Survey

This report details the findings of the following surveys:
• A desk-based assessment undertaken during June 2022; and
• A walkover survey undertaken on June 17th 2022
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2.5 Objective

The objectives of this study are to identify and report:
• Likely ecological constraints associated with the proposed works;
• Mitigation measures that are likely to be appropriate;
• Where further ecological surveys are necessary;
• Actions considered necessary to comply with planning policy, and UK wildlife legislation and
• Opportunities for the project to deliver ecological enhancement.

3 Methodology

3.1 Surveyor

The site was surveyed by BedsRCC Ecologist, Richard Lawrence MCIEEM.

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3.2 Desk Study

The Multi-Agency Geographic Information for the Countryside (MAGIC) online database was accessed during July 2022 for information on:

- Designated areas that form the National Network of sites which includes Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites within 5km of the site;
- Statutory sites designated for nature conservation such as Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR) and Local Nature Reserves (LNR)
- within a 2km radius of the site;
- Natural England's Impact Risk Zones (IRZs) for SSSI, SAC, SPA and Ramsar sites within which the site was located;
- Any European Protected Species Mitigation (EPSM) Licences granted by Natural England within a 2km radius of the site; and
- Positive great crested newt licence returns from within 2km.

Cambridgeshire and Peterborough Environmental records Centre (CPERC) was consulted on the 16th of June 2022 for the following information for a 2km radius around the application site:

- Non-statutory nature conservation designations, such as County Wildlife Sites (CWS);
- Legally protected species, such as great crested newts, reptiles, birds and otters, badgers, bats; and
- Notable species, such as those listed as Species of Principal Importance in England.

Aerial photographs, maps and field observations were used to identify habitats in the wider landscape which could be impacted by development of the site.

3.3 Habitat Survey

The survey involved a site visit on the Date to record and map habitat types and ecological features within the site. The survey was undertaken in accordance with *Guidelines for Preliminary Ecological Appraisal* (CIEEM, 2017), and the general principles and methods outlined in the Phase 1 Habitat survey manual. Features of interest were identified as target notes on the Habitat Map (**Appendix 1**).

Stands of vegetation and areas of artificial land cover were classified following the Phase 1 vegetation system and mapped using Google earth imaging and image editing software. Notable features of interest and stands of vegetation too small to map were identified using target notes on the Habitat Map (**Appendix 1**).

3.4 Protected and Notable Species Assessment

During the habitat survey the site was searched for evidence of and assessed for potential to support protected and notable species.

This included species listed under the *Conservation of Habitats and Species Regulations (as amended) 2017*, the *Wildlife and Countryside Act 1981 (as amended) (WCA)*, and those given extra protection under the *Natural Environment and Rural Communities (NERC) Act*

2006, *Countryside and Rights of Way (CRoW) Act 2000*, and the *Protection of Badgers Act 1992.* The following protected / notable species were considered within the assessment, where available, current National guidelines were followed in respect of each species or group of species.:

3.4.1 Plants

Plants were noted during the habitat survey.

3.4.2 Amphibians

The site and the surrounding area was assessed for suitability for amphibians, specifically Great Crested Newt (*Triturus cristatus*) and Common Toad (*Bufo bufo*) and an initial fingertip survey was undertaken by a licenced surveyor.

Any ponds on or near the site were assed for their habitat suitability for GCN using the Habitat Suitability Index (HIS) (Oldham et. al. 2000).

3.4.3 Otters

The site was assessed for its suitability to provide resting places for otters and surveyed for otters signs (spraint, print, resting areas, feeding remains and sightings).

3.4.4 Water Vole

The site was assessed for its suitability for Water Voles and surveyed for their signs (holes, prints and feeding signs).

3.4.5 Badgers

The site and areas adjacent to the site (where accessible) were surveyed for badger (*Meles meles*) evidence (setts, latrines, pathways, footprints, foraging signs, snuffle holes, badger hairs and badger remains).

3.4.6 Bats

Potential for the site and the surrounding area to provide opportunities for roosting, foraging and commuting bats was assessed.

3.4.8Hazel Dormouse

The site was assessed for potential to support the hazel dormouse (*Muscardinus avellanarius*) by reference to records of the nearest known population and assessing the suitability of on site and adjacent habitats during the site visit and from aerial imagery.

3.4.9Hedgehog

The site was assessed for suitability to support hedgehogs.

3.4.10 Birds

The site was assessed for potential to support nesting birds.

3.4.11Reptiles

The site was assessed for suitability to support reptiles.

3.4.12 Fish

The site was assessed for suitability for fish.

3.4.11 Invertebrates

The site was assessed for suitability for invertebrates.

3.4.12 Other Protected and Notable Species

The site was assessed for suitability to support other protected and notable species more generally.

3.4.13 Invasive Species

Incidental observations of non-native invasive species listed on Schedule 9 of the Wildlife and Countryside Act were noted and mapped.

3.5 Evaluation

Designated sites, habitats and species (where presence has been identified) have been evaluated in accordance with the *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial and Freshwater* (CIEEM, 2018).

These guidelines aim to give consistency in evaluating the importance of the ecological features within and around a site, which help inform any effects or impacts a scheme will have upon them.

A value of the ecological features (designated sites, habitats or species) has been assigned according to their level of importance using the following terms:

- International and European
- National
- Regional
- County
- Local; and
- Negligible

3.6 Limitations and Assumptions

During the field survey access was available to the entire site and some adjoining areas. Dense vegetation growth made getting to some parts difficult, the baseline conditions reported represent those identified at the time of the survey.

Although a reasonable assessment of the site can be made during a single survey, this report does not constitute a full botanical survey or detailed habitat or species survey or assessment and single surveys cannot give any information regarding seasonal variations.

The report provides an overview of the likelihood of protected and notable species occurring on the site but the absence of a species cannot be confirmed when no evidence was found.

Further surveys are recommended where there is reasonable likelihood of a protected species being present and impacted by the development proposal. This is based on the suitability of the habitat and any evidence observed.

Provided the proposed works, site conditions and habitats and adjacent sites remain unchanged, the results of this assessment are likely to remain valid for up to eighteen months i.e. January 2024. If works have not begun by this time it may be necessary to update the assessment.

4 Results and Evaluation

The following section presents the results, evaluation and discussion of the designated sites, habitats and protected / notable species, which may be present on site and/ or impacted by the proposed development.

4.1 Designated Sites

4.1.1 Statutory Sites

Details of statutory sites designated for nature conservation and other sites recognised for their nature interest within 2km of the site are provided in **Table 4.1**.

No sites of **International importance** or **European importance** were returned within 2km of the application site.

Sites of Special Scientific interest (SSSI) are of **national importance**.

Local Nature reserves (LNR) and County Wildlife Sites (CWS) are of **local importance.**

Table 4.1: Designated and recognised sites within 2km of the application site.

Site Name	Distance from site	Area (ha)	Reasons for designation
SSSI			
St Neots Common	Adjacent	33.35	This riverside common holds alluvial grassland and associated ponds, ditches and willow carr which together provide an area of diverse wildlife habitat. The sward is species-rich, and the invertebrate fauna is likely to be diverse.
Little Paxton Pits	0.6 miles	127.38	An extensive area of flooded gravel pits of varied age, with a diverse vegetation structure. Nationally important for wintering wildfowl and an important stopping point for migrants. The rich invertebrate fauna includes a number of national rarities.
LNR			
Little Paxton Pits	0.6 miles	59.9492	
CWS			
Little Paxton Pits Non-SSSI	1.3 miles	102.03	Supports at least 3 species of breeding wader; a population of a Nationally Scarce vascular plant species; at least 3 species of Pondweed (*Potamogeton spp.*); contains a type 10A standing water body with at least 5 submerged and floating species.
River Great Ouse	Adjacent/ within	N/A	A major river not grossly modified by canalisation or poor water quality; supports >0.5ha NVC S6 swamp; >0.5ha S4 swamp; >0.05ha MG13 grassland; a NS vascular plant (*Nymphoides peltata*); breeding populations of a NR dragonfly (*Libellula fulva*)

The site falls within the St Neots Common SSSI and Little Paxton Pits SSSI Impact Risk Zones (IRZ) as defined on the MAGIC database; however, the proposed development does not fall into any of the categories listed for those SSSI's as likely to be a risk to those sites. Therefore, it is not anticipated that The Local Planning Authority needs to consult Natural England on this proposal regarding likely impacts on those SSSIs.

The willow carr and long grass add to the habitats of the adjacent SSSI and the application is ecologically linked to this site so consideration will need to be given to the potential impact on those habitats.

Due to the small-scale size, location and nature of application site the proposed development is highly unlikely to have a significant negative effect on any European site (either alone or in combination with other plans or projects). Further, it is not directly connected with or necessary to the management of such sites.

No further assessment is recommended for statutory conservation sites.

4.1.2 Non-Statutory Sites

Details of non-statutory sites designated for nature conservation that were located within 2km of the application site are provided in **Table 4.1**.

The River Great Ouse CWS runs through the site and will be directly affected by the development over a short section.

It is considered that the development will be small enough and located sufficiently far enough from any of these sites for there to be any direct or indirect impacts on their habitats. Further, there does not appear to be any direct public path, hydrological link or other habitat connectivity between these sites and the application site (Natural England, 2021). No significant impacts to non-statutory sites are expected.

No further action is recommended in respect of statutory sites.

4.2 Habitats

The habitats below were recorded within the site during the survey.
No protected, BAP, Habitats of Principal Importance or locally important floral species or habitats were recorded
during the survey. Habitat types are described below and shown on the Habitat Map (**Appendix 1**).

- Open Water, River G2,1,3
- Open Water, Stream G2,1,2
- Broadleaved Semi-natural Woodland A1,1,1
- Improved Grassland B4
- Ruderal, C3,1

4.2.1 Open Water,

River G2,1,3

The site is bounded to the north by the River Great Ouse, the in-channel vegetation was not sampled for this survey but did feature a duckweed (*Lemna sp.*). The Marginal veg was dominated by Common Nettle (*Urtica dioica*) along with other species such as Willowherb (Epilobium sp.), Teasel (*Dipsacus fullonum*), and various grasses. Additionally there are Common Hawthorn (*Crataegus monogyna*) shrubs along the southern bank and a large Willow (*Salix spp.)* on the Northern bank.

The River Great Ouse

The River Great Ouse and its structures

Stream, G2,1,2

There is a roadside ditch running north south on the edge of the site that was dry at the time of survey and contained a small population of Himalayan Balsam along with Common Nettle and grasses.

The roadside ditch

4.2.2 Broadleaved Semi-Natural Woodland, A1,1,1

The west of the site features an area of Broadleaved Semi Natural woodland dominated by Willow spp. (*Salix spp.)* with very little ground flora other than Common Nettle – this is Willow Carr woodland.

There is an area of Broadleaved Woodland to the east of the site (the other side of the road to the main site) that is dominated by Sycamore (*Acer pseudoplatanus*), with the addition of English Oak (*Quercus robur*), Elm (*Ulmus sp.*), Common Hawthorn, European Beech (*Fagus sylvatica*), Elder (*Sambucus nigra*) and Ash (*Fraxinus excelsior*) with a ground flora dominated by Ivy (*Hedera helix*) with Garlic Mustard (*Alliaria petiolata*) and Bramble (*Rubus fruticosus agg*).

The edge of the Willow Carr.

The edge of the Broadleaved woodland.

4.2.3 Improved Grassland G4

Unmanaged grassland

The area of unmanaged grassland is dominated by a few common grass species such as Great Brome (*Bromus diandrus*), Cock's-foot (*Dactylis glomerata*) and Timothy (*Phleum pratense)* with occasional patches of creeping thistle and blending tinto the ruderal areas of Common Nettles.

4.2.4 Ruderal C3,1

There are several areas of ruderal vegetation dominated mainly by Common Nettle and Bramble with occasional other species such as Burdock (*Arctium sp.*).

Ruderal vegetation

4.3 Protected and Notable Species

"Recent records" refers to records within the last 10 years. Older records have been included in some of the discussions where considered appropriate.

MAGIC did not return any records of granted EPSM licences on the site or from within 2km of the site.

4.2.1 Plants

There were no recent records or sightings of protected plant species from the site or the immediate surrounds. None of the recent records of plants returned from CPERC were anywhere near the site.

4.3.2 Amphibians

4.3.2.1 General

The MAGIC portal indicated that three pond surveys had been undertaken for GCN within 2km of the site between 2017 and 2019. None of the ponds surveys were found to be hosting GCN.
GCN were reported in Licence returns for Little Paxton Pits on numerous occasions during 2015.

CPERC returned no additional recent records of GCN (over and above the 2015 licence return record) and several older records for the same site and one other distant location in Little Paxton.

There were 2 recent (2018 and 2020) of Common toad records from CPERC, one In Little Paxton Pits and one in St. Neots, neither are very close to the site.

No ponds were located within the site but one is present on the edge of St. Neots Common immediately adjacent to the site. A preliminary fingertip search of suitable refuges around this pond was undertaken during the site visit but no evidence of any amphibians was found.

Other suitable refuges found within and adjacent to the site were also searched and no evidence of amphibians found.

The site was dominated by long grass and riverside vegetation with some willow carr, and these habitats do hold some potential for Great Crested newt during their land phase.

4.3.2.2 GCN Habitat Suitability Index

The GCN Habitat suitability Index (HIS) for the adjacent pond has been calculated as follows:

Factor 1 (Location): Zone A – **SI = 1**
Factor 2 (Pond Area): Approximately 550m^2, **SI = 1**
Factor 3 (Permanence): Not known but as wet during the site visit assumed to not dry out, **SI = 0.9**
Factor 4 (Water Quality): No netting was undertaken but the water appeared to contain few invertebrates and little submerged vegetation, **SI = 0.33**
Factor 5 (Shade): 54% of the pond margin is shaded by trees, **SI = 1**
Factor 6 (Water Fowl): There was no evidence of water fowl. **SI = 1**
Factor 7 (Fish): No netting was undertaken but there were no fish seen and no indication of fish presence. **SI-= 1**
Factor 8 (Pond Count) there are two ponds within 1km of the pond but these are separated from it by the Great Ouse which may constitute a major barrier as they are less likely to cross it. However, they have been considered available for the purposes of this calculation. Pond density = 0.64, **SI = 0.55**
Factor 9 (Terrestrial Habitat) approximately 37% of the area within 250m provides accessible good terrestrial habitat with the remaining area being sub-optimal or inaccessible (river, urban area, roads, allotments), **SI = 0.67**
Factor 10 (Macrophytes) the only plants seen on the pond was the reed fringe and over shading willows. Macrophyte cover is estimated to be less than 10% therefore. **SI = 0.3**

HSI (product of the 10 factors)$^{1/10}$ = **0.71 = Good**.

4.3.3 Otters

There were eight recent records of Otter from the immediate area of the site reported from CPERC, the majority of these are of road killed otters and the road here seems to be an otter RTA blackspot.

There were large quantities of spraint present under the bridge and this area is obviously much frequented by otters.

No evidence of otter resting sites was found on site.

4.3.4 Water Vole

There were no records of Water Vole from CPERC

There was no evidence of Water Voles found on site.

4.3.5 Badgers

CPERC returned 13 confidential records of badgers, the most recent of which was 2012. Including a single outlier sett on the other side of the river with no likely connectivity with the site.

There was no evidence of badger setts or signs seen on or near to the site.

4.3.6 Bats

There were 88 records of bats from the CPERC data, 28 of which were recent records. The vast majority of the records are from Little Paxton Pits, with a few from residential areas nowhere near the site.

4.3.6.1 Roosting

The area of willow carr could contain trees with potential for bat roosts. No preliminary bat roost assessment was undertaken on any of the trees. The works will get no closer to this area than about 20m and protection fencing will be erected to prevent casual access during the construction phase.

The concrete and other structures within the site did not appear to provide any suitable bat roosting opportunities as they are maintained in good condition - no cracks in mortar or loose or fallen blocks; and did not appear to have any voids to provide roosting areas for bats.

4.3.6.3 Foraging and Commuting

The whole site, river plus banks, grassland area and willow carr provide good foraging habitats for a wide range of bats and the river is likely to be a commuting corridor.

4.3.7 Hazel Dormouse

There were no records of Hazel Dormouse from CPERC and there appears to be no suitable habitat for the species on site or anywhere within 2km. The willow carr is unlikely to be suitable for dormice due to the likelihood of repeated wet conditions during the winter.

4.3.8 Hedgehog

There were two recent records of Hedgehogs from CPERC, neither particularly near the site.

Whilst the site provides some suitable habitats for hedgehogs it is bounded by a river on one side and busy road on another and is therefore difficult for them to access.

4.3.9 Birds

There were a large number of bird records returned from CPERC (over 6500) mainly due to the presence of the highly recorded Little Paxton Pits being within the 2km search area. None of the records were directly from the site and none of the records were of nesting birds.

Although no particular effort was made to record birds, none were noted on site during the walkover visit.

The habitats found on site provide suitable conditions for a wide range of breeding birds, especially tall bankside vegetation, willow car and scrubby bramble patches.

4.3.10 Reptiles

There were only five recent records of reptiles returned from CPERC, and an additional nine older records. These were all Grass Snake (*Natrix helvetica*) and none were from on or near the site with all the records coming from little Paxton Pits or nearby to that site.

A search of suitable refuges was undertaken on the site and no evidence of reptile use of the site was found.

The site does provide some suitable habitats for reptiles, particularly Grass Snake in the form of the river and adjacent long vegetation; there is little suitable habitat for other reptiles.

4.3.11 Fish

There were no records of fish returned from CPERC, this seems an unlikely representation of the reality here and is considered that there have been no fish records submitted to the records centre rather than there being no fish present.

No specific fish survey was undertaken as part of this study and no evidence of fish was noted (other than unidentified bones in otter spraint).

The site is likely to provide good habitat for a number of fish species.

4.3.12 Invertebrates

There were a large number of invertebrate records returned from CPERC (over 1,300). As for most other species groups, the vast majority of these are from Little Paxton pits and are unlikely to be of relevance to the site. No site specific records were returned.

No effort was gone to record invertebrates during the site visit but the site contains potentially very valuable habitat for invertebrates of conservation concern in the form of the river and its banks and Willow Carr.

Norfolk Hawker is a species of note found at Little Paxton Pits but there were no records from on or near the site. The site does not seem to hold suitable habitat for the species (no network of grazing marsh streams or water soldier present) and it is unlikely to establish a breeding colony here.

4.3.12 Other Protected, Priority and Rare Species

CPERC returned two records of Brown Hare *Lepus europaeus* and one of Harvest Mouse *Micromys minutis*.

The site provides good habitat for European Beaver (*Castor fibre*) but no records were returned and no evidence was noted on site. (Whilst the nearest known beaver populations are distant from this site and not connected directly they have begun to crop up all over the UK unexpectedly in recent months and now they have been granted European Protected Species status in the UK consideration needs to be given to them in suitable locations.)

4.3.13 Invasive Plants

A small population of Himalayan Balsam (*Impatiens glandulifera*) is present in the dry ditch running along the roadside.

No records of other invasive plants were returned from the record centre.

5 Recommendations

This section discusses recommendations for further surveys, general mitigation, and possible enhancements in line with relevant wildlife legislation.

5.1 Further Surveys:

5.1.1. Amphibians

The pond adjacent to the site is suitable to harbour Great Crested Newts even though no evidence and no records were found their presence cannot be ruled out on the basis of this survey. The proposed works will come within 100m of the pond but will not affect the pond. The habitats that will be affected by the works are sub-optimal for the ground phase of GCN and it is therefore recommended that a fingertip search is undertaken of the affected area immediately prior to the works being undertaken by a suitably licenced and qualified individual to ensure no newts are present. If, in the unlikely event that any are found they can be safely placed at the time of the survey in suitable habitat elsewhere on site which should not require additional licencing. If they are found on site, then newt proof fencing may be required to temporarily exclude them from the work site which should not require additional licencing.

5.1. Bats

As some of the trees on site may have some suitability for bats a Preliminary Bat Roost Survey should be undertaken on any trees it is intended to prune, coppice, pollard or fell prior to any works being undertaken (The willow carr is outside the work area so the trees there should remain unaffected).

5.1.2 Birds

As much of the vegetation along the river banks and part of the rest of the site have potential to support breeding birds, a breeding bird survey is recommended if works that will disturb the vegetation on site are to be undertaken during the breeding bird season (March to September).

5.1.4. Fish

No data on fish was available and none were surveyed for. As the site may impact the passage of fish consideration should be given to a fish specific study to address any potential impacts the works may have on them.

5.2 General Mitigation

5.2.1 Otters

The site is obviously much used by otters transiting and the road here has resulted in the deaths of numerous animals in recent years. The project is an ideal opportunity to install some kind of safe passageway for otters past the structures and under the road in order to ensure they can continue safely past the development and the likelihood of road deaths is reduced rather than increased.

5.2.7 Invasive Species: Himalayan Balsam

If works are to be undertaken during the spring or summer then Himalaya Balsam should be manually removed from the site prior to works beginning to ensure that it does not set seed and spread further over the site.

5.2.8 Nocturnal animals

Use secured planks to allow any animals that fall in to any trenches, holes or deep pits overnight to escape during construction; alternatively these can be covered to prevent access. At the end of each working day checks should be undertaken to ensure that these provisions to protect nocturnal species (such as otter, hedgehog and badger) have been made.

6 Conclusion

The site supports a small number of common habitats along with the River Great Ouse, a County Wildlife Site. The site offers areas that may support roosting bats and breeding birds which warrant further investigation if those habitats will be disturbed during construction.

The nearby pond has potential for Great Crested Newts but there is little suitable habitat where the development will occur and no evidence of them was found during the survey and no records of them exist from this area. Notwithstanding that, care should be taken during the construction phase to ensure no newts are harmed whilst works are being carried out.

The site is frequented by Otters, although there was no evidence of them using the site for resting. There are potential opportunities to enhance passage for otters during the development and care during the construction phase should be taken to ensure no traps are left for them.

The fish use of the site warrants further investigation as, although there were no records of fish from the area and no sign of fish noted, there is likely to be significant use of the site by fish.

7 References

Oldham R.S., Keeble J., Swan M.J.S. & Jeffcote M. (2000). Evaluating the suitability of habitat for the Great Crested Newt (Triturus cristatus). Herpetological Journal 10(4), 143-155.

Appendix 1

Habitat Map

Key

- Standing Water
- Running Water
- Semi improved Neutral Grassland
- Tall Ruderal Vegetation
- Broadleaved Secondary Woodland
- Dry ditch
- Approximate site boundary

Appendix 3 – Increased Abstraction Option Assessment

1 Introduction

Further to the Geomorphology report developed for the proposed St Neots HEP scheme[1], this brief report provides additional information relating to an alternative proposal for this scheme. This proposal involves an increased abstraction from the River Great Ouse, where the maximum offtake is increased from 13.0 m³/s to 16.2 m³/s, the latter value being the calculated Qmean for the watercourse.

2 Abstraction Terms

The alternative proposed abstraction for the scheme is indicated in Table 1. The depleted flow remains unchanged relative to an abstraction of 13.0 m³/s up to a flow of 16.351 m³/s. At this flow, more than 13.0 m³/s can be abstracted without compromising the minimum residual flow of 3.351 m³/s.

A flow of 16.351 m³/s is approximately equivalent to the Q29 rescaled flow (16.46 m³/s). For flows above Q29 the depleted flow bypassing the scheme is reduced relative to the 13.0 m³/s abstraction proposal. For example, at the Q20 flow listed there is a 36.9% reduction in the depleted flow, however as flows increase the impact of the increased abstraction becomes negligible. The proportion of flow abstracted is reviewed in more detail in section 3.1.

Table 1 Alternative abstractions

% of Year	Offord Gross DMFs 1992-2022	m3/s at site (by ratio)	(Minimum residual flow)	Available flow	Chosen option - Usable Flow (m3/s)	Depleted flow	% change in depleted flow
0	201.000	198.106	3.351	194.755	16.200	181.906	-1.8
5	56.445	55.632	3.351	52.281	16.200	39.432	-7.6
10	36.800	36.270	3.351	32.919	16.200	20.07	-13.8
20	22.000	21.683	3.351	18.332	16.200	5.483	-36.9
30	15.700	15.474	3.351	12.123	12.123	3.351	0.0
40	11.800	11.630	3.351	8.279	8.279	3.351	0.0
50	9.550	9.412	3.351	6.061	6.061	3.351	0.0
60	7.840	7.727	3.351	4.376	4.376	3.351	0.0
70	6.480	6.387	3.351	3.036	3.036	3.351	0.0
80	5.340	5.263	3.351	1.912	0.000	5.263	0.0
90	4.420	4.356	3.351	1.005	0.000	4.356	0.0
95	3.750	3.696	3.351	0.345	0.000	3.696	0.0

[1] WHS10058- St. Neots Geomorphology Report. 2023.

3 Potential impacts of increased abstraction

The relative impacts of increasing the maximum abstraction from 13.0 to 16.2m³/s are herein assessed. As mentioned in the section above, only flows in exceedance of the Q29 flow will be affected by the elevated maximum abstraction value.

3.1 Intake

Above the Q29 flow, abstraction will be increased relative to the 13.0 m³/s (maximum) proposal. Figure 1 compares the proportion of flow abstracted between the two proposals. For the most part the difference between the two proposals is less than 10%, apart from between the Q24 and Q14 percentile flows. The difference is most pronounced at the Q22 flow at 15.9%, whereby 80.6% of the flow is abstracted in the 16.2 m³/s proposal with 64.7% abstracted in the 13.0 m³/s proposal.

As outlined in the main report sediment transport is expected to be highest during high flow events for example at the Q5 flow. The differences here are less pronounced at this flow, with a lower proportion of flow abstracted (<30%). Relative to the 13.0 m³/s proposal, 5.8% more flow is abstracted and there is a 7.6% fall in the depleted flow heading through the sluices. This differences between the two proposals continue to reduce moving to higher flow above the Q5. In this regard, the reduction in entrained material heading through the sluices is not expected to be significant relative to the 13.0 m³/s proposal. At low flows above Q29 the conclusions in the main document remain the same.

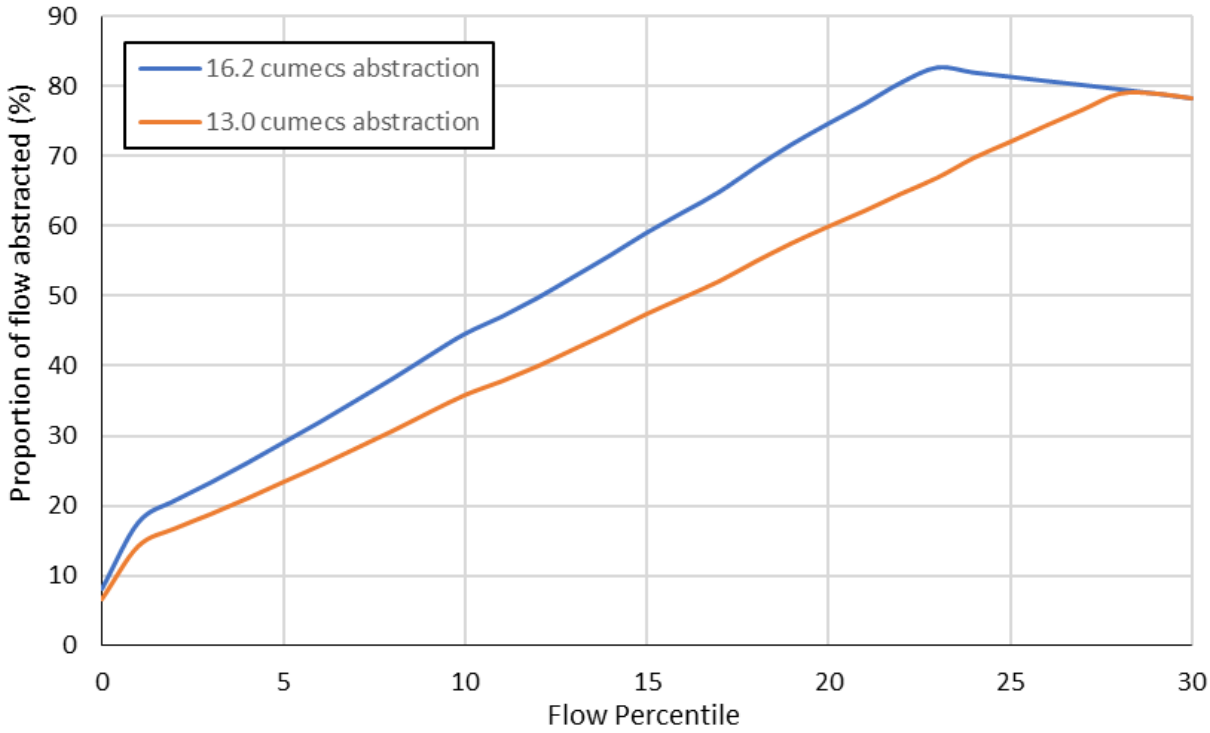

Figure 1- Proportion of flow abstracted (16.2 m³/s vs 13.0 m³/s abstraction)

3.2 Outfall

At Q22 the scheme would begin abstracting the maximum turbine flow of 16.2 m^3/s, which including fish pass flows, would result in an outfall of 17.5 m^3/s. Assuming as in the main report a design width of the outfall chamber (6m) and the calculated water depth at this location (approximately 2.6m), velocities are likely to peak at approximately 1.12m^3/s. This is only a marginal increase (0.17m^3/s) in maximum velocities relative to the 13.0 m^3/s proposal, which again relative to velocities from the sluice gate outfall remains small. In this regard the conclusions in the main report for the outfall remain the same.

4 Conclusion

The following conclusions are made:

- Only flows greater than Q28 will be impacted by the increased maximum abstraction of 16.2m^3/s.
- The largest impacts in terms of the proportion of flow abstracted are between the Q14-Q24 where the differences between the two proposals exceed 10%.
- For the Q5, a representative higher flow percentile, there will be a 5.8% increase in the proportion of flow abstracted however the total proportion of flow abstracted remains below 30%. This continues to represent a relatively small proportion of flow which decreases further moving to higher flow percentiles where sediment transport will be greatest.
- Whilst there will be a small change in sediment transport between the two proposals, the impacts are expected to be insignificant.
- Calculated velocities at the outfall are again relatively low, at 1.12m^3/s, as per the conclusion of the main report, this is low relative to the outfall velocities at the sluice, however fine material may be mobilised as a result of the scheme, therefore some amount of controlled dredging is again advised.