

## 1. BRIEF

I, Jerome Keohane was engaged by An Bord Pleanala as consultant Hydrogeologist/Hydrologist to advise the Inspector/Board on the likely impacts of the proposed development from the hydrogeology/hydrology perspectives, having regard to all aspects of the proposed developments including access tracks, foundations and turbines.

The brief provided to me by An Bord Pleanala, identified the following key responsibilities;

- Review and consider relevant documentation and observations submitted by the applicant, planning authority, prescribed bodies and third parties at all stages of the process, focussing particularly on the relevant sections of the environmental impacts statements (including any revisions to the EIS).
- Carry out site visits(s) if deemed necessary
- Set out and agree timescales with the Inspector.
- Liaise with the Inspector, and ecological consultant in relation to the oral hearing.
- Attend at the oral hearing
- Liaise with the ecological consultant in relation to potential or likely impacts of the proposed developments on groundwater dependent terrestrial ecosystems in the vicinity including Lough Croan Turlough SAC, due to potential or possible impacts on groundwater flows.
- Prepare and submit a report with reasoned conclusions on the hydrogeological/hydrological effects of both proposed developments including if relevant any cumulative impacts.

## 2. TASKS COMPLETED

In order to perform my brief, I undertook the following actions;

- Review of documentation, provided to me by An Bord Pleanala, in both hard copy and digital format.
- Development of preliminary overview and identification of items requiring clarification.
- Site visit on 03 May 2016, to carry out a general visual assessment of the topography and setting of the proposed development, and to inspect the location of each proposed turbine, and the routes of access roads. This was mainly carried out on foot, with vehicle access to expedite access where appropriate.
- Attendance at Oral Hearing, Radisson Hotel, Athlone 09/10 June 2016.
- Preparation of report.

## 3. KEY QUESTIONS ADDRESSED IN ASSESSMENT

Having reviewed the documentation and undertaken the site visit, I consider the following questions need to be addressed as part of my assessment.

1. Was the issue of hydrological impact on the nature of the turloughs surrounding the proposed development, given appropriate importance from the outset by the

applicant and the consultative bodies, and did this have an effect on the nature and extent of the investigations undertaken?

2. Did the applicant and its advisors commission and undertake appropriate investigation and interpretation of the findings of these investigations to enable them to develop and present a robust conceptual model understanding of the hydrogeological and hydrological environment?
3. Does this conceptual model provide sufficient information to rule out any potential impacts on the integrity of Natura 2000 sites beyond all scientific doubt?

#### **4. GENERALISED SETTING OF PROPOSED DEVELOPMENT**

The site comprises approximately 20 Ha of undulating lowland hilly topography comprising a low ridge that falls from 104m O.D in the northeast to some 60m O.D to the south and to under 70m O.D to the southeast. The topography is locally steep in places. The land use generally comprises pasture which ranges from rough inaccessible heavily scrub vegetated strewn with boulders to improved grassland surrounded by dry stone walls.

The more elevated undulating topography of the proposed development site is set within flatter topography through which tributaries of the River Suck pass. These lower areas also contain water features, some permanent and some seasonal.

Some of the seasonal features within 15km are identified as Turloughs and are afforded special protection under the Habitats Directive.

In addition there are other protected features within the area which comprise grasslands, bog, lake, callows and eskers.

The geological setting of the site is dominated by Limestone, which is extensively karstified.

There is significant interaction between groundwater and surface water in this area.

Having walked the site, the site can be described as hummocky with significant variations in elevations and underfoot conditions over short distances. The Phase I site, ground conditions appear to me to be dominated less by glacial deposits than Phase II. I also observed a number of karst features (collapse /dolines) on and around the site confirming the underlying karst nature of the site.

All of the Phase I proposed development is mapped by the Geological Survey of Ireland as lying within the Suck Groundwater Body. This suggests that the site is therefore potentially hydraulically connected to any groundwater features within the groundwater body, situated in a down gradient direction from the site. Generally, the hydraulic gradient and groundwater gradient mirrors the topographic gradient, which in this case suggests that the crest of the low ridge will act as a watershed, with some drainage to the NE and some to the SW. In addition there will be some flow to the SE from the southeastern corner of the site as shown in a report concerned with flooding in the Ballyglass catchment, prepared by

Ryan Hanley in 2010. Using this mapped catchment together with flow following topography, the following assessment of connectivity with protected sites and turloughs is proposed;

EUROPEAN SITE	PHASE I	PHASE II (1-16)	PHASE II (17,18.19)
	PL20-244346	PI20-244347	PI20-244347
GROUNDWATER BODY	SUCK	SUCK	FUNSHINAGH
SPA			
Four Roads Turlough	Y	N	N
Lough Croan Turlough	Y	N	N
River Suck Callows	Y	Y	N
Lough Ree	N	N	Y/N
Middle Shannon Callows	N	N	N
SAC			
Lough Ree	N	N	Y/N
Lisduff Turlough	Y/N	N	N
Four Roads Turlough	Y	N	N
Lough Croan Turlough	Y	N	N
Lough Funshinagh	N	N	Y
Killeglan Grassland	N	Y	N
Ballynamona Bog/Corkip Lough	N	N	Y
Castlesampson Esker	N	N	Y
River Shannon Callows	N	N	Y
Turloughs			
Lough Croan	Y	N	N
Four Roads	Y	N	N
Lough Feakle	N	Y	Y
Corkip Lough	N	N	Y
Dysart (Thomas Street)	Y	N	N
Cuilleenirwan	Y	N	N
Along Ballinglass Canal/River	Y	Y	N

**ASSESSMENT OF CONNECTIVITY OF PROPOSED SITES WITH EUROPEAN SITES AND TURLOUGHES  
based on mapped groundwater bodies, topography and assessment of groundwater flow  
directions.**

Y : suggests connectivity on basis of available information

N: suggests no connectivity on basis of available information

Y/N: Uncertain

It should be appreciated that the nature and extent of the connection needs to be understood to fully assess the potential impact and this can only be established by investigation. The efficacy of the investigative process undertaken by the applicant in this regard is assessed below.

## 5. ANALYSIS OF KEY QUESTIONS

*Q1 was the issue of hydrological impact on the nature of the turloughs surrounding the proposed development, given appropriate importance from the outset by the applicant and the consultative bodies?*

To answer this question, I have reviewed the documentation in a chronological fashion and I have listened to the evidence and arguments posed at the Oral Hearing.

### **Chronological review of planning process to date.**

The setting of the proposed development in the context of the karst was identified and acknowledged at an early stage (October 2010) by the applicant and is mentioned in the EIS.

It is stated in Chapter 9 (Soils and Geology) (section 9.7) of the EIS that the GSI databases identify a number of karst features in the area with two turloughs within 1.5km. The document states that a number of dolines were identified within the site, especially in the southeastern corner of the site where they display a linear trend.

A geophysical survey was proposed at this stage to investigate the presence of any karst features.

Chapter 10 (Hydrogeology), states that as part of the consultation process, that the GSI were consulted and they made no specific reference to groundwater. The report confirms the karst nature of the bedrock, but does not specifically provide an assessment of impacts of Turloughs.

It is stated that since the turbine bases are shallow that any interference with the groundwater flow regime is extremely unlikely that the potential impacts of (i) alteration in recharge patterns (ii) creation of preferential pathways are of minor significance given the scale of the development and would create negligible residual impact.

I could find no site specific evidence to support these conclusions. I am assuming that this was then taken to imply that consequent consideration of impacts on turloughs was not warranted.

In Chapter 11 Hydrology, the distance between Lough Croan and Cuilleenirwan Lough and the proposed turbine locations is "deemed sufficient as to eliminate the risk of any interaction or impact". At this stage it appears to me that the applicant considered the

Turloughs remote from the proposed development by nature of distance and predicted negligible impacts arising from activities related to the proposed development.

The Natura Impact Statement (July 2010) submitted by the applicant states “the main concern with regard to the proposed project is with migrating birds”, and “there would be no direct or indirect impacts on any of the Natura 2000 sites listed within 15km of the wind farm”. This position did not significantly change in a revised NIS submitted as part of the RFI.

Objections made as part of the planning process referred to items including the karst area, numerous karst features, fragile ecosystem, purported network of caves and streams, all turloughs not shown, flooding local to turbines T4, T5 and T6, depth to rock not known, etc.

The request for further information from Roscommon County Council did raise general issues regarding hydrology/hydrogeology as follows;

- Item 4 requested the applicant to clarify in detail the existing drainage network and proposed drainage network to attenuate run-off, guard against soil erosion and safeguard downstream water quality.
- Item 12 stated that the summary of impacts through soil contamination and interference with buried karst was a concern and stated it was imperative that concerns regarding areas of the site which may contain karst features are fully addressed. The applicant was requested to elaborate on proposed engineering and mitigation measures to ensure groundwater are protected should these features be encountered.
- Item 13 requested information on the proposed geophysical investigation to identify unstable ground or buried features
- Item 15 related to a turlough in the locality of Turbine 6

The Applicant submitted a response to these items in a document dated August 2011

In relation to

- Item 4: the applicant stated that very little variation in was seen below the topsoil layer in the trial pits, the permeability was moderate to high suggesting that 100% of the effective rainfall constitutes groundwater recharge. They stated that “there is no existing drainage network and it is not proposed to install a site drainage network” a series of proposed work practices were outlined to guard against soil erosion and pollution.
- Item 12: the applicant stated that a geophysical survey had been undertaken in March 2011 designed to identify the locations of karst features, such as caves, swallow holes, dolines and turloughs and particularly those features with no surface expression. A suite of mitigation measures were outlined to protect groundwater.
- Item 13: reported on the findings of the geophysical survey, which was undertaken in March 2011
- Item 15: the applicant confirmed the nature and extent of flooding, stating that no turbines are located within the flooded zone.

The appellants issued a response dated 21 September 2011 to the FI and commented as follows

- Item 4: Stated that “the level of detail provided was insufficient”.
- Item 12: Submitted that hydrological and hydrogeological impact assessment had not been properly carried out and “the potential impact of the proposed development on the active karst landscape was not comprehensively assessed”.
- Item 13: stated that “having regard to the sensitive nature of this area which is an active karst landscape and the significant impact which the proposed development will have on the landscape, it is not appropriate to leave borehole surveys to detailed design stage”.
- Item 15: stated that “based on the information supplied one cannot be satisfied that the proposed development will not alter flow paths within the karst and/or reactivate dormant paths and thus exacerbate flooding in the area”.

On 4<sup>th</sup> October 2011 Roscommon County Council decided to grant permission subject to 33 conditions, The conditions did not specifically mention the turloughs or SAC's, but reiterated in condition 5, the requirement to implement all environmental, construction and ecological mitigation measures set out in the EIS and further information response. The requirement for an environmental monitoring programme for the construction phase of the development was included in condition 8. Discharge of water to turloughs was prohibited under Condition 15, and required works at Turbine 6 to be undertaken during May to September only.

In their appeal to An Bord Pleanála dated 25 October 2011, the Wind Turbine Action Group appealed the decision on a number of grounds which included

- (i) Adequacy of the EIS: that the EIS failed to address concerns regarding the potential detrimental impact of the proposed development on the receiving environment of the wider site area and the designated sites in the proximity to the appeal site which are likely to be inextricably linked to the active karst by way of conduits which are likely to form part of the pattern of recharge for turloughs in the surrounding area. Lack of evidence based conclusions in respect of the impact of the proposed development on the landscape.
- (ii) Adequacy of the NIS: That the NIS had not addressed groundwater impacts to Natura sites that it has failed to demonstrate beyond reasonable doubt that Natura site integrity will not be adversely affected as required by the Habitats Directive and European case law.
- (iii) Impact of the proposed development on the karst landscape. The appellants at this stage retained experts such as Dr. Michael Long and Dr. Les Brown, who prepared reports in respect of geotechnics/geology and hydrogeology respectively. While Dr. Long focussed mainly on the geotechnical complexity of construction of the windfarm, Dr. Brown focussed on the impacts on sensitive habitats stating “the application does not achieve the required level of confidence to mitigate against significant long term impacts to sensitive habitats protected by the European Union. It was also stated that the planners report ignores the impact on hydrology and how protected sites are recharged.
- (iv) A significant risk of increase in flood risk.

A rebuttal of the third party appeals was received by the Board on 30 November 2011. In relation to the adequacy of the NIS, IWCM quoted the distance (1.1km) and the relatively small area converted to hardstanding as reasons why it is extremely unlikely that the proposed development would have any impact on water quality or recharge patterns, in addition they state that a suite of mitigation measures were provided in the EIS that would be protective of the environment.

In a counter response by the appellants dated 13/12/2011 to the response by the applicant to the appeals, they submit that " because of the highly varied and sensitive karst nature of the appeal site, that design solutions should be presented at planning stage in order that the planning authority can assess both the problems encountered and the engineering solutions proposed to satisfy themselves that any impact upon this karst recharge will be minimised" They state that , " the catchment area is not understood and no consideration has been given to interference with the groundwater regime".

The Inspectors report of March 2012 states that "whilst the turloughs in the immediate vicinity are not within the conservation area, it is likely, due to their proximity and occurrence within a limited area, that they are interconnected via the groundwater network" and "due to their shallow character a reduction in groundwater levels could have a significant impact on these sensitive ecosystems as well as the conservation areas. Conversely a rise in groundwater level could increase flooding in the area." She also stated that "the construction details and mitigation measures submitted with the application and further information are at times contradictory" she states further that "the nature and scale of risk to groundwater is not known in the absence of detailed investigations and design solutions" and "a change in groundwater flows in the area, as a result of the development could have a significant impact on both the habitats and the species using them". The Inspector states that she considers a "higher burden of proof is required to demonstrate the development will not have adverse impacts on Lough Croan and that it has not been established beyond all reasonable doubt that adverse effects on the integrity of Lough Croan will not occur.

The Board of An Bord Pleanala considered the subject of hydrology and the potential for adverse impact by the proposed development on groundwater quality and flow in the karst. The Board stated it was satisfied taking into account the information supplied by the applicant including resistivity test data submitted to the planning authority at further information stage that subject to normal good construction practice, turbine foundations can be developed at this location without significant impacts on the hydrology or hydrogeology of the area. The Board overruled the Inspectors recommendation and granted permission.

The decision was challenged in the High Court and a number of affidavits were sworn and submitted in relation to hydrology and hydrogeology (Long, Johnston, Burke). The appellants highlighted the lack of investigation undertaken in relation to Turloughs and (Johnston) stated that "specific investigation of the supporting hydrogeology of the Turloughs is required, and that the EIS had taken only a generalised view since no observational data (other than geophysics) had been collected". He states further that "in karst of this type, that increasing distance from a discharge point is no guarantee of protection".

In a response to Professor Johnston's affidavit, Waterwise stated that "there are a number of aspects of the subsurface that are not as yet fully understood and again this was

acknowledged. Recommendations were outlined that will facilitate the development of a thorough conceptual model at the post-consent detailed design stage”.

A similar rebuttal was prepared by Mr. Usher of Quadconsult, which mainly concentrated on construction activities. He stated that the applicant has consistently acknowledged the karstified nature of the area. He states that “trial pitting carried out was intended to prove or otherwise the presence of rock head near to the surface and the excavator used for this was eminently suited to this task”.

Justice Finlay Geoghegan stated in her judgement 25/7/2014, that she considered that the Board had not lawfully conducted an appropriate assessment in accordance with Article 6(3) of the Habitats directive capable of upholding its determination.

The Applicant responded in May 2015, stating that they, “the Applicant is of the view that the extensive material submitted during the course of the planning appeal constituted the best scientific evidence in the field and was entirely appropriate to enable the Board to reach complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposed development. The applicant also states that, “the mitigation measures proposed in the information submitted by the applicant, and captured in the conditions of consent, are extremely detailed and comprehensive and fully exclude the possibility of any impact on hydrogeology or recharge patterns arising from the proposed development. As a consequence there is no reasonable scientific doubt as to the absence of impacts on a European site”. And “where there is uncertainty in relation to whether there was a possible indirect hydrogeological link between the development and a European site, the applicant has assumed the presence of such links and assessed the proposed development on this basis”. They refer to the Jennings O’Donovan report of March 2015, and state “the drilling results correlate reasonably well with the geophysics results and give a level of comfort with the interpretation of the geophysics”.

A supplementary EIS and NIS information was submitted by the applicant on 18<sup>th</sup> May 2015 in respect of the likely significant impacts of the proposed grid infrastructure

In a submission by O’Connell Clarke Solicitors dated 22<sup>nd</sup> April 2015 on behalf of Ted Kelly, they refer to the judgement of Ms. Justice Finlay Geoghegan whom they reference stating that “appropriate assessment will only arise where the screening process has determined that there is a likelihood of significant effects, that the Appropriate Assessment must (i) by examination and analysis identify all aspects of the development which could affect the conservation objectives of a European site, and must (ii) contain complete, precise and definitive findings and conclusions and must not have lacunae or gaps considering the best scientific knowledge in the field and after the Competent Authority decides that no reasonable scientific doubt remains as to the absence of identified potential effects”.

In a submission by The Department of Arts Heritage and the Gaeltacht dated 18 May 2015, it is stated that “for habitats such as turloughs, maintenance or restoration of habitat condition requires maintenance or restoration of groundwater and hydrological dynamics”.

A further submission by the Department on 19<sup>th</sup> October 2015 states that the Department is of the view that information submitted by the applicant does not give sufficient consideration to the uncertainty and lacunae that still remain as to the potential effect of the proposed development over their lifetime on the conservation objective and integrity of



nearby European sites, including in combination with other pressures and activities. The Department is of the view that it is not feasible to conclude an appropriate assessment that is favourable to the proposed development that is in keeping with the jurisprudence.

A submission by Kavanagh Burke 19/10/2015 on behalf of Ted Kelly reiterated the High Court observation that "an Appropriate Assessment may only include a determination that the proposed development will not adversely affect the integrity of any relevant European site where upon the basis of complete, precise and definitive findings and conclusions made, that no reasonable scientific doubt remains as to the absence of the identified potential effects".

A submission by IWCM on behalf of the applicant on 19<sup>th</sup> October 2015 states that their interpretation of the Judicial review judgement pointed exclusively to procedural shortcomings, specifically the obligation of the Board to correctly record its reasons for its determination "The applicant submits that the proposed development is entirely in accordance with the proper planning and sustainable development of the area and is unlikely to have any significant impact on the environment and no reasonable scientific doubt remains as to the absence of impacts on any designated European site".

A submission by Kavanagh Burke on behalf of Ted Kelly dated 19 October 2015 concludes that the latest information submitted by the applicant does not address any of the gaps in the information as identified by the Boards Inspectors.

In a further submission by the Department on 8 December 2015, they suggest that they do not agree with the applicant's interpretation of Justice Finlay Geoghegan's judgement of July 2014 i.e. that the board had merely failed to record the reasons for its determination. They reiterated the Departments understanding that "an assessment or analysis must be conducted in reaching precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of proposed developments on the integrity of European or Natura sites".

A submission by IWCM on behalf of the applicant dated 8<sup>th</sup> December 2015 suggests that the Board has been furnished with the "hugely detailed Environmental Impact Statement and Natura Impact Statement. They state that no "empirical evidence has been submitted by any other party including DAHG to contradict this weight of scientific evidence" they suggest that " the mitigation measures proposed by the applicant were fully incorporated into the conditions of consent imposed by the planning authority (and subsequently by the Board). The applicant submits that this clearly demonstrates that the scientific evidence which it has submitted is entirely appropriate, does not have any lacunae or gaps and fully enables the Board to reach complete, precise and definitive findings and to impose specific mitigation measures accordingly to fully remove any impacts on European sites.

They state that it is entirely appropriate for the Planning Authority to give approval in principle and leave questions of technical detail over for subsequent agreement.

They state that the Jennings O'Donovan report was to address the lacunae alleged by the appellant in the material submitted by the applicant

Professor Johnston at the Oral hearing gave evidence that groundwater is the driver of turloughs and that the turlough ecology depends on the frequency and duration of flooding and stated that "if the recharge of groundwater to the turloughs is impeded it will have an effect on the turloughs". He also stated that "no serious investigation of the measured

response of turloughs to rainfall had been undertaken and that this is a major gap". He stated that "conventional borehole led investigation can be uncertain in karst areas, so that measurement of the response of turloughs water levels to rainfall, together with the use of a hydraulic model can give information on the extent and response of the turlough catchment to rainfall events".

Professor Johnston stated in response to questioning that the type of investigation proposed by Jennings O'Donovan would not satisfy his reservations in respect to the most appropriate form of investigation to determine the effects on turloughs.

This was reiterated by Rose Burke, who stated that the proposed investigations outlined by Jennings O'Donovan would inform the proposed construction solution for the foundation bases, but would not address the impacts on Turloughs.

Prof Johnston's stated that possible impacts on Turloughs would be either related to quality or quantity. In terms of quality he stated that disturbance of the ground for bases and roadways would possibly alter the recharge regime could allow ingress of nutrients (Phosphorous and Nitrogen), which could make their way to the turloughs. He also felt that any change to flow regime by grouting/blocking conduits could alter the frequency and duration of flooding. He gave some examples from other parts of the country where changes in land use had created impacts on the nature of Turloughs. He felt that the two key issues to investigate, were (i) determine the catchment area to the turlough and (ii) determine the response of the turlough to rainfall regime and only when these were understood could an assessment of the impact be undertaken.

Mr Kenny on behalf of the applicants suggested that Prof Johnston's main thesis was that "the applicant had not done testing to determine the interrelationship between the site, the groundwater and the turloughs". He stated that his clients approach has been to assume a relationship between the ground and the turloughs. He suggested that undertaking the form of investigation proposed by Prof. Johnston would only confirm or deny something that had always been assumed.

Prof Johnston responded saying that whilst a connection can be assumed, the nature of the connection must be evaluated.

Mr. Kenny suggested to Prof Johnston, that once a connection is assumed, if the proposed development does not interfere with this connection, then no impact will arise.

Prof Johnston argued that the construction of the (mitigated) bases and roadways will interfere with the groundwater.

Mr Kenny suggested that taking into account the investigations including the resistivity testing and the boreholes, that there was enough information before the Board to allow the Board to determine if a foundation solution can be found to ensure that there is no adverse interaction with the karst layer and no sediment or pollution is allowed from the construction or operation into the Turloughs.

Prof Johnston responded that it is a fundamental requirement to investigate the nature of the connection and not just assume that there will be no impact.

Mr Kenny proposed an additional condition (should consent be granted) that his client would be prepared to accept, that no turbines would be built over an active karst feature. Prof

Johnston responded that it would be a difficult condition to achieve and he would need to see a detailed methodology of how it could be achieved before he would accept it.

Mr. Kenny read out the statement from the Board, and its satisfaction in respect to the previous decision, mentioning the extra data from the Jennings O Donovan report together with additional conditions that his client would accept. He suggested that given the current understanding there is no basis to show any integrity impact on the Turloughs.

Prof. Johnston cautioned the difference between the application of mitigation measures to protect the immediate groundwater underlying bases and roadways and the effect that these mitigated structures will have on the Turloughs.

## **CONSIDERATION OF THE ISSUE**

It appears to me that the importance of the hydrological status of the Turlough habitats has evolved with time in the process. It was not identified by the Department at the planning stage, and this possibly informed the reaction of the applicant and Roscommon County Council. The initial NIS submitted by the applicant did not address it.

The Department representative at the Oral Hearing, Dr David Tierney explained that the Department did not have hydrological expertise in house, which would explain the perceived bias towards birds.

I suspect that engagement by the appellants of experts in this area raised the profile of the issue during the process.

The Inspector and the Board (although they reached different conclusions) identified it as a key issue and it was considered in detail at the judicial review. The Judge examined the process (Appropriate Assessment) for assessing the possible impacts on the Turloughs and identified the constraints in respect of the burden of proof required in terms of scientific certainty.

In subsequent submissions to the Board, the issue has been highlighted by the Appellants, and the Department (May 2015) has acknowledged its importance.

The applicant has argued that they have always accepted a linkage exists between the site and the Turloughs, that potential impacts will be negligible once the mitigation measures are in place, that sufficient information has been provided to allow the Board to make a determination and that further post consent investigation will provide a more comprehensive conceptual model to allow a more comprehensive impact assessment to be undertaken. I include my assessment of the linkages based on topography and interpreted flow direction at the start of this report.

Prof. Johnston who appeared on behalf of the appellants at the Oral hearing argued that selection of mitigation measures to prevent direct impact on the groundwater underlying the site, is different to the assessment of the impact these mitigated structures might have on the groundwater recharge mechanisms to Turloughs and that the investigations and proposed investigations were not designed to address this difference. He said it was a fundamental requirement to investigate the nature of the connection and reliance on assuming that there is a connection and this connection will not be interfered with is not

sufficient. He recommended measurement of water levels in turloughs in response to rainfall events and the mapping of catchments to the turloughs.

The key potential impacts on Turloughs will be related to changes to the quantity or quality of groundwater recharge that can either, change the frequency and extent of flooding (quantity) or introduce nutrients that might lead to changes in the flora of a turlough (quality). Whilst I accept that these are the main potential impacts, the key question is how significant these impacts might be and this can only be determined by an appropriate investigation.

In summary I would suggest that the Applicant feels they have undertaken adequate investigations (Geophysics, trial pits and boreholes) to inform the Board in making its determination and they intend undertaking further investigation to re-inforce their view of no impact on the Turloughs, whereas the Appellants feel that the applicants have focussed on mitigating impacts created by the construction of the scheme at the expense of assessing what impacts these mitigated structures will have on the Turloughs.

I am satisfied that the Department and the Applicant have modified their approach to the impact on turloughs through the process and have more recently in the process, taken it more seriously. The appellants and their experts have consistently argued that the issue has not been adequately investigated by the applicant.

I am of the opinion that the investigation process undertaken by the applicant has not addressed the onerous constraints that apply when considering an appropriate assessment of impact on turlough habitat.

Therefore, it does appear to me, that the issue of impacts on Turloughs was not given appropriate importance from the outset, and this has had an effect on the nature and extent of the investigation undertaken.

***Q2. Did the applicant and its advisors commission and undertake appropriate investigation and interpretation of the findings of these investigations to enable them to develop and present a robust conceptual model understanding of the hydrogeological and hydrological environment?***

To assess this question, I have examined the investigations undertaken to date, and considered their findings and the interpretation drawn by the Applicant from the findings. I also posed a series of questions to the experts retained by the applicants at the Oral Hearing.

### **Chronological review of Ground Investigation process to date.**

I am satisfied that the desk study undertaken in relation to this process, did adequately identify the hydrogeological and hydrological setting of the proposed development. It appears that consultations with the GSI did not raise the turlough hydrogeology as a specific issue. The GSI raised the issue of slope stability as a major issue with Phase I and the nearby geological heritage site of the Castlehampson Esker in relation to Phase II. In addition the GSI referred the applicant to the relevant datasets that should be consulted.

Ms Ibbotson stated at the Oral Hearing that Waterwise advised the applicant of the importance of the karst environment at an early stage in the process.

Ms Ibbotson stated that the karst issue had influenced the design of their investigation process. She stated that the initial desk study survey did confirm the karst nature of the site, and some karst features not recorded on the GSI karst database were identified at the walk-over stage. The trial pits were focussed mainly on ground conditions at the individual turbine sites and the site in general. She stated that Waterwise then advised their client at the further information stage that the karst/turloughs issue needed to be looked at in more detail and the geophysics was recommended as a good first method to use, to be supplemented later by drilling.

Ms Ibbotson indicated that Waterwise had no input to the initial NIS and the statement that impact on birds was the main issue regarding impact on habitats.

Ms Ibbotson agreed with the general GWB descriptions from the GSI, and suggested that this did influence the investigation. When asked about the recharge mechanisms she agreed that recharge on the site comprises both point recharge and diffuse recharge mechanisms.

When questioned about a linear alignment of dolines encountered in the SE corner of the site and other observations on trends. Ms Ibbotson felt there was no consistent trend.

When questioned about the 100% of effective rainfall recharging groundwater and how this varied from the GSI values. Ms. Ibbotson agreed that there would be variation in terms of recharge mechanisms across the site. Ms. Ibbotson stated that the GSI information was not available at the time the EIS was prepared, and suggested that if the recharge value was less than 100% and closer to the GSI figure of 80%, that it would not negate the proposed mitigation measures. Ms Ibbotson stated that however that even though it would suggest 20% going to surface water, there were no surface water features identified.

21 trial pits were excavated in one day during June 2010. When asked about the suitability of the excavator used for the trial pits, Ms Ibbotson stated that the ground was quite compact, which limited the depth, but argued that the trial pits were nonetheless informative. Ms Ibbotson confirmed that at the time planning was submitted the ground conditions were described as "shallow bedrock at every location, with shallow sandy Clay subsoil". Ms Ibbotson agreed that the psd analysis (38% fines and 4% clay) of the soil sample together with the compactness of the subsoil, was at variance with the free draining appearance of the landscape.

Ms Ibbotson confirmed that no insitu measurement of permeability was made, that no digital terrain or hydrological techniques were used to model surface flows, and that no direct investigation was undertaken on the turloughs close to the site. Any comments on filling mechanisms are therefore general comments. Ms Ibbotson stated that comments regarding distance from turloughs being sufficient to limit any impacts were made in the context of surface flows only and in the context of the distance from individual turbine bases only.

Dr. Hodgson explained the ERT system and stated that the use of geophysics was something that evolved through the investigative process. It was used to assist in both geotechnical and hydrogeological work. He confirmed that the trial pit findings were used in interpretation and that in his experience features less than 2.5m in diameter cannot be detected by this technique. He stated that the geophysics should be re-calibrated to take

account of the findings from the boreholes drilled in 2015, but this had not yet been undertaken.

Dr Hodgson stated that the main use of geophysics is to infer compositional changes, i.e types of material and susceptibility of areas to karstification. He stated that he was confident in the quality of the surveys because the RMS error was low in all cases. With regard to the range of resistivity values, Dr Hodgson said that changes to the fabric of the rock, the weathering state, the presence of sand or clay can all have a bearing on the resistivity value, so the choice of which material to choose is down to interpretation.

He confirmed that consistently high resistivity values were interpreted as areas of competent limestone with no karst features and these related to turbine locations 1,6,7,8,9,10. When asked about a specific feature at Turbine 13, which was interpreted as a fault zone or channel feature. Dr. Hodgson explained that it was represented on the resistivity sections as a sharp change in resistivity values, which was then interpreted as a fault or a channel feature.

Dr Hodgson confirmed that the initial report submitted with planning concluded that there was bedrock at 0.4m to 2.5m depth, with three distinct layers being identified from a top layer of unweathered fresh limestone, over a karstified layer over and then an intermediate limestone. Any revised interpretation of this report has not yet been submitted.

Dr. Hodgson explained that seismic geophysics which depends on the traveltime of sound through ground materials was used at 1-2 locations to assist the interpretation of the resistivity.

At Turlough 6. Dr. Hodgson agreed that the variation in resistivity values measured around Turbine 6 suggested variation in the subsoil type from Clay to Sands, which could correspond with a range of permeabilities and could thus have a bearing on the nature of groundwater recharge.

With regard to the Quadconsult report, I asked for clarification on a statement made by Mr. Usher in the report, regarding perched water. The clarification stated that the statement was made in response to a contention by the appellants that the resistivity results show subsurface fissures and saturated areas that could mean a water conduit is in existence. Mr Usher clarified that in his experience a saturated area was more likely to be as a result clays or silts or perched water in a layer of gravel rather than a conduit, since a conduit would only appear saturated if substantial water is flowing through it. He says this is entirely consistent with the trial pit investigation.

Mr Kiely stated that the Jennings O'Donovan report was not commissioned to address any possible lacunae in the previous work, but to investigate the ground conditions further, examine foundations and to tailor the next round of site investigations. He stated that the review of resistivity testing comprised a review of the findings mainly, no new interpretation was undertaken, and the report was used to identify the key risk locations that required further investigation.

When asked about the standpipe in RC-T5, Mr Kiely stated that no groundwater measurements over a prolonged period had been taken from the borehole. It was envisaged that the borehole would be one of a number of boreholes that would be drilled and tested later in the post consent investigation

Mr. Kiely stated that the proposed trial pits would be for geotechnical design of the roadways.

Mr Kiely stated that the Hydrogeologist would make the call regarding standpipes in future boreholes as part of the post consent investigation. The purpose of the monitoring would be from an engineering point of view to determine water levels. Ms Ibbotson stated that from a hydrogeological perspective it would build on the understanding of the site, and assist in micro siting.

When asked about the reason for permeability testing, Mr. Kiely stated that it would be used mainly from an engineering perspective to see how quickly excavations might fill or empty. He stated that the tests would be simple tests like falling head tests.

When asked about specific boreholes (RC-SS, RC-T4 and RC-T5) drilled in 2015, Mr Kiely stated that the findings suggested significant thickness of glacial Till rather than weathered rock.

He acknowledged that the initial ground model was at variance with the findings from boreholes drilled in 2015 and stated that these findings would suggest the need to re-interpret the geophysical profiles, but that this would only be done as part of the post-consent investigation.

No specific hydrogeological investigation has been undertaken on the site, although Waterwise did draw conclusions from observations, resistivity testing and trial pit excavation. I questioned Waterwise during the oral hearing on their conceptual understanding of the hydrological/hydrogeological environment.

I felt in reading the documentation that the water balance presented was over simplistic suggesting simply that all 100% of effective rainfall became groundwater recharge without any detailed description of the recharge mechanisms and flow dynamics and discharge mechanisms. I considered it important to understand the different mechanisms through which rainfall entered the ground and thereafter passed through the ground, the interactions with turloughs and the discharge mechanisms from the aquifer.

Ms Ibbotson accepted that there will be variations in permeability across the site. She suggested that these anomalies would be further explored during the detailed post consent investigation and any potential impacts could be dealt by applying mitigation measures or the turbine could be excluded if the risk was felt to be too great.

Ms Ibbotson stated that once the post consent investigation was undertaken, that the findings would be combined to augment the current understanding.

Having walked the site, I have formed the impression that there is sufficient variability in conditions and permeability across the site to have warranted a more extensive assessment and description of drainage conditions.

Professor Johnston on behalf of the Appellants having heard my questioning of the applicants experts commented that there appeared to be inconsistencies and anomalies in the data presented suggesting a lack of knowledge of the hydrogeological regime, which would be an essential part of assessing the impact on turloughs.

Mr. Kenny in summing up his experts evidence, suggested that perhaps in light of the findings from the boreholes, that the original conceptual model was too conservative.

## CONSIDERATION OF THE ISSUE

I am satisfied that Waterwise appreciated the karst setting of the site, however its significance does not seem to have been appreciated by the project team, including ecology and engineering experts. The impression I take from the evidence presented at the Oral hearing is that the applicant considers that they have up to now presented a worse case conceptual model, based on few data, and that they intend to fine tune this model with a comprehensive post construction investigation. The inference being that any revised model will be less conservative.

I feel however, that the current lack of information, the generalised conceptual model, and the lack of site specific data undermines this position. For instance permeability seems to be an important parameter from both an engineering and hydrogeology perspective, but no measurements have been made. I feel that there is significant lateral and vertical variation in permeability to have warranted a more detailed investigation. The resistivity survey appeared to demonstrate this variability, but this was not built upon. A standpipe was fitted in a borehole drilled in 2015, and has not been monitored since it was installed, missing a chance to obtain useful data over a very wet winter period.

I also feel that the understanding by the applicant of the recharge to groundwater mechanisms is quite generalised. The absence of site specific permeability testing, the lack of a comprehensive spatial understanding of the extent of point source and diffuse recharge across the site and the lack of measurement of groundwater and turlough responses to rainfall events are all significant deficits in the information required to properly assess impacts. Without this level of fundamental understanding, it seems to me that the determination of how construction (including proposed mitigation measures) of bases and access roadways will affect groundwater recharge, cannot be reliably informed.

The Quadconsult report suggests that the resistivity profiles are more likely to show saturated silts and clays or perched water in a layer of gravel, which in my view would suggest possible vertical variability in permeability in addition to horizontal variability. In my opinion this would strengthen the need for a detailed investigation to confirm the ground model and the absence of complete and definitive data from such a detailed investigation, limits the ability to fully assess any potential impacts and proposed mitigation measures.

I am concerned that the Resistivity geophysics, which was supported by a flawed (did not go to a meaningful depth, and was wrongly interpreted as indicating shallow bedrock) trial pit investigation is not accurate in light of boreholes (RC-T4, RC-T5 and RC-SS) drilled in 2015. The resistivity data was referenced by Roscommon County Council and the Board as a significant pillar of their approval.

In the context of assessing the impact on turloughs, the burden of proof does require the presentation of complete, precise and definitive findings that represents the best scientific knowledge in the field.



I am not convinced that assumption of a worst case scenario together with provision of a suite of proposed mitigation measures that can be applied as required, satisfies this requirement.

The suggestion that there is a need for a comprehensive post consent investigation to produce a comprehensive conceptual model and to more accurately assess the impact (if any) on turlough habitats within the study area suggests that the current model is not comprehensive and cannot therefore be proposed as worse case, since worse case is a relative term.

***Q3 Does this conceptual model provide sufficient information to rule out any potential impacts on the integrity of Natura 2000 sites beyond all scientific doubt?***

I am satisfied that the applicant has the experience and can retain the necessary professional expertise to construct and operate this windfarm. I am also satisfied that on a site not hydraulically connected to Natura 2000 sites, that the proposed mitigation measures augmented by a post consent investigation and construction and environmental management plan to the scale outlined by Jennings O'Donovan would provide adequate protection to the groundwater immediately beneath the site.

However, I am not satisfied that this level of confidence can be extended to the protection of the preservation of Turlough Habitat without the presentation of more complete, precise and definitive findings that represents the best scientific knowledge in the field as required by the Appropriate Assessment process as I understand it, and to date, I am not satisfied that the nature and extent of investigation that has been undertaken in respect of this proposed development meets the standard and consistency required to generate such findings.

With some modification (along the lines outlined by Professor Johnston whereby the catchments of the turloughs are mapped and measurements of the response of groundwater levels and turlough levels are collated with rainfall data), the proposed investigation, has the potential to generate such findings. However on the basis of my understanding of the requirement that "no reasonable scientific doubt remains as to the absence of the identified potential effects", I am not satisfied the present understanding of the hydrological/hydrogeological environment can eliminate that doubt. The key deficiencies as I see them are; lack of site specific measurement of permeability, lack of integration of resistivity measurements to assist spatial variation of permeability measurement, poor understanding of the spatial distribution of point source and diffuse recharge, lack of detailed long term monitoring of groundwater levels on the site and turlough responses to rainfall events.