

Appendix C: Geomorphology Photo Survey (3rd November 2020)

A photo survey was undertaken by a Binnies Geomorphologist (Dr Jennifer Collins) on the 3rd November 2020 on behalf of NRW to support the impoundment licence and WFD compliance assessment. The walkover was undertaken with the Project Manager (Jack Lewis-Roberts), a Binnies Civil Engineer (Michael Calder) and Binnies Geotechnical Engineer (Richard Colin) to provide context to the wider project and site constraints. A Binnies Ecologist (Matt Rung) subsequently visited the site and potential implications for the Gwydir Forest Mines SAC have been discussed and documented within the HRA accordingly.

Heavy rainfall had preceded the site visit but reservoir levels in the Llyn Fuchus Las reservoir were not noted by the project manager to be particularly high. The weather was very mixed with short showers and sunny spells on the day of the walkover. The walkover was completed on foot between Pen y Gwaith reservoir and Llyn Fuchus Las. Pictures were captured at points of interest in an upstream, downstream and cross-stream orientation. what3words references were identified for each location for ease of relocation to support any fixed point photography required in the future. Photographs, location references and observation notes of 25 points of interest are provided in Table C.1. A map of photo locations is provided in 123242-BUK-ZZ-00-DR-EN-00003.











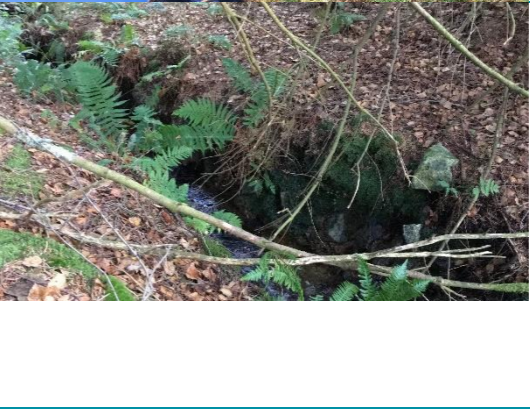
The walkover survey confirmed that the watercourse downstream of Pen y Gwaith reservoir has been subject to a number of historical modifications as a result of the mining activities in the area. This includes suspected modifications to support mining activities (e.g. Locations 1, 11 and 14), remediation activities (e.g. Locations 18 and 19) and road infrastructure through the Gwydir Forest (e.g. Locations 17 and 22).












The watercourse is characterised as a narrow (~0.5-2m bankfull width), steep headwater stream. Along the length surveyed a range of bed material was observed, the natural bed material was predominantly comprised of pebble gravel (fine to coarse) in the upper sections. Evidence of bed armouring was noted downstream of the reservoir (as expected), a bed disturbance exercise confirmed a layer of finer material protected below the armoured surface.













The bed material notably coarsened downstream (gravel, cobbles and small boulders), sediment transport may be inhibited by channel structures and/or the sediment supply is limited. Sections of the channel were reinforced with concrete and lined with plastic sheets, both of which were noted to have failed in some locations.










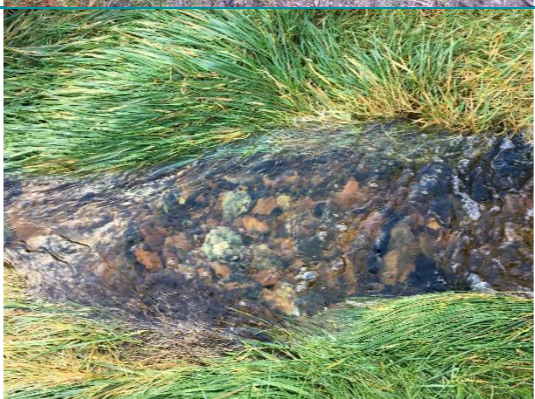
Further investigation of opportunities to remove these redundant structures is recommended, particularly for the areas of the plastic sheeting which may be an active source of plastic pollution. Connectivity between the mine heaps was evident, raising a concern of these areas as a source of zinc and lead contamination to the Conwy water body.













Table C-1 Geomorphology Photo Survey

| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|---|---------------------------|--|---|---|---|
| | | Upstream | Cross-Stream | Downstream | |
| 1 – Pen y Gwaith Reservoir – existing spillway | ///shady.filer.throat |  |  |  | <ul style="list-style-type: none">• The reservoir water was noted to be particularly clear with vegetation growth along the water margins.• Mixed sediment sizes were noted on the bed of the reservoir, ranging from fine sediment to small boulders.• The existing spillway was extensively overgrown with established vegetation.• The dam embankment was vegetated and spongy underfoot. |
| 2 – Pen y Gwaith Reservoir - North East Dam | ///erupts.drifter.airbase |  | Photo not available |  | <ul style="list-style-type: none">• See observations in Location 1. |
| 3 – Pen y Gwaith Reservoir – Temporary Spillway | ///lordship.founders.back |  |  |  | <ul style="list-style-type: none">• The temporary spillway erected on the North East Dam appeared in relatively good condition with some minor scour noted at the base of the temporary spillway.• The dam was also vegetated and spongy underfoot in this location. |
| 4 - Watercourse – Temporary Spillway | ///jetliner.civil.chatted |  |  |  | <ul style="list-style-type: none">• See observations in Location 3. |







| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|--|---------------------------------|--|---|---|---|
| | | Upstream | Cross-Stream | Downstream | |
| 5 – Pen y Gwaith Reservoir – North East Dam | ///corrode.looks.throw |  |  |  | <ul style="list-style-type: none"> • See observations in Location 3. |
| 6 – Pen y Gwaith – Embankment B | ///mothering.scaffold.declines |  |  |  | <ul style="list-style-type: none"> • Extensive vegetation was observed within reservoir from the embankment including trees. • No obvious in flow to the reservoir was observed. • The embankment was vegetated. In comparison to the North East Dam, the embankment felt firm underfoot. |
| 6 – Pen y Gwaith – Embankment A | ///emulated.chemistry.petrified | Photo not available |  |  | <ul style="list-style-type: none"> • Vegetation was observed within reservoir from Embankment A but significantly less established than observed from Embankment B. • No obvious in flow to the reservoir was observed. • Embankment A appeared in a similar condition to Embankment B. In comparison to the North East Dam, the embankment felt firm underfoot. |
| 7 – Watercourse – downstream of reservoir, upstream of abstraction point | ///snails.reflector.discouraged |  |  |  | <ul style="list-style-type: none"> • The watercourse bankfull width was ~ 1m width downstream of the reservoir, widening downstream of the abstraction point ~1m. • The substrate predominately comprised fine to coarse gravel • The former spillway confluence was noted in this location, established vegetation suggested no recent flow of water down this channel. • Disturbance of the bed suggested the presence of an armoured gravel layer protecting a layer of finer material. • Abstraction outbuilding was in current operation. |

| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|--|-------------------------------|--|---|---|--|
| | | Upstream | Cross-Stream | Downstream | |
| 9 – Watercourse – downstream of reservoir, downstream of abstraction point | ///irritate.beakers.uniform |  |  |  | <ul style="list-style-type: none">• Minor scour noted around the base of the outbuilding.• Fallen trees and leaf litter providing hydraulic complexity and localised widening.• See notes for Location 7. |
| 10 – Watercourse – downstream of reservoir, culvert on access track | ///quietest.dampen.gathers |  |  |  | <ul style="list-style-type: none">• The channel narrowed in this location.• Similar substrate size and structure noted in this location to the upstream sections of the watercourse. |
| 11 – Watercourse – downstream of access track | ///building.spoiled.owned |  |  |  | <ul style="list-style-type: none">• The channel was ~1m wide in this location and appeared incised in comparison to the upper sections of the watercourse.• Channel planform exhibited as unnaturally straight with evidence of bank resectioning and embanked.• Fallen trees encouraging step pool sequences.• Disturbance of the bed suggested the presence of an armoured gravel layer protecting a layer of finer material.• The watercourse was heavily shaded by mature trees and challenging to access through trees. |
| 12 – Watercourse – downstream of access track | ///pairings.congested.refills |  |  |  | <ul style="list-style-type: none">• See observations in Location 11. |

| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|---|---------------------------|--|---|---|---|
| | | Upstream | Cross-Stream | Downstream | |
| 13 – Watercourse – upstream of mine spoil heaps and structure | ///rules.ozone.rash |  |  |  | <ul style="list-style-type: none">• The channel widened to ~1.5m at bankfull in this location above a weir structure. The cross-section was wide and shallow with a few small boulders exposed.• Evidence of bank modification was less evident in this location.• The watercourse was heavily shaded by mature trees and challenging to access through trees. |
| 14 – Watercourse – near mine spoil heaps and weir structure | ///agency.squired.gender |  |  |  | <ul style="list-style-type: none">• An informal weir structure was noted in this location ~ 1.5m in height constructed from small boulders and in dilapidated condition.• Sediment accumulation notes upstream of the structure with tree established within the channel. |
| 15 – Watercourse – near mine spoil heaps and pipe culvert | ///encodes.oils.cupboards |  |  |  | <ul style="list-style-type: none">• The stream narrowed downstream of the weir structure as it flowed past mine spoil heaps• No active erosion of the spoil heaps was noted by the stream.• Rilling of the spoil heaps may suggest runoff from the spoil heaps into the stream following rainfall.• Small informal pipe culverts were noted to allow the river to flow under a foot path.• The channel margins were vegetated with grass-like plants. |
| 15 – continued | ///encodes.oils.cupboards | N/A |  | N/A | <ul style="list-style-type: none">• Similar substrate noted upstream and downstream of the informal weir structure. |

| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|--|-------------------------|--|---|---|--|
| | | Upstream | Cross-Stream | Downstream | |
| 16 – Watercourse – upstream of lower access track and spoil heaps | ///those.mourner.worker |  |  |  | <ul style="list-style-type: none"> Following a very steep section of channel, the stream flowed past more spoil heaps from Hafna mine. The channel was ~1.2m wide in this location and evidence of historical erosion of the spoil heaps. A small pipe culvert ~300m in diameter was observed under the footpath, |
| 17 – Watercourse – downstream of lower access track | ///rash.leaky.available |  |  |  | <ul style="list-style-type: none"> The stream flowed through a pipe culvert ~300m pipe in diameter under an access track. Downstream of the culvert outfall, there was clear evidence of an eroded structure. This may have been installed as an erosion protection measure to protect the track. Whilst still flowing through woodland, the trees were set back from the stream allowing light to reach the stream. The stream was notably steeper downstream of the culvert. |
| 18 – Watercourse – downstream of lower access track (potential remediation site) | ///woes.opts.model |  |  |  | <ul style="list-style-type: none"> Downstream of the culvert, plastic sheeting had been installed presumably as a form of former mine remediation works. No records of these works were known by the walkover participants. Inspection of the sheeting indicated that water was flowing above and below the plastic sheeting. No substrate was observed above the plastic sheeting, suggesting sediment transport had supply. |
| 19- Watercourse – downstream of lower access track (potential remediation site - failed) | ///munch.wishes.dating |  |  |  | <ul style="list-style-type: none"> Further downstream, the plastic sheeting had failed with water flowing above and below the sheeting. Active bank erosion was noted on the left bank, a bankfull width of ~2m was observed. Coarser substrates were noted in this location, with a dominance of larger gravels, cobbles and small boulders. |

| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|--|------------------------------|--|---|---|--|
| | | Upstream | Cross-Stream | Downstream | |
| 20- Watercourse – along lower access track | ///chap.bravest.groomed |  |  |  | <ul style="list-style-type: none">As the stream followed the route of the access track, the channel notably steepened. The stream flowed through a series of steep cascades, and pipe culverts. |
| 21 – Cascade near Mill | ///hammocks.lampost.chip |  |  |  | <ul style="list-style-type: none">See observations for Location 21. |
| 22 - Concrete lined channel | ///lined.corporate.flotation |  |  |  | <ul style="list-style-type: none">Downstream of the mill, further evidence of erosion projection was observed potential to protect road infrastructure. This channel appeared to be lined with concrete, and functioned similar to a long smooth flume.A point of failure was noted in the concrete flume adjacent to a section of bank erosion and localised widening.No substrate was observed on the channel bed, indicating that sediment transport capacity exceeded the sediment supply. |
| 23 - Llyn Fuches Las | ///woodstove.sweated.binder |  |  |  | <ul style="list-style-type: none">Visibility of the channel was challenging as it flowed into Llyn Fuches Las. From the viewpoints available, the stream appeared to flow through multiple channels surrounded by established vegetation and mature trees. |

| Location and Description | what3words reference | Orientation of Photo | | | Observations |
|--|-------------------------------|---|--|--|--|
| | | Upstream | Cross-Stream | Downstream | |
| 24 - Llyn Fuches Las | ///constrain.closed.info |  |  |  | <ul style="list-style-type: none">• Extensive vegetation in Llyn Fuches Las was noted, the bed was not visible. |
| 25 - Llyn Fuches Las Embankment and Spillway | ///submits.occupations.peachy |  |  |  | <ul style="list-style-type: none">• Erosion of the Llyn Fuches Las spillway was noted, and temporary erosion protection measures has been installed by NRW to prevent further erosion.• Several sandbags were disturbed during the walkover which were replaced, suggesting recent high flows were experienced down the spillway. |

