

## River Avich Hydro-scheme

### Survey of the bryophyte interest

#### Summary

A bryophyte survey of the site was carried out by Gordon Rothero (7-8<sup>th</sup> March, 2013), and the following points are taken from the full report.

The valley of the River Avich is an important bryophyte site. The site as surveyed has some 129 bryophyte species (50 liverworts, 79 mosses, listed in Annex 2), a good total for a site with limited rock exposures; this is probably due to the moderately base-rich andesite geology and the broadleaf tree cover. There are two nationally scarce species, *Radula voluta* and *Leptoscyphus cuneifolius*, both oceanic liverwort species with a very restricted distribution in Europe. There are 19 oceanic species, all listed in Table 3, an average total for a ravine site in the Loch Awe area and these give the site its main interest. Of these species, seven are oceanic ravine indicator species giving a site score of nine (see Table 3 for the scoring); well above the threshold level of six points indicating a site of national importance. The most notable features of the site are the well-spread population of *Radula voluta* on rocks in the inundation zone of the river and the very large population of *Leptoscyphus cuneifolius* on birches. The significance of the medium amount of change due to the scheme on the high bryophyte interest on the site, using the criteria set out in the matrix in Table 2, is classed as **major**.

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#### 1. Introduction

1.1. This report consists of a summary, a description of the survey methods, a report on the bryophyte communities and species on the site and their significance. Annex 1 has all the target notes with grid references and Annex 2 has full species list for the site as surveyed. In this report, nomenclature for the bryophytes follows Hill et al, 2008 (A checklist and census catalogue of British and Irish bryophytes, British Bryological Society). The definition of 'oceanic species' follows Hill & Preston (Hill MO & Preston CD, 1998. The geographical relationships of British and Irish bryophytes. Journal of Bryology, 20: 127-226). Definitions of nationally rare and scarce species are taken from lists published by the Biological Records Centre.

1.2. The proposal is for a run-of-the-river hydro scheme on the River Avich with intake options at the outflow from Loch Avich at c. NM9554.1448 (Intake option 1) and on the main river just above the Avich Falls at c. NM9650.1404 (Intake option 2). The powerhouse area is on the flatter ground by the old powerhouse building at c. NM9684.1395. The proposed pipeline route from Intake option 1 follows the river on the north side and then runs along the track before crossing the river about halfway to the proposed powerhouse. It then runs along the south bank to join the existing path and old pipeline route to the powerhouse. The pipeline from Intake option 2 follows the old pipeline route in its entirety.

1.3. The River Avich is a river draining Loch Avich which has an easy-angled upper section below the loch and then a section with small waterfalls and cascades before the gradient eases again towards the public road. The rock in the central section is andesite sandwiched between gritty Dalradian schist, both rock types giving a moderately base-rich substrate. Bedrock is often exposed as slabs at the sides of the river but the low crags only occur in the steeper central section around the falls but stones and boulder are frequent over much of the site. Again, the watercourse is only steeply incised in the central section which contains the waterfalls. The whole of the affected section of the burn has a variable cover of broadleaf trees, usually as a corridor between the ranks of conifer plantation. The abundant epiphytic

flora suggests that humidity levels are high but this may be due as much to the shelter of the conifers as to the watercourse and broadleaf tree canopy. Away from the watercourse corridor the ground is all production forest with consequent levels of habitat modification and disturbance.

1.4 The area involved in the proposed scheme has no sites designated for the conservation of the botanical interest.

## 2. Survey and evaluation methods

2.1. A standard Phase 1 walkover method was used to assess the bryophyte populations along the section of the burn that will have reduced flow ie. from the potential powerhouse and tailrace site, as indicated on the map supplied, to the intake area. Target notes were made along the burn and the banks on either side, describing the general bryophyte communities present and any species of interest. The very low water levels meant that the whole affected section was accessible and was surveyed.

2.2. The pipeline route as indicated on the map supplied was similarly surveyed as was the area around the proposed powerhouse.

2.3 The criteria used to assess the magnitude of the effects of the hydro scheme are based on the scale of the impact on the site, the sensitivity of the bryophyte populations and the duration of the effect.

**Table 1. Scale for magnitude of ecological impact**

<b>Magnitude of impact</b>	<b>Definition</b>
High	Wholesale change to most of a site or species population.
Medium	Substantial but partial change to a site or species population; or large change to small fraction of the site or species
Low	Minor change to part of a site or species population, or loss of a very small proportion of a site or population.
Negligible	Minimal change on a very small scale.

2.4 The sensitivity of a bryophyte feature is broadly related to its ecological and conservation interest, with bryophytes of international and national significance having high sensitivity and those of more local significance having medium sensitivity. However, the local knowledge of the surveyor may lead to some variation in the use in these categories and this is explained in the text where necessary. The bryophyte interest in woodlands and ravines in the oceanic west of Scotland is normally assessed by reference to the number of oceanic species, as listed by Hill & Preston (1998), as well as to the presence of nationally rare or scarce species. The best of these wooded ravines are of international importance as the bryophyte communities they contain are rare in Europe and may contain some species which are globally rare. This conservation interest can be assessed by the occurrence on the site of a number of indicator species which are given a score according to rarity and threat level and this score aggregated for the site (Averis et al., 2012). This list of oceanic ravine indicator species also includes rare or scarce riparian species which may occur in sites away from the

oceanic west. The current threshold level for a nationally important site using this watercourse bryophyte assessment is a score of six. An evaluation of the bryophyte flora on this site is given in section 4 below.

2.5 The change in the pattern of discharge down the rivers will presumably continue indefinitely and so any impact on the bryophytes as a result of this change is likely to be permanent giving a medium impact as defined in Table 1. The matrix for determining the impact of the scheme on the bryophyte interest is given in Table 2.

**Table 2. Matrix for determining the Significance of an Ecological Impact related to Sensitivity of the Feature and Magnitude of Change**

Sensitivity of bryophyte interest	Magnitude of Change			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	Minor
Negligible	Minor	Minor	Minor	Minor

\*Shaded cells indicate a significant impact

### 3 Baseline conditions

3.1. A detailed and localised account of the bryophyte populations that will be affected by the proposed scheme is given in Annex 1 as target notes, and Annex 2 has a bryophyte species list for the main site on the River Avich.

#### 3.2. Background to bryophytes in the Loch Awe area.

Loch Awe has an oceanic climate and the surrounding hills, woodlands and ravines have an extremely rich bryophyte flora. In particular, the area is rich in oceanic species, those bryophytes limited to the western fringes of Britain, many of which are rare in Europe. However, parts of the Loch Awe area are not particularly well-recorded and, in the area local to this scheme, much may well have been lost to extensive afforestation. Much of the rock in the area is acidic so that outcrops of more basic rock, as on the River Avich, are locally significant.

#### 3.3 Description of the bryophyte interest in the areas affected by the scheme.

3.3.1 The riparian bryophytes in and by the burn are locally abundant, often covering most of the available rock surface, but the diversity is usually low. The most common species are *Platyhypnidium riparioides* which is overwhelmingly dominant on rocks in the burn and waterfalls and *Thamnobryum alopecurum* which is often dominant in the inundation zone. This combination is typical of burns with a catchment over moderately base-rich rocks. Other frequent riparian species in the inundation zone include, *Fontinalis antipyretica*, *Chiloscyphus polyanthos*, *Cinclidotus fontinaloides*, *Racomitrium aciculare*, *Sciuro-hypnum plumosum*, *Scapania undulata*, *Pellia epiphylla*, *Blindia acuta*, *Plagiochila porelloides*, *Fissidens taxifolius*, *Ctenidium molluscum* var *molluscum*, *Hygrohypnum eugyrium* and occasionally *Hyocomium armoricum*. The infrequent, sheltered, steep rock faces close to the burn have a limited development of the community of small oceanic liverworts with *Lejeunea patens* by

far the most common but *Harpalejeunea molleri* occasionally occurs here. The most significant population in this habitat is that of the nationally scarce, oceanic liverwort *Radula voluta* which has a number of stands, usually on slabby rocks and boulders in the lower part of the inundation zone.

3.3.2. The rocky banks have an abundance of common woodland floor species like *Thuidium tamariscinum*, *Rhytidiadelphus loreus*, *Dicranum majus*, *Hylocomium splendens*, *Loeskeobryum brevirostre*, *Rhytidiadelphus triquetrus*, *Mnium hornum*, *Breutelia chrysocoma* and more locally *Ptilium crista-castrensis*, *Bazzania trilobata*, *Dicranodontium denudatum*, *Kindbergia praelonga* and *Eurhynchium striatum*. On the steeper banks, particularly north-facing, rocky slopes, there are also stands of *Sphagnum quinquefarium*, with the oceanic species *Plagiochila spinulosa* and the filmy fern *Hymenophyllum wilsonii*. Where there is some seepage of water down the banks giving a wet soil, there is a large population of the liverwort *Trichocolea tomentella* usually accompanied by *Calliergonella cuspidata*, *Rhytidiadelphus triquetrus*, *Ctenidium molluscum* var *molluscum*, *Plagiochila asplenioides*, *Sphagnum girgensohnii* and more locally *Sphagnum palustre*, *Sphagnum fallax* and *Sphagnum squarrosum*.

3.3.3. There are only a small number of crags above the river on the site and, on the moderately base-rich rock, species include abundant *Saccogyna viticulosa*, *Isothecium myosuroides* var. *myosuroides*, *Diplophyllum albicans*, *Pellia endiviifolia*, *Dichodontium flavescens*, *Rhizomnium punctatum*, *Fissidens dubius*, *Palustriella commutata*, *Hookeria lucens*, *Plagiomnium undulatum*, *Fissidens taxifolius*, *Neckera crispa*, *Tortella tortuosa* and *Plagiochila spinulosa*. Some wetter crags have in addition species like *Anoetangium aestivum*, *Pohlia wahlenbergii* var. *wahlenbergii*, *Conocephalum conicum*, *Jungermannia atrovirens*, *Fissidens adianthoides*, *Amphidium mougeotii*, *Blindia acuta*, *Bryum pseudotriquetrum*, *Oxyrrhynchium hians*, *Aneura pinguis*, *Dichodontium pellucidum* and both *Leiocolea bantriensis* and *Leiocolea collaris*. On one crag there is a good population of the oceanic ravine indicator species *Metzgeria leptoneura*.

3.3.4. The woodland floor away from the river usually has just common pleurocarpous species like *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Thuidium tamariscinum*, *Rhytidiadelphus triquetrus*, *Dicranum majus*, *Mnium hornum* and locally *Loeskeobryum brevirostre*. Where the ground is wetter *Sphagnum girgensohnii*, *Sphagnum capillifolium* and *Polytrichum commune* can be frequent. Under the conifers the ground is often completely covered by *Thuidium tamariscinum* with smaller amounts of *Polytrichum commune* and *Rhytidiadelphus triquetrus*.

3.3.5. In the sheltered sites in the river corridor, the epiphytic flora is often luxuriant and contains a number of interesting species. On the oaks *Isothecium myosuroides* var. *myosuroides* is usually dominant with smaller amounts of *Frullania tamarisci*, *Hypnum cupressiforme*, *Dicranum scoparium* and locally *Scapania gracilis*, *Plagiochila punctata* and *Plagiochila spinulosa*. On birch and alder over much of the site the abundance of *Scapania gracilis*, *Plagiochila punctata* and the nationally scarce *Leptoscyphus cuneifolius* is notable, and this community even strays onto Sitka spruce, which is very unusual. The flora on ash is more diverse; locally there are festoons of *Neckera crispa* and much *Loeskeobryum brevirostre* around the bases of trees. Higher up there are usually stands of *Frullania tamarisci*, *Frullania dilatata*, *Metzgeria furcata*, *Metzgeria consanguinea*, *Plagiochila punctata*, *Zygodon conoideus* and more locally *Plagiochila exigua* and *Harpalejeunea molleri*. There is a similar flora on hazel in sheltered places by the river and in addition there are small populations of *Aphanolejeunea microscopica*, *Colura calyptrifolia* and *Drepanolejeunea hamatifolia*, all oceanic ravine indicator species.

**Table 3. Nationally scarce and oceanic species recorded from the River Avich**

<b>Nationally scarce species</b>	<i>Leptoscyphus cuneifolius</i>
<i>Radula voluta</i>	<i>Metzgeria leptoneura</i> (1)
<i>Leptoscyphus cuneifolius</i>	<i>Plagiochila bifaria</i>
	<i>Plagiochila exigua</i> (1)
<b>Oceanic species (19 taxa)</b>	<i>Plagiochila punctata</i>
<i>Aphanolejeunea microscopica</i> (1)	<i>Plagiochila spinulosa</i>
<i>Breutelia chrysocoma</i>	<i>Radula voluta</i> (3)
<i>Campylopus atrovirens</i>	<i>Saccogyna viticulosa</i>
<i>Colura calyptrifolia</i> (1)	<i>Scapania gracilis</i>
<i>Drepanolejeunea hamatifolia</i> l(1)	<i>Ulota phyllantha</i>
<i>Harpalejeunea molleri</i> (1)	<i>Zygodon conoideus</i>
<i>Hyocomium armoricum</i>	
<i>Lejeunea patens</i>	

\*Figures in () are oceanic ravine indicator species scores

#### 4. Evaluation of the bryophyte flora

4.1. The site as surveyed has some 129 bryophyte species (50 liverworts, 79 mosses, listed in Annex 2), a good total for a site with limited rock exposures and which is probably due to the moderately base-rich andesite and the tree cover. There are two nationally scarce species, *Radula voluta* and *Leptoscyphus cuneifolius*, both oceanic liverwort species with a very restricted distribution in Europe. There are 19 oceanic species, all listed in Table 3, an average total for a ravine site in the Loch Awe area and these give the site its main interest. Of these species, seven are oceanic ravine indicator species giving a site score of nine (see Table 3 for the scoring); well above the threshold level of six points indicating a site of national importance. The most notable features of the site are the frequent patches of *Radula voluta* on rocks in the inundation zone of the river and the very large population of *Leptoscyphus cuneifolius* on birches.

4.2. This site has an important oceanic flora, particularly in an area which has been so altered by plantation woodland. With a score of nine for oceanic ravine indicator species and in the local context, the site is assessed as having high sensitivity for the bryophyte interest.

#### 5. Potential impacts of the scheme

5.1 There are two main areas of impact of the scheme on the bryophytes. There will be the various effects of the reduced flow of water down the main watercourse and there will be the direct impact of the construction of the intakes, pipelines, powerhouse and access tracks. The effect of these changes will be different in each case.

5.2 In the burn, the ecology of the species concerned suggests that the reduced flow will lead to a long-term shift of some centimetres by the riparian species towards the new base water level. With *Platyhypnidium riparioides* and *Thamnobryum alopecurum* so dominant, it seems highly unlikely that there will be any substantial change in the main species. However it is possible that, as a result of a reduction in the frequency of scouring in the flow regime, an increase in cover of larger species may lead to the loss of some habitat for the small oceanic liverworts, and in particular this may affect the patches of *Radula voluta*. Apart from this possibility, it seems unlikely that the composition of the flora will change a great deal.

5.3. For the species on rocks and banks above the water channel, the reduction in flow in the burn will probably make little difference as most are not dependant on irrigation and humidity derived from the main burn. It is not easy to assess the impact of the proposed

scheme on the important epiphytic flora. While the humidity associated with the river corridor is important, the sheltering effect of the conifer plantations on either side clearly has a role and presumably these trees will be clear-felled at some point. It seems likely that the removal of the conifers will have at least as big an effect on the epiphytic bryophyte populations as any changes brought about by the proposed hydro scheme.

5.4 There will be some direct damage to the bryophyte interest from the construction of the intake as there are stands of *Radula voluta* at both of the intake site options. The initial part of the pipeline route from Intake option 1 also has trees with a good epiphytic flora as do other short stretches of the route. Much of the route along the existing tracks has only common bryophyte species and has already had much disturbance.

5.5. The significance of the medium amount of change due to the scheme on the high bryophyte interest on the site, using the criteria set out in the matrix in Table 2 above, is classed as **major**.

## **6 Mitigation.**

6.1 It is presumed that some spate flows will continue down the burn and so the changes to the hydrology of the burn will be limited to that extent; this may be sufficient to give enough erosion to keep habitat open for *Radula voluta*.

6.2 The proposed intakes have stands of *Radula voluta* and care should be taken to cause minimum damage to these stands. In mitigation, removal of the small amount of Rhododendron on the site before it becomes established would benefit the bryophyte interest in the long term.

6.3. The scheme using intake option 2 is much the same as an old hydro scheme, parts of which are still visible. It is of interest to note that stands of *Radula voluta* have persisted in this lower section of the river below the intake, but nothing is known of the size of the old scheme or of the period over which it operated.

6.4. Management of the woodland along the river corridor to minimise the effect of clear-felling on the epiphytic flora would mitigate some of the effects of both changes in the discharge down the river and the felling.

6.5. The apart from short sections near the intakes and river crossing, the pipeline route and the powerhouse site have just common species that are abundant over the whole site and in the area in general and need no mitigation.

## **7 Residual impacts**

7.1 The reduction in flow will have a residual impact in that the distribution of bryophyte populations on rocks in and by the burn is likely to change though given the dominance of a few species, it seems unlikely that species composition or diversity will be much altered. The main concern is that the open spaces on rock surfaces required by *Radula voluta* will be reduced but the continuation of occasional spates may moderate this process somewhat.

7.2 Whichever intake option is chosen, some stands of *Radula voluta* will almost certainly be lost during the construction process. The construction of the powerhouse and pipeline should have only a local residual impact on the bryophytes if every effort is made to avoid broadleaf trees where possible.

## 8 References

Averis, A.B.G., Genney, D.R., Hodgetts, N.G., Rothero, G.P. & Bainbridge, I.P, 2012. Bryological assessment for hydroelectric schemes in the West Highlands – 2nd edition. Scottish Natural Heritage Commissioned Report No.449b.

Hill MO & Preston CD, 1998. The geographical relationships of British and Irish bryophytes. *Journal of Bryology*, 20: 127-226.

Hill MO, Blackstock TH, Long DG & Rothero GP. 2008. A Checklist and Census Catalogue of British and Irish Bryophytes. British Bryological Society.

## Annex 1:- River Avich Hydro Scheme. Target notes

### River Avich

1) NM9684.1395. Tailrace area. On rocks in the burn *Platyhypnidium riparioides* is very abundant as is *Thamnobryum alopecurum* in the inundation zone. *Chiloscyphus polyanthos* and *Cinclidotus fontinaloides* also occur on rocks in the water and *Hyocomium armoricum*, *Racomitrium aciculare* and *Ctenidium molluscum* var *molluscum* occur on bigger rocks and in the inundation zone at the sides. The bryophytes on the banks consist mostly of common pleurocarpous species like *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Thuidium tamariscinum*, *Rhytidiadelphus triquetrus* and *Loeskeobryum brevirostre* with some *Hylocomiastrum umbratum* and *Plagiochila spinulosa*, and in wetter areas, more *Sphagnum girgensohnii*, *Calliergonella cuspidata* and *Trichocolea tomentella*. The trees have a good epiphytic flora with *Isothecium myosuroides* var. *myosuroides*, *Scapania gracilis*, *Plagiochila punctata*, *Plagiochila spinulosa*, *Frullania tamarisci*, *Harpalejeunea molleri*, *Neckera crispa* and *Ulota phyllantha*. There is very little change in this bryophyte flora for some 100m downstream.

2) NM9679.1394. A more incised section of the river on the bend. The very large boulders in the river here have *Ctenidium molluscum* var *molluscum*, *Hygrohypnum eugyrium*, *Racomitrium aciculare*, *Plagiochila porelloides*, *Lejeunea patens*, *Grimmia hartmanii*, *Hymenophyllum wilsonii* and a few patches of the nationally scarce oceanic liverwort *Radula voluta*. Low crags at the side have *Amphidium mougeotii*, *Isothecium myosuroides* var. *myosuroides*, *Diplophyllum albicans*, *Fissidens taxifolius*, *Lejeunea patens*, *Saccogyna viticulosa* and more *Radula voluta*. The riparian bryophyte flora and that on the banks is much as in Note 1.

3) NM9674.1392. Incised section to cascade. *Platyhypnidium riparioides* and *Thamnobryum alopecurum* remain abundant in the burn and inundation zone here with *Hyocomium armoricum*, *Brachythecium rivulare*, *Chiloscyphus polyanthos*, *Racomitrium aciculare* and *Fontinalis antipyretica*. The crags on the south side have a good flora with *Isothecium myosuroides* var. *myosuroides*, *Amphidium mougeotii*, abundant *Saccogyna viticulosa*, *Pellia endiviifolia*, *Dichodontium flavescens*, *Rhizomnium punctatum*, *Trichocolea tomentella*, frequent *Metzgeria leptoneura*, *Palustriella commutata*, *Hookeria lucens*, *Plagiomnium undulatum*, *Fissidens taxifolius*, *Neckera crispa*, *Tortella tortuosa* and *Plagiochila spinulosa*. The rocky banks have *Thuidium tamariscinum*, *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Rhytidiadelphus triquetrus*, *Ctenidium molluscum* var *molluscum*, *Dicranum majus*, *Loeskeobryum brevirostre*, *Conocephalum conicum* and *Plagiochila spinulosa*. Rocks by the cascade have further patches of *Radula voluta* with *Hygrohypnum eugyrium*, *Plagiochila porelloides*, *Grimmia hartmanii*, *Ctenidium molluscum* var *molluscum* and *Amphidium mougeotii*. Above this the river is more open and easy-angled and has much the same flora as Note 1.

4) NM9699.1400. An open bouldery stretch of the river still with *Platyhypnidium riparioides* dominating in the burn and *Thamnobryum alopecurum* in the inundation zone. Other species here are *Chiloscyphus polyanthos*, *Racomitrium aciculare* and *Sciuro-hypnum plumosum*. On the low crags at the side, *Saccogyna viticulosa* is abundant and on the banks are *Rhytidiadelphus loreus*, *Thuidium tamariscinum*, *Loeskeobryum brevirostre*, *Plagiochila spinulosa*, *Dicranum majus*, *Hylocomium splendens* and large patches of *Trichocolea tomentella* where it is flushed. There is a well-developed epiphytic flora here with *Scapania gracilis*, *Plagiochila punctata*, *Plagiochila spinulosa* and the nationally scarce *Leptoscyphus cuneifolius* all frequent on birch and on ash and hazel, *Isothecium myosuroides* var. *myosuroides*, *Frullania tamarisci*, *Frullania dilatata*, *Lejeunea patens*, *Harpalejeunea molleri*, *Plagiochila exigua*, *Metzgeria consanguinea* and *Zygodon conoideus*. There are also large patches of *Neckera crispa* on ash. There is a similar flora to the next cascade.



5) NM9661.1403. In the cascade and the adjacent rocks *Platyhypnidium riparioides* and *Thamnobryum alopecurum* are again dominant with *Chiloscyphus polyanthos*, *Sciurohypnum plumosum*, *Racomitrium aciculare*, *Hyocomium armoricum*, *Ctenidium molluscum* var *molluscum*, *Rhizomnium punctatum*, *Lejeunea patens*, *Scapania undulata*, *Dichodontium flavescens*, *Pellia epiphylla*, *Trichostomum tenuirostre* and a few patches of *Radula voluta*. *Saccogyna viticulosa* is abundant on the wet banks and on wet soil are *Trichocolea tomentella*, *Hookeria lucens*, *Calliergonella cuspidata*, *Palustriella commutata* and *Plagiochila asplenioides*. *Plagiochila spinulosa* is locally abundant on the old oaks with *Hymenophyllum wilsonii* and *Plagiochila punctata* and *Leptoscyphus cuneifolius* frequent on birch. The river is braided and on the island are *Hylocomium splendens*, *Thuidium tamariscinum*, *Rhytidiadelphus loreus*, *Ptilium crista-castrensis*, *Breutelia chrysocoma*, *Sphagnum quinquefarium*, *Dicranodontium denudatum*, *Hylocomiastrum umbratum*, *Bazzania trilobata* and *Mylia taylori*.

6) NM9657.1404. Avich Falls. There is little change in the main riparian flora from Note 5 but there are good patches of *Fontinalis antipyretica* here and some *Hygrohypnum eugyrium* and *Cinclidotus fontinaloides*; *Radula voluta* is rare in the main fall but more frequent near the old weir. On rocks by the river are *Amphidium mougeotii*, *Bryum pseudotriquetrum*, *Fissidens taxifolius*, *Pellia endiviifolia*, *Dichodontium flavescens*, *Fissidens adianthoides*, *Saccogyna viticulosa* and *Diplophyllum albicans*. On the banks are *Hylocomium splendens*, *Thuidium tamariscinum*, *Rhytidiadelphus loreus*, *Ptilium crista-castrensis*, *Breutelia chrysocoma*, *Sphagnum quinquefarium*, *Hylocomiastrum umbratum*, *Bazzania trilobata* and *Sphagnum palustre* and *Calliergonella cuspidata* where it is wetter. The good epiphytic flora continues with *Plagiochila exigua*, *Harpalejeunea molleri*, *Zygodon conoideus* on ash and much *Plagiochila punctata* and *Leptoscyphus cuneifolius* on birch; *Loeskeobryum brevirostre* is frequent on the bases of the trees with *Isothecium myosuroides* var. *myosuroides* above.

7) NM9650.1403. Intake option 2 at the old weir. On and by the old weir are *Platyhypnidium riparioides*, *Thamnobryum alopecurum*, *Fontinalis antipyretica*, *Brachythecium rivulare*, *Dichodontium flavescens*, *Pellia epiphylla* and *Plagiochila porelloides*. On the S side the wet banks have *Thuidium tamariscinum*, *Calliergonella cuspidata*, *Rhytidiadelphus triquetrus*, *Plagiochila asplenioides*, *Loeskeobryum brevirostre*, *Plagiomnium undulatum* and *Brachythecium rivulare*. On the N side are *Rhytidiadelphus loreus*, *Rhytidiadelphus triquetrus*, *Thuidium tamariscinum*, *Dicranum majus*, *Ptilium crista-castrensis* and *Sphagnum quinquefarium*. On hazel are *Frullania tamarisci*, *Metzgeria consanguinea*, *Harpalejeunea molleri* and *Zygodon conoideus* and on birch *Plagiochila punctata*, *Scapania gracilis*, *Plagiochila spinulosa* and *Leptoscyphus cuneifolius*. There is a little *Radula voluta* on the rocks just below the weir on the N side. Above the weir there is a pool with very limited bryophyte interest but the same flora on the banks and trees.

8) NM9646.1411. An easy-angled section with a riparian flora limited to larger stones with *Platyhypnidium riparioides* and *Fontinalis antipyretica*. *Trichocolea tomentella* is abundant on the wet banks with some *Conocephalum conicum* and *Cirriphyllum piliferum*. On ash and hazel are *Plagiochila exigua*, *Harpalejeunea molleri*, *Drepanolejeunea hamatifolia* with large patches of *Neckera crispa* and on birch *Plagiochila punctata* and *Leptoscyphus cuneifolius* are locally abundant.

9) NM9638.1414. Cascades to the footbridge. On rocks in and by the river are *Platyhypnidium riparioides*, *Thamnobryum alopecurum*, *Lejeunea patens*, *Hygrohypnum eugyrium*, *Plagiochila porelloides*, *Radula voluta*, *Ctenidium molluscum* var *molluscum*, *Racomitrium aciculare*, *Pellia epiphylla*, *Scapania undulata*, *Hyocomium armoricum*, *Jungermannia atrovirens*, *Dichodontium flavescens* and *Fissidens taxifolius*. The good epiphytic flora continues with in addition *Aphanolejeunea microscopica* on hazel; *Isothecium*

*myosuroides* var. *myosuroides*, *Plagiochila spinulosa* and *Hymenophyllum wilsonii* festoon old oaks by the bridge.

10) NM9631.1414. A low cascade with no change in the riparian flora from Note 9 except for the addition of *Hygrohypnum ochraceum*, but no *Radula voluta* here. *Neckera crispa* is abundant on some ash trees with *Loeskeobryum brevirostre* and good patches of *Plagiochila exigua*. On the low crags additional species include *Fissidens dubius*, *Bartramia ithyphylla* and *Plagiochila bifaria*.

11) NM9624.1420. A low cascade with a large crag on the north side. There are several patches of *Radula voluta* on large rocks some 25m below the cascade. *Plagiochila exigua* is again frequent on the ash trees with *Harpalejeunea molleri*, *Zygodon conoideus* and *Homalothecium sericeum*. The wet banks have large stands of *Trichocolea tomentella* with *Calliergonella cuspidata* and *Rhytidiadelphus triquetrus*. On the crags are *Anoetangium aestivum*, *Pellia endiviifolia*, *Pohlia wahlenbergii* var. *wahlenbergii*, *Palustriella commutata*, *Conocephalum conicum*, *Jungermannia atrovirens*, *Dichodontium flavescens*, *Fissidens adianthoides*, *Amphidium mougeotii*, *Blindia acuta*, *Bryum pseudotriquetrum*, *Oxyrrhynchium hians*, *Aneura pinguis*, *Dichodontium pellucidum* and both *Leiocolea bantriensis* and *Leiocolea collaris*.

12) NM9620.1418. A similar cascade to Note 11 but with some 15 patches of *Radula voluta* on rocks on the south side with *Lejeunea patens*. A flat section above with a similar bryophyte flora on the banks and trees but limited interest in the burn.

13) NM9604.1426. A flat stretch with lots of trees down across the river and with conifers close by. The flora in the burn is limited to the larger rocks and the sides which have *Platyhypnidium riparioides*, *Fontinalis antipyretica*, *Plagiochila porelloides*, *Fissidens taxifolius*, *Thamnobryum alopecurum*, *Pellia epiphylla*, *Hyocomium armoricum*, *Rhizomnium punctatum* and *Scapania undulata*. An addition to the epiphytic flora here is *Colura calyptrifolia* on a few hazels. On logs here are *Nowellia curvifolia*, *Riccardia palmata*, *Scapania gracilis*, *Plagiochila punctata*, *Dicranum scoparium* and *Isothecium myosuroides* var. *myosuroides* and there are good patches of *Hylocomiastrum umbratum* on the bank.

14) NM9588.1432. A quiet stretch with a similar riparian flora to note 13. There is a remarkable abundance of *Leptoscyphus cuneifolius* on the birch and alder here and lapun spreads onto some of the sitka. *Plagiochila spinulosa* is abundant on the old wall and also on one magnificent old oak. Above this the ground is disturbed by the construction of the new bridge.

15) NM9571.1436. A long, easy-angled stretch above the new bridge. The riparian flora is limited to *Fontinalis antipyretica* in the burn and *Chiloscyphus polyanthos*, *Pellia epiphylla* and *Fissidens taxifolius* on rocks at the side. On the wet banks are *Trichocolea tomentella*, *Calliergonella cuspidata*, *Sphagnum palustre* and *Sphagnum fallax* and better-drained ground has *Hylocomium splendens*, *Thuidium tamariscinum* and *Hypnum jutlandicum*. *Plagiochila punctata* and *Leptoscyphus cuneifolius* remain frequent on the birch and alder and *Microlejeunea ulicina* occurs on willows.

16) NM9562.1442. A riffle in the river with some rocks with *Platyhypnidium riparioides*, *Thamnobryum alopecurum*, *Fontinalis antipyretica* and low rocks at the side with *Lejeunea patens*, *Conocephalum conicum*, *Fissidens taxifolius*, *Rhizomnium punctatum*, *Sciurohypnum plumosum*, *Lejeunea cavifolia* and a few patches of *Radula voluta*. *Plagiochila exigua* and *Harpalejeunea molleri* are frequent on ash and *Plagiochila punctata* and *Leptoscyphus cuneifolius* locally abundant on birch.

17) NM9557.1443. Patches of *Radula voluta* occur on low rocks at tree roots from here right up to the outflow from Loch Avich.

18) NM9544.1447. Intake option 1 at the outflow from Loch Avich. Rocks in the outflow area have *Fontinalis antipyretica*, *Cinclidotus fontinaloides*, *Thamnobryum alopecurum*, *Calliergonella cuspidata* and are apparently 'eutrophicated' by birds. Rocks in the inundation zone on the south side have frequent patches of *Radula voluta* with *Calliergonella cuspidata*, *Ctenidium molluscum* var. *molluscum*, *Rhizomnium punctatum*, *Fissidens taxifolius*, *Pellia epiphylla* and *Dichodontium pellucidum*. On the bank above are *Thuidium tamariscinum*, *Hylocomium splendens*, *Sphagnum girgensohnii*, *Sphagnum squarrosum*, *Ptilium crista-castrensis*, *Sphagnum capillifolium* and on birch *Plagiochila punctata*, *Scapania gracilis*, *Frullania tamarisci*, *Leptoscyphus cuneifolius* and *Isothecium myosuroides* var. *myosuroides*. There is no *Radula voluta* on the north side which has a similar riparian flora to that on the south side plus *Climacium dendroides*, *Plagiomnium undulatum* and *Scapania undulata*. On hazel here are *Frullania tamarisci*, *Frullania dilatata*, *Ulota phyllantha* and *Metzgeria furcata* and birch *Plagiochila punctata* and *Leptoscyphus cuneifolius*. On the bank are *Rhytidiadelphus loreus*, *Thuidium tamariscinum*, *Pleurozium schreberi*, *Plagiochila spinulosa*, *Isothecium myosuroides* var. *myosuroides* and *Hylocomium splendens*.

### Pipeline route

19) The initial part of the route lies along the N bank of the river which is steep and has trees. On oaks are *Plagiochila punctata*, *Plagiochila spinulosa*, *Isothecium myosuroides* var. *myosuroides*, *Frullania tamarisci* and on hazel *Metzgeria consanguinea*, *Lejeunea patens*, *Frullania tamarisci* and *Frullania dilatata*. On the bank are *Rhytidiadelphus loreus*, *Thuidium tamariscinum*, *Pleurozium schreberi*, *Plagiochila spinulosa*, *Isothecium myosuroides* var. *myosuroides*, *Eurhynchium striatum* and *Hylocomium splendens* with *Trichocolea tomentella* in wetter parts.

20) NM9568.1438. A less steep and more open section just below the forest road to the new bridge. No change in the flora on the ground from Note 19 with the addition of *Loeskeobryum brevirostre* and in wetter areas *Sphagnum palustre*, *Sphagnum fallax* and *Sphagnum capillifolium*. *Leptoscyphus cuneifolius* is quite frequent on birch and *Harpalejeunea molleri* occurs on the ash trees.

21) Beyond the new bridge the route follows the forest road with little bryophyte interest; the flora consists mostly of common woodland pleurocarpous species.

22) NM9617.1422. The slope down to the point at which the pipeline route crosses to the south side of the river. *Rhytidiadelphus triquetrus* is common here with *Polytrichum commune*, *Loeskeobryum brevirostre*, *Rhytidiadelphus loreus*, *Calliergonella cuspidata* and *Thuidium tamariscinum*. Epiphytes include *Plagiochila punctata* and *Leptoscyphus cuneifolius* on birch and *Harpalejeunea molleri*, *Aphanolejeunea microscopica* and *Zygodon conoideus* on ash and hazel. For the river crossing see Note 12. The bank on the S side has *Thuidium tamariscinum*, *Calliergonella cuspidata*, *Trichocolea tomentella*, *Rhytidiadelphus triquetrus*, *Plagiochila asplenioides*, *Loeskeobryum brevirostre*, *Plagiomnium undulatum* and *Brachythecium rivulare*.

23) Below this the route runs through similar woodland and then into conifers with abundant *Thuidium tamariscinum* and some *Polytrichum commune* and *Rhytidiadelphus triquetrus*; *Plagiochila punctata* and *Scapania gracilis* on trees, including conifers and some rocks have *Plagiochila spinulosa*. In the conifers *Thuidium tamariscinum* becomes dominant with some *Polytrichum commune* and *Dicranum majus* and some of the trees have both *Plagiochila punctata* and *Leptoscyphus cuneifolius*.

## River Avich hydro scheme - bryophyte survey

24) NM9635.1414. Slopes above the footbridge. In the conifers are *Thuidium tamariscinum*, *Sphagnum girgensohnii*, *Plagiochila asplenioides*, *Cirriphyllum piliferum*, *Hookeria lucens* and *Calliergonella cuspidata* and *Plagiochila punctata* and *Scapania gracilis* on the trees. From this point the pipeline follows the path with limited bryophyte interest except for the epiphytes with *Leptoscyphus cuneifolius* still frequent on birches.

25) NM9653.1404. The section the pipeline from Intake option 2 to the main pipeline. The wet woodland floor has the wet banks have *Thuidium tamariscinum*, *Calliergonella cuspidata*, *Rhytidiadelphus triquetrus*, *Plagiochila asplenioides*, *Loeskeobryum brevirostre*, *Plagiomnium undulatum* and *Brachythecium rivulare*. The ash trees have a good epiphytic flora with *Plagiochila exigua*, *Plagiochila punctata*, *Harpalejeunea molleri* and *Zygodon conoideus* and *Plagiochila spinulosa*, *Plagiochila punctata* on oak alder and birch. The two pipeline options then merge to follow the existing path which also follows the old pipeline route.

26) NM9670.1390. The route runs through conifers and then out onto steep slopes with oaks, following the old pipeline route. Mostly common woodland floor species as above with good patches of *Sphagnum quinquefarium* and some *Anastrepta orcadensis*. *Plagiochila spinulosa* is locally abundant on the oaks and *Leptoscyphus cuneifolius* occurs on the birches. There is little change in this flora to the powerhouse site.

27) NM9684.1395. Powerhouse area. There area has been clear-felled in the past so there is some old brash and stumps and an old powerhouse (?) building. There are just common woodland floor species here including *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Thuidium tamariscinum*, *Dicranum scoparium*, *Sphagnum capillifolium*, *Calliergonella cuspidata* and *Plagiochila spinulosa* on old stumps. On the trees are *Isothecium myosuroides* var. *myosuroides*, *Scapania gracilis*, *Plagiochila punctata*, *Plagiochila spinulosa*, *Frullania tamarisci*, *Harpalejeunea molleri*, *Neckera crispa* and *Ulota phyllantha*.

**Annex 2: River Avich Hydro Scheme  
Bryophyte species list**

**Mosses (79 taxa)**

Amphidium mougeotii  
Anoetangium aestivum  
Atrichum undulatum  
Bartramia ithyphylla  
Blindia acuta  
Brachythecium rivulare  
Breutelia chrysocoma  
Bryum capillare  
Bryum pseudotriquetrum  
Calliergonella cuspidata  
Campylopus flexuosus  
Cirriphyllum piliferum  
Climacium dendroides  
Cratoneuron filicinum  
Ctenidium molluscum var. molluscum  
Dichodontium flavescens  
Dichodontium pellucidum  
Dicranella heteromalla  
Dicranodontium denudatum  
Dicranum majus  
Dicranum scoparium  
Encalypta streptocarpa  
Eurhynchium striatum  
Fissidens adianthoides  
Fissidens dubius  
Fissidens taxifolius  
Fontinalis antipyretica  
Homalothecium sericeum  
Hookeria lucens  
Hygrohypnum eugyrium  
Hygrohypnum ochraceum  
Hylocomiastrum umbratum  
Hylocomium splendens  
Hyocomium armoricum  
Hypnum andoi  
Hypnum cupressiforme var. cupressiforme  
Hypnum jutlandicum  
Isothecium alopecuroides  
Isothecium myosuroides var. myosuroides  
Kindbergia praelonga  
Loeskeobryum brevirostre  
Mnium hornum  
Neckera crispa  
Oxyrrhynchium hians  
Palustriella commutata s.str.  
Plagiomnium undulatum  
Plagiothecium undulatum  
Platyhypnidium riparioides  
Pleurozium schreberi  
Pohlia wahlenbergii  
Polytrichastrum formosum  
Polytrichum commune  
Polytrichum juniperinum  
Pseudoscleropodium purum  
Pseudotaxiphyllum elegans

Ptilium crista-castrensis  
Racomitrium aciculare  
Racomitrium aquaticum  
Racomitrium fasciculare  
Racomitrium lanuginosum  
Rhizomnium punctatum  
Rhytidiadelphus loreus  
Rhytidiadelphus squarrosus  
Rhytidiadelphus triquetrus  
Sciuro-hypnum plumosum  
Sphagnum capillifolium s.l.  
Sphagnum fallax  
Sphagnum girgensohnii  
Sphagnum palustre  
Sphagnum quinquefarium  
Sphagnum squarrosum  
Tetraphis pellucida  
Thamnobryum alopecurum  
Thuidium tamariscinum  
Tortella tortuosa  
Trichostomum tenuirostre  
Ulota bruchii  
Ulota phyllantha  
Zygodon conoideus

**Liverworts (50 taxa)**

Anastrepta orcadensis  
Aneura pinguis  
Aphanolejeunea microscopica  
Bazzania trilobata  
Calypogeia muelleriana  
Cephalozia bicuspidata  
Chiloscyphus polyanthos s.l.  
Colura calyptrifolia  
Conocephalum conicum  
Conocephalum salebrosum  
Diplophyllum albicans  
Drepanolejeunea hamatifolia  
Frullania dilatata  
Frullania fragilifolia  
Frullania tamarisci  
Harpalejeunea molleri  
Jungermannia atrovirens  
Leiocolea bantriensis  
Leiocolea collaris  
Lejeunea cavifolia  
Lejeunea patens  
Lepidozia reptans  
Leptoscyphus cuneifolius  
Lophocolea bidentata  
Lophozia ventricosa  
Metzgeria conjugata  
Metzgeria consanguinea  
Metzgeria furcata  
Metzgeria leptoneura  
Microlejeunea ulicina

## River Avich hydro scheme - bryophyte survey

*Mylia taylorii*  
*Nardia scalaris*  
*Nowellia curvifolia*  
*Odontoschisma denudatum*  
*Pellia endiviifolia*  
*Pellia epiphylla*  
*Plagiochila asplenioides*  
*Plagiochila bifaria*  
*Plagiochila exigua*  
*Plagiochila porelloides*  
*Plagiochila punctata*  
*Plagiochila spinulosa*  
*Radula complanata*  
*Radula voluta*  
*Riccardia palmata*  
*Saccogyna viticulosa*  
*Scapania gracilis*  
*Scapania undulata*  
*Trichocolea tomentella*  
*Tritomaria quinquedentata*