

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Adderstonlee Moss





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COMMISSIONED REPORT

Commissioned Report No. 712

**Investigation of Standing Water and Wetland SSSIs
thought to be under Diffuse Pollution Pressure:
Adderstonlee Moss**

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COMMISSIONED REPORT

Summary

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Adderstonlee Moss

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Diffuse pollution; SSSIs; wetland; water; soil; samples; recommendation.

Background

SNH contracted EnviroCentre to look at a number of Sites of Special Scientific Interest across Scotland thought to be adversely affected by diffuse pollution. EnviroCentre was asked to carry out a number of tasks to help SNH understand better whether sites are being affected by diffuse pollution and if so, what activities might be contributing to this pressure and how SNH could improve the condition of the sites.

If sites are identified as being affected by diffuse pollution, SNH hope that the results of this report will inform their work with managers of the sites to improve their conditions.

Main findings

- The desk study and site walkover identified potential existing and historical land use practices within the catchment that could adversely affect water quality and soil nutrient status.
- Analytical data supported an inflow of nutrients to the site but this was not particularly high given the catchment findings. It should be noted that the sampling assessment was undertaken as a single visit and the limited scoped dataset and a lack of historical data limits the ability to draw accurate conclusions to fully inform current site conditions.
- A series of recommendations are proposed to seek to aid the understanding of the site and afford a greater insight into the perceived changes taking place.

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EnviroCentre Ltd would like to thank the SNH Operations staff for their time and assistance in providing access to the site files held at the local office, providing landowner contact details, and in aiding the preliminary understanding of the site to assist with the health and safety evaluation prior to the initial visit.

Thanks are also extended to the site landowners for affording access to the site to enable the agreed scope of work to be undertaken.

1. INTRODUCTION

EnviroCentre Ltd was contracted by Scottish Natural Heritage (SNH) in August 2012 to deliver the 'Investigation of Standing Water and Wetland SSSIs under diffuse pollution pressure' project. The data collected from the project will be used to inform management decisions on wetland and standing water Sites of Special Scientific Interest (SSSI).

1.1 Site Location

Adderstonlee Moss is located approximately 3km (2 miles) south-east of Hawick in the Scottish Borders. The site is not directly accessible by vehicle although track access to the catchment is gained via an extended farm track off the A6088 trunk road. See Figure 1.1 in Annex 1.

1.2 Site Description

Adderstonlee Moss is a basin mire fen comprising an area of 16.33 hectares (SNH, 2008a) which lies in a shallow valley between Kirkton Hill, Hoggfield Hill and White Hill at an altitude of approximately 240m above Ordnance Datum. The fen is a peatland dominated by species of sedge vegetation. The largest area of habitat is the central area of moderately dense ungrazed wet willow and birch woodland. In addition to the wide diversity of plant species, the site also supports several rare insect species including an important water beetle assemblage (SNH, 2008b).

The main part of the site comprises a willow fen-carr with extensive drainage ditches. The site is bordered to the north by a belt of coniferous plantation and a shelter belt of forestry is located to the south-east. Peat deposits extend beyond the fence lines around the southern parts of the site and extend into the corresponding valleys (SNH, 2008b). Along the western side there is a margin of wetland vegetation.

The site is part of Kirkton Farm. To the north east of the site the land is managed fairly intensively as a stock farm with some arable land use. The wetter habitats have been left ungrazed so therefore have developed naturally, and part of the outer edge of the north eastern wet grassland habitat has been agriculturally improved by re-seeding with a rye grass mix in 2000 (SNH 2008b). The south-west side and east of the site is largely an area of unimproved rough grazing for sheep and cattle.

The underlying solid geology at the site consists of sedimentary wackes from the Hawick Group (British Geological Survey, n.d).

1.3 Site Hydrology

The site is located within the headwaters of a minor tributary of the Kirkton Burn, which is a tributary of the River Teviot. Two minor watercourses flow in a northerly direction through the site, one along the western boundary and the other passing through the eastern part of the site. The western watercourse originates from a spring in the southern extent of the site. A review of historic mapping shows the channel alignment has not altered significantly since the 1860's (National Library of Scotland, n.d), however the straight nature of the watercourses suggests that historic canalisation may have occurred prior to this date.

The confluence between these minor watercourses is situated just upstream of the northern site boundary. The catchment area to this boundary is 1.45km² and the annual average rainfall for this catchment is 914mm (Centre for Ecology and Hydrology, 2009).

1.4 Site History

A review of the SNH site files coupled with internet research revealed limited additional information above that within the SNH Site Management Statement (SNH, 2008b). The SNH document is therefore considered to be the main source of historical information for the site and is that from which the following information is taken.

The site was first recorded as Adderstonlee Moss on the 1857 Ordnance Survey map. In 1945 it became mapped as 'marsh' and in 1954 as 'scrub and marsh'. The varying descriptions may be a result of changes in water levels and land use.

SNH files record a new drain being formed in 1982 outwith the SSSI and adverse impacts on the water table were expected. Despite the concerns there appears to be no research into the impact and effects of this having been undertaken.

There is evidence of a weir on the Kirkton Burn to the north of the site near Kirkton Farm (SNH, 2008b).

It is speculated in the Site Management Statement (SNH, 2008b) that the natural succession of rich-fen, acid bog and woodland has probably been interrupted by the history of past land use. An example of this is peat cutting whereby evidence in both the north and south parts of the site indicate that such cuttings have been infilled.

1.5 Recent Site Management Practices

Outwith the information contained in the Site Management Statement (SNH, 2008b), there has been a lack of information available regarding previous or existing management practices at the site.

A Rural Development Contracts - Rural Priorities contract is in place with one landowner at the site (SNH, n.d.).

2. METHODOLOGY

The following sections outline the approach undertaken to fulfil the scope of works established by SNH in the Statement of Requirements (SOR).

2.1 Pre-site Attendance Desk Study

Before the initial site visit was undertaken the local SNH officer was contacted and a meeting held at the corresponding local office to discuss the local understanding of the site and review SNH records. Access to non-publically available data held by other regulators, including SEPA, was not available.

The meetings were also used to provide an insight into any health and safety constraints not readily apparent from the site maps.

Landowners of the site were notified of the planned site visit a week before the proposed visiting date. This allowed landowners the opportunity to ask any questions and also gave EnviroCentre staff a chance to gain a greater understanding of the workings of the site and the site surrounds. Landowner details are provided in Annex 2.

2.2 Site Attendance

The site was accessed and samples collected over a one day period – termed Visit 1. A follow up visit to the wider catchment was undertaken once the analytical data was available and appraised in context with the information obtained from the desk based exercise. Table 2.1 below shows site conditions on the day of each visit.

Table 2.1: Site Conditions

Adderstonlee Moss	Date of Visit	Weather Conditions	Grid References
Visit 1	6 November 2012	Mild, overcast, occasional showers	NT 534120
Visit 2	12 March 2013	Clear, cold, dry	NT 534120

2.3 Sampling Approach

SNH had determined the preferred locations for the collection of soil and water samples – as detailed in Figure 2.1 in Annex 1. EnviroCentre was not involved in determining these locations and had not assessed the suitability to access such before Visit 1. Due to certain access restrictions the locations of samples that EnviroCentre collected are detailed in Figure 2.2 in Annex 1. Changes to locations were kept to a minimum and are generally not deemed to have a significant impact on the sampling or conclusions.

All sampling methods were carried out by trained personnel. Photographs of each sampling location were taken (see Figure 2.3 in Annex 1) and grid references for each location recorded.

2.4 Sample Equipment

The following sample kit was used to undertake site field work:

- Handheld Global Positioning System (GPS) unit to record specific grid references;
- Handheld soil augers;
- Plastic bailers;
- Sample bottles (all sample bottles were written on to record locations, date and time); and

- Personal Protection Equipment (PPE - in line with the requirements of the site specific health & safety risk assessment).

All samples were given unique identification names and packaged in cool boxes with ice packs so as to keep samples at appropriate temperatures prior to being despatched to a United Kingdom Accreditation Service (UKAS) accredited laboratory for analysis.

2.5 Health and Safety

Site specific risk assessments were carried out before attending site. The assessment was based on information obtained from the meeting with the local officer and from EnviroCentre's extensive experience of undertaking previous work of this nature.

The risk assessment, which was completed by staff attending the site visit, included details of the landowner, nearest emergency services, and identified risks and proposed means of mitigation. Field operatives notified EnviroCentre head office when accessing and leaving site and wore the following appropriate PPE at all times:

- Warm and waterproof clothing;
- Waders;
- Waterproof footwear; and
- Hi-vis vest.

Biosecurity measures were rigorously implemented when entering and leaving site. Boots and equipment were washed when leaving site so as not to cross contaminate subsequent sites.

2.6 Water Samples

Surface water samples were collected from strategic locations within the surface watercourses on site. Collections were made from inflows, standing (open) water and outflows, to provide an understanding for the whole site.

Groundwater samples were collected using plastic bailers from slotted pipes installed with hand augered holes where soil samples were originally collected. The sampling methodology employed a geosock membrane for coarse filtration so as to minimise samples being heavily loaded with suspended solids and organic material.

Samples underwent initial on-site field tests using an OTT Quanta Handheld probe for the following parameters:

- pH;
- Temperature;
- Electrical Conductivity (EC);
- Dissolved Oxygen (DO);
- Oxidation-Reduction Potential (ORP); and
- Salinity.

The water samples were submitted for the following analyses to a UKAS accredited laboratory:

- Total calcium (Ca), magnesium (Mg) and sodium (Na);
- N Species – total nitrogen, nitrate and ammonium;
- P Species – orthophosphate and total phosphorus; and
- Total iron (Fe).

Dissolved and ferrous iron analyses were scheduled in but could not be undertaken by the laboratory due to insufficient sample. This data would have supported interpretation of results if available but is not considered critical for determining the presence or potential sources of diffuse pollution.

2.7 Soil Samples

Soil samples were collected from specific locations on site by hand augering holes into the ground. The soil samples were collected at two depths:

- the rooting zone; and
- a depth of approximately one metre below the rooting zone.

NB - In the corresponding results tables the samples are differentiated by the suffix 'A' for the rooting zone; and 'B' for below the rooting zone.

Soil samples were analysed for the following suite:

- Moisture content;
- Extractable nitrogen and phosphorus;
- Total nitrogen and phosphorus; and
- Total calcium (Ca); magnesium (Mg) and potassium (K).

Bulk density analysis was scheduled in but could not be undertaken by the laboratory due to insufficient sample. Total sodium (Na) and total organic carbon (TOC) were not scheduled in properly and analyses were not undertaken. The lack of this data is not considered to affect interpretation of results in terms of determining the presence and potential sources of diffuse pollution.

2.8 Field Observations

On accessing the site for the first visit, and the wider catchment for the second visit, the following field observations were noted:

- Geo-referenced photograph locations of surrounding land use (refer to Figure 2.4 in Annex 1);
- Adjacent land use;
- Identified and potential pollution sources; and
- Atypical or unusual site features (e.g. fly tipping, vandalism, etc.).

In addition, mapping of the immediate surrounding catchment was completed following the second site visit (see Figure 2.5 in Annex 1). This process utilised the Flood Estimation Handbook (Centre for Ecology and Hydrology (CEH), 2009) catchments and Land Cover data (Land Cover Map 2007) to populate GIS mapping. The output was used to aid the interpretation of results and further inform the study conclusions.

3. STUDY LIMITATIONS

The scope of the commissioned study presented a series of limitations which should be borne in mind when reviewing this report. These are outlined below:

- Sampling was undertaken on a single visit. Whilst this afforded consistency for the samples collected, the weather conditions preceding and at the time of the visit may have directly influenced the observations made and any analytical results obtained.
- Sampling comprised a single set of samples from each of the accessible pre-determined locations. Repeat or continuous sampling over an extended (seasonal) period would be preferred to enable a greater dataset to be collected. This would present a more representative assessment of the site and allow for seasonal/climatic variations.
- The dataset provides a 'snapshot' of the site condition. Due to the limited availability of historical data (see section 1.4) there is very limited scope for comparisons to be made with previous records or allowance for assessment of seasonal or climatic factors.
- The scope of work did not include the assessment of rainfall within the catchment or measurement of the inflow(s)/outflow(s) of associated drainage ditches or watercourses.
- The limited dataset does not allow for any statistical analysis of the results to be undertaken. No adjustment has been made for anomalous results or to determine trends over time.
- The sampling methodology used to obtain groundwater samples (obtained from a circa. 1m depth coupled with geosock membrane for coarse filtration) typically results in these samples being heavily loaded with suspended solids and organic material meaning that the samples appear 'dirty' to the naked eye. To avoid interference with the laboratory analytical instrumentation and erroneous results, on receipt at the laboratory these are processed on a x10 dilution. It is this dilution process which explains why some of the results are reported as a less than value rather than the equivalent level of detection of 'clean' samples. The same dilution approach is applied to heavy silted surface water samples.
- The weather conditions prior to and during the site visit should be taken into consideration when reviewing the results. According to the Met Office (n.d.) the seasonal rainfall totals for summer, autumn and winter 2012 in eastern Scotland were 161%, 89% and 82% respectively of the annual average rainfall levels for the period 1981-2010. This should be taken into consideration when reviewing the results as it could result in bias when compared with years where average rainfall levels were recorded. The higher rainfall will directly influence runoff, dilution and catchment water levels/throughput which have not been assessed.

4. ANALYTICAL DATA

The following tables show the results obtained from the initial site visit (Site Visit 1) in which samples from the pre-determined locations (or as close to as practically possible) were collected. Where the pre-determined locations were not accessible comparable alternative locations with the same habitat features were sampled.

Table figures in red indicate relative atypical (e.g. high or low values) or anomalous results relative to the remaining dataset or which would typically have been expected to be observed from a site of this nature. These are discussed further in section 6.2.

4.1 Water Quality Field Test Data

The following data was collected by a suitably qualified operative using the methods outlined in section 2.

Table 4.1: Water Samples - Field Data and Observations

Sample ID	Nat. Grid Reference		Temp (°C)	pH	Salinity (psu)	DO (%)	DO (ppm)	ORP (mV)	EC (mS/cm)	Comments
AD01	NT 53292	12285	9.45	7.56	1.45	N/A	N/A	206	2.83	Surface water - clear with a few minor s/s; no odour
AD02	NT 53355	12243	9.18	6.98	0.27	N/A	N/A	181	0.558	Groundwater - cloudy brown with fine brown s/s; no odour
AD03	NT 53492	11841	9.39	7.02	0.34	N/A	N/A	189	0.697	Surface water - clear with some leaf litter and fine s/s; no odour
AD04	NT 53542	11827	8.89	6.91	0.24	N/A	N/A	210	0.497	Groundwater - brown discolouration with fine brown s/s; no odour
AD05	NT 53413	11672	9.38	6.61	0.12	N/A	N/A	277	0.254	Surface water - clear with few s/s; no odour; slow flow
AD06	NT 53276	11712	8.94	6.83	0.35	N/A	N/A	263	0.719	Surface water - slight brown discolouration, fine s/s; no odour; slow flow
AD07	NT 53280	12011	9.48	7.26	0.47	N/A	N/A	239	0.956	Surface water - clear with fine s/s; no odour; very slow flow
AD08	NT 53280	12161	8.93	7.1	0.29	N/A	N/A	246	0.608	Groundwater - cloudy brown with fine brown s/s; no odour

NB - DO meter failed to calibrate whilst on site and hence no readings were obtained. The missing data did not have any major implications on the analysis and synthesis as it is not essential for determining pollution pressures.

4.2 Laboratory Results

The data in the following tables was collected by a suitably qualified operative using the methods outlined in section 2.

Table 4.2: Water Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Sample Type ⁺	Total Ca (mg/l)	Total Mg (mg/l)	Total Na (mg/l)	Total Fe (mg/l)	Amm N (mg/l)	Nitrate as N (mg/l)	Phosphate as P (mg/l)	Total P (mg/l)	Total N as N (mg/l)
AD01	NT 53292	12285	SW (O)	42	5	4	0.19	0.01	0.2	<0.01	<0.1	<1
AD02	NT 53355	12243	GW	26	6	4	7.13	1.0	<0.2	<0.01	0.2	5
AD03	NT 53492	11841	SW (I)	30	5	4	0.21	0.01	<0.2	<0.01	<0.1	<1
AD04	NT 53542	11827	GW	30	5	4	3.91	0.22	<0.2	<0.01	<0.1	2
AD05	NT 53413	11672	SW (I)	20	1	3	0.25	0.02	<0.2	0.08	<0.1	<1
AD06	NT 53276	11712	SW (OW)	28	3	3	0.05	0.01	<0.2	<0.01	<0.1	<1
AD07	NT 53280	12011	SW (I)	53	4	4	<0.01	0.02	0.3	<0.01	<0.1	<1
AD08	NT 53280	12161	GW	30	4	4	0.29	0.1	<0.2	<0.01	<0.1	<1

+ Surface water samples are designated either inflow (I), outflow (O) or open water (OW)

Table 4.3: Soil Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Soil Type*	Extractable N (mg/Kg)	Total Ca (mg/Kg)	Total Mg (mg/Kg)	Total P (mg/Kg)	Total K (mg/Kg)	Tot Moisture** 105°C (%)	Total N (mg/Kg)	Nitrate (mg/l)	Nitrogen (%)	Extractable P (mg/l)
AD02A	NT 53400	12200	Organic rich dark wet sludge	2.8	10000	3550	1340	1240	80.4	<3.0	<0.2	2.0	6.01
AD02B	NT 53400	12200	Organic rich dark sludge	1.1	5360	7650	530	1200	56.6	<1.3	<0.2	0.9	5.73
AD04A	NT 53400	11800	Organic rich dark wet sludge	1.3	7560	2840	1360	1220	70.0	<1.5	<0.2	1.93	7.35
AD04B	NT 53400	11800	Organic rich dark wet sludge	0.9	7120	2440	1360	740	77.5	1.4	0.5	2.24	4.84
AD08A	NT 53300	12100	Organic rich dark wet sludge	0.6	13700	1160	588	764	71.1	<0.8	<0.2	2.12	5.73
AD08B	NT 53300	12100	Organic rich dark wet sludge	0.8	18300	1160	299	450	75.4	<1.0	<0.2	2.27	6.12

* Soil types are field observations

** Total Moisture = Water content

A/B suffix: A = Rooting Zone and B = Below Root Zone

5. SITE OBSERVATIONS

To enhance the understanding of Adderstonlee Moss and the surrounding area, preliminary research was undertaken and complemented with a second site walkover to further understand the landforms, drainage configurations, potential environmental sensitivities and possible diffuse pollution sources influencing the site.

5.1 Desk Study

The Site Management Statement (SNH, 2008b) records an 'Objective for management' of enhancing the conditions of the site by maintaining the extent of key habitats and maintaining low-nutrient water quality through low or zero fertiliser inputs along with minimising the arable cultivation within the area.

The basin fen at the site is in unfavourable declining condition as assessed in 2003 due to poor quality of non-woody vascular vegetation on the site. Agricultural operations and the presence (or change in extent) of invasive species have been identified as the main pressures on the site by SNH. The presence of low brown moss cover and widespread common reed at the site could be associated with long term nutrient enrichment. The implementation of catchment protection through buffer zones has been recommended. (SNH, n.d.)

5.2 Catchment Walkover

From the second site visit post-receipt of the analytical results, the following observations of the surrounding catchment were made:

- No visible pollution sources were observed within the site boundary although some litter and what appeared to be minor fly tipping was observed.
- Sheep and cattle were present in close proximity to the site boundary at the time of visit. None were observed within the fenced part of the site.
- Improved pasture was evident within the site and notably beyond the eastern boundary of the site.
- Man-made drainage ditches are present throughout the site. It would appear that these have been historically altered and extended over time. Not all of the ditches are marked on the site maps.
- At the time of the site visit there was evidence of felling of trees and stripping of low branches. It was thought to have been undertaken to aid access within the fenced boundary.
- A residential property with probable septic tank provision is located 300m due south west of the site boundary.
- The weir on the Kirkton Burn highlighted through the desk study was not visited as part of the site walkover.

5.3 Summary

The following table provides a summary of the key site features which were observed during both site visits or identified in the desk study undertaken as part of the initial works.

Table 5.1: Summary of key observations

Activities	Observations
Fencing	Entire boundary of site is fenced (condition variable and not fully appraised).
Fishing	Not applicable.
Grazing	Site boundary and land within adjacent catchment observed being grazed by cattle and sheep, including grassland improvement (areas reseeded with rye grass).
Monitoring	Condition monitoring was last carried out in 2003. No water or soil data was reviewed for the purposes of this study.
Public Access	No public access directly to the site however, a public footpath is present to the west of the site and access can be readily gained in favourable weather conditions.
Shooting	There is a consent for shooting.
Point Pollution Sources	None observed within the SSSI boundary.
Properties in catchment	One residential property (Adderstone Lee) is present in the site catchment. Given the rural nature of the catchment it is suspected that this is served by a septic tank.
Unusual, Distinctive or Atypical Features	At the time of the site visit there was evidence of tree felling and mechanical stripping of low branches on standing trees within the fenced SSSI boundary. There was also minor evidence of fly tipping within the site.

A mapped summary of the perceived catchment pressures is detailed in Figure 5.1 in Annex 1.

6. INTERPRETATION OF RESULTS

The following assessment is based on the field tests and laboratory analytical results only.

6.1 General summary

Although no discernible trends of elevated nutrient enrichment were evident from the sample dataset (potentially due to timing of sampling), the results do indicate that agricultural improvements in the eastern side of the site are likely to have resulted in an increased nitrogen and phosphorus load entering the site through surface and groundwater flows.

No apparent trends were observed from assessing the changes in composition of the surface water samples collected at the inlet through to the outlet of the site. With the exception of iron and total nitrogen concentrations in the groundwater samples, none of the inorganic analyses were elevated. The inorganic concentrations of bioavailable nutrients were typically higher in the groundwater samples compared to the surface water samples.

Elevated total nitrogen results were observed in the two eastern groundwater samples (AD02 and AD04) compared with the other groundwater sample collected from a more central location within the site (08). This indicates a possible inflow of nutrients from the eastern part of the catchment.

The presence of elevated total nitrogen (the highest value recorded across the site) and ammonia in AD02, coupled with an elevated iron result, indicates anoxic conditions. This corresponds with elevated phosphorus levels in the upper (root zone) soil samples with the exception of sample of AD04A where phosphate levels were effectively the same in both root and below root zone samples.

The dataset shows a low nitrogen to phosphorus (N:P) ratio and this is consistent across all the soil samples collected and may reflect nutrient uptake by the plant communities present.

The slow flow observations made to the surface waters AD05, 06 and 07 are indicative of waterlogged soils and lack of maintenance in the channels.

6.2 Atypical results

No consistent atypical or anomalous results were recorded from the soil or water samples at Adderstonlee Moss. Of the limited data set the only observations of note are discussed below:

- Particularly elevated electrical conductivity and salinity were recorded at AD01. These parameters were elevated throughout the site but particularly high at the outflow point. This is likely associated with elevated natural mineral content augmented through the accumulation of minerals in the wetland area.
- Elevated levels of total nitrogen and ammonia were recorded at AD02 in water. A high concentration of extractable nitrogen was encountered in soil at this location. This could be due to nutrient input from the adjacent improved grassland (noted as arable land in land use map – Figure 2.5).

6.3 Additional considerations

See study limitations presented in section 3.

Historical or future data collected for the assessment and evaluation of the beetle assemblages may comprise water quality analyses which could be of value in understanding long-term trends and changes within the site.

7. CONCLUSIONS

The analytical results do not show a definitive trend of elevated nutrients within the site. There are however observations that indicate there have been changes within the catchment over time which will have directly influenced soil and water quality. This included long-term changes to the nutrient status of the site resulting from diffuse agricultural sources and management practices within the catchment.

The site sits in a shallow gorge and receives surface and groundwater flows from the surrounding hills namely Kirkton (east); Hoggfield (south); and White (west). Over the course of many thousands of years the site will have changed as it acts as a sink for the surrounding landform. It is likely that the site initially comprised a lake which over time has been infilled by organic material. This in turn created a rich substrate in which other plants could prosper and the further infilling and successional change that is presently observed. This process will be compounded at present by the infilled drainage channels and poorly draining soils within the site boundary.

The site will be heavily influenced by the quality and quantity of water which flows to the site. These flows vary seasonally, will leach nutrients from the surrounding catchment and due to the levelling out of the landform and poor drainage, these will allow solids to settle and accumulate, trapping further solids and nutrients and resulting in successional change. This process is likely to be dominated by surface water flows influenced by agricultural practices although groundwater sources may have a notable seasonal impact.

Evidence of agricultural improvements to the immediate catchment – and particularly in the east - is expected to have resulted in an accelerated nutrient inflow to the site. Coupled with poor drainage, it is considered that this could have a direct effect on the existing vegetation with a greater availability of nutrients altering the naturally occurring community composition. The nutrient transfer may be further heightened by the coniferous plantation which adjoins from Buckstruther Moss to the east. There will be some runoff, albeit minimal in comparison, from the access track which passes to the west of the site. This track is expected to be used by farm and 4x4 vehicles which will have a heightened impact and cause rutting in wet weather conditions leading to the infilling of the site drains and inhibiting throughput.

One residential property, Adderston Lee, is present within the catchment and lies approximately 300m to the south west of the site. Given the remote location of the site, it is expected that this dwelling will be on a septic tank and hence the foul water flows could drain into the site. The collection of soil and water data within the fields out with the site boundary, or the boundary itself, would be needed to corroborate this.

From the desk study it would appear that site condition monitoring has not been undertaken since 2003. It would be of value for this to be updated to aid the understanding of any changes to the catchment, the site and the plant communities since the previous assessment.

8. RECOMMENDATIONS

Based on the limited understanding gained from the sampling exercise and catchment visits, the following recommendations are proposed. From the stated conclusions and identified pressures the key actions to seek to reverse the present declining status of the site are to address the inputs to the moss from the agricultural and forestry activities (vii and x), the quality of the multiple inflows (iii) and impact of the site drains (xi) and the potential sewage inputs from the neighbouring property (ix).

8.1 Monitoring

- i. Undertake a long-term targeted monitoring study at selected locations within the site for key nutrients – to include orthophosphate and bioavailable (extractable) nitrogen. Ideally this would be undertaken over the course of several seasons (ideally for a minimum of one year). The data from such should be compared alongside rainfall data and seasonal abnormalities to seek to understand the nutrient dynamics taking place within the site.
- ii. In conjunction with i, assess the seasonal flow and nutrient loads of the Adderstonshields Burn within and outwith the site boundary. This data would be of direct value in being able to assess the flow dynamics of the site and to understand retention times and season variations in throughput.

8.2 Other commissioned studies

- iii. Undertake hydrological and hydrogeological assessment of the contributing catchment in order to determine the quality and quantity of the source flows. Given the waterlogged nature of the site it would be of value in undertaking a further site walkover during a period of low rainfall (but not drought conditions) to see whether groundwater derived flows are evident on site.
- iv. Review and repeat the site condition monitoring which is last understood to have been undertaken 10 years ago. The findings from this exercise would indicate whether the site has further declined since the September 2003 visit and could help identify issues (e.g. a change in vegetation type) not otherwise highlighted through this study.
- v. Review the historical beetle assemblage data using one of the known macroinvertebrate intolerance to pollution indices. Unlike 'spot' monitoring, the beetles are present all the time so provide a consistent indicator of the prevailing environmental conditions. Given that over 18 water beetle species have been identified at the site, through using the variations in the community composition and population numbers, and known variations to pollution tolerance between genus/species, it may be possible to gain a further insight into the likely changes to water and soil quality at the site over time.
- vi. Undertake a detailed library review, including historical mapping and local data sources, to seek to understand historical land use and information relating to the former SSSI site and contributing catchment. This should seek to determine when the peat cutting is likely to have been undertaken and when ceased, and the resulting timescale for the infilling of the associated excavations.

8.3 Landowner / Tenants

- vii. Proactively engage with local landowners to understand the existing and (foreseeable) proposed changes to the immediate catchment including field use, crop

type and soil conditioning approaches. Consider a management agreement and appropriate strategies accordingly - for example (but not exclusive to) nutrient management planning, buffer strips, exclusion zones, routine spot monitoring *etc.*

- viii. Proactively engage with local landowners to understand the management practices which are undertaken within the SSSI boundary. At the time of the site visit there was evidence of felling of trees and stripping of low branches to aid access within the fenced boundary.
- ix. Proactively engage with nearby house owner to ensure that septic tanks are managed appropriately.
- x. Review the forestry management practices undertaken within the wider catchment. Particular consideration should be given to understand the historical operation, times of planting and felling and application of any soil improvers so as to manage the impacts to the SSSI.
- xi. Review of the ownership of the identified land drains and the future management and maintenance of such.

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ANNEX 1: FIGURES

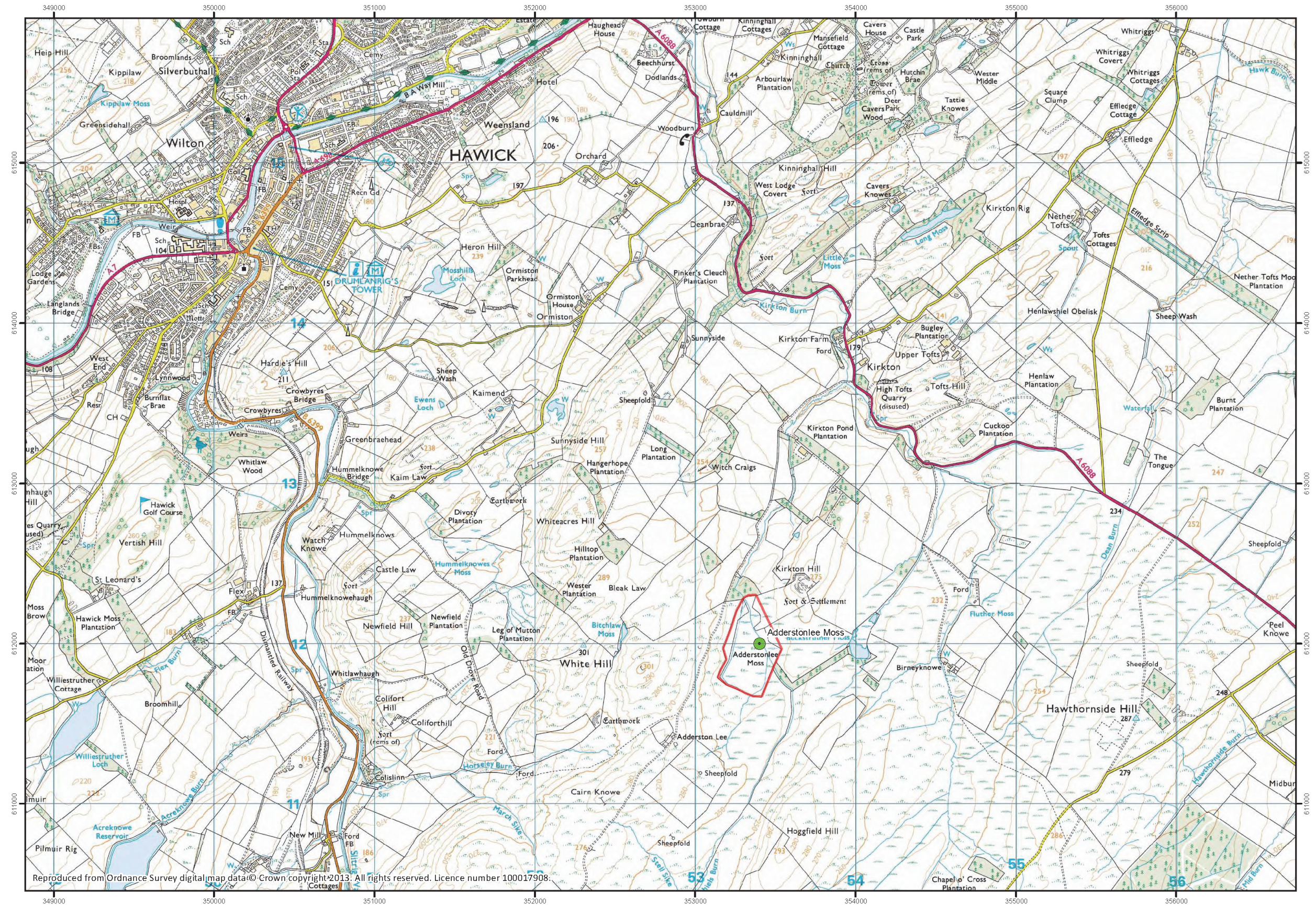


Figure 1.1. Site Location Map

Adderstonelee

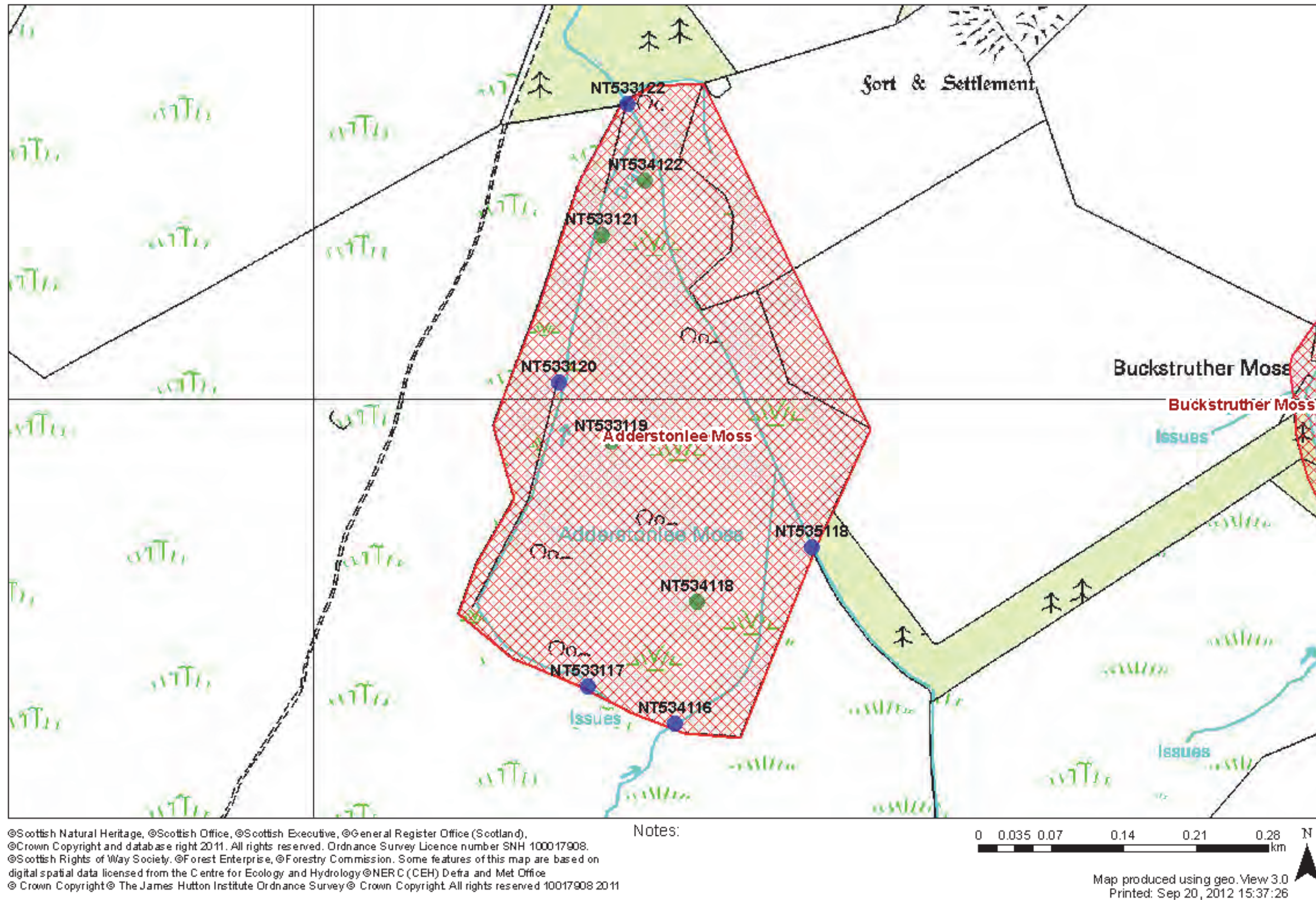


Figure 2.1: SNH Proposed Sampling Location Plan

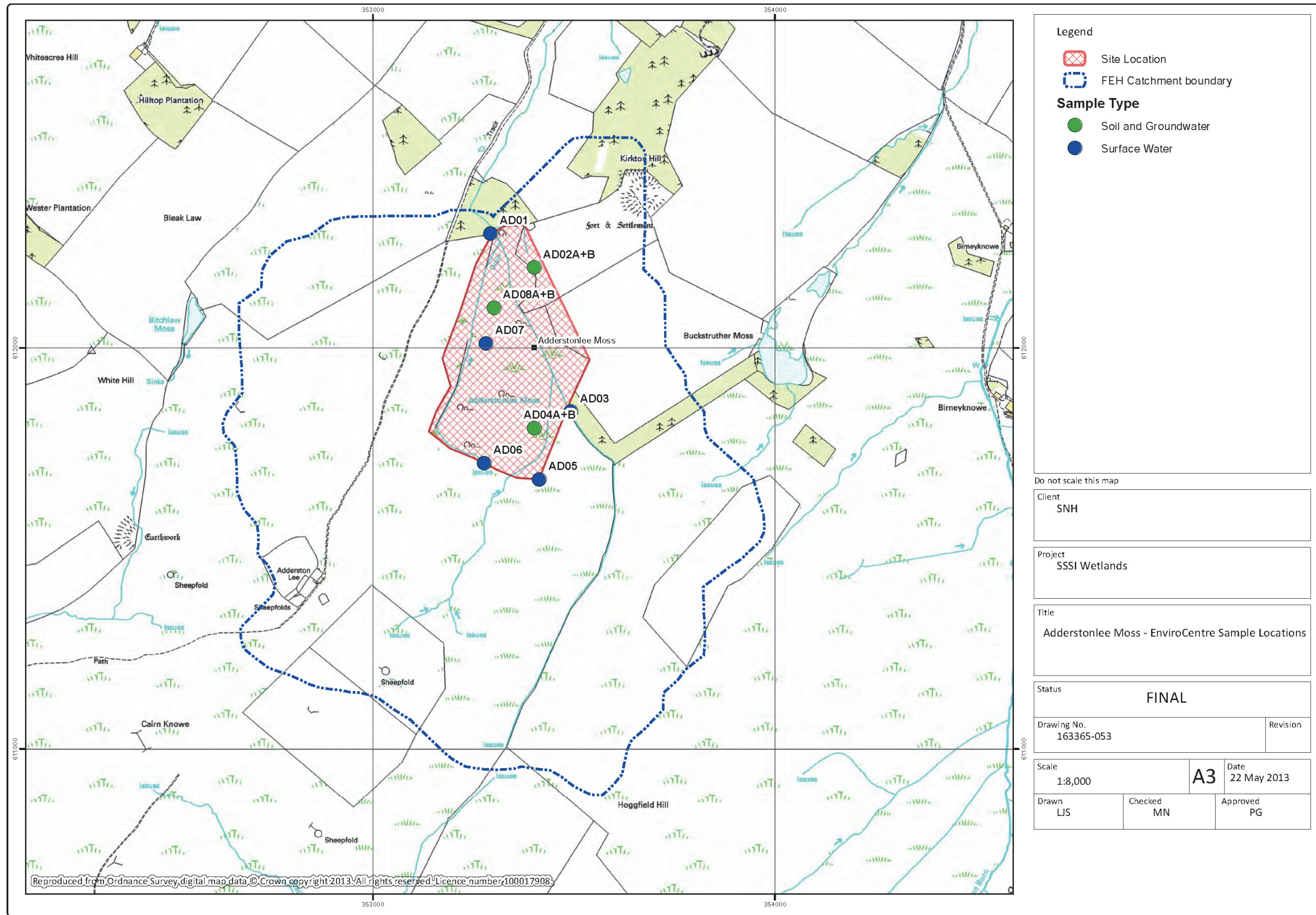
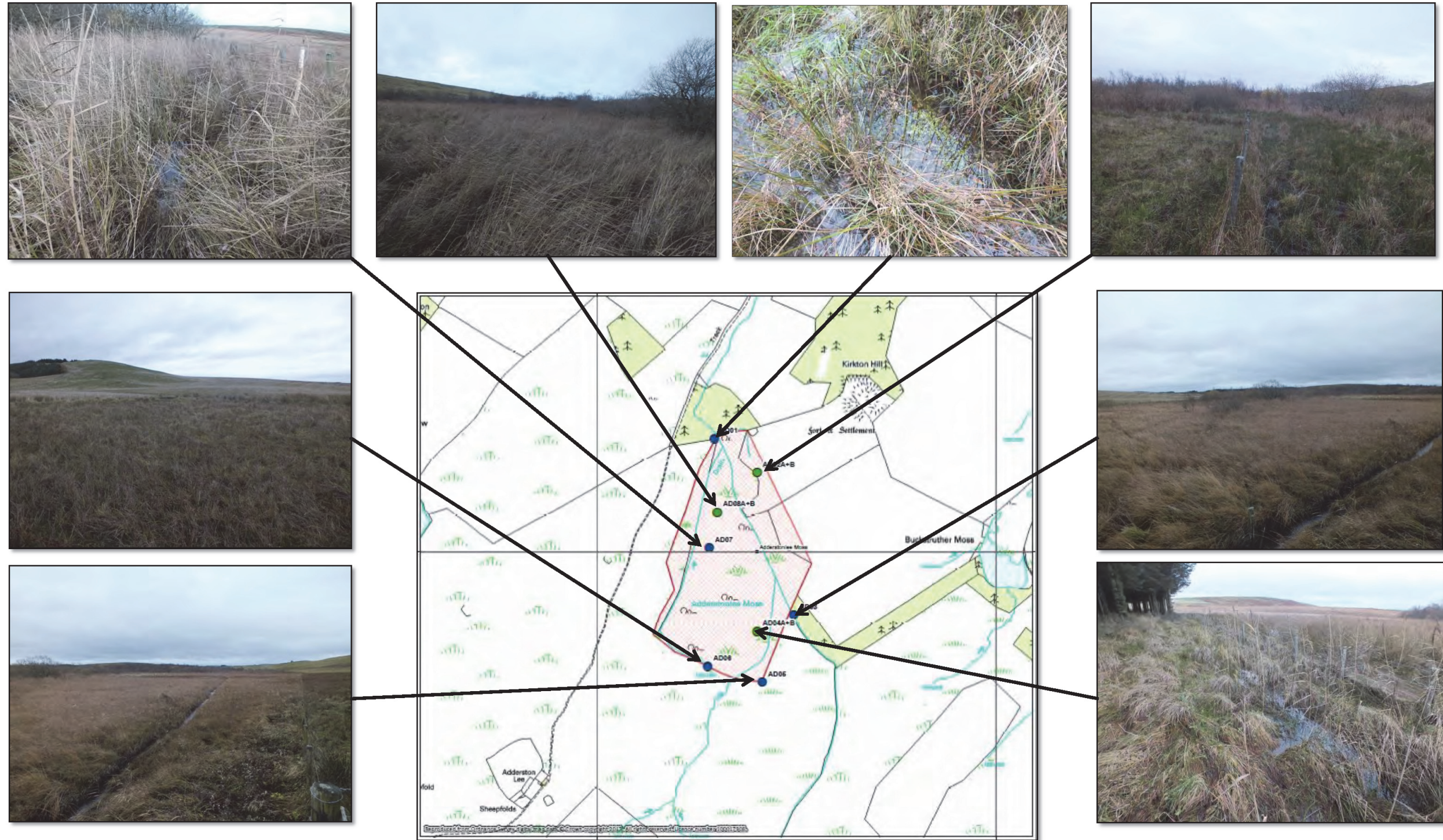


Figure 2.2: Plan of Actual Sampled Locations



**Photograph Log - Sample Locations
(Photographs taken on 6th November 2012)**

Figure 2.3: Photographs of Sampling Locations

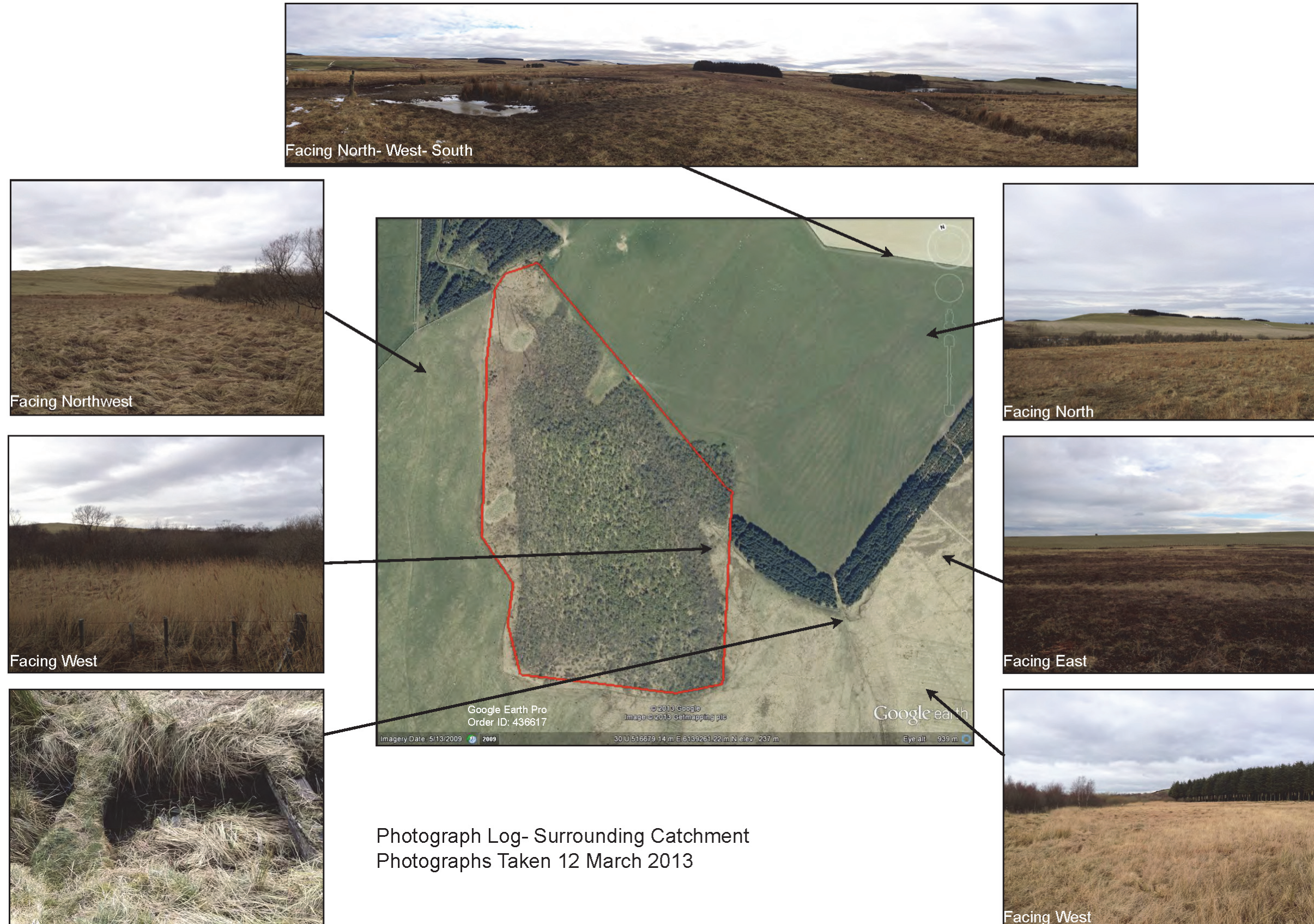


Figure 2.4: Surrounding Land Use Photographs

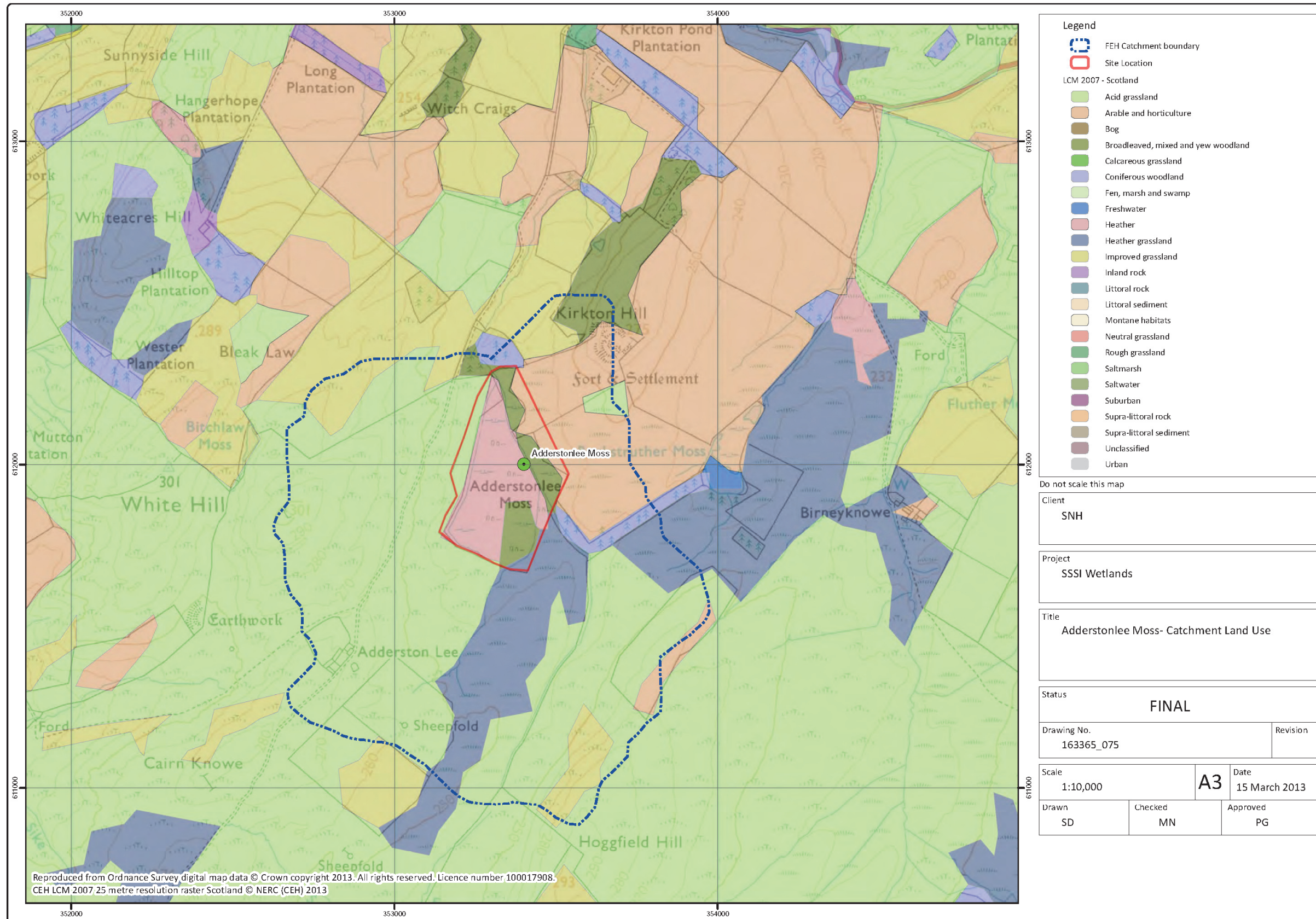


Figure 2.5: Catchment Land Use Characteristics

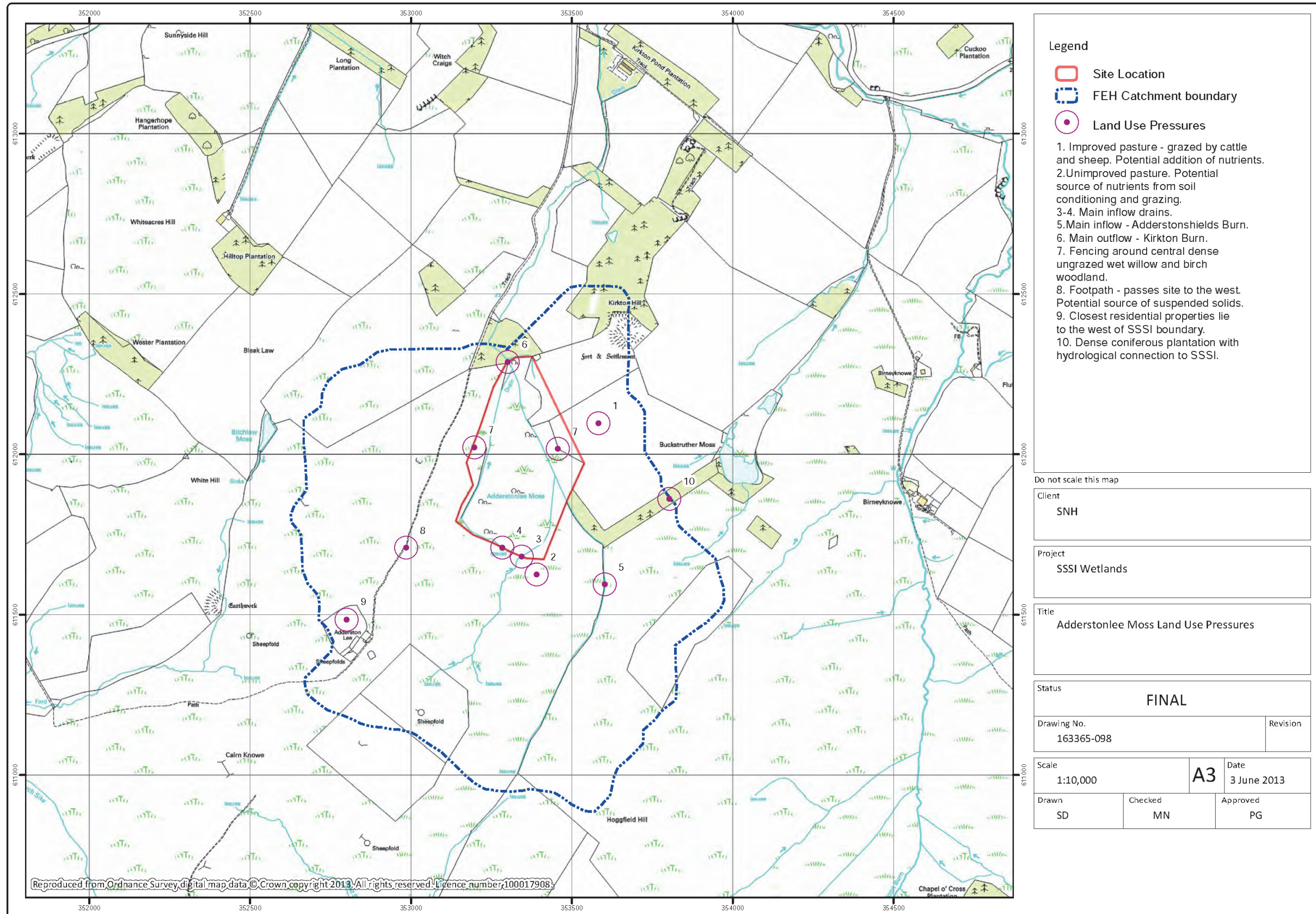


Figure 5.1: Catchment Pressures Summary

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