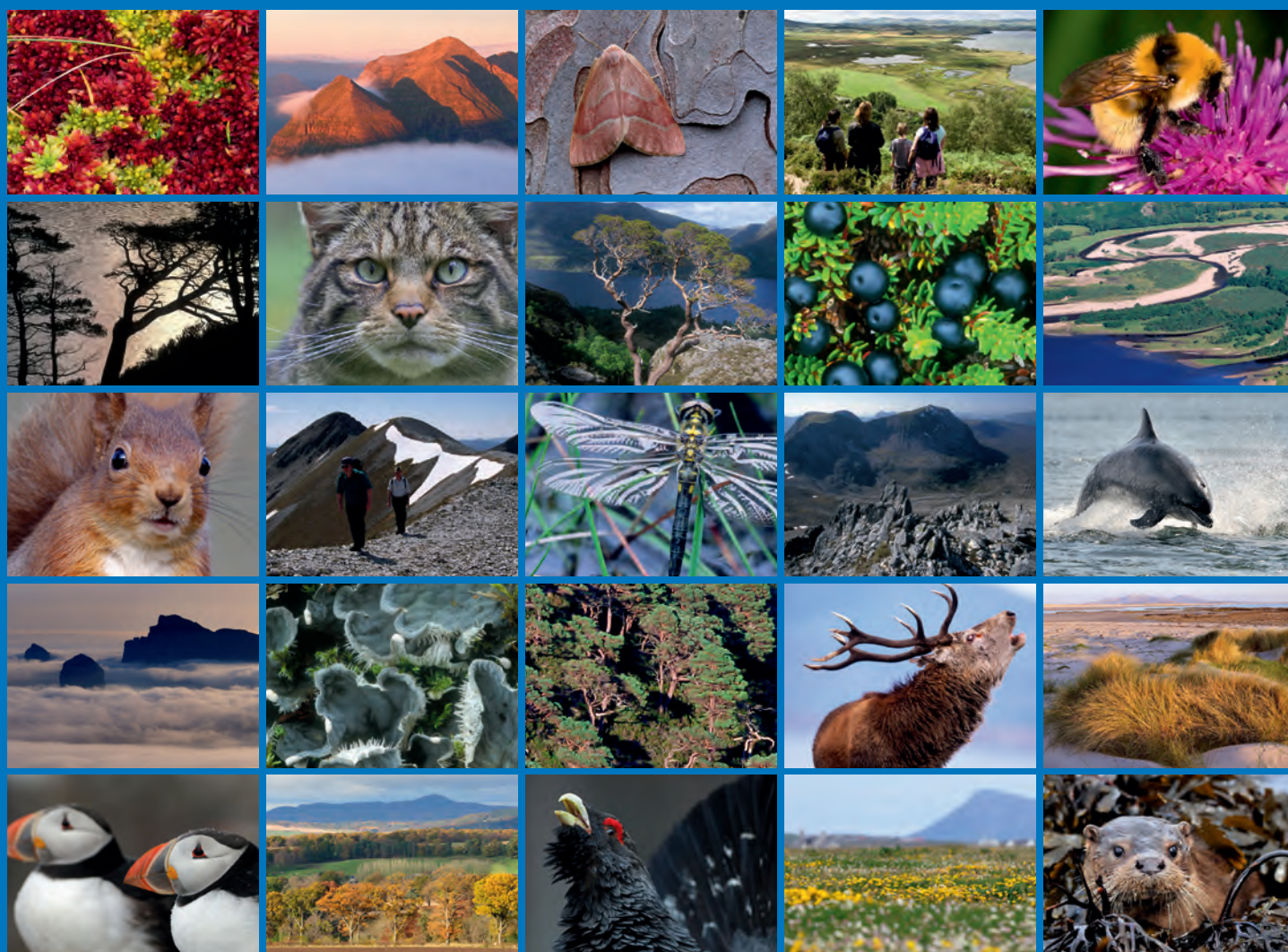


Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Gattonside Moss





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COMMISSIONED REPORT

Commissioned Report No. 724

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

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COMMISSIONED REPORT

Summary

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

Commissioned Report No. 724
Project No: 13700
Contractor: EnviroCentre Ltd.
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Keywords

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

- Analytical data supported claims of elevated nutrient status from agricultural improvements to the surrounding land. 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 constrain the ability to draw accurate conclusions to fully inform current site conditions.
- Site walkover revealed possible additional inflows not previously identified and potential land use practices within the immediate catchment that could adversely affect the hydrology and nutrient availability within the site.
- A series of recommendations are proposed to determine the site hydrology and understand the impact of newly identified inflow sources and infilled drainage. It is considered that this additional information will help further the understanding of the perceived changes taking place at the site.

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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

Gattonside Moss SSSI is situated approximately 1.5 kilometres (1 mile) north of the village of Gattonside, which lies north of Melrose. The site is not directly accessible by vehicle but a track which leads to the western side of the site is accessed via Davie's Brae road. See Figure 1.1 in Annex 1.

1.2 Site Description

Gattonside Moss is a Site of Special Scientific Interest (SSSI) which comprises a relatively deep, elongated basin fen consisting of medium-rich fen vegetation over an area of 5.21 hectares.

The fen vegetation is mainly herbaceous dominated by sedge swamp communities. The transition zones of this fen are poorly separated but develop into a central mix of mesotrophic and oligotrophic pools and hummocks which show excellent examples of bog sphagnum dominated 'lawns'. The fen also grades into an area of willow carr towards the eastern end of the Moss (SNH, 2010b).

To the south of the fen there remains a small fragment of wet-heath and birch/willow scrub that completes a sequence of semi-natural vegetation from fen and swamp through to acid-grassland. This shows a natural transition of vegetation, this has now become seriously reduced in distribution within the Scottish Borders (SNH, 2010b).

Gattonside Moss is also designated for the diverse beetle assemblages present on site. In 2010, 22 species of water beetle were recorded (SNH, 2010a).

The underlying solid geology at the site consists of sedimentary wackes from the Hawick Group (British Geological Survey, n.d). The derived soils are predominantly Kedslie series brown earths (imperfectly drained brown forest soils) with gleyed horizons and a fine textured till. To the north of the sites lies a small area of Peden series soils which are also very poorly draining non-calcareous gleys (SNH, 2010b).

1.3 Site Hydrology

The western site boundary is located in proximity to the catchment divide between Packman's Burn, which flows in an easterly direction to the Leader Water, and a minor watercourse which flows in a westerly direction to the Blake Burn. The catchment area draining to the site is 0.35km² and the annual average rainfall for this catchment is 774mm (Centre for Ecology and Hydrology, 2009). The dominant inflow to the site is surface water runoff from the surrounding topography.

The northern part of the site is fed by a series of groundwater springs located on the western boundary of the site – the number, composition and interrelationship of which is not confirmed. A series of small water filled pools are present on the site, which support the aforementioned beetle assemblage. These are not mapped and are expected to vary in size and depth depending on seasonal inflows.

The main outflow from the site is a man-made land drain which bounds the southern part of the site before flowing south along the Ferny Hill Plantation boundary. It is assumed that this drain discharges to Packman's Burn. This drain is very slow flowing and largely infilled.

1.4 Site History

A review of the SNH site files coupled with internet research revealed limited additional information above that within the Site Management Statement (SNH, 2010b). 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:

- Historical forestry records dating back to the 11th century refer to the site, with future records detailing agricultural devastation of woodland. During the 19th and 20th centuries small scale peat digging and drainage works are also known to have occurred.
- During the 1980s the site owner constructed a sealed drain running just above the northern edge of the Moss. This drain collects runoff from the field drains above the Moss and feeds them into the stream below the exit from the Moss, thereby removing excess nutrient runoff and iron ochre from the field to the north of the Moss.
- The main area of the Moss is now only grazed by cattle. The south-eastern parcel of land has small birch scrub which currently shows signs of being grazed, however it is unclear as to whether this is due to natural grazing by deer or whether the area is actually being grazed by stock.

1.5 Recent Site Management Practices

Outwith the information contained in the SNH site file, as summarised above, there is no information available regarding previous or existing management practices.

It is understood that there is no management agreement currently in place for the site.

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.

The meeting was 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 to 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

Gattonside Moss	Date of Visit	Weather Conditions	Grid References
Visit 1	6 November 2012	Overcast, mild, occasional showers.	NT 550367
Visit 2	12 March 2013	Clear, cold and sunny. Snow on ground.	NT 550367

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 had to be changed and are as 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 fieldwork:

- 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 site. As appropriate, 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;
- 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 the analytical results obtained.
- For the same reasons outlined above, access to certain parts of the site may have been restricted and limited access to the predetermined sampling location.
- Sampling comprised a single set of samples from each of the 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, measure loch levels or the inflow(s)/outflow(s) of associated 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.
- Due to limitations in the mapping data used to compile the FEH catchment boundary, the area defined in the Annex 1 maps does not necessarily present a true reflection of the hydrological catchment for the site. The groundwater catchment area was not determined as part of this study.

4. ANALYTICAL DATA

The following tables show the results obtained from the initial site visit (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 or observations relative to the collected dataset or which would typically be expected from a site of this nature. These are discussed further in section 6.2.

4.1 Water Quality Field Data

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

Table 4.1: Water Quality Field Data and Observations

Sample ID	Nat. Grid Reference		Temp (°C)	pH	Salinity (psu)	DO (%)	DO (ppm)	ORP (mV)	EC (mS/cm)	General Field Observations
GAT01	NT 55100	36637	8.61	7.46	0.25	N/A	N/A	232	0.532	Surface water - slightly discoloured with mixed size organic suspended solids; no odour; slow flow
GAT02	NT 55098	36638	8.11	6.52	0.32	N/A	N/A	319	0.677	Groundwater - light milky brown with fine brown suspended solids; no odour
GAT03	NT 55125	36647	8.50	6.62	0.27	N/A	N/A	274	0.566	Surface water - very slightly discoloured with fine suspended solids; no obvious odour; slow flow
GAT04	NT 55042	36761	8.32	5.68	0.11	N/A	N/A	335	0.230	Groundwater - light brown discoloured with fine brown suspended solids; no odour
GAT05	NT 54883	63772	8.30	6.06	0.14	N/A	N/A	341	0.298	Groundwater - light brown cloudy with fine brown suspended solids; no odour
GAT06	NT 54777	36774	8.37	5.91	0.15	N/A	N/A	270	0.332	Groundwater - cloudy brown with fine brown suspended solids; no odour
GAT07	NT 54618	36735	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Groundwater - light brown discoloured with fine brown suspended solids; no odour

N/A – No result obtained due to field probe failure/error.

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)
GAT01	NT 55100	36637	SW (O)	9	4	9	3.2	0.30	<0.2	<0.01	0.1	3
GAT02	NT 55098	36638	GW	10	69	18	3.33	0.55	<0.2	1.12	<1.0	49
GAT03	NT 55125	36647	SW (I)	15	5	6	0.44	0.30	<0.2	0.07	<0.1	1
GAT04	NT 55042	36761	GW	<10	<10	<10	10.6	0.02	<0.2	0.02	1.4	<1
GAT05	NT 54883	63772	GW	18	16	<10	44.9	0.26	<0.2	0.21	<1.0	7
GAT06	NT 54777	36774	GW	40	16	<10	31.1	0.30	<0.2	0.12	2.7	7
GAT07	NT 54618	36735	SW	15	<10	<10	72.4	0.38	<0.2	0.12	<1.0	3

+ Surface water samples are designated either inflow (I), outflow (O) or open water (OW)
 Red text denotes samples that are above typical ranges for the observed dataset.

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)
GAT02A	NT 55100	36600	Firm organic with some gravels	1.8	527	8320	217	2620	52.8	<2.0	<0.2	0.32	9.75
GAT02B	NT 55100	36600	Grey silt and gravel horizon with low organic content	<0.5	518	8440	217	2430	24.2	<0.8	0.3	0.10	6.51
GAT04A	NT 55000	36700	Firm organic with some gravels	1.4	979	2230	291	1380	57.5	<1.6	<0.2	0.53	8.89
GAT04B	NT 55000	36700	Grey silt and gravel horizon with low organic content	0.6	721	8340	213	2480	23.8	0.8	0.2	0.06	8.30
GAT05A	NT 54800	36700	High organic dark coloured wet sludge	0.8	9610	3220	596	3160	94.4	<1.0	<0.2	1.06	8.13
GAT05B	NT 54800	36700	High organic dark coloured wet sludge	<0.5	4520	3820	395	3090	89.8	<1.8	1.3	0.95	6.51
GAT06A	NT 54700	36700	High organic dark coloured wet sludge	1.7	13200	1950	795	1240	77.4	<1.9	<0.2	1.82	9.36
GAT06B	NT 54700	36700	High organic dark coloured wet sludge	0.7	632	5160	298	1730	92.1	<0.9	<0.2	1.64	6.06

* Soil types are field observations

** Total Moisture = Water content

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

Red text denotes samples that are above typical ranges for the observed dataset.

5. SITE OBSERVATIONS

To enhance the understanding of Gattonside 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, 2010b) records an 'Objective for Management' of enhancing the conditions of the site including 'ensuring appropriate water levels by maintaining inputs, along with maintaining the quality of this water'. This directly supports the requirement to maintain the water beetle assemblage. The statement further states that grazing must be managed to produce an even grazing intensity and fence lines managed to maintain such.

The basin fen and beetle assemblage features at the site are in unfavourable no change (September 2003) and favourable maintained condition (August 2002) respectively. Severe poaching and grazing of the margins of the mire basin by stock on both northern and southern edges was observed during the Site Condition Monitoring for the basin fen feature (SNH, n.d. a). It was noted that fencing may have been broken. Scrub and trees encroachment was observed on the site and it was noted that stock does not enter deep water to control scrub which could become an issue. Proposed remedy mechanisms included removal of scrub from the fen and control of gorse on the knowe to make more space for stock access and reduce poaching on the fen edge.

The only quantitative data reviewed comprised limited comments in an extract from a 2010 SNH report regarding monitoring of the beetle assemblage at the site (SNH, 2010a). The data was limited to field observations relating to acidic pH and low conductivity values. No information was included to confirm where these samples were collected and hence the data is of limited value to the diffuse pollution study.

Seasonal water extraction with a pump to supply six troughs in adjacent fields has been consented (SNH, n.d. b).

5.2 Catchment Walkover

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

- The site was free of litter and no visible pollution sources were observed within the site boundary.
- The site sits in an upland location but is directly influenced by the surrounding topography which comprises hills to the north, west and south.
- The only locations of open water observed on site were in the northern valley fen section in areas close to the source of the springs. The southern part of the site largely comprised scrub vegetation including gorse and mature Scots Pine (*Pinus sylvestris*) trees.
- The northern part of the site was markedly drier than the southern area, with the latter being the wettest at the southern-most boundary.

- The immediate fields abutting the site to the north and east comprised improved pasture. No grazing was observed in the adjacent fields at the time of the visit. This may be due to the unfavourable weather conditions and presence of snow on the ground.
- Evidence of the immediate surrounding land having been improved for agricultural purposes. Evidence of muck spreading was observed as having recently taken place in the fields which lie immediately east and south of the site. This may also explain the absence of grazing stock. No buffer zones were observed to be in existence although the activities did not appear to have encroached onto the SSSI site.
- Given the remote nature and limited access routes to the site, it appeared that the site had not been recently visited by vehicles. Whilst accessible on foot, and a designated right of way footpath passes along the length of the southern perimeter, there was no evidence of recent visits.
- A man-made drainage ditch – believed to pass from Ferny Hill plantation (to the south west and hydrologically connected to the site) - is present along the southern boundary of the site. However it would appear that this has now been largely infilled through natural deposition and vegetation growth. The ground in this area was observed to be inundated with water.
- Man-made changes to the drains were considered to have been undertaken in the field abutting the northern boundary of the site. This would align with the landform and presence of the adjacent springs. It has been previously recorded that these flows are high in iron (see section 1.4) however, no orange-brown discolouration of flows was observed.
- No detailed assessment of the areas of standing water was undertaken however, it was considered that the southern part of the site was wetter than the northern area.

5.3 Summary

The following table provides a summary of the key site features which were observed during the 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	Site is fenced however a detailed assessment of the suitability and integrity of the entire perimeter was not undertaken. It is considered that the low height of the fencing would prevent cattle/sheep access but not restrict deer from the site.
Fishing	Not applicable.
Grazing	According to the SNH Site Management Statement, the site is currently grazed by cattle however none were observed within the SSSI perimeter during either site visit.
Monitoring	Condition monitoring was carried out in 2002 and 2010. No detailed historical soil or water records were available from the desk study review.
Public Access	Site has footpath access and a designated route along the southern boundary line. There is gated access to the site (albeit that the associated track access to site is significantly constrained) on the eastern and western boundary of the site.
Shooting	Consents for shooting and release of pheasants. A small cabin present at the western boundary. Evidence of likely feed pens (e.g. for pheasant) are present in the northern valley fen section. This could lead to some build up of organic material but this was not considered to be significant based on observations. No spent cartridges were observed during the site attendances (albeit that this was limited by snow cover).
Point Pollution Sources	None observed within the SSSI boundary. Agricultural sources within the adjacent catchment were noted during the second site visit.
Properties in Catchment	None
Unusual, Distinctive or Atypical Features	The 2002 Site Condition Monitoring assessment states that thirty species of beetle (including ten new records) were recorded at the site.

6. INTERPRETATION OF RESULTS

The following assessment is based on the field tests and laboratory analytical results only. For the reasons detailed in section 5.1, the qualitative data reviewed during the desk study was not deemed suitable for comparative purposes.

6.1 General Summary

Only three surface water samples were identified in the initial sampling requirement - namely a single sample of the 'combined' springs within the northern part of the site, and both an inflow and an outflow of the drain on the southern boundary – hence no standing ponds were sampled. This limited dataset constrained the ability to draw definitive conclusions but would indicate that the water on site is of mesotrophic to eutrophic rather than oligotrophic in composition.

The field probe to obtain dissolved oxygen data was not functioning correctly at the time of the site visit. Due to the transient nature of this parameter it was not possible to accurately obtain this from a subsequent laboratory analysis. When compared with the corresponding pH and metals results, it is however anticipated that the groundwater samples would have comprised a lower dissolved oxygen result than those in the surface water samples.

With the exception of iron, no discernible change in surface water quality between the inflow and the outflow was evident. The assessment is limited by the lack of a comparison for the GAT07 sample but the results are considered to be influenced by the groundwater flows and the *in situ* processes.

Soil samples GAT05 and GAT06 obtained in the northern part of the site were markedly different in type to GAT02 and GAT04 obtained from the southern part in that the former were freer draining and lower in organic content. Despite these differences, the nutrient composition was quite similar with elevated phosphorus values and relatively low nitrogen values. This corresponds with the water sample results and indicates either a greater demand for nitrogen within the site vegetation, or an imbalance in the nitrogen:phosphorus (N:P) ratio in the applied soil conditioning practices.

Phosphorus values across the site were elevated with values in the upper (root zone) soil samples being higher than those taken at depth. Higher nitrogen values were recorded in the northern part of the site with an atypical level observed in the groundwater outwith the southern perimeter. These nutrients are present in bioavailable formats and may (in part) explain the changing characteristics of the vegetation within the site.

The slow flow observations made to the surface waters GAT01 and GAT03 are indicative of waterlogged soils and infilled drainage channels.

6.2 Atypical Results

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

- GAT05, GAT06 and GAT07 have elevated iron levels with the latter, a surface water having the highest of these at 72.4mg/l. As these are all located within the northern part of the site, this is understood to be associated with the groundwater influenced flows as detailed in section 1.4:

“During the 1980s the site owner constructed a sealed drain running just above the northern edge of the moss, this collects runoff from the field drains above the moss and feeds them into the stream below the exit from the moss, thereby

removing excess nutrient runoff and iron ochre from the field to the north of the moss.” (SNH, 2010b)

- It is considered that the iron results are influenced by the geology resulting from precipitation into solution through the acidic and low oxygen conditions. As no dissolved oxygen data is available, this claim would need to be confirmed through further monitoring.
- The low moisture content of the soil samples obtained from the northern part of the site indicates that the deeper soil substrate is freely draining. This supports the finding that the corresponding samples in the down-gradient southern part of the site comprised greater organic matter (detritus) and were observed (at the time of the second visit) to be waterlogged.
- The elevated calcium in the upper zone of GAT06 is considered atypical given that the site lies in a non-calcareous catchment. It is therefore assumed that this elevated result is due to drainage improvements and/or soil conditioning practices on the adjacent agricultural fields.
- With the exception of GAT02, which recorded an elevated value of 1.12mg/l, the concentrations of phosphate as P in the water samples were all below 0.21mg/l. Comparatively, GAT04 and GAT06 had elevated total phosphorus values of 1.4mg/l and 2.7mg/l respectively. All of these samples were from groundwater sources and indicate an inflow of nutrients to the site from the surrounding catchment.
- Total nitrogen results were elevated in all bar GAT04 however, the surface water sample GAT02 recorded a high result of 49 mg/l. As above, this is a groundwater sample and further supports the view that there is an inflow of nutrients to the site from the surrounding catchment.

6.3 Additional Considerations

See study limitations presented in section 3.

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

Aligned with the limitations outlined in section 3, the analytical results show a definitive trend of elevated inorganic nutrients within the site. There are observations that appear to indicate that the site has been, or is being, influenced by agricultural practices (for example, soil improvements through muck spreading and changes in drainage of the surrounding land) within the wider catchment over time which will have a direct influence on water and soil quality. The water samples were not consistent with the mesotrophic and oligotrophic status assigned to the site designation with higher nitrogen and phosphorus values recorded.

The artificial drainage - namely that on the southern boundary and that within the fields immediately to the north of the site - are considered to have a direct effect on the site. The former drains Ferny Hill plantation and will be directly influenced by the forestry practices. The northern drain, which was not identified for the sampling exercise, is considered to be influenced by upland topography, the land practices in the adjacent field and potentially by the groundwater springs. Samples from the infilled drains at both locations would have further aided the study and helped to confirm whether they benefit or hinder the site in terms of the retention of flows and/or nutrients.

It is considered likely that there are historical nutrient accumulations within the site and the adjacent land which will continue to influence the vegetation. Quantification of the volumes of sediment and concentration of nutrients would help to establish a more complete picture of the site and how water quality is seasonally influenced.

Although rainfall will have an appreciable influence, the site appears to be predominantly supplied by a series of spring sources which are located on the north-western boundary. Subtle changes in the site water levels are likely to lead to direct changes in vegetation types so understanding the seasonal and annual variations in site hydrology will help understand how this is influenced. Whilst results indicate that these are groundwater derived, no detailed hydrological assessment of such was made during this study however, it is expected that these will be directly influenced by changes in adjacent land practices.

The desk based study and site visits confirmed the presence of small areas of standing water. It is understood that these comprise important habitats for beetle assemblages and for the last (known) monitoring undertaken by SNH in 2010 was deemed to be favourable. Given the variations in tolerance of differing beetle species to aquatic pollution, it would potentially be a useful exercise to assess the beetle data to understand whether changes in population composition are indicative of water quality changes.

Unconfirmed forestry activities within the site and/or the surrounding catchment, are also likely to influence site hydrology. Historical records imply that there have been variations in the size of the wooded area, including the planting of conifer and cutting of peat. Whilst these activities are likely to have a direct influence of the site in terms of hydrology and nutrient retention, the lack of detail in the information reviewed means that this is not possible to draw definitive conclusions for the purpose of this study.

The management of birch and willow scrub on site is noted in the 2010 Site Condition Monitoring report. No details are stated as to how this is being controlled, but if manual cutting techniques are employed then the resulting waste should be removed from site to minimise the build-up of leaf litter and ensure that the nutrients are not simply recycled within the soil through microbial activity. It is expected that changes in the site drainage would have a direct influence on the success of controlling scrub vegetation.

The desk study revealed that there have been historical changes in the fencing provision and grazing permitted at the site. This is highlighted as a management need in the 2010

SNH Site Management Statement. No further information has been made available to confirm if this has been undertaken. Communication with the SNH known landowners highlighted a likely change in ownership which may have further implications on the future management or use of the site. Details of the landowner communications are provided in Annex 2.

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

8. RECOMMENDATIONS

Based on the understanding gained from the sampling exercise and catchment visits, the following recommendations are proposed:

8.1 Monitoring

- i. Undertake a long-term targeted monitoring study at selected locations within the site for key plant nutrients and include the identified land drains out with the site boundary. Ideally this would comprise linear transects across the site to aid changes with distance from source and 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 atypical seasonal variations, as well as land use practices, to seek to understand the nutrient dynamics taking place within the site.
- ii. Review the areas of standing water within the site and determine the extent of seasonal/annual variation in water levels. If calculated over a period of time this could help further the understanding of the hydrology regime on site and whether the ponds were expanding or contracting in size. This understanding would afford additional benefits to maintaining (or improving) the designated beetle assemblage.

8.2 Other Commissioned Studies

- iii. Undertake hydrological and hydrogeological assessment of the spring sources (unknown in number) on the western boundary, and also in the wider contributing catchment, as these provide a notable contribution to the site and will directly influence the quantity and quality of available water and nutrients.
- iv. 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, it is expected that 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 the site, and particularly water quality, over time.

A review of the historical beetle data may also provide an insight and further understanding to the changes to the scale and number of standing water pools at the site. This may afford opportunities to vary the size and depth of the pools to enhance the beetle population.

- v. Given the distinct difference in the N:P soil concentrations across the site, there may be benefits in understanding the respective nutrient uptake by the present site flora. This in turn would provide valuable information in the effects of, and need to manage, the application of fertiliser within the catchment.
- vi. From the desk based research it would appear that historically the catchment was more densely wooded than it is at present. Consideration should be given to undertake a detailed library search to seek to determine the extent of this and subsequently appraise how this may have led to a change in the site, the site hydrology and the corresponding nutrient status.

8.3 Policy

- vii. Review the grazing access and associated management policy at the site. As outlined in the Site Management Statement (SNH, 2010b) this has been subject to variation over time and is likely to directly influence the vegetation on site.

8.4 Landowners

- viii. Proactively engage with local landowners to understand the existing and (foreseeable) proposed changes to the immediate catchment including field usage and soil conditioning approaches. Consider appropriate management strategies accordingly - for example, nutrient management planning, buffer strips, exclusion zones, routine spot monitoring *etc.*
- ix. Review the forestry management practices undertaken within the wider catchment. Deforestation within the catchment has the ability to significantly alter the hydrology and can alter the composition of water and soils through leaching of nutrients. 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 on the SSSI.
- x. Review the ownership of the identified land drains and the future management and maintenance of such.
- xi. Seek early engagement with the new landowner to ensure an appropriate management approach is taken at the site. See Annex 2 for details.

From the stated conclusions and identified pressures (Figure 5.1) 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 catchment (viii) including the contributing springs (iii), field drains (x) and woodland management (ix); and the water levels/through flow at the site (ii).

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ANNEX 1: FIGURES

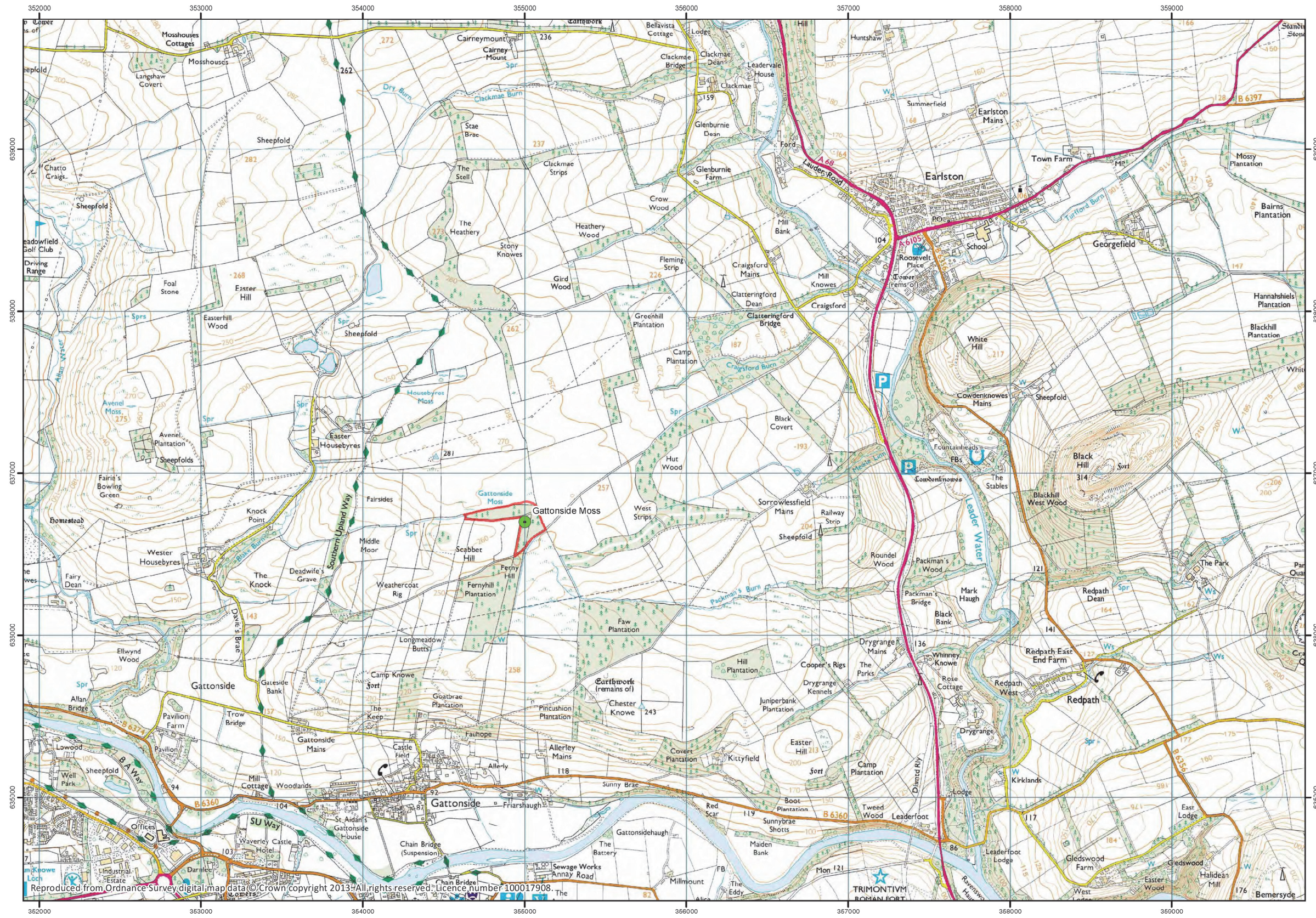
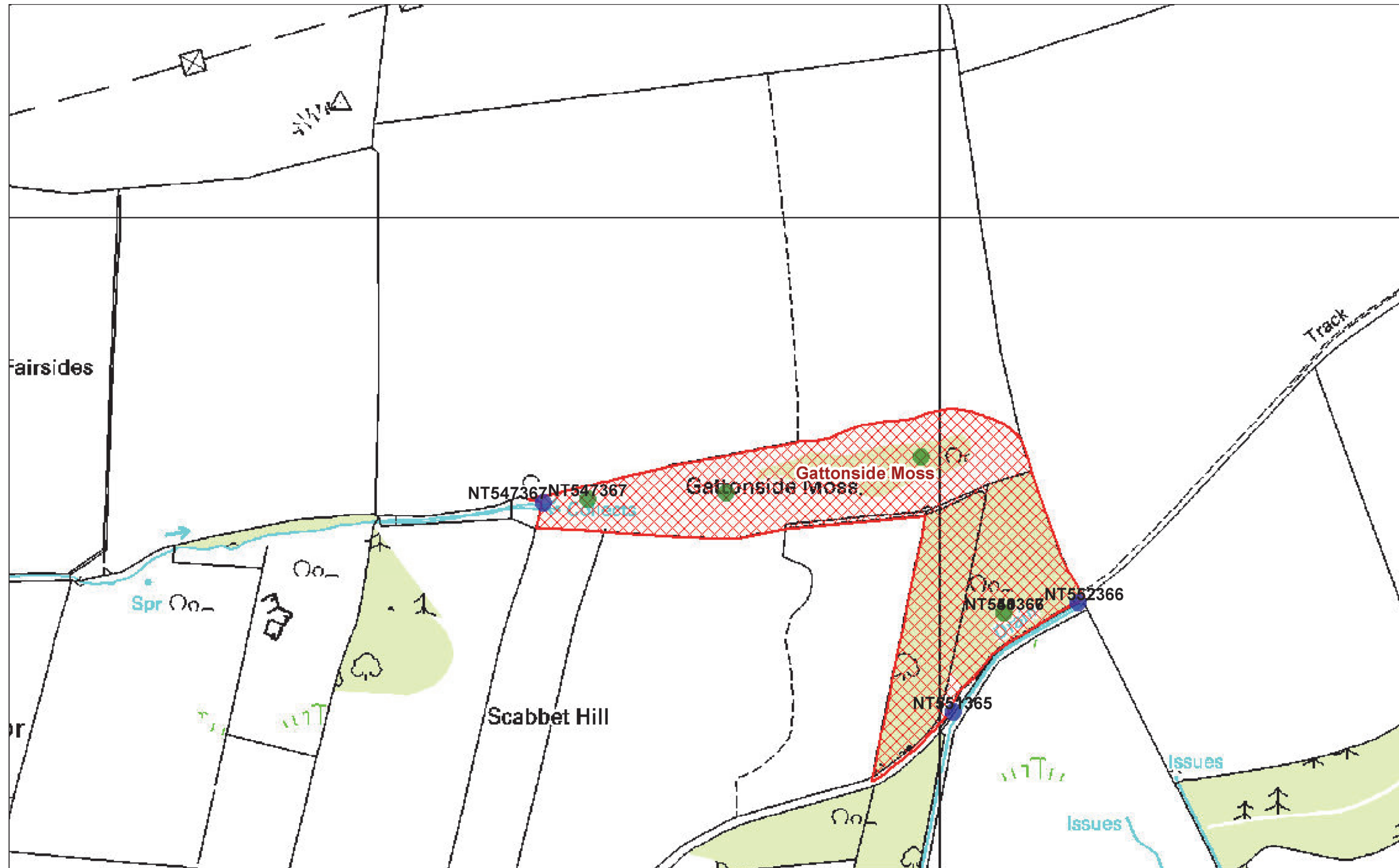


Figure 1.1: Site Location Map

Gattonside



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Notes:



Map produced using geo.View 3.0
 Printed: Sep 20, 2012 15:45:32

Figure 2.1: SNH Proposed Sampling Location Plan

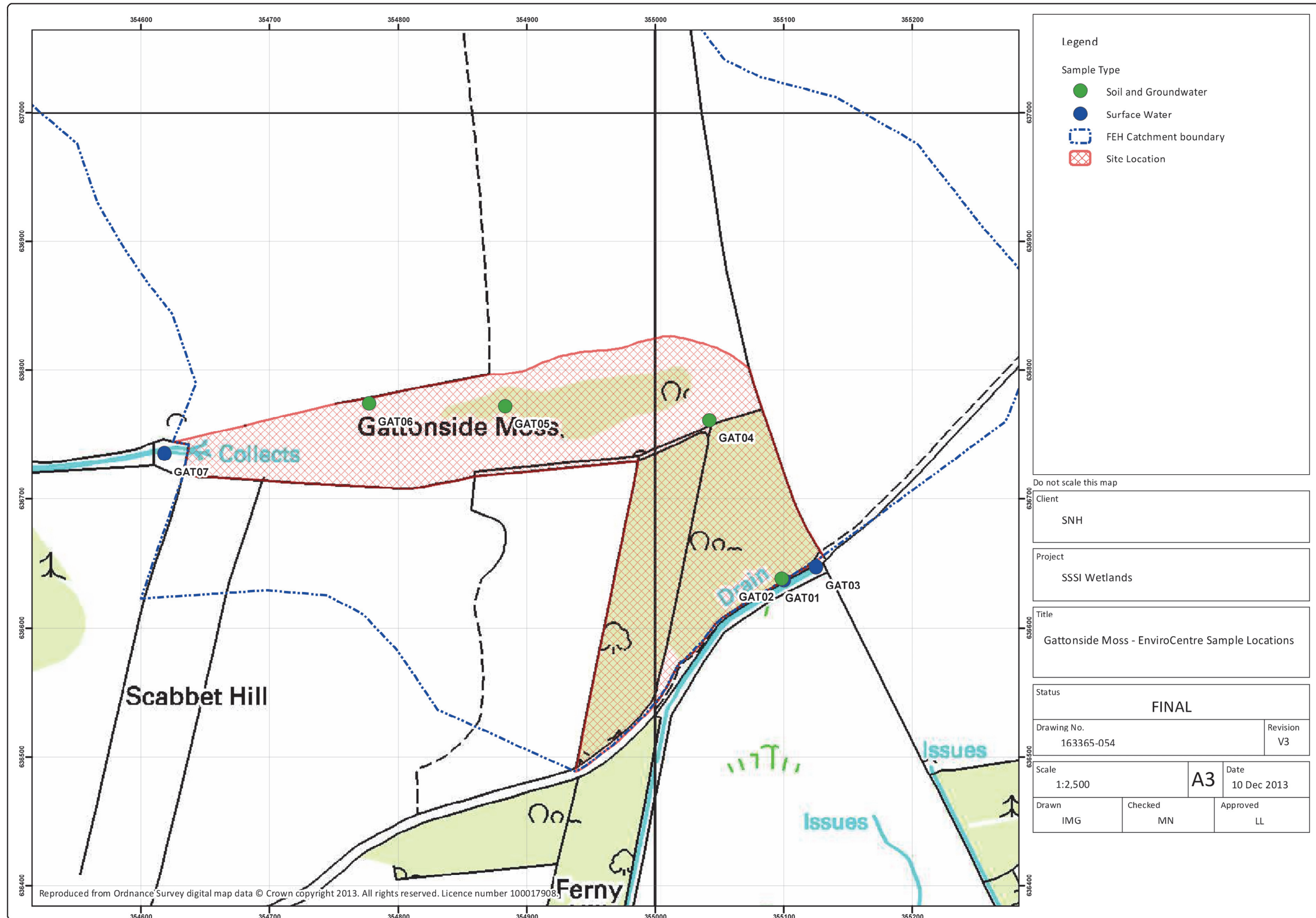
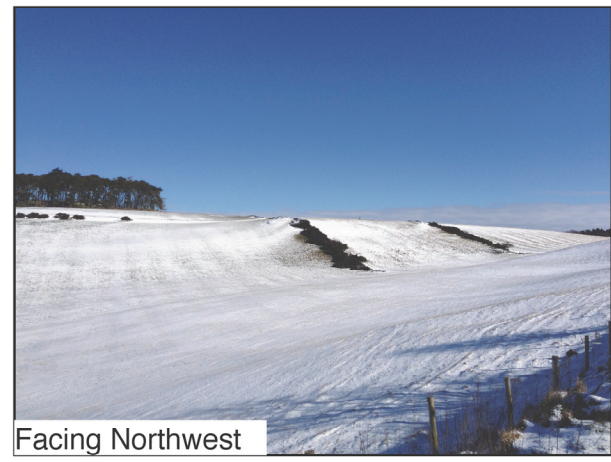
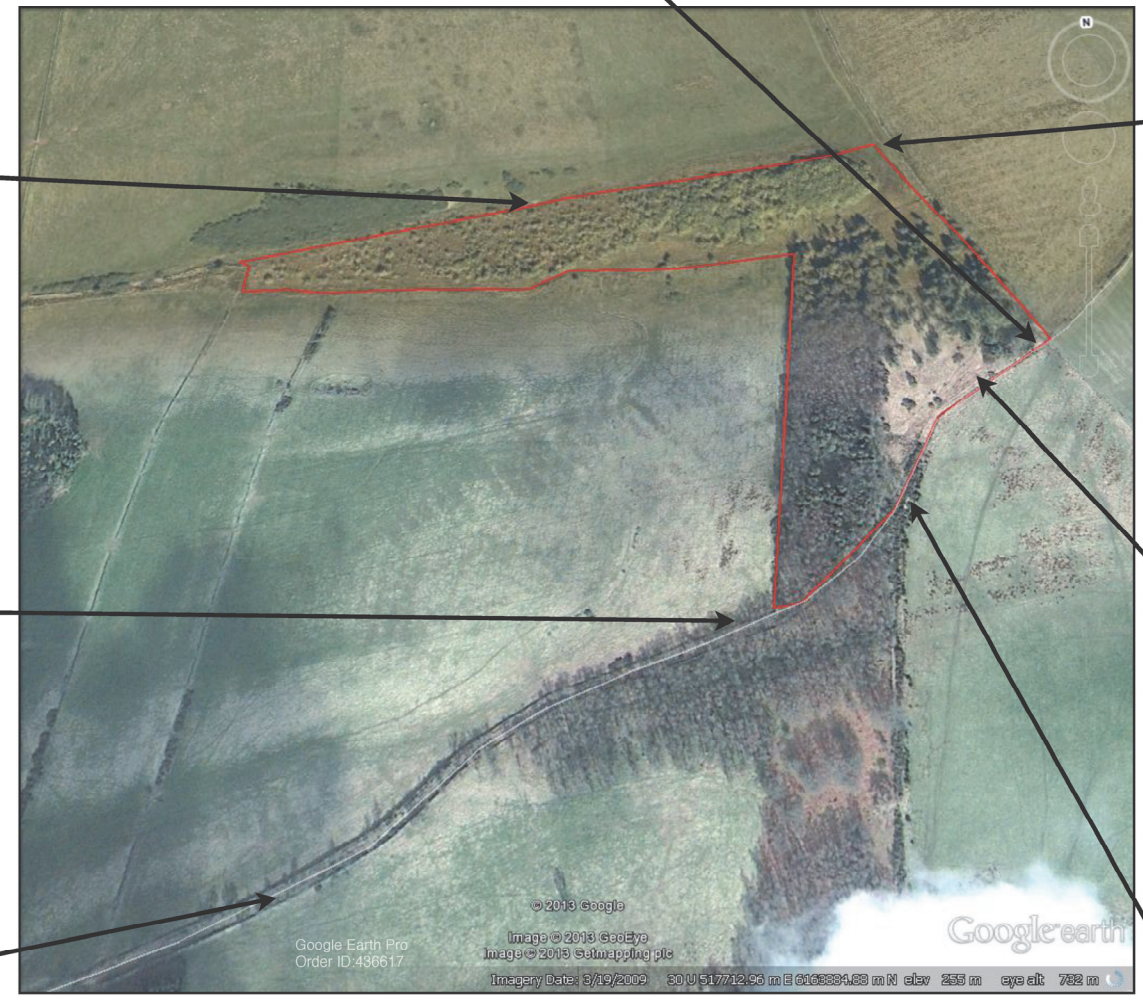


Figure 2.2: Plan of Actual Sampled Locations



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

Figure 2.3: Sampling Location Photographs



Photograph Log- Surrounding Catchment
Photographs taken 12th March 2013

Figure 2.4: Surrounding Land Use Photographs

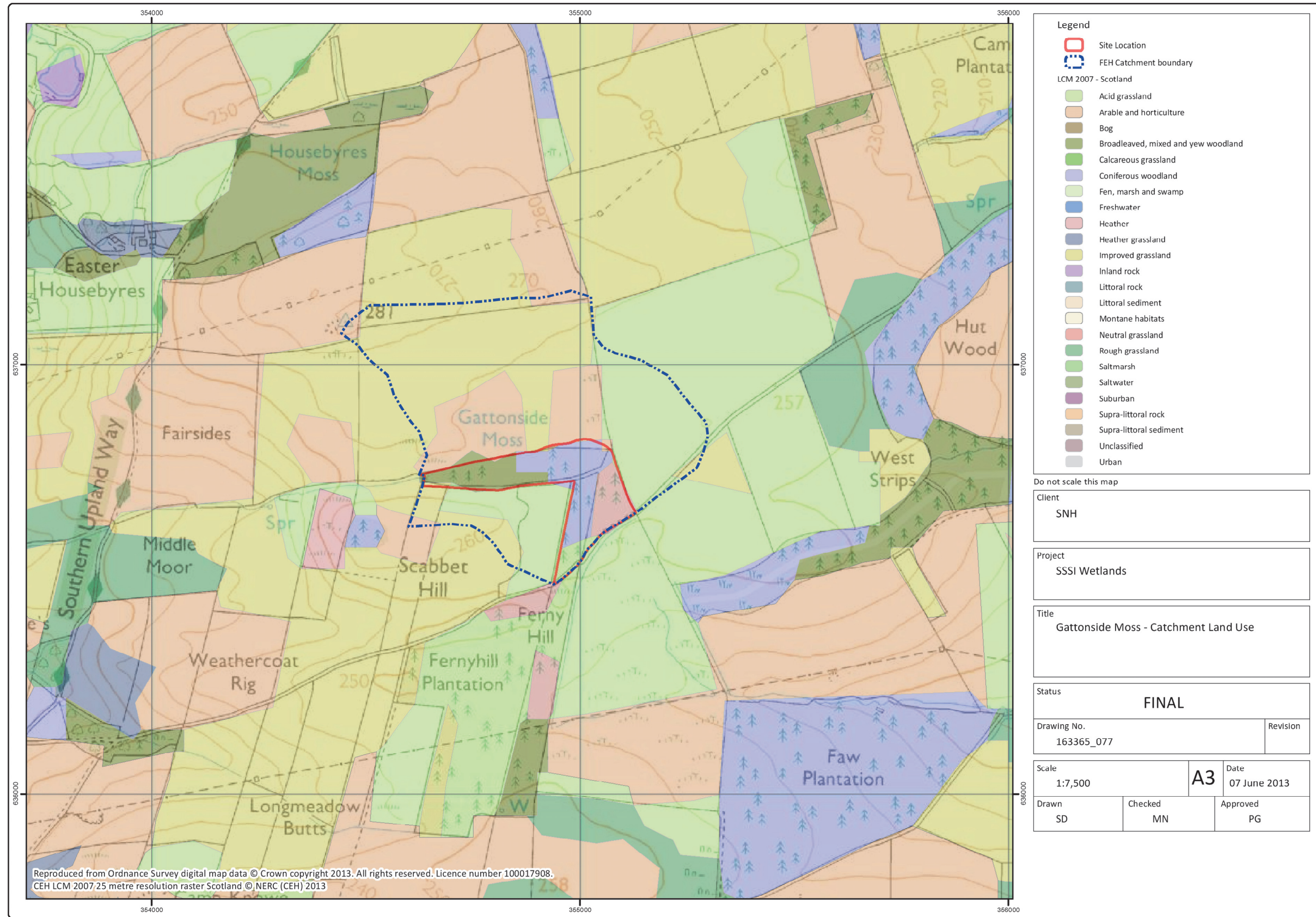
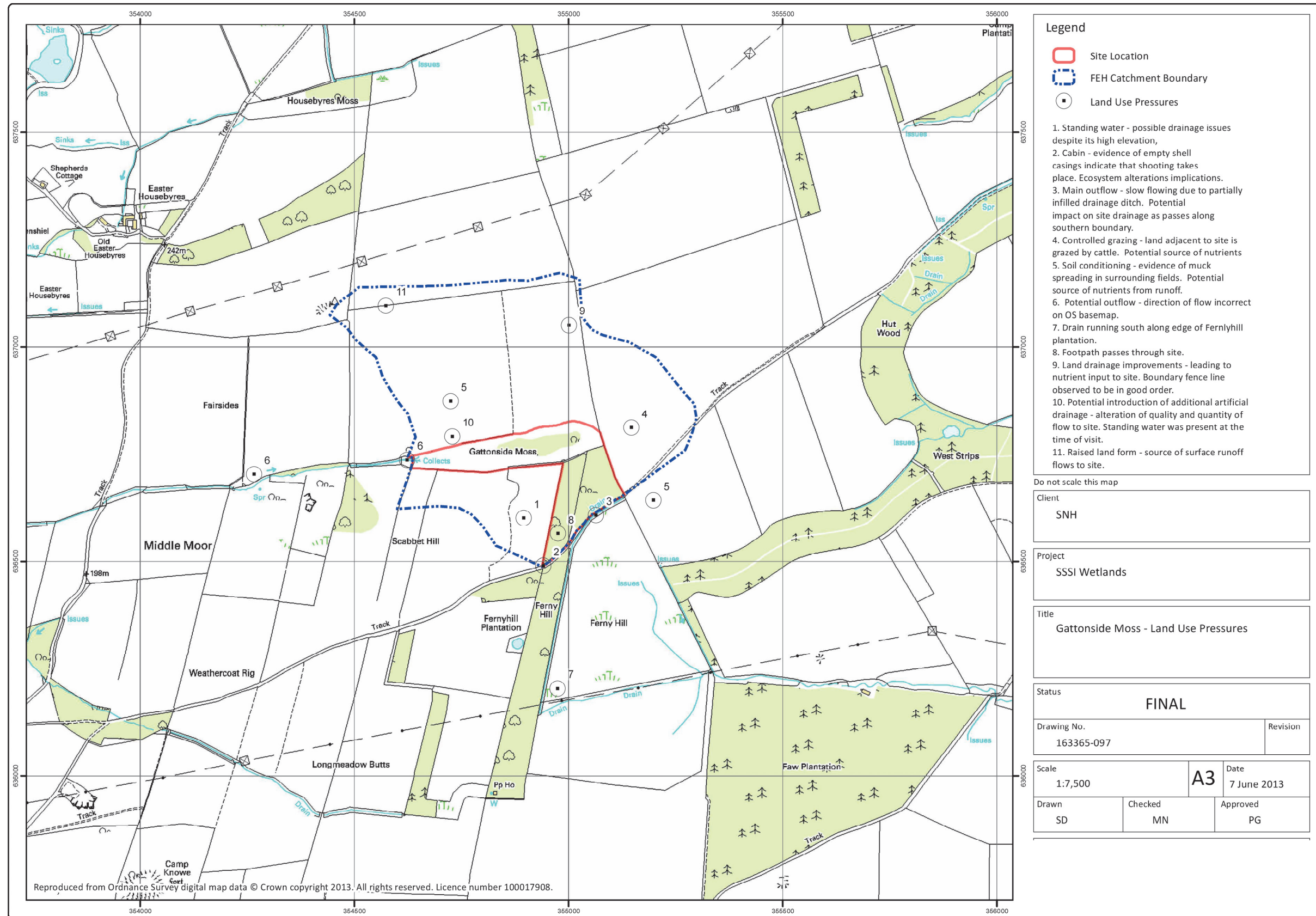


Figure 2.5: Catchment Land Use Characteristics



- Legend**
- Site Location
 - - - FEH Catchment Boundary
 - Land Use Pressures
1. Standing water - possible drainage issues despite its high elevation,
 2. Cabin - evidence of empty shell casings indicate that shooting takes place. Ecosystem alterations implications.
 3. Main outflow - slow flowing due to partially infilled drainage ditch. Potential impact on site drainage as passes along southern boundary.
 4. Controlled grazing - land adjacent to site is grazed by cattle. Potential source of nutrients
 5. Soil conditioning - evidence of muck spreading in surrounding fields. Potential source of nutrients from runoff.
 6. Potential outflow - direction of flow incorrect on OS basemap.
 7. Drain running south along edge of Farnyhill plantation.
 8. Footpath passes through site.
 9. Land drainage improvements - leading to nutrient input to site. Boundary fence line observed to be in good order.
 10. Potential introduction of additional artificial drainage - alteration of quality and quantity of flow to site. Standing water was present at the time of visit.
 11. Raised land form - source of surface runoff flows to site.

Do not scale this map

Client
SNH

Project
SSSI Wetlands

Title
Gattonside Moss - Land Use Pressures

Status
FINAL

Drawing No. 163365-097 Revision

Scale 1:7,500 **A3** Date 7 June 2013

Drawn SD Checked MN Approved PG

Figure 5.1: Catchment Pressures Summary

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