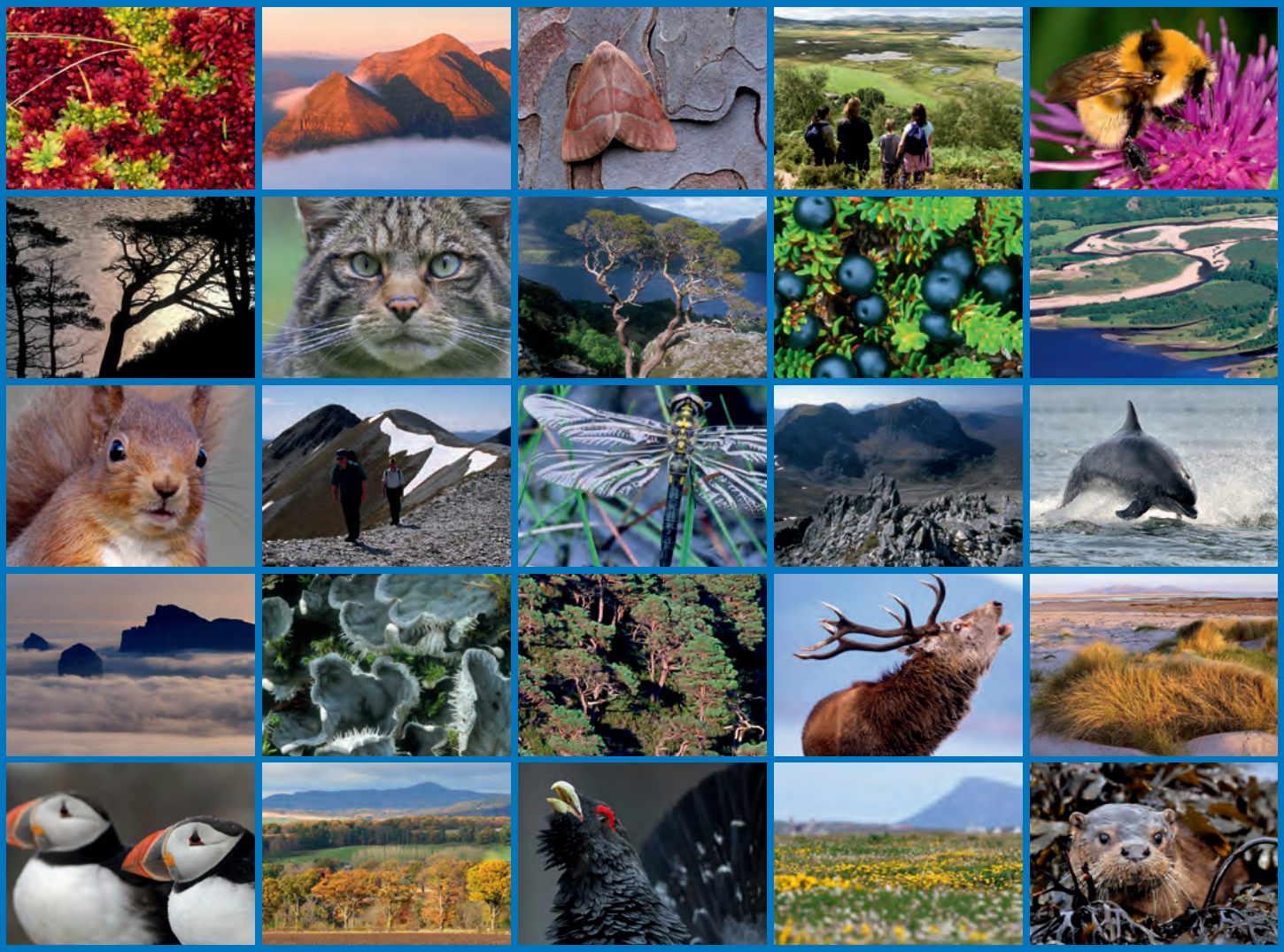
Scottish Natural Heritage
Commissioned Report No. 727

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Loch Watston



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COMMISSIONED REPORT

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Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Loch Watston

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This report should be quoted as:

EnviroCentre Ltd. Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Loch Watston. *Scottish Natural Heritage Commissioned Report No. 727.*

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COMMISSIONED REPORT

Summary

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Loch Watston

Commissioned Report No. 727
Project No: 13700
Contractor: EnviroCentre Ltd.
Year of publication: 2015

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 was inconclusive in determining nutrient levels that would be typical of a eutrophic waterbody. However, there was evidence of nutrient enrichment within the sample dataset. The sampling assessment was undertaken as a single visit and the limited dataset constrains the ability to draw accurate conclusions on current site conditions.
- Site walkover revealed potential existing and historical land use practices within the catchment that could adversely affect water quality and loch dynamics. This included long-term changes to the nutrient status resulting from diffuse agricultural sources, management practices, sewage inputs and variations to the flow regime in the loch.
- A series of recommendations are proposed to aid the understanding of the loch flow regime and understand the impact of land management practices. It is considered that this additional information will help further the understanding of the observed changes taking place at the site.

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Acknowledgements

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

Loch Watston is located approximately 2 kilometres (1.2 miles) south of Doune, Stirlingshire. The site is accessed via fields immediately adjacent to the B826 (Doune to Thornhill) or the access track to Lochfield. See Figure 1.1 in Annex 1.

1.2 Site Description

Loch Watston is a small, nutrient-rich lowland loch surrounded by a narrow band of woodland which lies in a small basin. The 13.75 hectare site was designated a SSSI in 1990 for its eutrophic loch and open water transition fen features (SNH, 2011a).

The site sits within a lowland landform at an altitude of 40m AOD. The loch is sheltered within mature woodland to the north west, north east and south, which is in turn entirely surrounded by agricultural fields. The catchment is dominated by arable crops although occasional grazing and rough pasture is known.

The muddy substrate of the loch supports a rich assemblage of aquatic plant species (SNH, 2011a).

The underlying solid geology at the site consists of sandstone with subordinate conglomerate, siltstone and mudstone of the Strathmore Group. There are no drift deposits recorded at the site itself while glacial till is present across the wider catchment (British Geological Survey, n.d.).

1.3 Site Hydrology

Loch Watston is located within the River Forth catchment. The catchment area draining to the loch is 1.58km^2 and receives an annual average rainfall of 1087mm (Centre for Ecology and Hydrology, 2009). Two minor burns flow into the site from the north west. The main outflow is a burn flowing south from the loch. It is understood that all these watercourses have been widened and deepened in the past and there is evidence of historic straightening. All field drains from surrounding farmland are also understood to enter into the loch (SNH, 2011b).

SNH file records reference an old concrete dam across the outflow which is now completely degraded (SNH, 2011b). This led to water levels being historically controlled by the use of a sluice gate, in turn allowing exposure of the mud/silt along the margins of the loch and allowing seeds to germinate and nutrients to be flushed from the loch.

1.4 Site History

The fields surrounding the site boundary have been mainly cropped with cereals in the past, agricultural operations have included ploughing as well as the introduction of fertilisers. The woodland surrounding the north-western boundary is managed for pheasants with feeding hoppers present. This area of the site is also subject to grazing from deer (SNH, 2011b).

A boat house was present on the loch (SNH, 2009a) and it is understood that recreational angling was previously a common practice with the loch stocked and fished by an angling club.

SNH files reference the site as being used as a mill pond with a sluice installed to control flows from the loch. The sluice infrastructure remains (SNH 2009b). The waterbody has contracted based on the position of the boat house relative to the edge of the loch but the rate of change is not known. It is further reported that the sluice was historically operated at the start of each working day to provide water to a smithy and sawmill in Blairdrummond. It is therefore likely that water levels were historically held at an artificially higher level.

Keymer's site visit report (Keymer, 1981) states that the site was historically an important wildfowl site in the winter with up to 2000 Pink-footed Geese (*Anser brachyrhynchus*) present while various wildfowl have been known to breed on site during the summer months.

1.5 Recent Site Management Practices

Outwith the information contained in the Site Management Statement (SNH, 2011b), there has been a lack of information available regarding previous or existing management practices at the site.

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. Access to non-publically available data held by other regulators, including SEPA, was not available.

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 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

Loch Watston	Date of Visit	Weather Conditions	Grid References
Visit 1	26 November 2012	Clear, cold and sunny	NN 712004
Visit 2	20 February 2013	Clear, cold and dull	NN 712004

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 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. Samples were taken from the shore which can introduce a bias as it may not reflect average conditions in the water body.

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 western Scotland were 144%, 104% and 128% 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 Flood Estimation Handbook (FEH) catchment boundary, the area defined in the Annex 1 maps does not necessarily present a fully accurate reflection of the hydrological catchment for the site. Whilst this affords a valuable tool for the purposes of this study, the mapped boundary should be viewed as an indicative guide only and be subjected to detailed verification to be considered definitive.

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 (µS/cm)	Comments
LW01	NN 71206	00181	7.01	6.55	0.11	28.2	3.39	-130.0	240	Groundwater - dark, cloudy brown with fine brown suspended solids; no odour
LW02	NN 71108	00225	6.68	6.84	0.17	15.7	1.85	-135.4	360	Groundwater - light brown with fine suspended solids; very faint organic (sulphur) odour
LW03	NN 70869	00282	6.74	6.36	0.12	56.3	6.78	-132.4	257	Surface water - clear with some very fine brown suspended solids; no odour
LW04	NN 70858	00542	6.74	6.65	0.13	63.0	7.58	-133.9	263	Surface water - clear with only a few, very fine suspended solids; no odour
LW05	NN 70909	00547	7.34	6.80	0.11	65.2	7.7	-137.9	240	Surface water - clear with a few very minor suspended solids; no odour
LW07	NN 71131	00430	7.12	6.71	0.11	48.2	5.74	-139.8	228	Surface water - clear with only a few, very fine suspended solids; no odour
LW08	NN 71263	00342	6.92	6.28	0.13	17.9	2.11	-143.0	265	Groundwater - dark, cloudy brown with fine brown suspended solids; very faint organic (sulphur) odour
LW09	NN 71260	00308	7.22	6.53	0.10	24.3	2.89	-140.8	200	Surface water - clear with only a few fine suspended solids; no odour
LW10	NN 71310	00010	7.61	6.96	0.11	56.2	6.65	-134.6	226	Surface water - clear with some very fine suspended solids; no odour

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)
LW01	NN 71206	00181	GW	32	6	8	6.39	0.5	1.0	0.13	0.6	3
LW02	NN 71108	00225	GW	71	10	12	16.6	0.2	<0.2	0.03	1.2	3
LW03	NN 70869	00282	SW (I)	35	5	6	3.69	0.02	4.2	0.01	0.1	5
LW04	NN 70858	00542	SW (I)	28	4	7	0.11	0.02	4.4	0.01	<0.1	5
LW05	NN 70909	00547	SW (I)	22	4	6	1.2	0.02	5.1	0.05	<0.1	6
LW07	NN 71131	00430	SW (OW)	24	5	6	0.29	0.02	1.6	0.04	<0.1	2
LW08	NN 71263	00342	GW	43	8	40	12.2	0.18	<0.2	0.05	1.1	2
LW09	NN 71260	00308	SW (OW)	18	3	4	0.21	0.05	0.7	0.03	<0.1	2
LW10	NN 71310	00010	SW (O)	26	4	6	0.04	0.02	2.3	0.02	<0.1	3

+ Surface water samples are designated either inflow (I), outflow (O) or open water (OW)
Red figures denote samples that are above typical ranges for the observed dataset.
No shallow groundwater was encountered at LW06 and therefore no groundwater sample could be obtained.

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)	Total Moisture ** 105°C (%)	Total N (mg/Kg)	Nitrate (mg/l)	Nitrogen (%)	Extractable P (mg/l)
LW01 A	NN 71216	NN 00181	High organic, wet black sludge	2.0	8320	7160	7.74	2170	87.4	<2.2	<0.2	1.62	23.7
LW01B	NN 71216	NN 00181	High organic, wet black sludge	0.6	14400	11000	<2.0	312	87.2	<0.8	<0.2	1.3	<6.0
LW02A	NN 71108	NN 00225	High organic, wet black sludge	0.6	7180	5250	<2.0	1110	80.9	<0.8	<0.2	0.88	<6.0
LW02B	NN 71108	NN 00225	High organic, wet black sludge	<0.5	17900	1420	<2.0	346	86.2	<0.7	<0.2	1.34	<6.0
LW06A	NN 71054	NN 00470	High organic, wet black sludge	0.6	18500	2020	2.88	712	89.4	<0.8	<0.2	2.55	8.83
LW06B	NN 71054	NN 00470	High organic, wet black sludge	0.6	6630	9090	2.83	1640	79.9	<0.8	<0.2	1.03	8.66
LW08A	NN 71267	NN 00343	Organic rich brown soil with small gravel	<0.5	4980	3110	<2.0	726	60.9	<0.7	<0.2	0.46	<6.0
LW08B	NN 71267	NN 00343	Organic rich brown soil with small gravel	1.2	5770	6760	<2.0	1650	65.2	<1.4	<0.2	0.56	<6.0

** Soil types are field observations*
*** Total Moisture = Water content*
*A/B suffix: **A** = Rooting Zone and **B** = Below Root Zone*
Red figures denote samples that are above typical ranges for the observed dataset.

5. SITE OBSERVATIONS

To enhance understanding of Loch Watston and the surrounding area, preliminary research was undertaken and complemented by 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

There are records of numerous site condition monitoring assessments having been undertaken at the site by SNH but minimal reference to suggested site management practices being implemented or undertaken. Of the records reviewed, there appears to have been a notable number of visits within a relatively short time period (five in six years between 2004-2009): as follows:

- Vascular plant assemblage monitoring (SNH, 2004a): The site was assessed as being in unfavourable- declining condition because some key species were not found and it was inferred that the loch is gradually drying out and potentially suffering from nutrient enrichment.

- Open water transition fen monitoring (SNH, 2004b): The site was initially assessed as being in unfavourable- declining condition due to nettles and cleavers being present and reed canary grass had established on the site. The presence of these species could be an indicator of nutrient enrichment.

- Eutrophic loch monitoring (SNH, 2004c): The eutrophic loch feature was classified as being in favourable condition. No evidence of a consistent trend to indicate a change of the overall condition was found. Water and habitat quality in the loch was considered to be good.

- Vascular plant assemblage monitoring (SNH, 2009a); and

- Site visit to assess whether nutrient enrichment was leading to an unfavourable condition for the 'open water transition fen' feature (SNH, 2009b): This concluded that the proportion of *Phalaris*, nettles and cleavers, which are all possible indicators of nutrient enrichment, was low enough to allow the fen feature to be considered as being in favourable condition.

Whilst similarities in the perceived pressures are repeatedly referenced, the concluding status varies. This is attributed to variations in the characterisation of the marginal vegetation composition notably that of *Phalaris spp*.

The Site Management Statement (SNH, 2011b) records an 'Objective for Management' of enhancing the conditions of the site by 'maintaining the naturally nutrient-rich open water body and associated fen habitat through encouraging careful application of fertilisers, other chemicals and the use of buffer strips'.

In 2009 a site condition observation by SNH stated there was a "slimy/spongy/silty smelly 'gunge' of about 5cm thick covering the sandy shelf". It is speculated that the 'gunge' may be an indication of increased nutrient enrichment and supressing submergent vascular plants (SNH, 2009a). It is not known or recorded whether any analytical assessment of this material was made or whether any repeat visits to assess its condition were made.

An SNH file note records non-native Rhododendron at the north west corner of the site around NN708 005, into the woodland to the south of this, and a scattered community on the

north side of the site around NN 710 004 (SNH, 2009b). It further states that management of this problem should be considered as this has implications for the existing flora as it out-competes native species, exerts a drying effect on the fen margin and poses a threat to other wildlife. The report also references the presence of nettles within the site boundary which is potentially indicative of nutrient enrichment.

The presence of Canadian pondweed (*Elodea canadensis*) is reported in 2004 (SNH, 2004c).

The Site Condition Monitoring of the Eutrophic loch feature in 2004 did not clearly indicate a trend towards nutrient enrichment, and although it suggested that buffer habitats would be effective, it also suggested that there is a real potential that farming inputs could affect the site (SNH, 2004c).

The site was not designated until 1990 and assumed to be excluded from the initial designation based on the 1982 assessment stating that 'Loch Watston was not considered worthy of SSSI status on botanical grounds … because it is suffering gross enrichment, presumably largely because of the large bird population" (Taylor, 2009b).

A site visit note from 1988 stated that large quantities of spray drift were blowing onto the site (SNH, 2009b). The nature of the spray is not stated but assumed to be an herbicide or pesticide application.

The desk study identified that historical water quality samples have been taken – albeit that the records are not particularly detailed in terms of location, depth *etc*. The SNH Condition Monitoring Form for the Eutrophic loch (SNH, 2004c) states that a single sample of Total Phosphorus of 26µg/l was recorded during water sampling. The form also details that the analysis of the sample was delayed. It is stated that this figure is within the expected range for eutrophic lochs as defined by the Draft Common Standards Monitoring Guidance (JNCC, 2004) however, EnviroCentre consider this to be incorrect and to be indicative of a mesotrophic waterbody. No other parameters were recorded but a comment is included that 'the water clarity was fairly good and colour was only slightly green' (SNH, 2004c). Given the limited information on the location, depth and weather conditions at the time of the monitoring, and any repeat or consistency of data, confidence in this data is low and has therefore been discounted for the purposes of this study.

EnviroCentre has not been made aware of any previous/other work in regards to addressing the above issues.

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. No visible pollution sources were observed within the site boundary.
- No discernible algal blooms were observed in the loch however, this is not unexpected given the time of year the site visits were undertaken.
- The arable fields bounding the site were ploughed and unvegetated (bare soil) at the time of the second site visit. This can aid nutrient runoff to the site.
- Silage bales were observed in the pasture field to the north west of the site. This contradicts the understanding that the surrounding land is only used for arable crops.

- The site is partly fenced from the surrounding catchment. The site visits did not fully assess the integrity of the fencing however, observations of it being damaged or incomplete were noted during the first visit. Access by livestock would therefore be possible and unauthorised grazing, trampling and dunging within the site could occur.

- There is no public access to the site however, a public footpath passes along the north western boundary and access to the site could be readily gained.

- Recreationally the site has been used for fishing and shooting (pheasants and wild fowl). No observations of either taking place were noted during the site visits.

- All field drains appear to flow into the site and in turn drain into the loch. There are no visible signs of pollution but fertilisers and soil conditioners applied to the adjacent arable land could readily pass into the waterbody.

- The loch is surrounded by a developed tree line. Whilst this can act as a buffer to the immediate catchment, no formal buffers were observed to be in place.

- Extensive area of reed evident around the north western part of site with smaller fringe to the south and east. The northern area of reed aligns with the loch inflow.

- Properties on the perimeter of the site (namely Causewayend Cottage, Causewayend Farm and an unnamed building next to Causewayend Farm) are deemed likely to be on septic tanks – with the corresponding discharges entering the site. There are further properties within the catchment which are deemed likely to contribute to the nutrient load for the wider catchment but depending on the hydrology, are unlikely to exert a direct influence of the SSSI site.

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

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	Partial fencing (observed damaged) around the site boundary
Fishing	Historical use for recreational fishing. Present use unconfirmed.
Grazing	No evidence of stock on site. This is supported by the majority of the surrounding catchment being used for arable crops. Reported evidence of minor grazing by deer in the northern part of the site.
Monitoring	Condition monitoring was carried out in 2004, 2006 and 2009. Historical water quality data from 1981 exists on SNH file. No known soil data records.
Public Access	No formalised public access to site. A public footpath passes along the north west perimeter but does not enter the SSSI boundary.
Shooting	Site understood to be used for pheasant and wildfowl shoots. A shooting platform and feeders are present within the wood.
Point Pollution Sources	None observed within the SSSI boundary.
Properties in Catchment	Three residential properties (Causewayend Cottage, Causewayend Farm and x1 unnamed) are confirmed within the immediate catchment to the north west of the site boundary. Given the rural nature of the catchment is it speculated that these properties will be served by septic tanks. These properties, and depending on the location of the septic tank facility potentially Lochfield Farm, Drumlochan House and Sauchans Farm, are those which would be most likely to exert an influence on the site.
Unusual, Distinctive or Atypical Features	Recently ploughed arable land adjacent to site with suspected application of soil enhancers (*e.g.* fertilisers and muck spreading - although not observed taking place at time of site visit); presence of silage bales in fields to the east of the site indicate grazing of stock.

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

The surface water quality at the site comprised elevated concentrations of bioavailable nutrients notably total nitrogen and nitrate indicative of a result of the agricultural practices within the catchment. The dataset was not suitable to confirm whether the loch was eutrophic or mesotrophic. Dissolved oxygen levels in the surface water were at levels generally compliant with the 6ppm standard of the Freshwater Fisheries Directive (2006/44/EC) to support salmonid fish.

For a eutrophic waterbody, the water column typically contains at least 0.035mg/l total phosphorus (which includes phosphorus bound up in plankton and 0.5mg/l or more total inorganic nitrogen (mainly in the form of dissolved nitrates) (Environment Agency, 2012). Whilst such levels simplify the complex interaction between plant nutrients and the hydrological and physical characteristics of individual waterbodies, they serve to show the sensitivity of the trophic state to artificially increased levels of nitrogen and phosphorus. In the single open water sample appropriate for establishing the trophic status of the waterbody, the concentration of total phosphorus was below the 0.10mg/l level of detection and the total nitrogen concentration was 2.0mg/l. As phosphorus is likely to be the limiting factor over nitrogen in a eutrophic system, this sample alone is insufficient to confirm the status of the waterbody. That said, the comparable values recorded at the surface water inlet LW03 indicate a level of nutrient enrichment which is representative of eutrophication.

With the exception of nitrogen parameters, the surface water results indicated no significant changes in concentrations of the monitored parameters from the inlet source waters to the outlet. Elevated total nitrogen results of 2.0-6.0mg/l and nitrate results of 4.2-5.1mg/l were recorded for the three inflow samples. These were notably higher than the open water or the outflow samples. As the open water sample was lower in total nitrogen than any of the inlet samples or the outlet, this potentially indicates the flushing of nutrients from the site although additional data would be required to confirm this.

With the exception of iron concentrations in the groundwater samples, none of the analysed metals values were deemed to be particularly elevated. The iron values were consistently high in all three groundwater samples with values of 6.39-16.6mg/l recorded. As these are groundwater samples where conditions are such that dissolution of iron is likely to occur under low oxygen conditions this is not unexpected. The elevated value of 3.69mg/l in the inlet surface flow of LW03 is however markedly higher than the other surface waters and is deduced that this is likely to be influenced by a groundwater source or influence from field drains.

The soil samples highlight consistently elevated levels of phosphorus, nitrogen and potassium across the site but particularly in samples LW01 and LW06. These parameters are the primary constituents of artificial fertilisers which are understood to be applied to the adjacent catchment. The values recorded in the two stated samples were at levels which would indicate a significant enrichment from that which would be present naturally. The distribution of the highest samples does not afford a consistent trend across the catchment. It is possible that both are ‘sinks’ whereby the topography and drainage lead to a build-up of concentrations at these locations.

It is of interest to note that the nitrate level in all soil samples was below the detectable levels whereas extractable nitrogen, % nitrogen and total nitrogen were all elevated. This potentially indicates that the nitrogen is predominantly in the elemental form (and therefore consistent with the application of artificial fertilisers) or in a bound form not analysed - *e.g.* ammonia – which would indicate the application of animal wastes to the adjacent land.

6.2 Comparison with Historical Analytical Data

The desk study revealed limited historical data held on SNH site files (Keymer, 1981). Whilst the specific location and the sampling and analytical methods are unknown, the following water quality parameters were recorded (it is assumed from open water) from the loch on 9 September 1981. No comparative soils sample data was available.

Table 6.1: Summary of water quality data from September 1982 at Loch Watston

pH	Dissolved Calcium (mg/l)	Total Phosphorus (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Ammonium (mg/l)
6.6	29	0.20	0.12	<0.01	<0.05
-	31	0.20	0.12	0.01	<0.05

Due to the aforementioned limitations, as well as the advancements in analytical assessment, the accuracy and relevance of these results should be viewed with caution. There are however interesting comparisons with the samples collected during Visit 1, namely that the pH and calcium values are comparable and the phosphorus and phosphate values are typically higher and the nitrogen values lower for the 1982 samples.

6.3 Atypical Results

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

- The elevated conductivity reading for LW02 of 360µS/cm is potentially attributable to the level of suspended solids in the sample and/or the elevated total iron value.

- Faint organic (sulphur) odours from groundwater samples LW02 and LW08 were observed. As this corresponds with low dissolved oxygen, slightly acidic pH and elevated iron concentrations, this is indicative of organic degradation. This observation is consistent with the visual observations of decaying organic matter in the corresponding soil samples.

- Elevated iron values were recorded in all three groundwater samples with values of 6.39-16.6mg/l recorded. As these are groundwater samples where conditions are such that dissolution of iron is likely to occur this is not unexpected. The elevated value of 3.69mg/l in the inlet surface flow of LW03 is markedly higher than the other surface waters and is deemed highly likely to be influenced by the groundwater source.

- An elevated total sodium result of 40mg/l was recorded at LW08. There is no clear explanation for this result which is notably higher than the other samples. It is possible that this corresponds to salt applied to the B826 but without further sampling and assessment this should, for the purposes of this study, be disregarded.

6.4 Additional Considerations

See study limitations presented in section 3.

No records or reports (anecdotal or otherwise) of algal blooms or fishing records were reviewed during this study. Information of this nature could be of value in understanding long-term trends and changes within the site.

7. CONCLUSIONS

Despite the limitations outlined in section 3, the analytical results show a definitive trend of elevated nutrients in the soil, surface and groundwater samples. In conjunction with the desk study and site walkovers, there are also observations that indicate there to have been changes in land use management in the immediate catchment which will have directly influenced the loch, namely the intensification in agricultural practices, influence of septic tanks and changes to the water levels in the loch.

Due to the surrounding topography, low lying position of the loch, and underlying permeable geology, it is expected that the site will be heavily influenced by the quality and quantity of water which flows to the site. These flows, which will vary seasonally, will leach nutrients from the surrounding catchment to the loch which in turn acts as a sink for the surrounding landform. The nutrients encourage plant growth which over time decay and, coupled with the inflow of suspended solids from the wider catchment, create a nutrient rich substrate. It is this continued infilling and accumulation which furthers successional change that is presently observed and is to the detriment of the designated site condition.

The historical information on the site is limited. With the exception of the use of the loch for water supply purposes and possible variations in land management resulting from developments in agricultural practices, it is assumed that the surrounding catchment is largely unchanged. It is therefore deemed that the changes in the former practices have influenced the SSSI in recent years.

The most notable observation which does not appear to have been fully assessed previously is the potential for runoff and nutrient enrichment affecting the inflow to the SSSI and loch from the immediate catchment. The permeable nature of the underlying sandstone geology is expected to aid migration of nutrients to groundwater from the intensively managed arable land and potentially less frequent grazing of stock. This will be enhanced through losses of vegetation during the harvesting cycle, increased runoff from ploughed land and the seasonal application of soil conditions, artificial fertilisers and herbicides – the extent and volumes of which are unknown.

The use of the loch to supply the mill at Blairdrummond would have led to a direct impact on the level of water within the loch. Although volumes are not known, it is considered that this would have influenced the water levels in the transition fen and may have accelerated nutrient enrichment through ‘flushing’. It is also likely to have aided algal blooms through lowering the loch depth. Historical records suggest this practice ceased some time ago and the present operation/control/maintenance is unknown. It is therefore possible that variations in operation undertaken by the present landowners could accelerate the nutrient input to the loch and its associated margins. There is value in understanding how the sluice operates and the requirements of the downstream catchment for the resulting flow. Correspondingly, the desk study references the widening and deepening of the site drains and watercourses which will have led to changes in the flow regime within the site. Given the expected inflows, and the associated solids from ploughed fields, these channels are also likely to have been slowly infilled and accumulated nutrient rich silts which would in turn be flushed into the loch. Site owners have consents for maintaining ditches and drains but no records of any maintenance having taken place are available.

The SNH file note (SNH, 2009b) refers to a variation on the current status with a view to increasing the level of the loch by 50 centimetres to its alleged former standing. It is largely accepted that this in principle would work to prevent continued drying of the loch margins, to dilute the level of nutrients in (and entering) the loch, and may afford flushing to remove retained nutrients within the present margins. Conversely, the increase in the surface area may adversely impact on the existing margin vegetation, lead to a reduction in the flow in the

receiving downstream watercourse, and may encourage the return of the large wildfowl numbers and their associated nutrient inputs.

The presence of nettles within the site (Taylor, 2009b) may indicate nutrient enrichment although this was not directly confirmed through this study. The residential properties at Causewayend lie approximately 400m to the north west of the site – and close to the inlet feeds to the loch. Given the remote location of the site it is expected that these dwellings will be on a septic tanks and hence the foul water flows are likely to drain into the site. The collection of soil and water data within the fields outwith the site boundary, or the boundary itself, would be needed to corroborate this.

It is highly probable that there are significant sediment accumulations within the loch. These will afford a plentiful supply of nutrients through disturbance by, and variations in, seasonal inflows as the shallow depth of the loch means it is unlikely to release nutrients through stratification. How water quality is seasonally influenced will directly influence the composition of the transition fen. The limited information of algal blooms (re: frequency, composition *etc.*) and historic water quality data restricts the conclusions which can be drawn in proving the loch has changed from mesotrophic status in 1980 to eutrophic status at present.

Historical reference to the potential for additional nutrient input from the visiting wildfowl populations should also be considered. Whilst current numbers are not known, a significant population descending on the loch could potentially add a notable nutrient load to the loch sediments.

There appears to be limited understanding of the current and historical land management practices, in both the surrounding arable land and the 'buffer' woodland immediately adjacent to the SSSI. From the observations made during the study this presents the greatest potential impact to the site, and confirms the repeated findings of the SNH Condition Monitoring.

8. RECOMMENDATIONS

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

8.1 Monitoring

i. It would be of value to the long-term status of the SSSI to understand whether the loch is still classified as eutrophic. For this to be determined, a more extensive seasonal monitoring programme is necessary.

ii. 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.

iii. In conjunction with i, assess the seasonal flow and nutrient loads of the inflow burns due north west of the site and compare these with those of the outflow from the south-east end of the loch. This data would be of direct value in being able to assess the flow dynamics of the loch and to understand retention times and season variations in throughput.

8.2 Other Commissioned Studies

iv. Undertake hydrological and hydrogeological assessment of the catchment to determine the source water regime of the loch.

v. Undertake core sampling of loch sediments to understand historic source pollution and retained nutrients. Although the loch is understood to be shallow, and therefore unlikely to stratify, artificial disturbance of the sediments could result in extensive nutrient release and significantly alter the nutrient availability within the loch and plant margins. It is considered likely that there will be a significant volume of nutrient bound up in the loch sediments and this may be being slowly released into the water column and aiding successional change.

vi. Sample and analyse the slimy/spongy/silty smelly ‘gunge’ covering the sandy shelf to confirm its composition and likely reasons for its proliferation.

vii. Review the loss of standing water within the loch and determine the extent of vegetation encroachment over time. The 2004 and 2006 SNH Condition Monitoring Reports make reference to the extent of open water habitat but this is not a quantitative assessment. No reference is included in the 2009 report. If such were routinely quantified, over time this would aid the understanding of loch dynamics. This information would also be directly beneficial to aiding the understanding of, and potential operation of, the sluice in the loch outflow (see xi).

viii. Consideration should be made to understand the functioning and management of the sluice on the outlet flow from the loch. This may be subject to regulatory control from SEPA and variations to such would therefore be likely to require consultation and approval.

ix. Review the biomass of marginal vegetation within the loch and the methods used to control/manage such. Such studies should seek to understand the seasonal growth

characteristics, nutrient uptake profile and successful control measures observed from other impacted waterbodies.

Where future management practices require vegetation to be treated instead of chemical applications, consideration should be given to the removal at the root zone rather than cutting of above ground stem. This should be followed by appropriate off-site disposal as this will lead to a net reduction in nutrients from the catchment, minimise regrowth and avoid the need for the use and reapplication of potentially harmful chemicals. This is particularly applicable to marginal and aquatic vegetation

x. Undertake a detailed library review, including historical mapping and local data sources, to seek to understand historical land use and information relating to loch use, size and depth. Where such is not available, commission a bathymetry survey of the loch to confirm depth and sediment profiles. This would aid the understanding of inflow and retained sediment volume.

xi. As it is understood that there have been no regular counts of waterfowl at the site in recent years, undertake a review to further understand the activity of the Pinkfooted Geese (*Anser brachyrhynchus*) population and seek to determine how this, and other wildfowl, could affect the loch vegetation and sediment through feeding, disturbance and nutrient load from droppings.

8.3 Policy

xii. Review the tree management approach within the landholding immediately adjacent to the loch. Although reference is made to the tree buffer (SNH, 2011), it is not known whether new tree planting has been undertaken in the catchment and how this may have impacted on nutrient uptake and on inflows to the loch and associated watercourses.

8.4 Landowners

xiii. Proactively engage with local landowners to understand the existing and (foreseeable) proposed changes to the immediate catchment including field usage, crop type and soil conditioning approaches. This should include access of livestock to the site and location of field drains. Consider appropriate management strategies accordingly - for example, nutrient management planning, bringing field drains to the surface, buffer strips, exclusion zones, routine spot monitoring, improved/repaired fencing *etc*.

xiv. Proactively engage with catchment landowners to understand the historical land use practices to determine changes which are likely to have influenced the site. It is speculated that the catchment was more densely wooded than it is at present and particularly the area immediately surrounding the loch. Consideration should be made to appraise how this may have led to changes at the site and the corresponding nutrient status of the loch.

xv. Review the fish stocks and associated policies of the loch as a fishery. By understanding the existing fish stocks and management practices, consideration can be made to the likely disturbance of sediments with regards nutrient release. If catch records are known, this would further aid the understanding of the health of the loch. Engagement with regular anglers could also provide an anecdotal insight into the algal blooms and changes in loch levels. If cooperative, this may present options for recording future conditions of water quality during attendance and would provide a

valuable no-cost approach to additional data collation on seasonal variations to water quality, loch levels *etc*.

8.5 External Consultations

xvi. Engage with SEPA to:

a. understand the sewerage provision (and compliance with any regulatory requirements) for the properties within the catchment; and
b. further the understanding of the site in terms of the sluice management/operation (see vii above); the benefits of maintaining the silt trap for the downstream catchment; and any identified/reported pollution incidents at the site.

From the stated conclusions and identified pressures (Figure 7.1) the key actions to seek to reverse the present declining status of the site are to address the inputs to the loch from the agricultural catchment including the inflow burns (iii and xiii), the potential pollution from domestic sewage (xvi.a), the contribution from the accumulated sediments (v), and the water levels/loch throughput (vii & viii).

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ANNEX 1: FIGURES

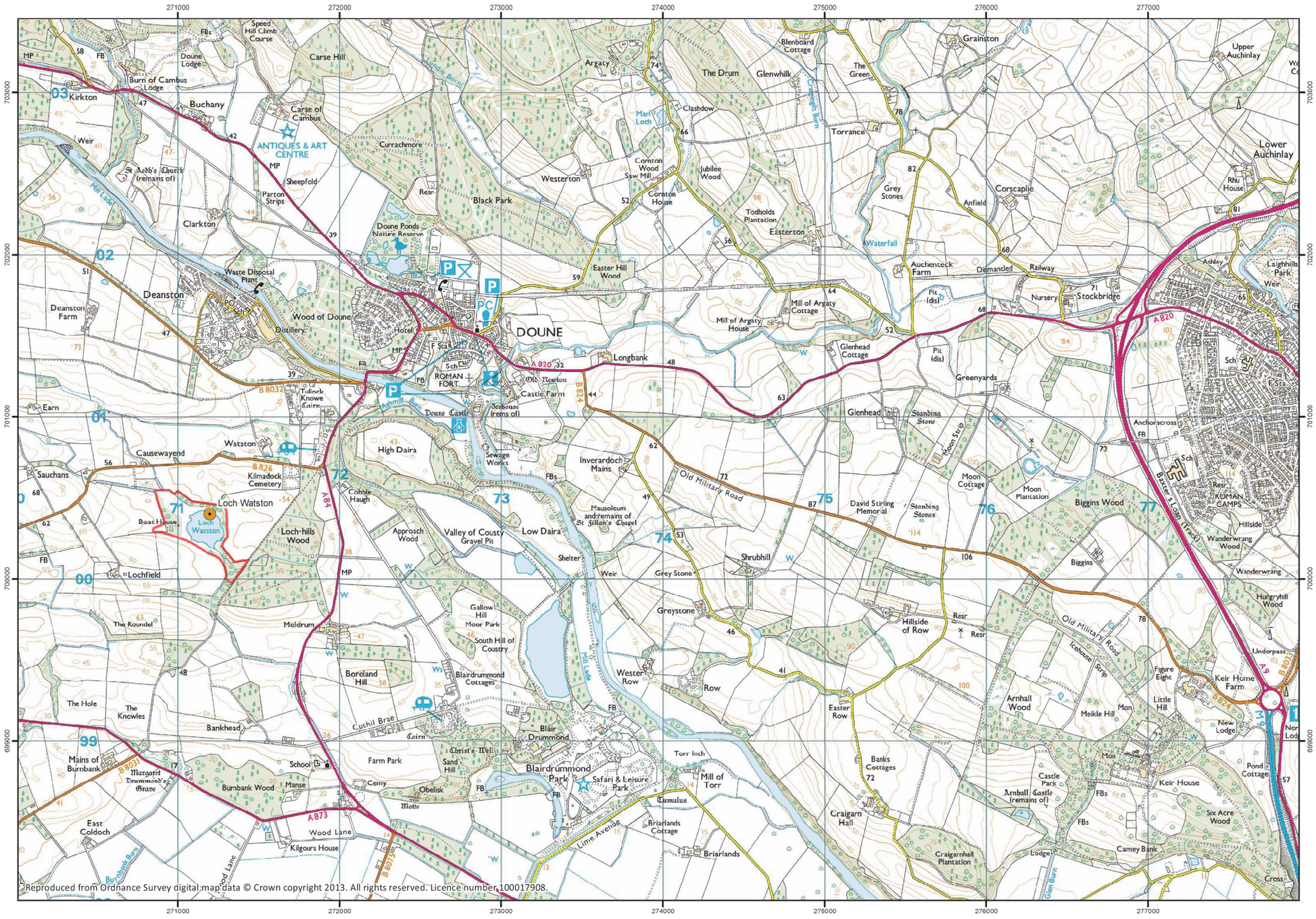

Figure 1.1: Site Location Map

Loch Watston

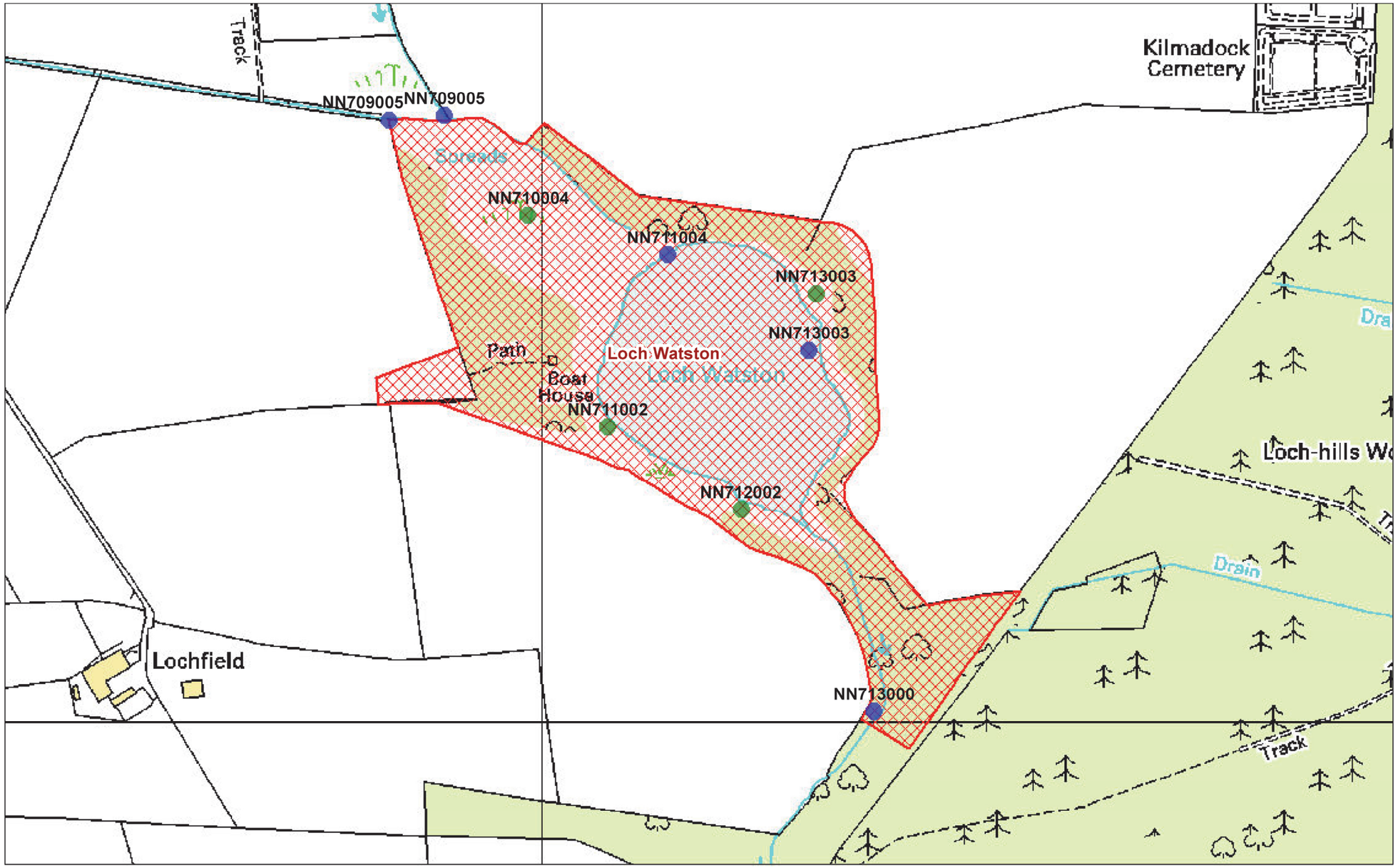

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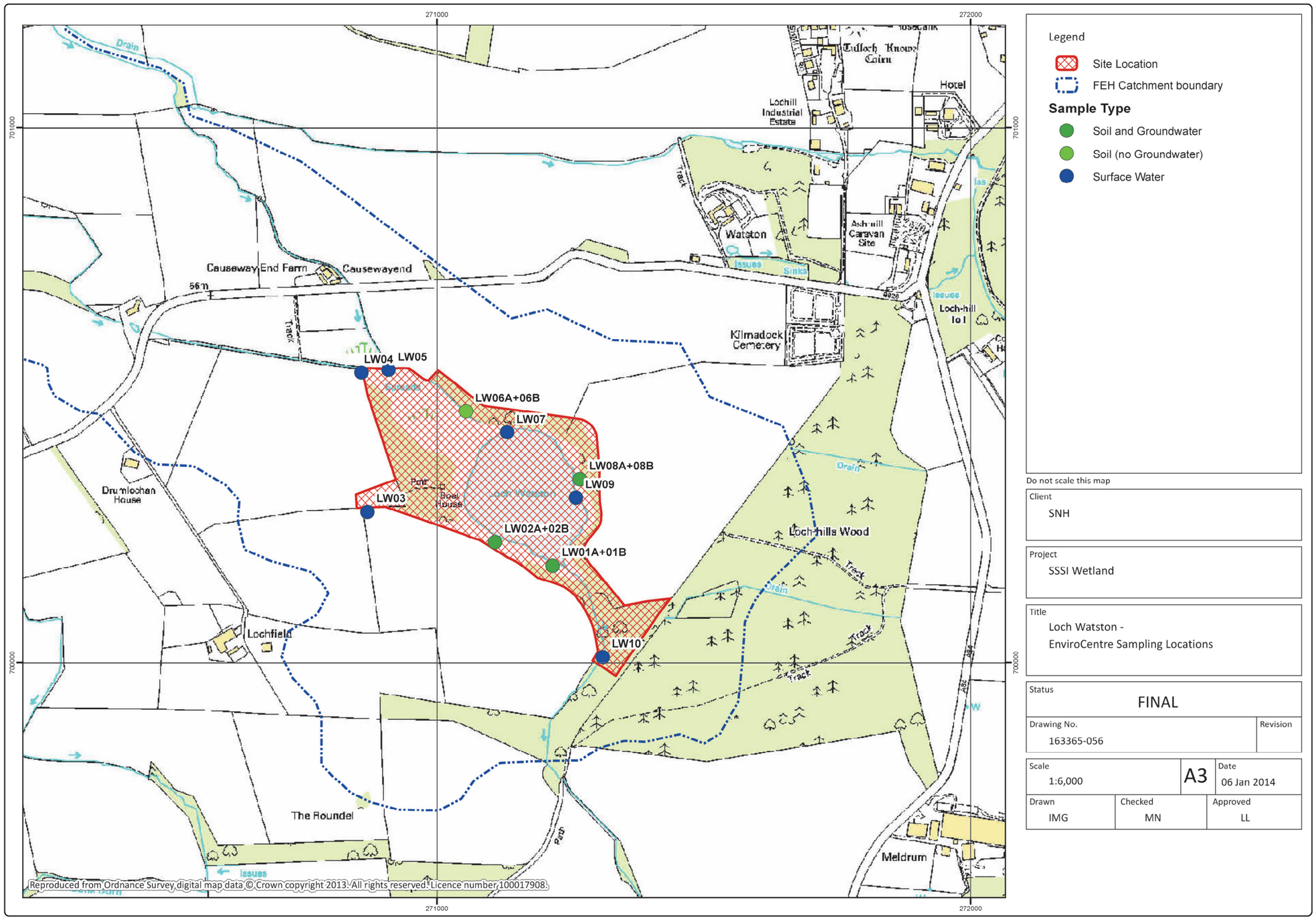
Figure 2.1: SNH Proposed Sampling Location Plan



Legend

- Site Location
- FEH Catchment boundary

Sample Type

- Soil and Groundwater
- Soil (no Groundwater)
- Surface Water

Do not scale this map

Client: SNH

Project: SSSI Wetland

Title: Loch Watston - EnviroCentre Sampling Locations

Status: FINAL

Drawing No.: 163365-056

Revision:

Scale: 1:6,000

A3

Date: 06 Jan 2014

Drawn: IMG

Checked: MN

Approved: LL

Figure 2.2: Plan of Actual Sampled Locations

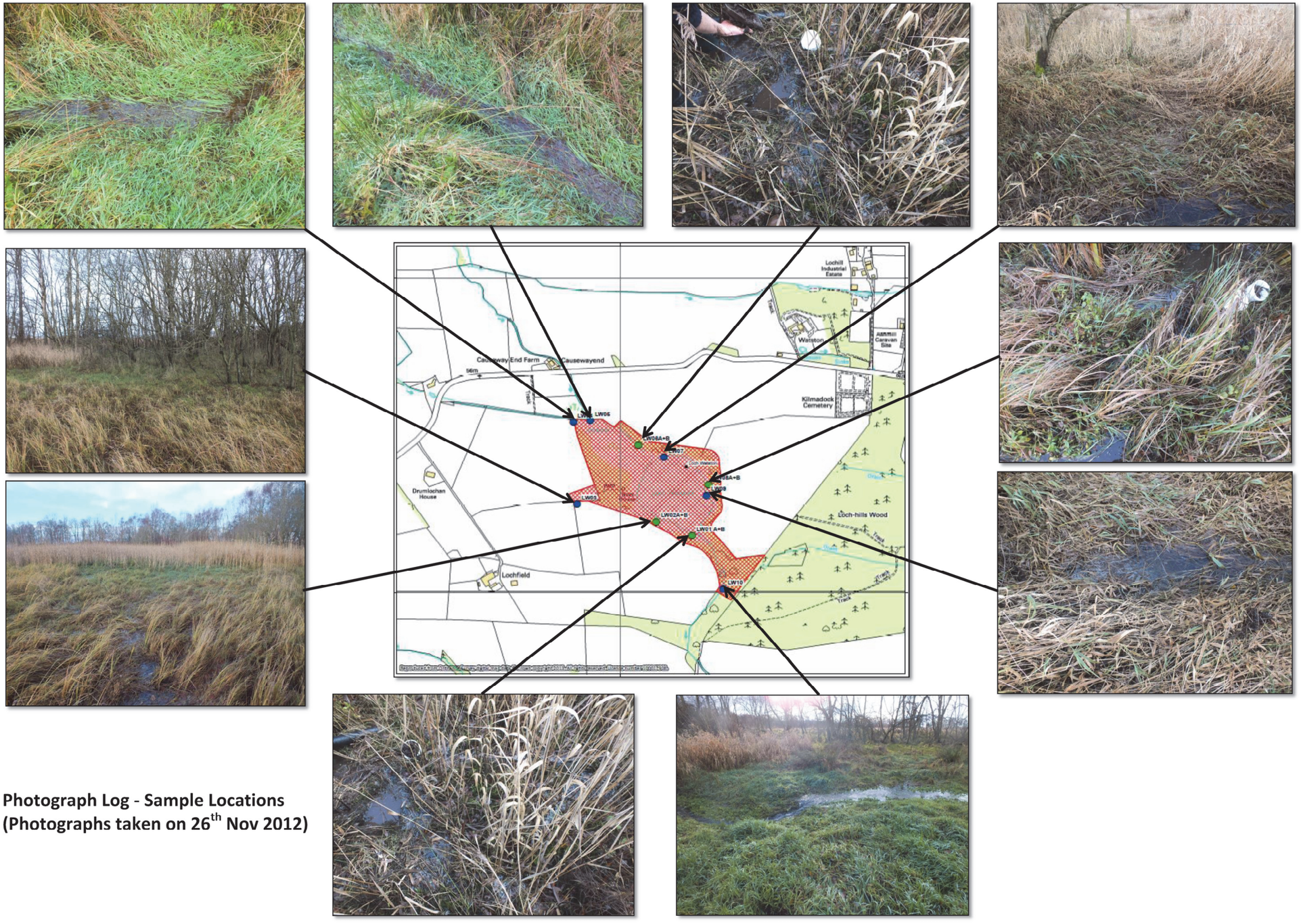


Figure 2.3: Sample Location Photographs

Figure 2.4: Surrounding Land Use Photographs

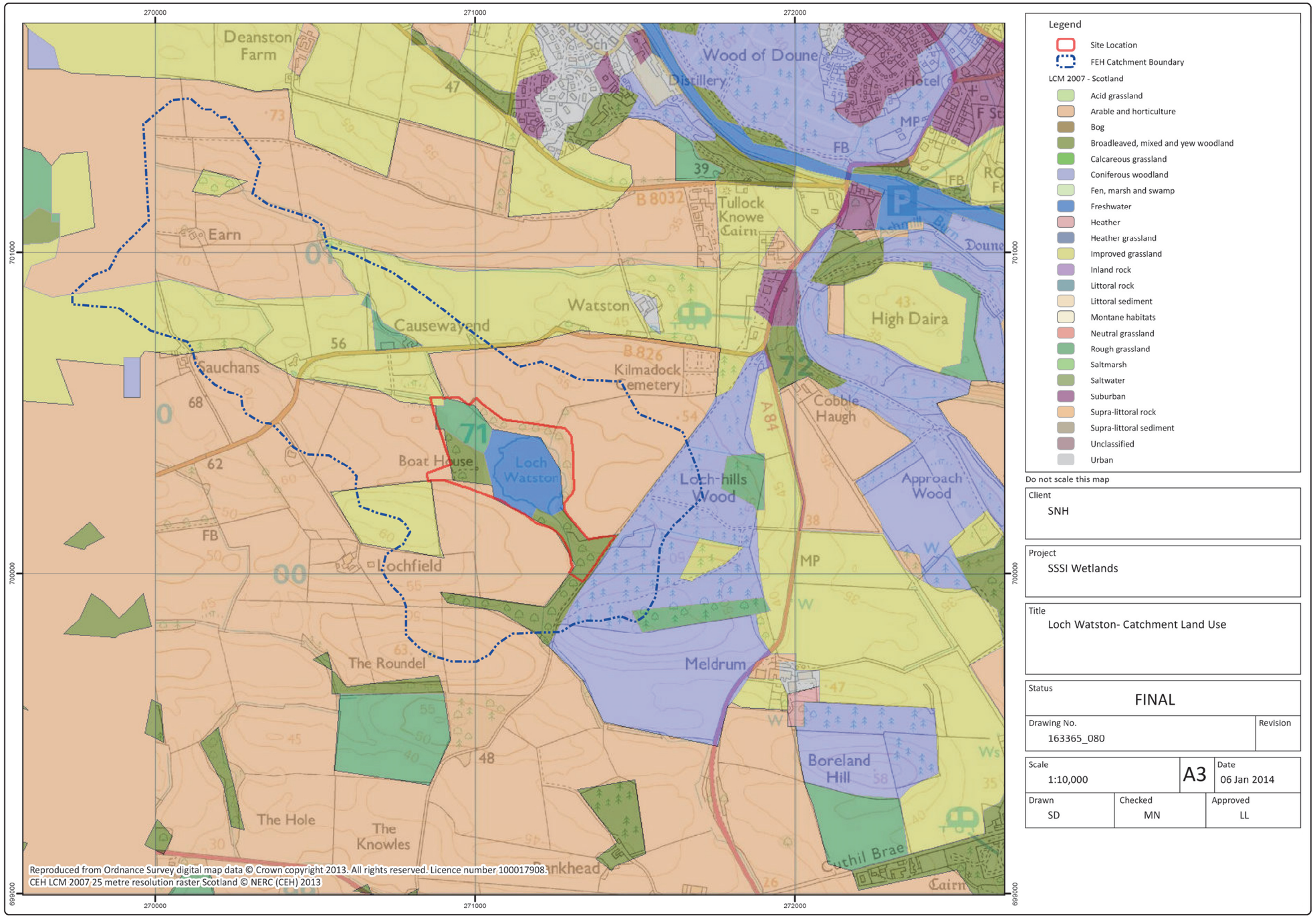


Figure 2.5: Land Use Characteristics Map

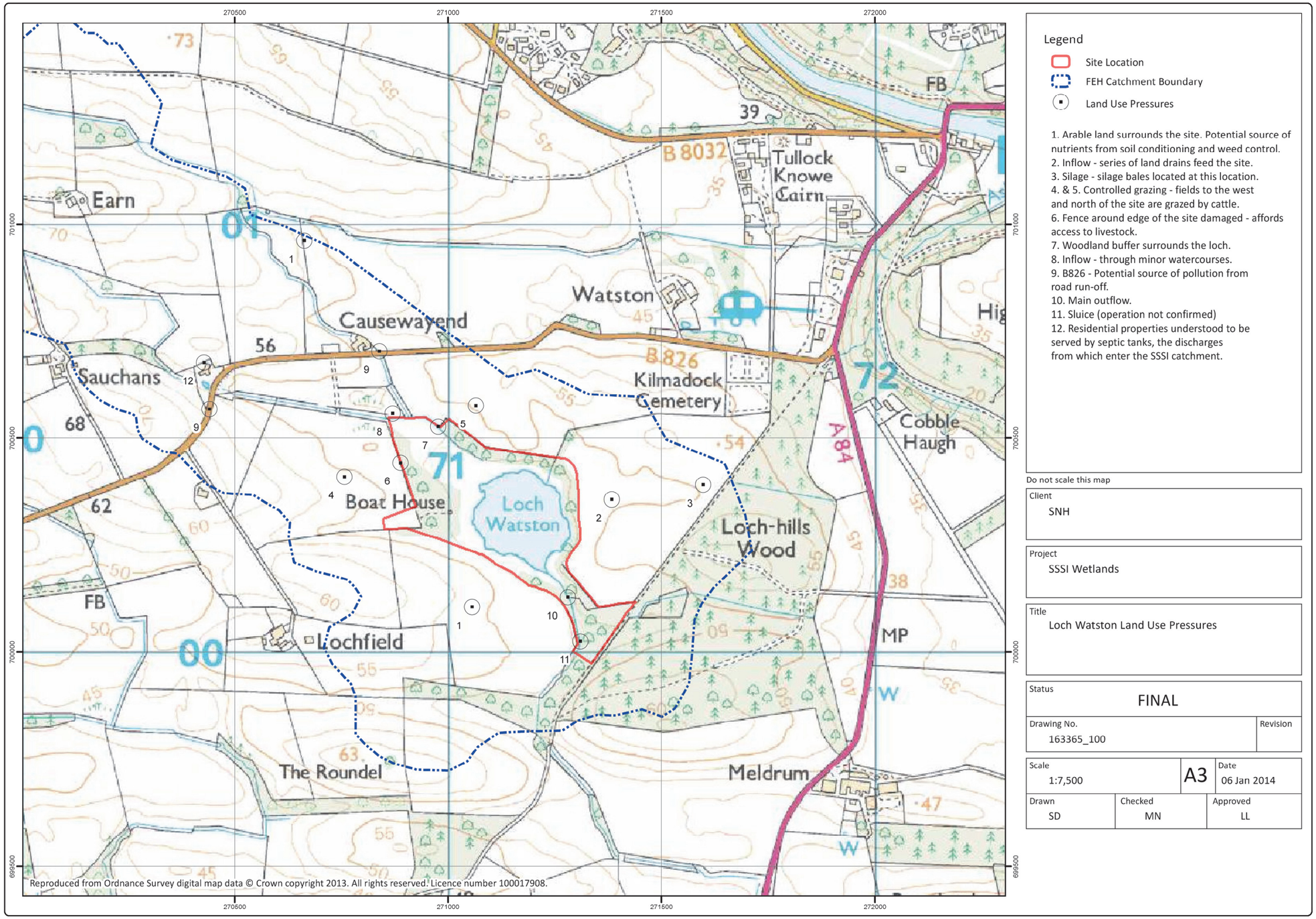


Figure 5.1: Catchment Pressures Map

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ISBN: 978-1-78391-123-3

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