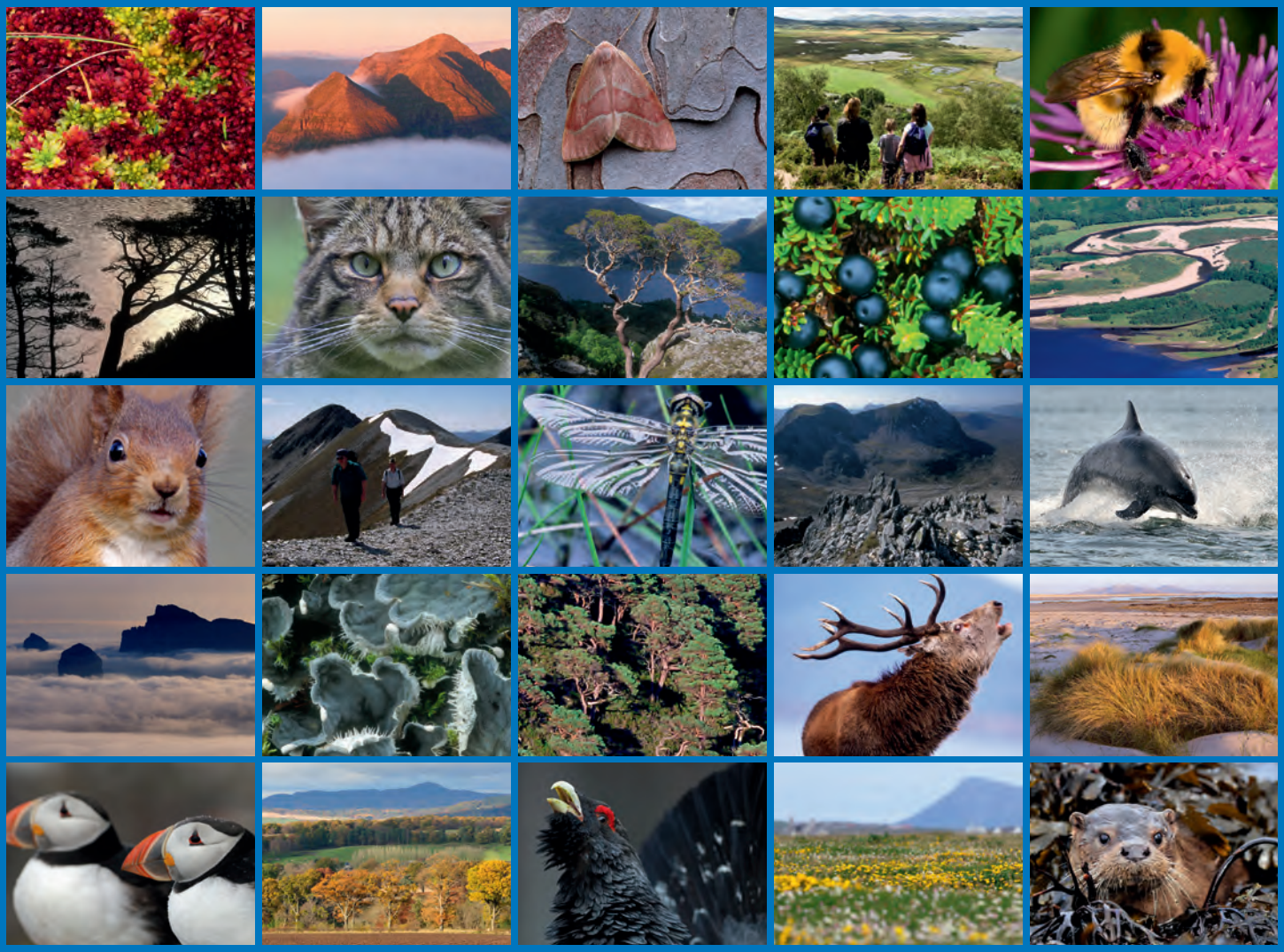
Scottish Natural Heritage
Commissioned Report No. 722

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Dolphinton - West Linton Fens and Grasslands



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COMMISSIONED REPORT

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Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Dolphinton - West Linton Fens and Grasslands

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COMMISSIONED REPORT

Summary

Investigation of Standing Water and Wetland SSSIs thought to be under Diffuse Pollution Pressure: Dolphinton - West Linton Fens and Grasslands

Commissioned Report No. 722
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

- The desk study and site walkover identified potential existing and historical land use practices within the catchment that could adversely affect water quality and soil nutrient status. This included long-term changes resulting from agricultural management practices within the catchment and farming activities in proximity of the site.
- Analytical data confirmed the presence of elevated nutrients. 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 constrains the ability to draw accurate conclusions to fully inform current site conditions.
- A series of recommendations are proposed to seek to aid the understanding of the site and afford a greater insight into the perceived changes taking place within the SSSI.

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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 standing water and wetland Sites of Special Scientific Interest (SSSI).

1.1 Site Location

Dolphinton - West Linton Fens and Grasslands (hereon referred to as Dolphinton SSSI) is located approximately 2km (1.2 miles) south west of West Linton at the foot of the Pentland Hills. The SSSI is accessible off the A702 trunk road. See Figure 1.1 in Annex 1.

1.2 Site Description

Dolphinton SSSI consists of four discrete sub-sites comprising a series of fens and unimproved grasslands which extend over a combined area of 64.59 hectares (SNH 2011a). As each sub-part is not separately named, to avoid confusion throughout this report the following references are applied:

- Northern Site 1 – Plot adjoining the north side of the A702, located at the foot of Mendick Hill.
- Northern Site 2 – Plot adjoining the southern side of the A702, located between Medwyn Mains and Medwyn Cottage.
- Southern Site – Plot due east of Kippit Farm and south of Ingraston Moss.

The sub-part of the site at Kippit Hill (immediately north of Kippit Farm) has not been included in this study.

The fen communities are classified as valley fens supporting rich fen vegetation, including a range of rare plants. These are relatively rare habitats in the Scottish Borders as most Borders mires are basin fens rather than valley fens. They are calcareous in nature due to their spring-fed water supply which originates from the base-rich glacial sand and gravel deposits.

The grassland at Slipperfield (Northern Site 1) is the most outstanding grassland of its type within the Scottish Borders, both in terms of structure and condition. Part of the site has formerly been afforested, resulting in an acid grassland community. The site is extremely bryophyte rich, with eight species being considered as local/regional rarities and two nationally scarce species.

The fens are not notified for the bird populations they support but nevertheless they are locally important for breeding waders with redshank, curlew, snipe, lapwing and oystercatcher all recorded as breeding within the composite site. Until 1991, the pool at South Slipperfield (Northern Site 1) supported a regionally important black-headed gull colony (SNH, 2011a).

The underlying solid geology at these three sub-parts of the site consists of sandstone and conglomerate of the Lanark Group. Drift deposits at the sites consist of glacial sands and gravels (British Geological Survey, n.d). During the Pleistocene era this area was covered by ice-sheets which deposited sands and gravels from the igneous andesitic rocks to the south-west of the site as they melted. These deposits formed eskers, kames and terraces on which the extensive calcareous grasslands are to be found (SNH, 2011a).

1.3 Site Hydrology

All four sites are located within the catchment of the Tarth Water and the area receives an annual average rainfall of approximately 880mm (Centre for Ecology and Hydrology, 2009).

The northern sites are located in the headwaters of the catchment, with an area of 4.23km^2 draining to the two sites. Several spring-fed burns flow from the north and east through Northern Site 1 to the Black Burn. The Black Burn originates to the south of Northern Site 2 before flowing through the site. Both sites also receive surface water runoff from the surrounding catchment. The Black Burn, a tributary of the Tarth Water, forms the outflow from the south-western corner of the northern sites.

The Southern Site is located in the catchment of the Garvald Burn which has a catchment area of 5.02km^2 to the confluence with the Tarth Water. A sand and gravel quarry is present within the catchment. The Garvald Burn flows along the eastern boundary of this site before confluencing with the Tarth Water downstream of its north-eastern corner site. A drain flows through the Southern Site parallel to the Garvald Burn and a second drain flows along the northern site boundary. A spring at the southern boundary may also provide an inflow to the site. The topography surrounding the Southern Site is relatively flat and therefore surface water runoff into the site will be limited.

All of the fen areas show evidence of changes through historic drainage.

1.4 Site History

Grassland areas of this SSSI have been continuously grazed by stock for generations. Some of the grassland on the ridges at South Slipperfield show signs of past conifer plantations. In these areas the diversity of grassland plant species is markedly lower.

There are several rabbit warrens either within the site or close by, especially at South Slipperfield (Northern Site 1). Although the grazing by rabbits results in a very short turf it is the erosion associated with burrowing that is considered to have a greater effect on the area (SNH, 2011b).

1.5 Recent Site Management Practices

Cattle, sheep and (occasionally) horses graze on the majority of the SSSI, except for one of the areas containing fen. Grazing takes place all year round with levels adjusted in response to the vegetation growth and the needs of the corresponding farms. In the past some of the calcareous grassland has shown signs of deterioration due to heavy grazing and trampling, however this has been remediated by a reduction in winter grazing. No winter feeding of cattle currently occurs on the site although some winter feeding of sheep is understood to take place.

Several ditches within sections of the site and at their periphery are regularly cleared to prevent water levels backing up. Since these wetlands are fed by springs from the sand and gravel aquifer this activity does not appear to significantly depress water levels within the fens (SNH, 2011b).

The Northern Site 1 is under a long term management agreement which does include grazing. The Northern Site 2 is managed through consents. The Southern Site has also a management agreement in place (SNH, 2008a).

There have been attempts by Tarmac Limited to obtain permission to extract gravel from the SSSI, however Scottish Borders Council has refused to grant planning consent on two occasions (SNH, 2011b).

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 – Visit 2 was undertaken once the analytical data was available and was 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

Dolphinton-West Linton Fens & Grasslands	Date of Visit	Weather Conditions	Grid References
Visit 1	5 November 2012	Dry, sunny, cold	NT125490
Visit 2	16 April 2013	Clear, mild and sunny	NT125490

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 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 GPS 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 (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 carried 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 entering 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 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 boundary to provide an understanding for the whole site, comprising standing water, inflows and outflows.

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 the analytical results obtained.

- The sub-part of the site located at Kippit Hill, north of Kippit Farm, was not considered in this study.

- For the same reasons outlined above, access to certain parts of the site may have been restricted and limited access to the predetermined sampling locations.

- 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 5) 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 water 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 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. 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 relative to the remaining dataset or which would typically have been expected to be observed from a site of this nature. These are discussed further in section 6.2.

4.1 Field Test Data

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

Table 4.1: Water Samples - Field Data and Observations

Sample ID	Nat. Grid Reference		pH	Salinity (psu)	DO (%)	DO (ppm)	ORP (mV)	EC (mS/cm)	General Field Observations
DOL01	NT 13210	49633	5.28	0.06	32.1	4.58	268	0.125	Groundwater - dark cloudy brown, with fine brown s/s; no odour
DOL02	NT 13201	49640	6.52	0.02	74.3	8.34	221	0.039	Surface water - very light brown discolouration, some very fine s/s; no odour
DOL03	NT 12836	49170	6.58	0.17	48.6	5.79	221	0.379	Groundwater - dark cloudy brown with fine brown s/s; no odour
DOL04	NT 12814	49160	6.95	0.18	58.6	7.18	198	0.390	Surface water - clear with few s/s; no odour
DOL05	NT 11721	47494	7.00	0.15	56.2	6.76	219	0.312	Surface water - clear with only few very minor s/s ; no odour
DOL06	NT 11790	47566	6.90	0.12	49.6	6.01	176	0.250	Surface water - inflow not marked on OS map, very slightly discoloured with few fine s/s; no odour
DOL09	NT 12246	47895	7.31	0.15	63.8	8.10	172	0.321	Surface water- clear with only a few very minor s/s; no odour

Red figures denote samples that are out with typical ranges for the observed dataset.

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)
DOL01	NT 13210	49633	GW	18	<10	<10	16.4	0.19	<0.2	0.09	2.5	13
DOL02	NT 13201	49640	SW (OW)	<1	<1	2	0.30	0.02	<0.2	<0.01	<0.1	<1
DOL03	NT 12836	49170	GW	74	17	<10	78.90	0.40	0.7	<0.01	1.1	2
DOL04	NT 12814	49160	SW (O)	40	8	7	0.17	0.01	6.9	0.02	<0.1	7
DOL05	NT 11721	47494	SW (I)	43	9	9	0.05	0.01	1.3	<0.01	<0.1	1
DOL06	NT 11790	47566	SW (I)	34	7	8	0.73	0.10	0.8	<0.01	<0.1	1
DOL09	NT 12246	47895	SW (I)	36	7	14	0.08	0.01	1.5	<0.01	<0.1	2

+ Surface water samples are designated either inflow (I), outflow (O) or open water (OW)
Red figures denote samples that are out with typical ranges for the observed dataset
Samples 7 & 8 were dry and no groundwater sample could *be collected.*

Table 4.3: Soil Samples – Laboratory Analysis

Sample ID	Nat. Grid Reference		Soil Type*	Extrac-table 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 (%)	Extract-able P (mg/l)
DOL01A	NT 13200	49600	Brown, very wet, organic silt with plant material	1.0	16600	1940	666	1400	85.5	<1.2	<0.2	1.21	11.5
DOL01B	NT 13200	49600	Black organic slightly silty with plant material	1.7	2910	613	325	180	71.1	<1.9	<0.2	1.6	<2
DOL03A	NT 12900	49200	Very wet, slightly fibrous black peat with roots	<0.5	18800	3020	832	983	69.3	<0.7	<0.2	1.87	7.68
DOL03B	NT 12900	49200	Black organic silt with roots	0.6	11900	2680	466	666	50.6	1.6	1	1.1	<2
DOL07A	NT 12000	47600	Black organic silt with roots	1.4	1220	3250	684	750	45.1	<1.6	<0.2	0.46	<2
DOL07B	NT 12000	47600	Black organic silt	<0.5	1880	3640	288	717	37.7	<0.7	<0.2	0.06	7.18
DOL08A	NT 12000	47800	Black fibrous peat with roots	1.2	18400	1470	598	631	70.1	<1.4	<0.2	1.88	11.2
DOL08B	NT 12000	47800	Black fibrous peat	0.6	8760	1300	170	328	81.9	<0.8	<0.2	1.06	4.89

** Soil types are field observations*
*** Total Moisture = Water content*
*A/B suffix: **A** = Rooting Zone and **B** = Below Root Zone*

5. SITE OBSERVATIONS

To enhance the understanding of Dolphinton 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, 2011b) records an 'Objective for management' of protecting the site and maintaining and where necessary enhancing its features of special interest including; to increase the plant species diversity of the grasslands and fens by implementing appropriate grazing regimes, restore the extent of the calcareous grasslands at Slipperfield, to control and reduce the extent of agricultural weeds in the SSSI by topping or grazing as appropriate, to increase the wetness of the fen habitats by control of outflow from ditches and to reduce the impact of overgrazing by rabbits through population control measures (SNH, 2011).

The 2007 site condition monitoring (SCM) assessment of the lowland calcareous grassland feature found it to be in unfavourable no change condition, due to the presence of undesirable species associated with agricultural grasslands and nutrient enrichment in both grassland compartments, as well as a decrease in the extent of the calcareous grasslands at the Northern Site 1 (SNH, 2007). The 2008 SCM assessment of the valley fen feature found it to be in unfavourable no change condition due to an absence of positive indicator species associated with fen habitats including a lack of *Sphagnum* (bog mosses), which would suggest that the fen is drier than is ideal (SNH, 2008a). The SCM assessment of the bryophyte assemblage feature found it to be in favourable maintained condition (SNH, 2008b).

Most of the communities at the Southern Site, particularly the central raised area were noted to be drying out. Rides cut through the sward in this sub-part meant a reduction in the wetland feature. The central basin area at the Northern Site 1 comprised a dense composition of swamp communities, however, the sward had become quite rank, and the boundaries between communities were becoming blurred. Sheep trampling has resulted in the impoverishment of some fen vegetation. Some fen vegetation on the Northern Site 2 was noted to be in quite poor condition as a result of cattle poaching. (SNH, 2008a)

Recommendations from the SCM included raising the water table at the Southern Site and Northern Site 1. Grazing at the Northern Site 2 should be reduced or re-targeted to avoid further damage from poaching. It is recommended that existing management agreements are reviewed (SNH, 2008a). This may include increasing grazing at the Northern Site 1 as it was noted to be under-grazed. It was also recommended that changes are made in fertiliser application on adjacent land (SNH, 2007).

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.

- Drainage ditches run through the site (particularly the Southern Site and Northern Site 2) and are present along the site boundaries. These appear to be for agricultural purposes.

- Road drainage from the A702 discharges to the northern sites.

- Improved pastures were observed to the north (up-gradient) of Northern Site 1 and surrounding the Southern Site. Arable lands are located to the northeast and south of the Northern Site 2 and to the west of Northern Site 1.

- Forestry was observed in the wider catchments of all sub-parts of the site.

- There are a series of farms and domestic dwellings located in close proximity of Northern Site 2 and other properties are present in the wider catchments. Private septic tanks and slurry tanks/silage pits are therefore assumed to be present.

- A disused railway runs along the southern boundary of Northern Site 2.

5.3 Summary

The following table provides a summary the key site features which were observed during the site visits undertaken as part of the initial works.

Table 5.1: Summary of key observations

Activities	Observations
Fencing	Partial fencing around site sub-parts. Not assessed as part of scoping.
Fishing	Not Applicable.
Grazing	Site sub-parts grazed by sheep and/or cattle. Grazing by rabbits particularly at Northern Site 2.
Monitoring	Site Condition Monitoring was carried out in 2007 & 2008. No previous physico-chemical monitoring results were made available for the site.
Public Access	No formalised access.
Shooting	None.
Point Pollution Sources	None observed within the SSSI boundary. Road drainage from A702 to northern sites.
Properties in Catchment	Two residential properties and two farms are located in close proximity of the northern sites. Other properties are also located within the catchments of the site. Given the rural nature of the catchment it is assumed that these properties will likely be served by septic tanks and silage pits/ slurry tanks are present at farms, which depending on their maintenance could lead to nutrient enrichment.
Unusual, Distinctive or Atypical Features	Drainage ditches run through the site (particularly the Southern Site and Northern Site 2). Poultry farm to the east of Northern Site 2. Forestry in wider catchments. Two disused quarries within the catchment of Northern Site 1. Intensive agriculture to the west and south of the northern sites (particularly within sub-catchment of Northern Site 2). A disused railway borders Northern Site 2 to the south.

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

6. INTERPRETATION OF RESULTS

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

6.1 General Summary

Groundwater at the northern sites shows impacts from agricultural land with elevated nitrate and total nitrogen recorded across this part of the site.

Both nitrogen and phosphorus levels in surface water samples in the Southern Site were noted to be fairly low. No groundwater samples could be taken in this area due to dry conditions at the time of the site visit.

It should be noted that there were only two sampling locations in both Northern Site 1 and 2 and these were designed by SNH in close proximity to one another. The results are therefore not necessarily representative of conditions in site as a whole.

Northern Sites

pH in this area of the site was noted to be slightly acidic. The lowest pH of 5.28 was recorded at DOL01 in groundwater and is likely attributable to the prevailing soil conditions (this area has been noted to be acidic due to historic forestry activities). Dissolved oxygen was typically higher in surface water as would be expected. Electrical conductivity readings were fairly uniform across the site with the exception of DOL02 which recorded a low value of 0.039µS/cm. It is noted that dissolved metals are also low in this sample indicating that this may be rain water influence which typically has low dissolved mineral content.

Total nitrogen levels are fairly varied with the highest value recorded at DOL01 in groundwater. Both nitrate and ammoniacal nitrogen at this location were significantly lower, which indicate the presence of other forms of nitrogen (*e.g*. organic, nitric) which could be associated with organic matter. The open water sample recorded the lowest nitrogen content (<1mg/l) with the outlet of Northern Site 2 (DOL04) noted to be higher at 7mg/l, likely highlighting the influence of agricultural activities in the catchment. Nitrate was also highest at this location. Nitrate was not recorded in the open water in Northern Site 1 (DOL02). Ammonia was typically higher in the groundwater samples than surface water samples. The distribution of nitrate and ammonia reflected the prevailing geochemical conditions in these environments (oxidising in surface water, reducing in groundwater).

Total phosphorus was below the limit of detection (LOD) in surface water samples. Groundwater samples recorded a maximum value of 2.5mg/l in DOL01. Phosphate levels were also generally low, also recorded at their highest levels in DOL01 at 0.09mg/l.

Iron was recorded at high levels within groundwater as would be expected with significantly lower levels in the surface water samples reflecting the natural processes in each of these distinct environments. The highest iron of 78.9 mg/l was recorded in DOL03.
Calcium and magnesium levels were variable with the highest values recorded in the groundwater sample from DOL03.

The highest total nitrogen in the soil samples was recorded in DOL03B below root sample. All other samples recorded values below the LOD (it is noted that the LOD for each sample is variable). The only positive result for nitrate was also recorded in the DOL03B sample. The higher nitrogen in this area may be influenced by agricultural activities associated with the farm to the west.

Total phosphorus was generally higher in the root zone samples with the higher values recorded in Northern Site 2. Extractable phosphorus was only encountered within the root zone samples with the highest levels recorded within Northern Site 1.

Calcium and magnesium levels within soils were variable, with the highest values recorded within the root zone samples. Levels were noted to be higher in DOL03 and are likely to be due to natural geological factors or attributable to historical liming of soils.

Southern Site

pH in this part of the site was noted to be slightly acidic to slightly alkaline water. Dissolved oxygen was moderate to high in all samples. Electrical conductivity readings were fairly uniform across the site with the lowest value recorded at DOL06.

Total nitrogen was noted to be fairly low and uniform between samples. Nitrate was recorded at similar levels across the southern site, although DOL06 was noted to be lower. Ammonia was generally low with the highest value also recorded in DOL06.

Total phosphorus and phosphate levels were below the limit of detection (LOD) for all water samples.

Calcium and magnesium levels were deemed to be similar across all samples.

All soil samples recorded total nitrogen below detectable limits, although it was noted that each sample recorded a different LOD (see section 3). All samples recorded nitrate below the LOD. Extractable nitrogen was noted to be highest within the root zone.

Total phosphorus was fairly uniform across the dataset with the highest levels recorded in the root zone samples. This could be attributed to the presence of low solubility calcium phosphate minerals. Extractable phosphorus was highest in the DOL08B root zone sample.

Calcium was noted to be significantly higher in both the root zone and below root zone samples in the DOL08 sampling location. This may reflect natural variations attributable to localised geology and soil type. It may also be attributable to historical liming of soils.

6.2 Atypical Results

The data from the Dolphinton - West Linton Fens & Grasslands site were fairly variable. The key observation of data is as follows:

Northern Sites

- DOL02 recorded a low Electrical Conductivity level (0.039mS/cm). It is noted that dissolved metals are also low in this sample indicating that this may be rain water influenced as this typically has a low dissolved mineral content.

- DOL03 recorded iron at 78.9mg/l and is considered to be a result of naturally occurring iron processes in an anaerobic environment.

- DOL03 recorded the highest ammonia and is also considered to be a result of natural processes in an anaerobic environment. The source of the nitrogen may be associated with the adjacent farm to the east or potentially agricultural pressures in the adjacent fields.

- Elevated nitrate of 6.9mg/l was recorded at the outflow in DOL04. The elevated nitrate is likely to be a result of agricultural runoff from surrounding fields and also the potential impacts of the neighbouring poultry farm.

- Elevated total phosphorus and nitrogen in DOL01 is likely attributable to agricultural runoff.

Southern Site

- Elevated extractable phosphorus was observed in DOL08A root zone sample and may highlight higher phosphate levels associated with the retention of phosphate on soil minerals from phosphate within agricultural field run off or, alternatively the presence of low solubility calcium phosphate minerals.

6.3 Additional Considerations

SEPA provided water quality data for the Tarth Water below Blyth Bridge (SEPA, n.d.), approximately 3km downstream of the Southern Site (~4km downstream of the northern sites). Samples at this location were taken on a monthly basis and data is available from January 2009 to July 2010. This data can be summarised as follows:

- pH levels in the burn reflect alkaline conditions – lower pH levels (more acidic conditions) generally observed in surface water at the site, particularly in the northern sub-parts.

- Dissolved oxygen levels are generally high (>9.4mg/l) – lower levels generally observed in surface water at the site, particularly in fen areas (as expected in areas of slow flowing water/ poor drainage).

- Electrical Conductivity ranged between 0.236-0.339mS/cm – comparable to levels observed in surface water at the site.

- Total Organic Nitrogen ranged between 1.85-3.55mg/l. Nitrate levels ranged between 1.85-3.54mg/l – slightly lower levels recorded at the site in surface water, with the exception of Dol04 in Northern Site 2. Ammonia and nitrite levels were generally very low. No clear temporal trends were observed.

- Total phosphorus ranged between 0.027-0.114mg/l – comparable to levels observed at the site. Ortho-phosphate levels ranged between 0.012-0.042mg/l. Highest levels for these compounds were recorded in late autumn through to early winter.

As described above, nutrient levels in the Tarth Burn downstream of the site were in general terms similar to those observed at the site.

7. CONCLUSIONS

The analytical results showed a trend of elevated nutrients within the northern parts of the site (Northern Site 1 at Slipperfield and Northern Site 2 at Medwyn). This is attributed to a consequence of agricultural activities in the sub-catchment.

The study area has three sub-parts; two in the north and one in the south (a fourth part of the SSSI located further south was not included in this study). Grassland areas and parts of the fens of the site have been continuously grazed by stock for generations, with drainage networks put in place on the site in the past, particularly in fen areas.

The latest Site Condition Monitoring (SCM) assessments at the site found the valley fen and calcareous grassland to be in unfavourable condition due to the presence of undesirable species associated with agricultural grasslands and nutrient enrichment in grassland compartments; an absence of positive indicator species associated with fen habitats (including Sphagnum) indicating that the fen is drying out at the Southern Site and Northern Site 1; and cattle poaching in the Northern Site 2. Management recommendations at the site have included raising the water table at the Southern Site and Northern Site 1; reducing/re-targeting grazing at the Northern Site 2; increasing grazing at the Northern Site 1 to control vegetation growth; and changing fertiliser application practices on adjacent land.

The northern sites collect drainage from a 4.2km^2 catchment, dominated by improved pastures to the north and arable land to the southeast and southwest, with some forestry plantations in the wider catchment. The southern site is surrounded by improved pastures and some forestry and drains a catchment of 5km^2 dominated by pastures, arable land and forestry. The lower parts of the site are also fed by groundwater (and groundwater fed springs) from the underlying sand and gravel aquifer. This groundwater will receive nutrients from the wider hydrogeological catchment, which is likely greater than the hydrological catchment.

Two disused quarries are present in the catchment of the northern sites. The A702 forms the boundary between the two northern parts of the site. A poultry farm is located immediately up topographic gradient of the Northern Site 2. It is not known whether waste from this farm is applied within the site catchment, in proximity of the site. There are several properties with septic tanks located in close proximity of the northern sites, potentially contributing further nutrients. There will be some runoff from the A702 which could contribute solids and other contaminants.

Groundwater at the northern sites shows impacts from agricultural practices in the surroundings and wider catchment, with elevated nitrate and total nitrogen recorded across this area. Total phosphorus levels in this area were noted to be low in surface water, and elevated in groundwater. These higher levels could be due to typical geochemical conditions and do not necessarily reflect a higher loading in the catchment. It should be noted that sampling locations in the northern sites were generally clumped together and results are therefore not necessarily representative of general conditions in these areas. Both nitrogen and phosphorus levels in surface water samples in the Southern Site were noted to be fairly low. No groundwater samples could be taken in this area due to dry subgrade conditions at the time of the visit.

8. RECOMMENDATIONS

Based on the limited 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 appropriately distributed locations for key nutrients particularly within the northern sites – to include orthophosphate and bioavailable (extractable) nitrogen. Ideally this would be undertaken over the course of several seasons (*e.g*. for a minimum of one year). The data from such should be compared alongside water levels and rainfall data and seasonal abnormalities to seek to understand the nutrient dynamics taking place within the site. In conjunction with this, assess the seasonal flow and nutrient loads of the main inflows and springs.

8.2 Other commissioned studies

ii. Undertake hydrological and hydrogeological assessment of the contributing catchment in order to determine the quality and quantity of the source flows. Assess the potential effects on hydrology and nutrient regime of raising the water table on the site.

iii. Assess current grazing loadings and associated nutrient input and impact on calcareous grasslands and fens in the different areas of the site to inform the corresponding management agreements.

8.3 Landowner/ Tenants

iv. Proactively engage with local landowners to understand the existing and (foreseeable) proposed changes to the immediate catchment including grazing loads, field use, crop type and soil conditioning approaches (including the adjacent poultry farm). Consider appropriate management strategies accordingly - for example (but not exclusive to) nutrient management planning, buffer strips, cut-off ditches, exclusion zones, treatment of agricultural runoff (e.g. constructed wetlands), re-routing road runoff, routine spot monitoring *etc*.

v. Engage with surrounding farms and households to ensure slurry/septic tanks and silage pits are adequately maintained.

vi. Proactively engage with catchment landowners to understand the historical land use practices to determine any changes which are likely to have influenced the site.

vii. Review the forestry management practices undertaken within the wider catchment. Particular consideration should be given to understand the historical operation, times of planting and application of any soil improvers.

8.4 Regulatory considerations

viii. Engage with SEPA to understand the controls in place at the operational quarries within the site catchment.

From the stated conclusions and identified pressures the key actions to seek to reverse the present unfavourable status of the site are to:

1. Further investigate the link between this status and pollution pressures from current grazing and agricultural practices at and adjacent to the site (i-v);
2. Assess potential impacts of raising the water table (ii); and
3. Address the inputs to the surface water and groundwater from agricultural (and other) activities within the wider catchment as required (iv-vii).

9. REFERENCES

British Geological Survey, n.d. DiGMapGB-625 Data download. Available at: http://www.bgs.ac.uk/products/digitalmaps/dataInfo.html

Centre for Ecology and Hydrology, 2009. *Flood Estimation Handbook (FEH).* CD-Rom Version 3.0. Wallingford, Oxfordshire.

Met Office, n.d. 2012 Weather summaries – Regional values. [Online] Available at: http://www.metoffice.gov.uk/climate/uk/2012

Scottish Environment Protection Agency (n.d). Water Quality Data – Tarth Burn below Blyth Bridge (Spreadsheet). Dates: Jan 2009-Jul 2012. Stirling, Scottish Environment Protection Agency.

Scottish Natural Heritage, 2007. *Dolphinton – West Linton Fens and Grassland – Lowland calcareous grassland - Site Condition Monitoring Form*. Inverness, Scottish Natural Heritage.

Scottish Natural Heritage, 2008a. *Dolphinton – West Linton Fens and Grassland - Valley Fen - Site Condition Monitoring Form*. Inverness, Scottish Natural Heritage.

Scottish Natural Heritage, 2008b. *Dolphinton – West Linton Fens and Grassland - Bryophyte Assemblage - Site Condition Monitoring Form.* Inverness, Scottish Natural Heritage.

Scottish Natural Heritage, 2011a. *Dolphinton – West Linton Fens and Grassland Site of Special Scientific Interest – Citation.* Inverness, Scottish Natural Heritage.

Scottish Natural Heritage, 2011b. *Dolphinton – West Linton Fens and Grassland - Statement.* Inverness, Scottish Natural Heritage.

ANNEX 1: FIGURES

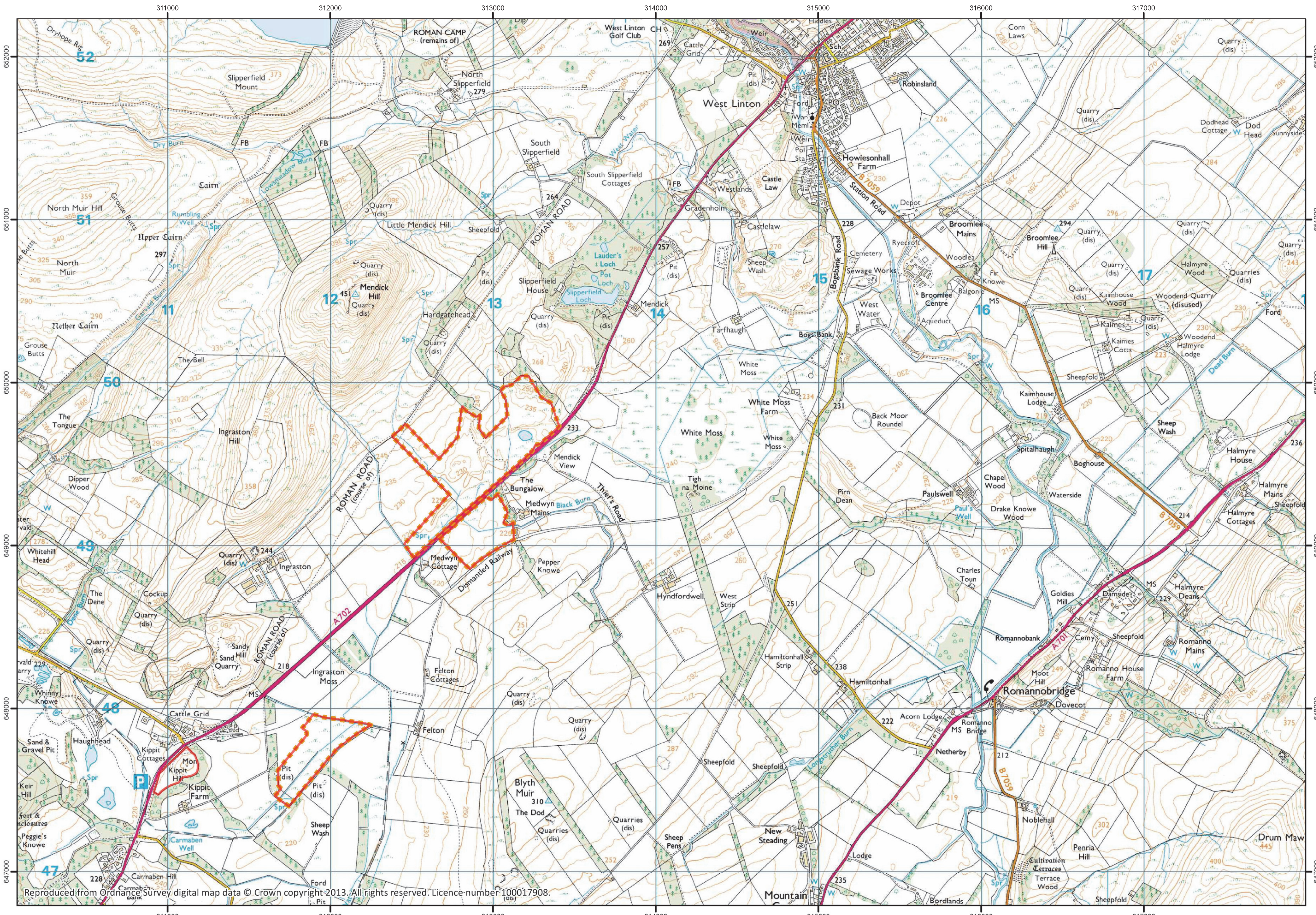
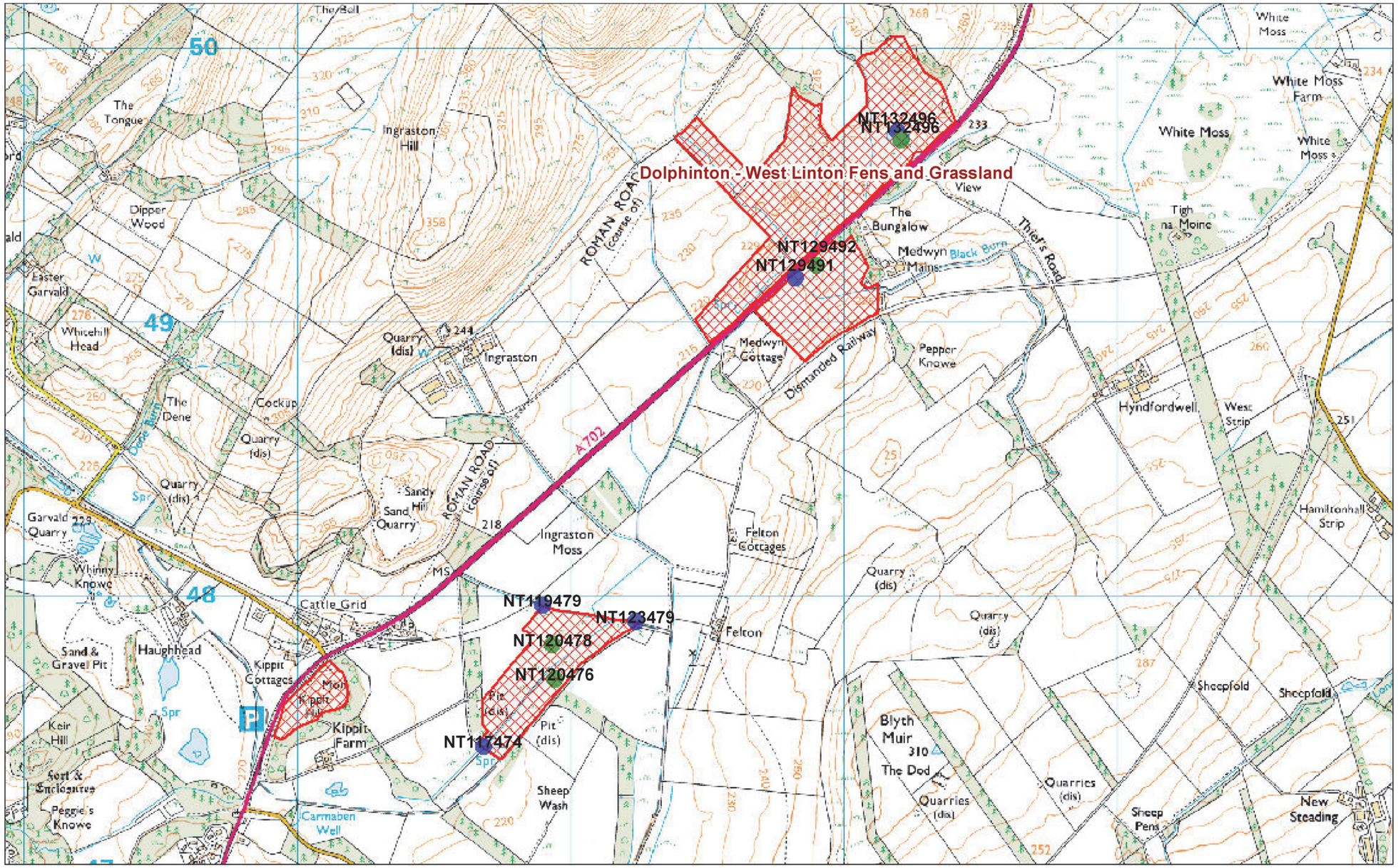


Figure 1.1: Site Location Map

Dolphinton



Notes:

Map produced using geo.View 3.0
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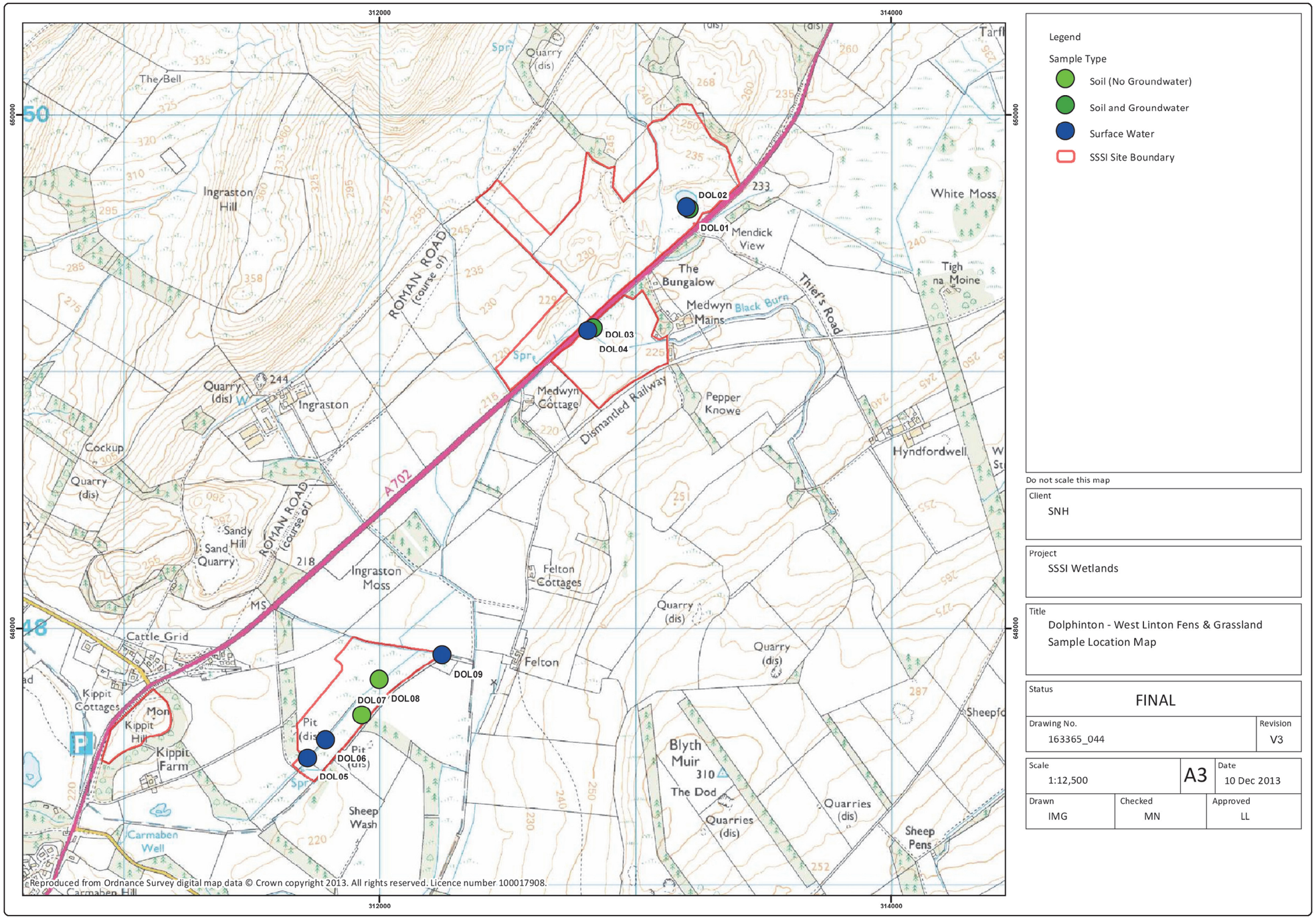
Figure 2.1: SNH Proposed Sampling Location Plan



Legend

Sample Type

- Soil (No Groundwater)
- Soil and Groundwater
- Surface Water
- SSSI Site Boundary

Do not scale this map

Client: SNH

Project: SSSI Wetlands

Title: Dolphinton - West Linton Fens & Grassland Sample Location Map

Status: FINAL

Drawing No.: 163365_044

Revision: V3

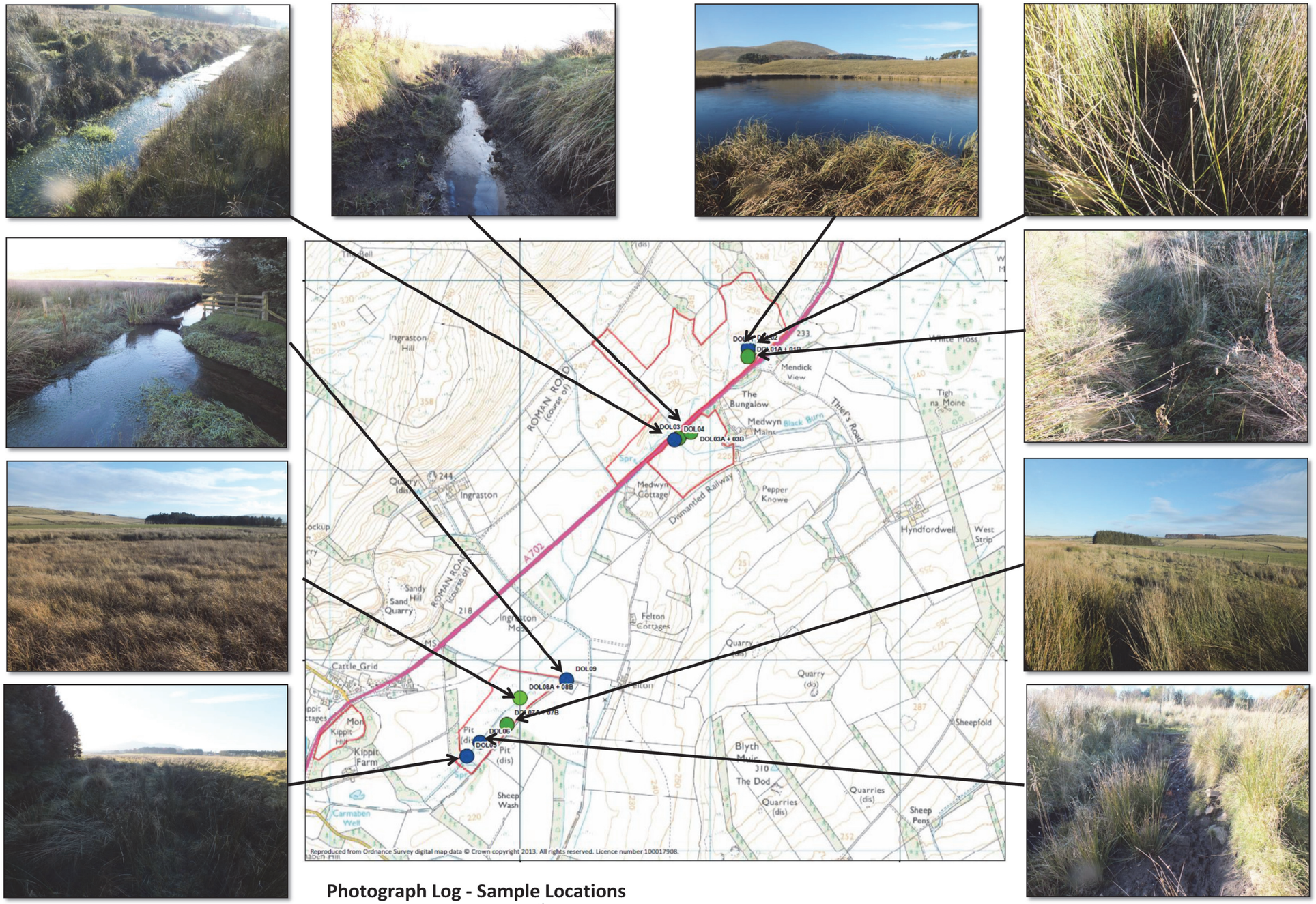
Scale: 1:12,500

A3

Date: 10 Dec 2013

Drawn	Checked	Approved
IMG	MN	LL

Figure 2.2: Plan of Actual Sampled Locations



Photograph Log - Sample Locations
(Photographs taken on 5th November 2012)

Figure 2.3: Photographs of Sampling Locations

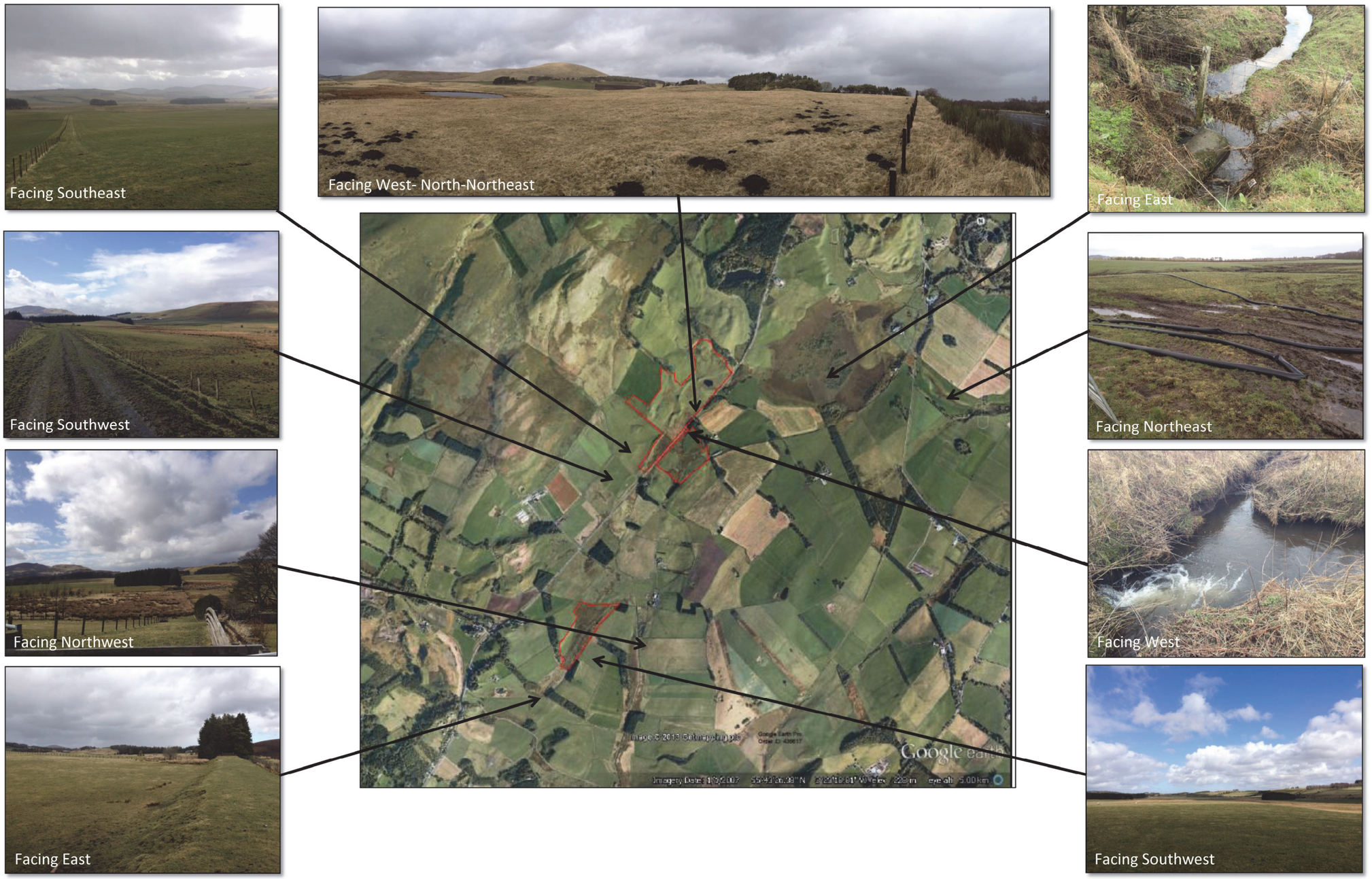
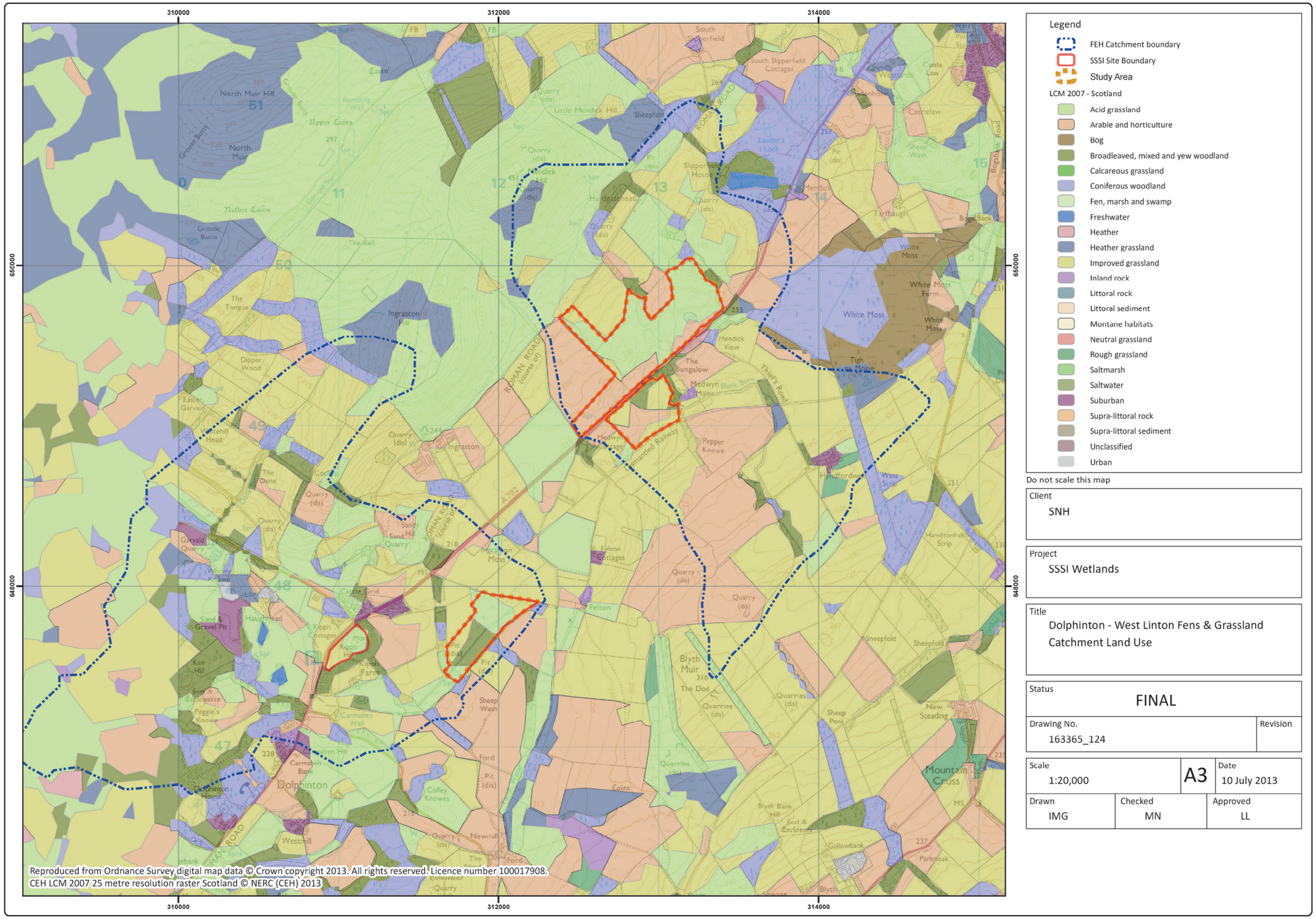


Figure 2.4: Surrounding Land Use Photographs



Legend

- FEH Catchment boundary
- SSSI Site Boundary
- Study Area

LCM 2007 - Scotland

- Acid grassland
- Arable and horticulture
- Bog
- Broadleaved, mixed and yew woodland
- Calcareous grassland
- Coniferous woodland
- Fen, marsh and swamp
- Freshwater
- Heather
- Heather grassland
- Improved grassland
- Inland rock
- Littoral rock
- Littoral sediment
- Montane habitats
- Neutral grassland
- Rough grassland
- Saltmarsh
- Saltwater
- Suburban
- Supra-littoral rock
- Supra-littoral sediment
- Unclassified
- Urban

Do not scale this map

Client	SNH
Project	SSSI Wetlands
Title	Dolphinton - West Linton Fens & Grassland Catchment Land Use
Status	FINAL
Drawing No.	163365_124
Revision	
Scale	1:20,000
A3	
Date	10 July 2013
Drawn	IMG
Checked	MN
Approved	LL

Figure 2.5: Catchment Land Use Characteristics

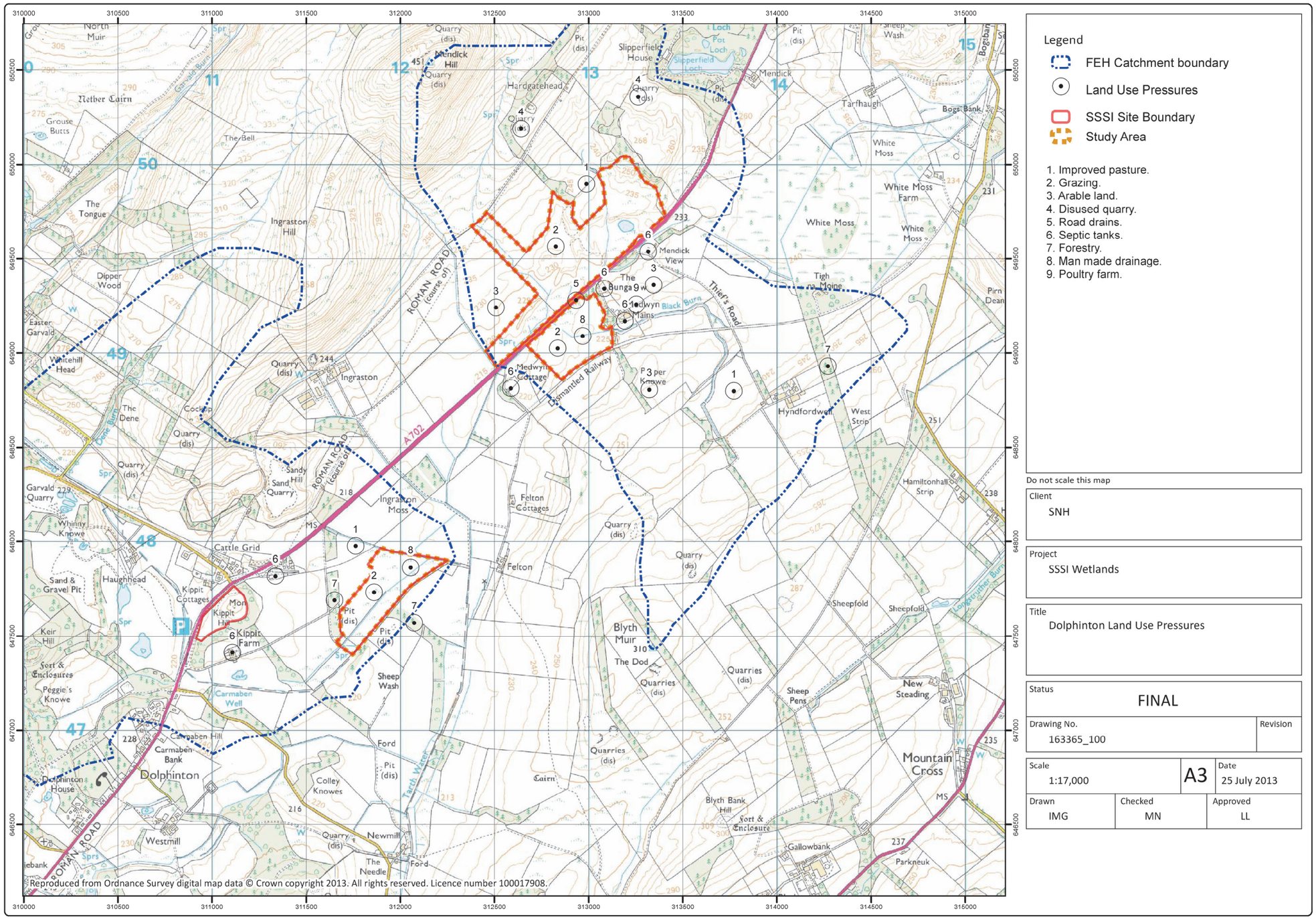


Figure 5.1: Catchment Pressures Land Use Summary

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