Strategy for Monitoring Groundwater Quality

West Penwith Moors and Downs SSSI

May 2025

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Foreword

Oracle Environmental Experts Ltd (OEE) were instructed by Natural England to undertake a survey of potential groundwater monitoring locations across the West Penwith Moors and Downs Site of Special Scientific Interest (SSSI). The West Penwith Moors and Downs SSSI was notified in 2022 and comprises a total area of approximately 3,044 hectares (ha) with a variety of semi-natural habitats including lowland heathland, fens, lowland dry acid grassland, bracken and scrub.

The main objective of this survey was to identify potential sampling locations of groundwater feeding 11 valley fens, or mires, located within the SSSI. OEE used this data to formulate a survey strategy with a view to the collection of baseline water quality data across the valley fens as part of a continuous monitoring programme.

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Executive summary

Background

The West Penwith Moors and Downs SSSI was notified in 2022 and comprises 59 land parcels covering a total area of approximately 3,044 hectares (ha). The SSSI comprises a variety of semi-natural habitats including lowland heathland, fens, lowland dry acid grassland, bracken and scrub.

Aims

This project aims to develop a groundwater monitoring strategy to assess the spatial and temporal variations in groundwater quality across the 11 valley fen features.

Approach

A desk study initially focused on the identification of existing potential groundwater monitoring points such as springs, wells and boreholes to avoid the requirement for the drilling of boreholes.

The desk study initially identified 78 wells, 51 springs and 9 water wells within, or close to, the study area.

A total of 60 potential locations were identified following further review and discussions with Natural England and landowners.

Site walkovers were carried out between 17 June 2024 and 17 July 2024 to assess the viability of locations identified during the desk study.

Locations were further assessed and scored based on their accessibility, year-round viability and requirement for additional infrastructure. Further review of the surrounding land use led to the designation of locations as Primary, Secondary (backup) or Unsuitable.

A total of 21 primary locations and 10 secondary locations have been identified across the 11 mires with a minimum of one primary location within each.

Managed heathland and pastoral land uses are well represented by the monitoring points with no representation of arable farming.

Monitoring Strategy

A three-year monitoring strategy has been developed to assess the baseline conditions of water entering the 11 mires.

Contents

Introduction 8
West Penwith Moors SSSI 8
Objectives 10
Desk Study 11
Approach 11
Results 11
Walkover Visits 11
Sampling Locations 13
Overview 13
1.0 Bostraze & Cryor 14
2.0 Gear 17
3.0 Tregerest 19
4.0 Bosilliack 22
5.0 Boswarva 24
6.0 Lanyon 27
7.0 Embla 29
8.0 Bussow Moor 31
9.0 Bodrifty 34
10.0 Tredinneck 36
11.0 Boswens 38
Summary 40
Appendix A – Location Summary Tables 42
Bostraze & Cryor 43
Gear 46
Tregerest 47

Bossiliack 49
Boswarva 50
Lanyon 53
Embla 54
Bussow Moor 56
Bodrifty 59
Tredinneck 60
Boswens 61
Appendix B - Sampling Strategy 65
Parameters 65
Sampling Techniques 66
Sampling Frequency 67
Sampling Point Enhancement 67
Appendix C – Unsuitable Locations 69
References 73

Introduction

Oracle Environmental Experts Ltd (OEE) were instructed by Natural England to undertake a survey of potential groundwater monitoring locations in the West Penwith Moors and Downs Site of Special Scientific Interest (SSSI).

The main objective of the survey was to identify potential sampling locations of groundwater feeding 11 valley fens, or mires, located within the SSSI. OEE used this data to formulate a survey strategy with a view to the collection of baseline water quality data across the valley fens.

West Penwith Moors SSSI

The West Penwith Moors and Downs SSSI was notified in 2022 and comprises 59 land parcels covering a total area of approximately 3,044 hectares (ha). The SSSI comprises a variety of semi-natural habitats including lowland heathland, fens, lowland dry acid grassland, bracken and scrub.

The SSSI is underlain by granite of the Land's End Intrusion which forms part of the larger Permian Cornubian Batholith which underlies much of Devon and Cornwall. This gives rise to acid loamy soils.

The SSSI also contains notable plant species and is a key breeding habitat for the Dartford Warbler, a species noted as 'Near Threatened' on the IUCN Red List.

A total of 11 valley fens have been identified within the SSSI which are predominantly fed by acidic groundwater derived from the underlying granitic geology. The valley fens developed in an environment reflecting natural hydrogeological processes, a key part of which is the supply of low nutrient, low pH water from the granite aquifer and associated poorly-buffered soils (Buss, 2023). Natural England currently consider that the majority of these features are in an unfavourable condition due to a variety of external factors, including the nutrient enrichment of groundwater by agriculture. This could result in detrimental changes in the wetland vegetation and other dependent biota and may lead to loss of characteristic species and vegetation communities. The 11 valley fens, or mires, are listed in Table 1 and shown in Figure 1.

Table 1: Valley Fen Features

Local Name	Approx. O.S. grid. Ref.	Surface water catchment area (ha)
Bostraze & Cryor	SW 392 321	300.19
Boswens	SW 407 320	111.33

Local Name	Approx. O.S. grid. Ref.	Surface water catchment area (ha)
Tregerest	SW 412 320	97.03
Boswarva	SW 422 335	85.83
Lanyon (Lanyon to Men-an-Tol)	SW 427 345	180.32
Bosilliack	SW 433 336	84.71
Bodrifty (Bodrifty to Bosporthennis)	SW 441 360	115.23
Tredinneck	SW 447 347	60.33
Gear and Chykembro Commons	SW 447 366	64.52
Embla (Embla North and South)	SW 482 372, SW 485 368	131.28
Bussow Moor	SW 501 387	160.29

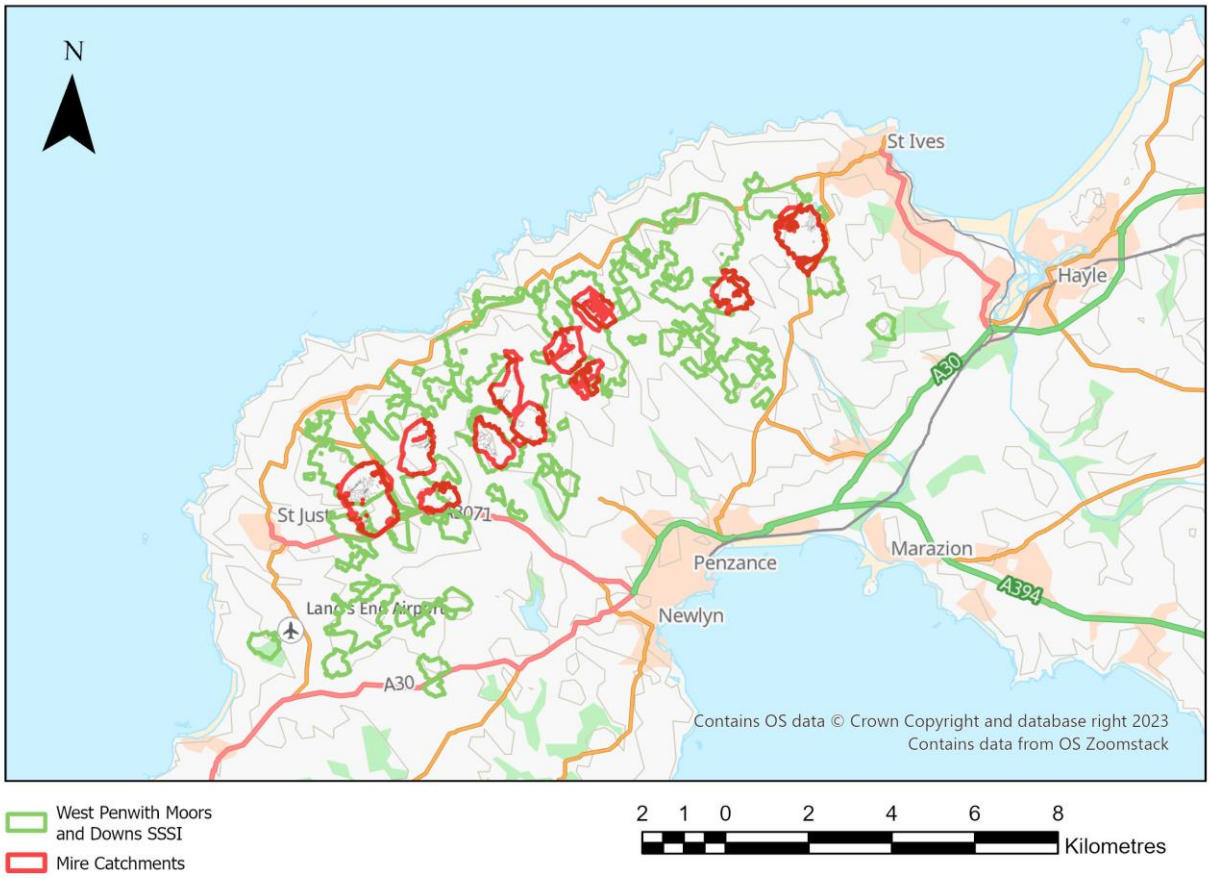


Figure 1: SSSI and Catchment Overview

Fig. 1: SSSI and Catchment Overview

It is the intention of Natural England to restore the valley fens to a favourable condition with a key consideration being engaging with farmers and landowners to discuss and manage their operations to work collaboratively towards this goal.

Objectives

This project aims to develop a groundwater monitoring strategy to assess the spatial and temporal variations in groundwater quality across the valley fen features.

A key part of achieving these objectives is the identification of suitable groundwater monitoring locations which provide suitable access and temporal reliability to allow representative samples of groundwater to be obtained. A further objective is to minimise the requirement for the installation of monitoring boreholes and utilise existing features such as springs and wells.

Desk Study

Approach

The desk study initially focused on the identification of existing potential groundwater monitoring points such as springs, wells and boreholes to avoid the requirement for the drilling of boreholes.

The following data sources were utilised:

- Ordnance Survey Mapping – Features marked as springs, ‘issues’ and wells were identified within each valley fen and in the immediately surrounding area.
- British Geological Survey Geo-Index – Records of boreholes and water wells held by the BGS were reviewed and recorded with each valley fen and surrounding area
- Defra Hydrology Data Viewer – Location of boreholes and availability of data reviewed.

An application was also made to the Cornwall Council Environmental Protection Office for details of private water supplies within the study area.

Results

The desk study initially identified 78 wells, 51 springs and 9 water wells within, or close to, the study area, with Cornwall Council providing details of 206 private water supplies, the majority of which were outside of the study area.

The potential monitoring locations were reviewed based on their proximity to the valley fens, in conjunction with discussions with Natural England. A total of 41 initial possible monitoring locations were identified across the 11 valley fens for further investigation by site walkovers. Further discussions with landowners by Natural England and the visual identification of unmapped features during the walkover, led to a final total of 60 potential locations being visited.

Walkover Visits

Walkover visits were undertaken jointly between OEE and Natural England, with NE making the relevant access arrangements with landowners.

Site walkovers were undertaken between 17 June 2024 and 17 July 2024 by David Newton of OEE with either Bethan Emmett or Julian Donald of Natural England. Locations were ‘scored’ on a scale of zero to nine based on accessibility, infrastructure and year-

round sampling viability. Locations given the highest score (nine) were considered the most suitable for use as monitoring locations. Scoring criteria are shown in Table 2.

Table 2: Summary of initial scoring criteria

Criteria	Score	Description
Accessibility		
Good	3	Easy access on foot from paths/tracks
Moderate	2	Access more challenging but possible
Poor	1	Difficult to access/requires works to access
None	0	No access possible
Infrastructure		
Present	3	Presence of accessible well, pipe or tank for sampling
Not Required	2	No infrastructure required to carry out sampling
Required	1	Infrastructure required to obtain samples
N/A	0	Samples likely cannot be obtained at all
Year Round Viability		
Good	3	High confidence samples can be obtained year round
Moderate	2	Moderate confidence samples can be obtained year round
Poor	1	Low confidence samples can be obtained year round
N/A	0	Samples likely cannot be obtained at any time of year

A summary of all locations visited, their scores and field notes is shown in Appendix A.

Sampling Locations

Overview

The following sections detail the potential sampling locations visited within each mire, and the initial scoring allocated based on the criteria shown in Table 2.

The locations were further assessed based on their proximity to one another, their spatial distribution and representation of differing surrounding land uses, and through discussions with Natural England relating to the objectives of the project. Miles & Gasca (2021) was also referred to when assessing flow paths within the mires.

Primary and secondary (backup) sampling locations were then selected and are presented for each mire along with a brief justification for their determination. Unsuitable locations were also identified.

Primary Locations

Primary locations are those considered likely to provide the most representative sample of groundwater entering the mires. They are typically located outside of the mire and up the anticipated hydraulic gradient.

Secondary Locations

Secondary locations may also be viewed as backup locations. These locations are to be considered for sampling when sampling of the primary locations is not possible. This may be due, for example, to there being no available water or access restrictions. Secondary locations are considered to provide a reasonable representation of groundwater entering the mires but with a lower degree of confidence than primary locations.

A number of locations have been designated as secondary due to their proximity to primary locations.

Unsuitable Locations

Unsuitable locations are those which are considered unlikely to provide a representative sample of groundwater entering the mires. This may be due to a number of factors including the sampling location being located with the mire itself, being located outside of the hydrological catchment, and the potential for external contamination, such as septic tank discharges. A list of the locations identified but deemed unsuitable is shown in Appendix C.

Location Identifiers

Sampling locations have been allocated a unique location ID with a number preceded by a ‘P’ identifying a primary location and a number preceded by an ‘S’ identifying a secondary location.

Each sub-section below includes a Figure showing the primary and secondary locations within each mire and photographs of the sampling locations.

1.0 Bostraze & Cryor

Survey Summary

Date of survey: 17 June 2024

Weather Conditions: Sunny with sporadic cloud

Surveyors: David Newton (OEE) & Bethan Emmett

Access: Via public rights of way from the east. Access is also possible via public right of way from north and west however not investigated on date of survey.

Number of potential features identified: 7

Survey Results

A total of two primary and one secondary sampling location was identified within Bostraze and Cryor as shown in Table 3.

Table 3: Summary of reviewed sampling locations – Bostraze & Cryor

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
4	Spring	6	Primary	Located at the western edge of lowland fen vegetation and up hydraulic gradient of it.	Heath Pastoral (Cattle grazing)	P1
5	Spring	8	Secondary	Within lowland fen vegetation and close to a	Waterlogged heath mire	S1

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
				sample point outside of the mire.		
6	Spring	7	Primary	Located approximately 10m west of lowland fen and up hydraulic gradient	Pastoral (Cattle grazing)	P2

All identified sampling locations assess groundwater entering the mire from the west/north west. These flows are into the lowland fen vegetation type.

The mire is located within the bottom of a valley and flow also occurs from a north-easterly direction into the mire. Flow from this direction would also enter the Mire Mosaic vegetation type. This is typically mire interspersed with lowland heath or acid grassland. This land use is not adequately assessed based on the available sampling locations.

The sampling locations are shown in Figure 2.

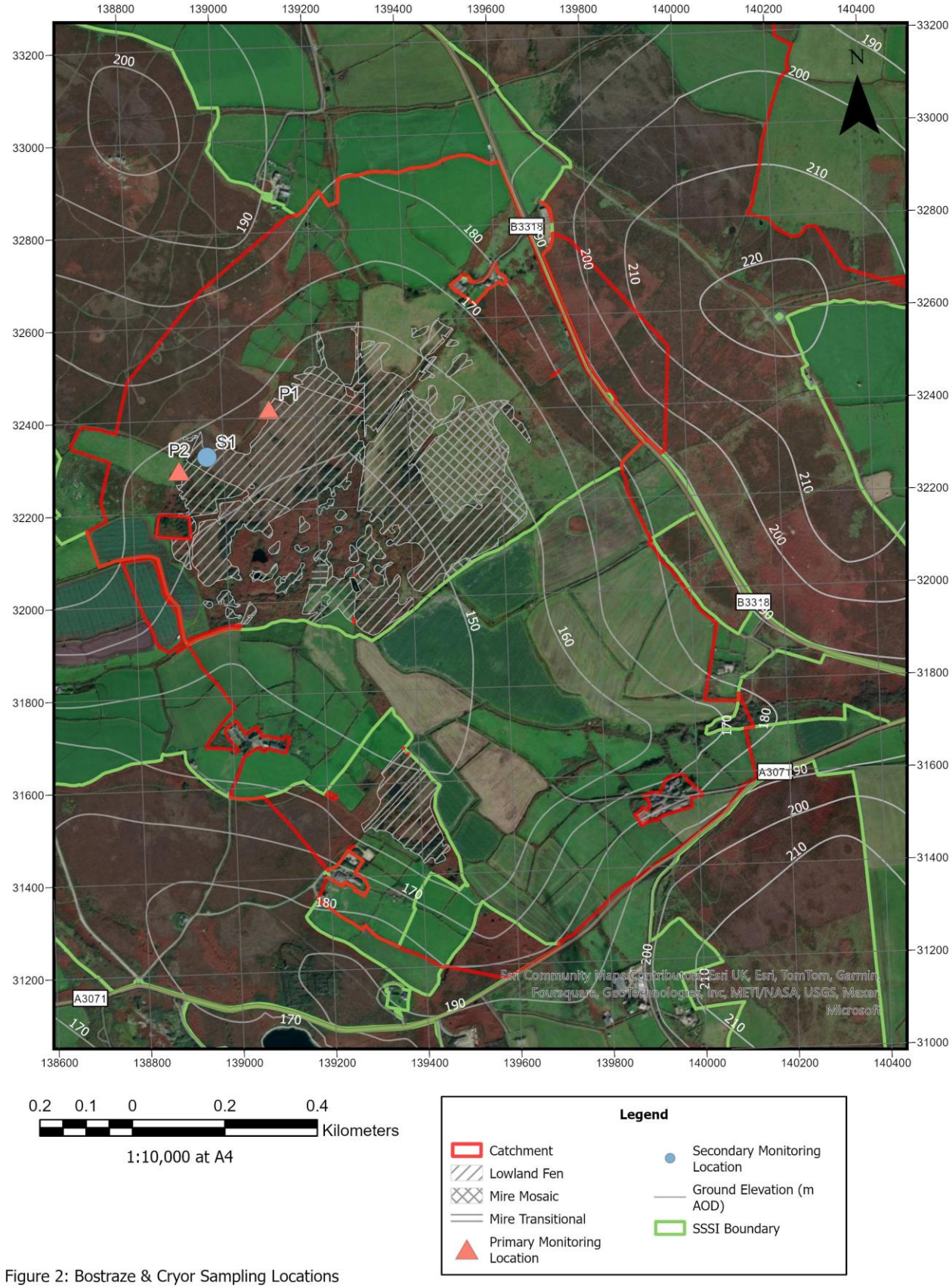


Figure 2: Bostraze & Cryor Sampling Locations

Figure 2: Bostraze ad Cryor Sampling Locations

2.0 Gear

Survey Summary

Date of survey: 17 June 2024

Weather Conditions: Sunny

Surveyors: David Newton (OEE) & Bethan Emmett

Access: Directly from the road to the west of the heath

Number of potential features identified: 1

Survey Results

A single monitoring location was located within the Gear study area and is detailed in Table 4.

Table 4: Summary of reviewed sampling locations – Gear

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
10	Spring	5	Primary	Only potential location within mire.	Heath/common	P3

This mire is located in a valley bottom with groundwater flow expected to follow topography in a north westerly direction. The primary upgradient land is heathland.

The sampling location is shown in Figure 3.

Figure 3: Gear Sampling Locations

Figure 3: Gear Sampling Locations

3.0 Tregerest

Survey Summary

Date of survey: 18 June 2024

Weather Conditions: Sunny

Surveyors: David Newton (OEE) & Julian Donald (NE)

Access: Access via roads and trackways from the south.

Number of potential features identified: 8

Survey Results

A review of the eight potential features identified led to the identification of two primary and one secondary monitoring location as shown in Table 4.

Table 4: Summary of reviewed sampling locations – Tregerest

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
15	Well	5	Secondary	Well infilled/collapsed. Up hydraulic gradient of more vegetation.	Pastoral (Horses)	S2
16	Surface Water	8	Primary	Potential outflow from upgradient infilled well at S2. Up gradient of mire vegetation.	Pastoral (Horses)	P4

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
18	Water well	9	Primary	Easy access for direct groundwater sampling, up hydraulic gradient of mire vegetation.	Pastoral – (Horses & Cattle)	P5

This mire is located on a north-east facing slope with groundwater flow expected to follow topography and be in a north easterly direction. The primary upgradient land use of all sampling locations within the catchment is pastoral with a combination of horse and cattle grazing. Heathland is located further upgradient beyond the mapped catchment.

The sampling locations are shown in Figure 4.

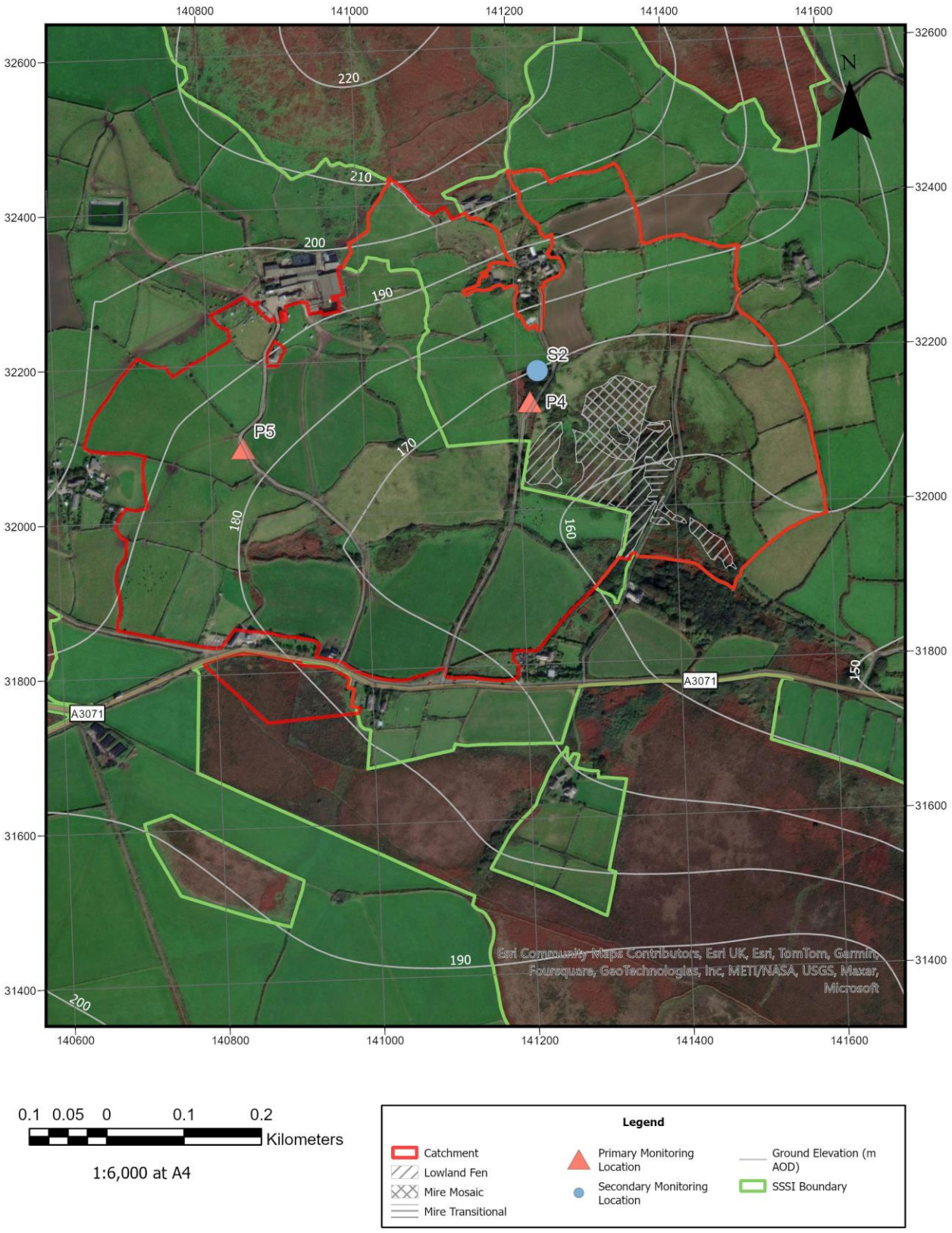


Figure 4: Tregerest Sampling Locations

Figure 4: Tregerest Sampling Locations

4.0 Bosilliack

Survey Summary

Date of survey: 18 June 2024

Weather Conditions: Sunny

Surveyors: David Newton (OEE) & Julian Donald (NE)

Access: Access via roads and trackways from the south.

Number of potential features identified: 2

Survey Results

A review of the two potential features identified led to the designation of both as primary monitoring locations as shown in Table 5.

Table 5: Summary of reviewed sampling locations – Bosilliack

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
19	Spring	5	Primary	Located on edge of mire hydraulically up gradient	Mosaic Mire/Heath	P6
20	Spring	5	Primary	Located on edge of mire hydraulically up gradient	Transitional Mire	P7

This mire is located within a valley with groundwater flow expected to follow topography in a southerly direction. The primary upgradient land use if heathland within the catchment with a mix of heathland and pastoral beyond the catchment.

The sampling locations are shown in Figure 5.

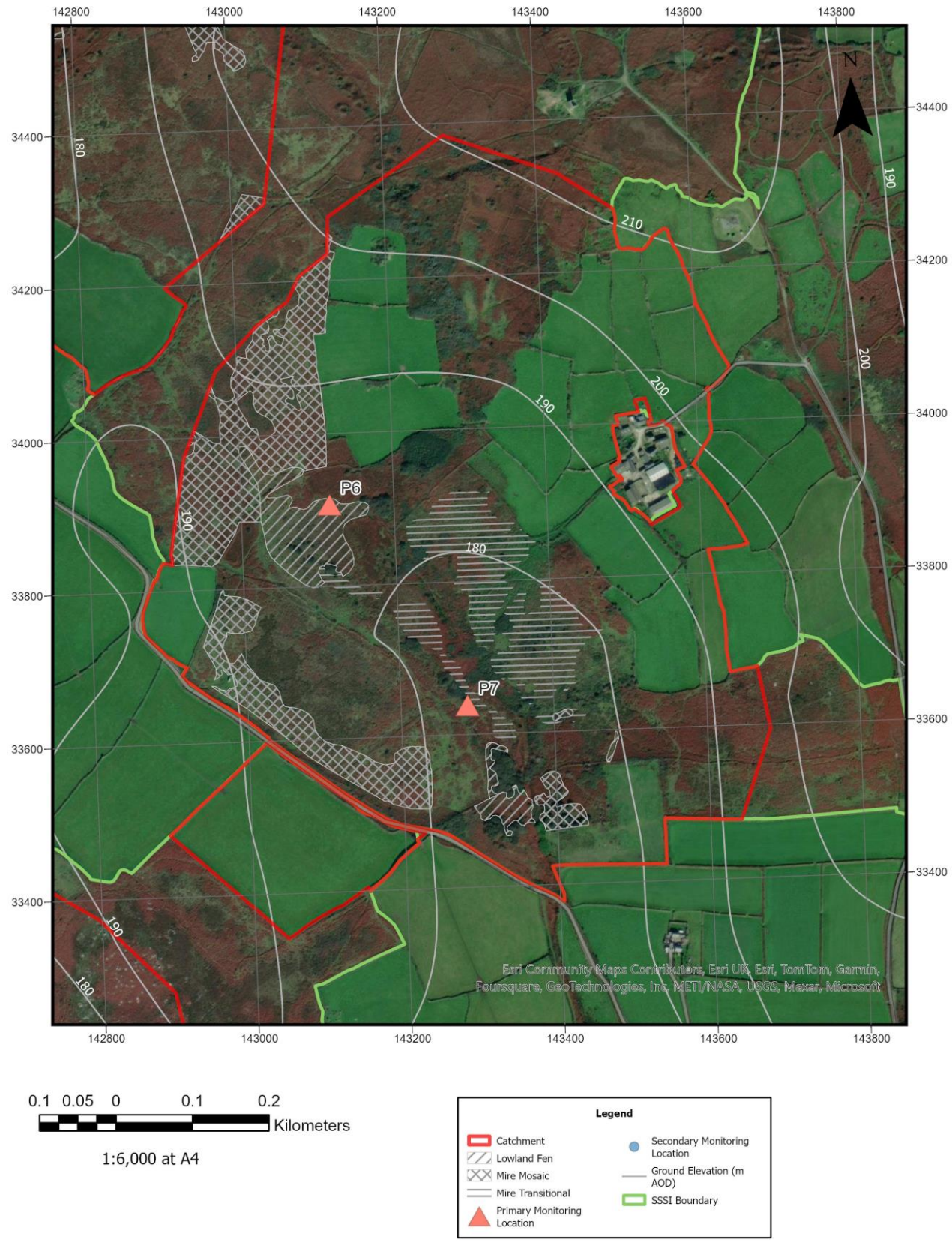


Figure 5: Bosilliack Sampling Locations

Figure 5: Bosilliack Sampling locations

5.0 Boswarva

Survey Summary

Date of survey: 18 June 2024

Weather Conditions: Sunny

Surveyors: David Newton (OEE) & Julian Donald (NE)

Access: Access via road and fields to the east. Access also potentially possible via farmhouse and tracks to the north.

Number of potential features identified: 4

Survey Results

A review of the four potential features identified led to the designation of two primary and two secondary locations as shown in Table 6.

Table 6: Summary of reviewed sampling locations – Boswarva

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
21	Spring	5	Secondary	Secondary location to P8 with less accessibility.	Mire/Heath	S3
22	Spring	7	Primary	At edge of Lowland Fen vegetation and up hydraulic gradient of mire. Better accessibility then S3.	Mire/Heath	P8
23	Spring	5	Secondary	Secondary to P8.	Heath	S4
24	Spring	6	Primary	At edge of Lowland Fen	Mire/Heath	P9

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
				vegetation and up hydraulic gradient of mire.		

This mire is located on the west facing slope of a north-south trending valley with groundwater flow expected to follow topography and flow westwards into the base of the valley. The primary up gradient land use is heathland with pastoral land use beyond to the west outside of the catchment. A region of pastoral land use is also present in to the north east of the catchment which is used for cattle grazing.

The sampling locations are shown in Figure 6.

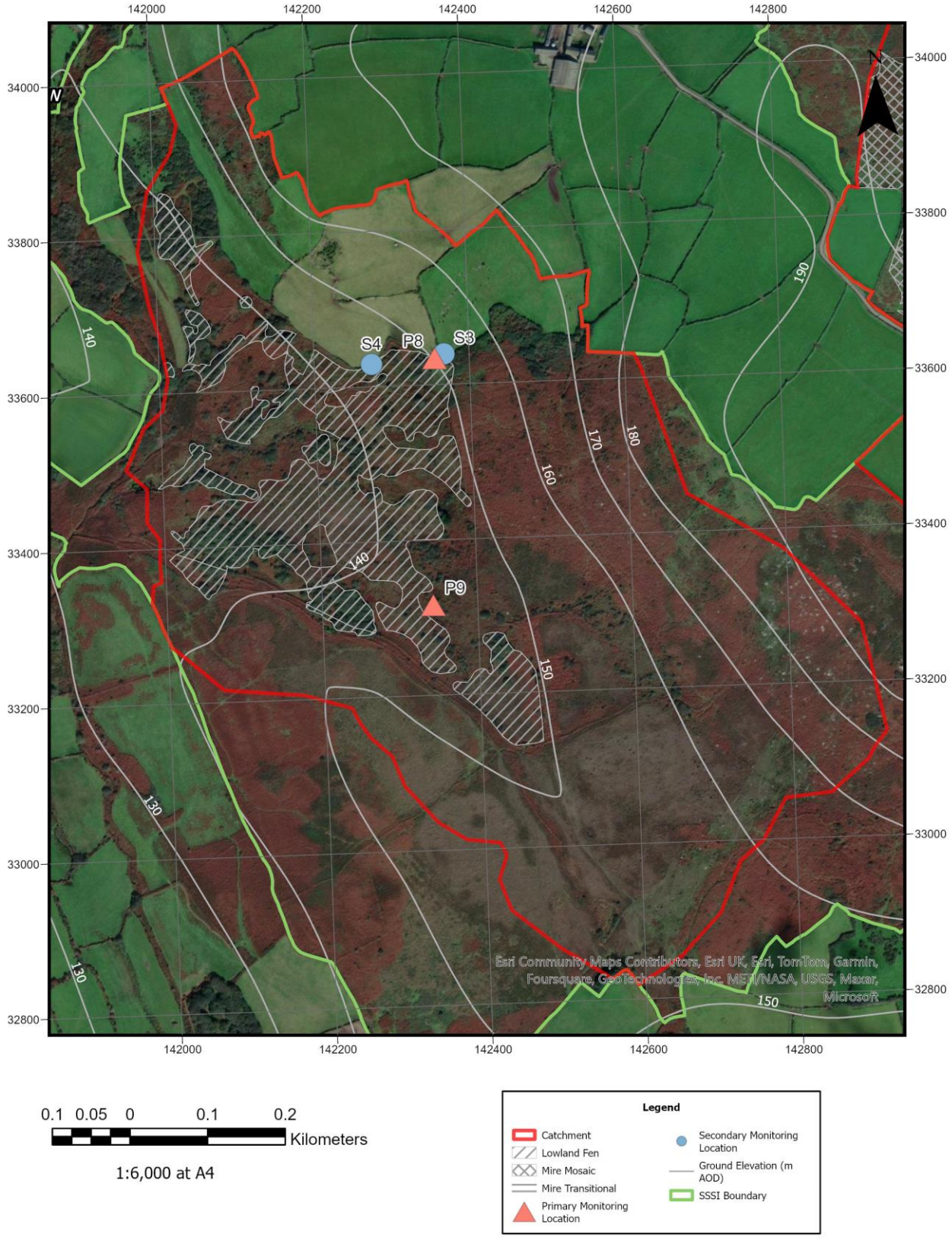


Figure 6: Boswarva Sampling Locations

Figure 6: Boswarva Sampling Locations

6.0 Lanyon

Survey Summary

Date of survey: 18 June 2024

Weather Conditions: Sunny

Surveyors: David Newton (OEE) & Julian Donald (NE)

Access: Access via track and public right of way from the south.

Number of potential features identified: 2

Survey Results

A review of the two potential features identified led to the designation of one primary location as shown in Table 7.

Table 7: Summary of reviewed sampling locations – Lanyon

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
26	Spring	8	Primary	Outside of mire and up gradient of Lowland Fen vegetation. Only viable sampling point.	Heath/ lowland fen	P10

This mire is located further north on the same west facing valley slope as Boswarva. Groundwater flow is expected to follow topography in a south/southeast direction through the catchment. The upgradient land use is primarily heathland.

The sampling location is shown in Figure 7.

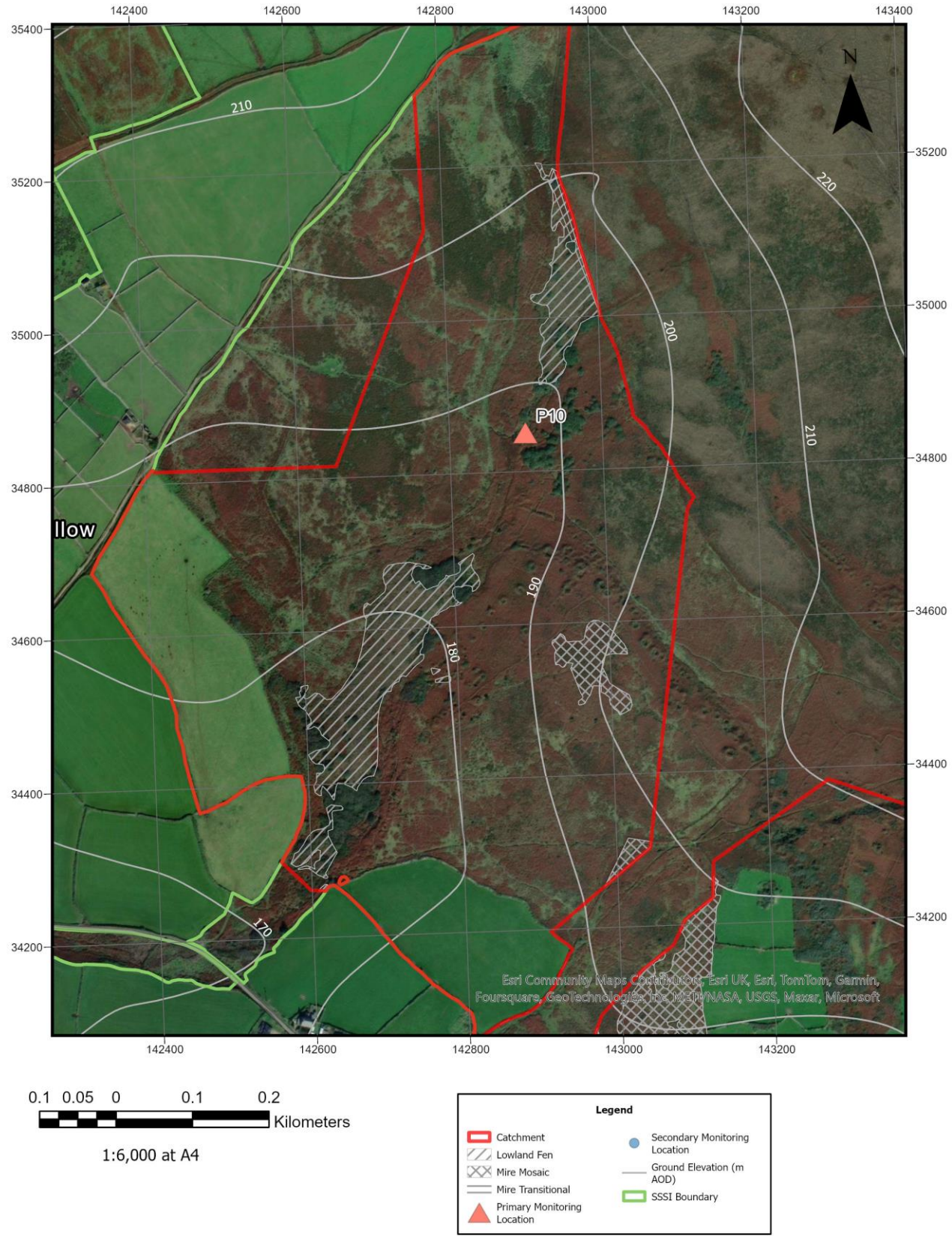


Figure 7: Lanyon Sampling Locations

Figure 7: Lanyon Sampling Locations

7.0 Embla

Survey Summary

Date of survey: 19 June and 12 July 2024

Weather Conditions: Overcast and drizzle

Surveyors: David Newton (OEE), Julian Donald & Bethan Emmett (NE)

Access: Access via tracks to the south and public right of way

Number of potential features identified: 9

Survey Results

A review of the nine potential features identified led to the designation of two primary and one secondary location as shown in Table 8.

Table 8: Summary of reviewed sampling locations – Embla

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
29	Spring	8	Primary	Up hydraulic gradient of mire vegetation.	Pastoral (Cattle grazing)	P11
57	Spring	6	Primary	Up hydraulic gradient of mire vegetation.	Pastoral (Cattle grazing)	P12
58	Surface Water	9	Secondary	Within mire vegetation	Pastoral (Cattle grazing)	S5

Embla is located on a steep east facing slop of a northwest-southeast trending valley. The land use within the catchment is almost entirely pastoral and used for cattle grazing. Groundwater flow is expected to be in south-easterly direction.

The sampling locations are shown in Figure 8.

Figure 8: Embla Sampling Locations

Figure 8: Embla Sampling Locations

8.0 Bussow Moor

Survey Summary

Date of survey: 19 June 2024

Weather Conditions: Overcast and drizzle

Surveyors: David Newton (OEE) & Bethan Emmett (NE)

Access: Access via road and tracks to the north.

Number of potential features identified: 10

Survey Results

A review of the 10 potential features identified led to the designation of three primary and two secondary locations as shown in Table 9.

Table 9: Summary of reviewed sampling locations – Bussow Moor

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
32	Spring	7	Secondary	Up hydraulic gradient of mire vegetation.	Pastoral - Horses	S6
33	Spring	7	Secondary	Up hydraulic gradient of mire vegetation but only flows 6-8 months per year according to landowner.	Pastoral - Horses	S7
36	Well	9	Primary	Up hydraulic gradient of mire vegetation. Location is a well for year-round sampling.	Pastoral	P13
39	Spring	6	Primary	Up hydraulic gradient of mire vegetation.	Pastoral - Dairy	P14

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
40	Spring	8	Primary	Up hydraulic gradient of mire vegetation.	Pastoral - Dairy	P15

This mire is located within a north-south trending valley with a steep slope making up its western extent. Groundwater flow is expected to be northwards towards the coast. The catchment contains a mix of land use with pastoral being the predominant land use with smaller regions of arable farming, woodland, heath and mire.

The sampling locations are shown in Figure 9.

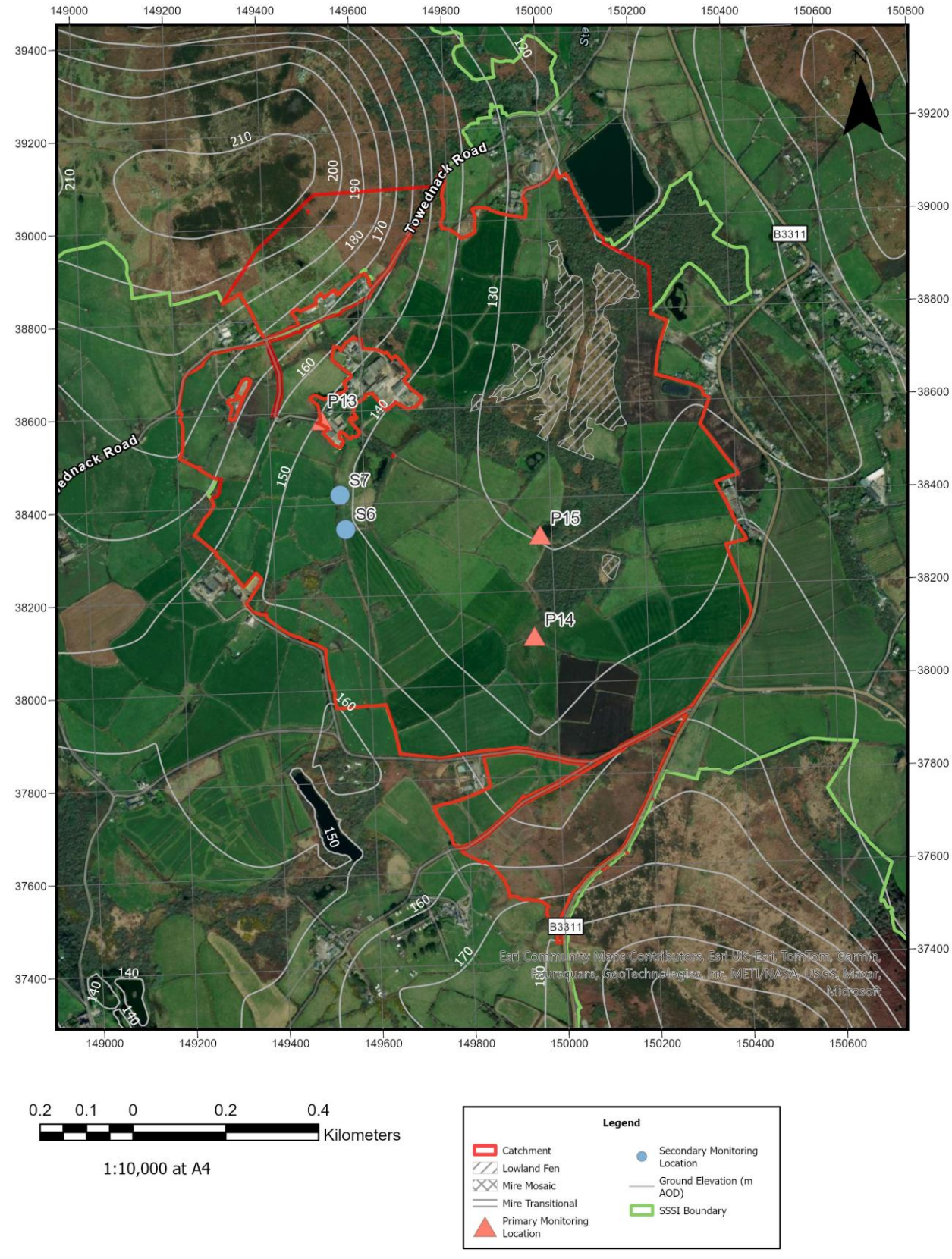


Figure 9: Bussow Moor Sampling Locations

Figure 9: Bussow Moor Sampling Locations

9.0 Bodrifty

Survey Summary

Date of survey: 20 June 2024

Weather Conditions: Sunny

Surveyors: David Newton (OEE) & Julian Donald (NE)

Access: Access via road and tracks to the south.

Number of potential features identified: 6

Survey Results

A review of the six potential features identified led to the designation of two primary locations as shown in Table 10.

Table 10: Summary of reviewed sampling locations – Bodrifty

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
43	Spring	9	Primary	Up hydraulic gradient on western side of mire vegetation.	Heath/pastoral (horses/cattle)	P16
45	Spring	9	Primary	Up hydraulic gradient on eastern side of mire vegetation.	Heath	P17

This mire is located in a north-west to south-east trending valley with the catchment encompassing both the east and west faces of the valley. Groundwater flow locally is expected to be towards the valley bottom and north-west towards the coast over a wider area. The predominant land use within the catchment is heath, with a small fraction of pastoral land. The sampling locations are shown in Figure 10.

Figure 10: Bodrifty Sampling Locations

Figure 10: Bodrifty Sampling Locations

10.0 Tredinneck

Survey Summary

Date of survey: 20 June & 16 July 2024

Weather Conditions: Sunny and overcast

Surveyors: David Newton (OEE) & Julian Donald (NE)

Access: Access via road and tracks to the south.

Number of potential features identified: 4

Survey Results

A review of the four potential features identified led to the designation of one primary location as shown in Table 11.

Table 11: Summary of reviewed sampling locations – Tredinneck

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
62	Spring	9	Primary	Up hydraulic gradient of mire vegetation and only viable sampling point.	Pastoral – (Horses)	P18

This mire is located further south in the same valley as Bodrifty with local groundwater flow expected to be predominantly south-easterly. The predominant land use within the catchment is pastoral.

The sampling locations are shown in Figure 11.

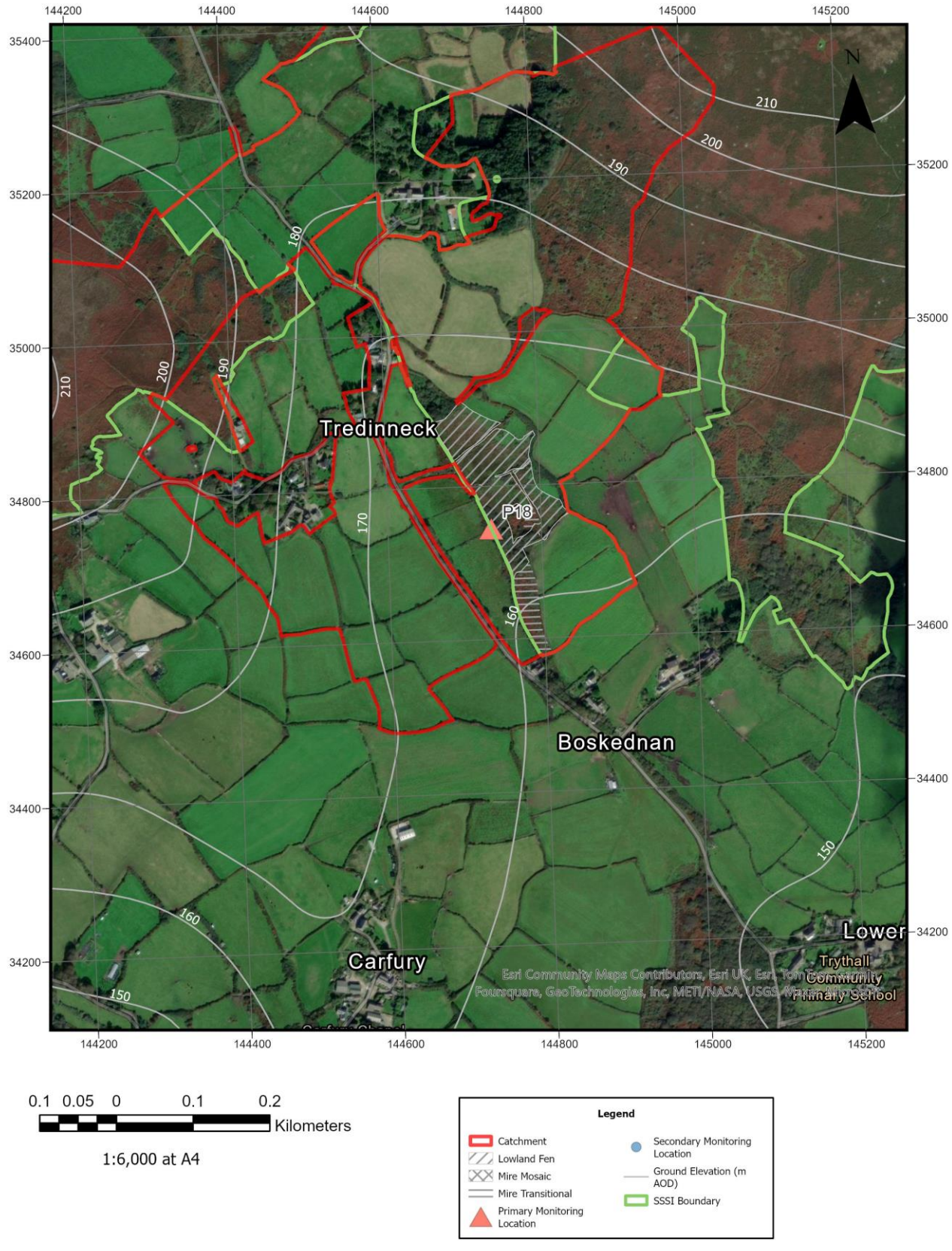


Figure 11: Tredinneck Sampling Locations

Figure 11: Tredinneck Sampling Locations

11.0 Boswens

Survey Results

A review of the seven potential features identified led to the designation of three primary and three secondary locations as shown in Table 12.

Table 12: Summary of reviewed sampling locations – Boswens

Walkover Form ID	Type	Overall Score	Designation	Justification	Primary upgradient land use	Location ID
50	Spring	6	Secondary	Up hydraulic gradient but at greater distance than primary locations.	Heath	S8
51	Spring	5	Primary	Upgradient of more vegetation.	Pastoral (Horses)	P19
52	Spring	9	Secondary	Upgradient of mire vegetation but at greater distance than primary locations.	Pastoral – (Horses)	S9
53	Spring	5	Primary	Upgradient of mire vegetation.	Pastoral – (Horses)	P20
54	Spring	8	Primary	Upgradient of mire vegetation	Pastoral – (Horses)	S10
55	Spring	6	Primary	Within mire vegetation	Pastoral – (Horses)	P21

This mire is located within an east-west trending valley with groundwater flow expected to be in an easterly direction. The predominant land use in the catchment is pastoral with regions of heathland in the north-west and south-east on the steepest slopes.

The sampling locations are shown in Figure 12.

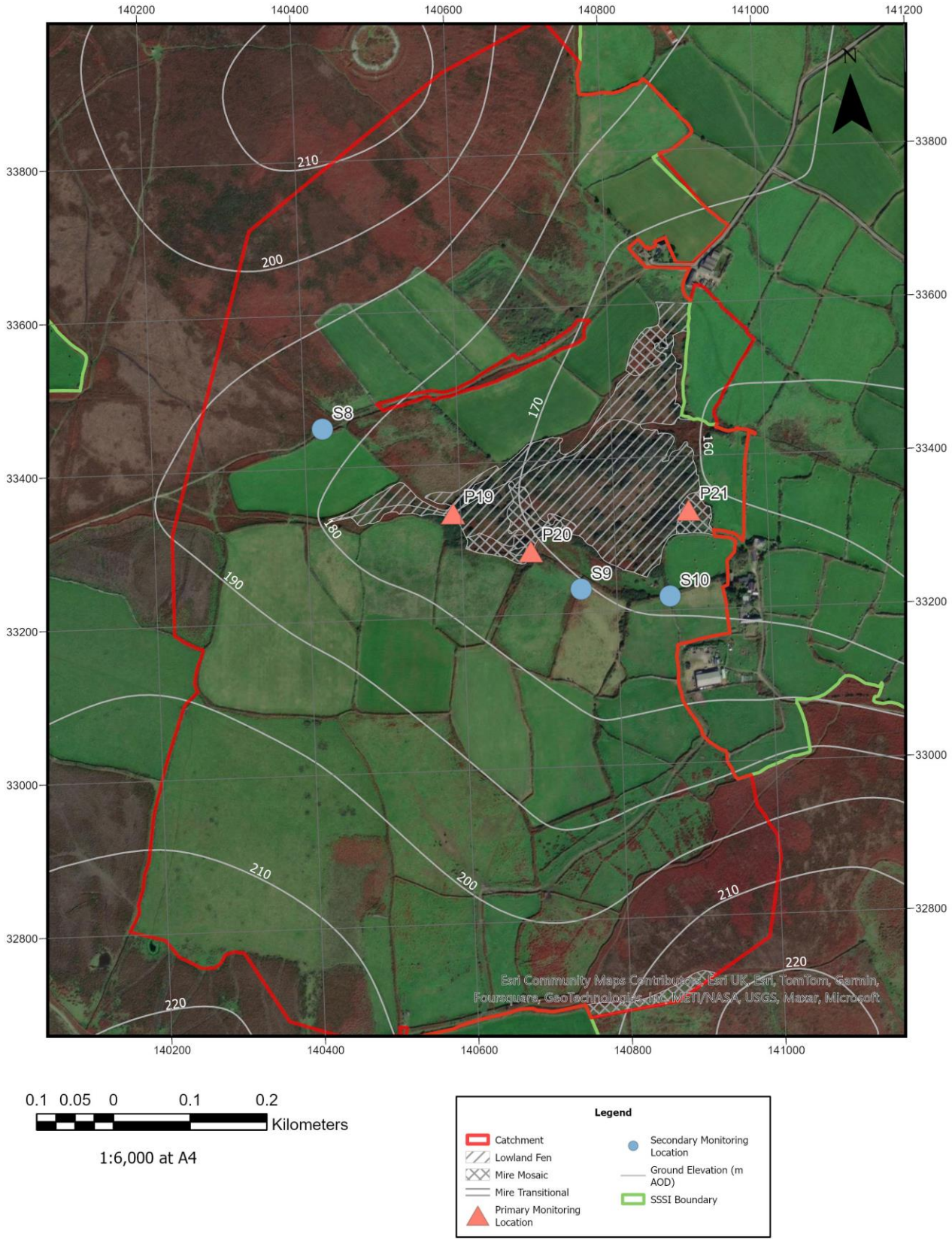


Figure 12: Boswens Sampling Locations

Figure 12: Boswens Sampling Locations

Summary

Primary & Secondary Locations

A total of 31 viable monitoring locations were identified across the 11 mires with 21 designated as primary locations and 10 secondary, or backup, monitoring locations. A total of 29 monitoring locations were deemed unsuitable based on their characteristics and/or the aims of the project.

A summary of the distribution of primary and secondary sampling locations across the study area is shown in Table 13.

Table 13: Summary of primary & secondary sampling locations

Mire	No. of primary	No. of secondary	Total
Bostraze & Cryor	2	1	3
Boswens	3	3	6
Tregerest	2	1	3
Boswarva	2	2	4
Lanyon (Lanyon to Men-an-Tol)	1	0	1
Bosilliack	2	0	2
Bodrifty (Bodrifty to Bosporthennis)	2	0	2
Tredinneck	1	0	0
Gear	1	0	1
Embla (Embla North and South)	2	1	3
Bussow Moor	3	2	5
Total	21	10	31

At least one primary location has been identified in each mire with secondary locations also identified in six mires.

Land-use Representation

A key aim of this strategy is to identify sampling locations which represent the different land use types surrounding the mires. A summary of the sampling locations and the vegetation types is shown in Table 14.

Table 14: Upgradient land use representation

Vegetation Type	No. of primary locations	No. of secondary locations
Pastoral	10	3
Pastoral - Dairy	3	0
Pastoral - Horses	1	4
Mire/Heath	3	1
Heath	3	2
Mire	1	0
Arable	0	0
Total	21	10

Both pastoral agriculture and managed heathlands are represented by the monitoring points. No monitoring points have been identified which would be representative of arable land use upgradient.

Monitoring Point Enhancement

A summary of the monitoring locations is shown in Appendix A with a total of 14 locations recommended for enhancement to increase the chance of them being viable for sampling all year round.

Monitoring Strategy

The monitoring strategy is presented in Appendix B.

Appendix A – Location Summary Tables

Survey Summary

Date of survey: 20-21 June 2024

Weather Conditions: Sunny and overcast

Surveyors: David Newton (OEE) & Julian Donald (NE)

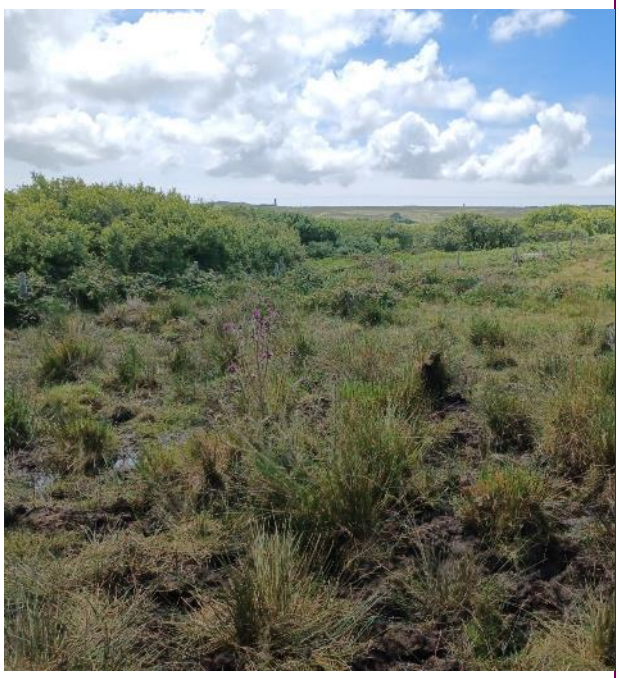
Access: Access via tracks to the south and north. Public rights of way on site.

Number of potential features identified: 7

Bostraze & Cryor

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P1	Spring	Install monitoring point to increase chance of sampling all year	///lushly.strictest.energy	50.1343117	-5.652342
S1	Spring	-	///light.screening.supreme	50.133368	-5.654188
P2	Spring	Fence from livestock	///beams.reputable.kindness	50.133099	-5.655029

ID	Sample Location	Area overview
P1	 **Sample location P1**	 **Area location P1**
S1	 **Sample location S1**	 **Area location S1**

ID	Sample Location	Area overview
P2		
	Sample location P2	**Area location P2**

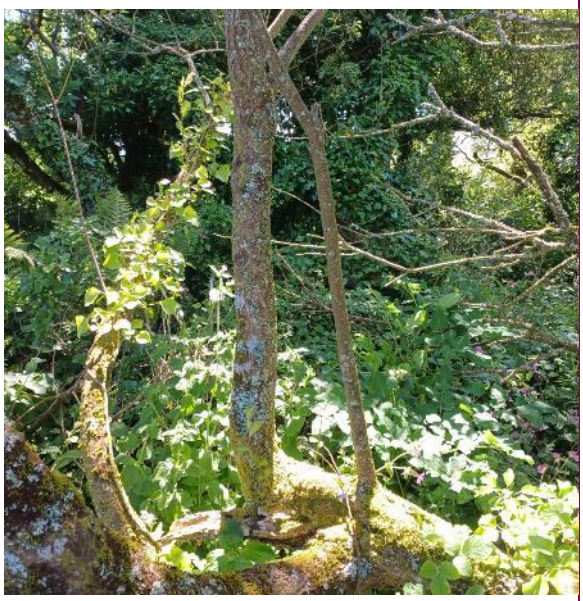
Gear

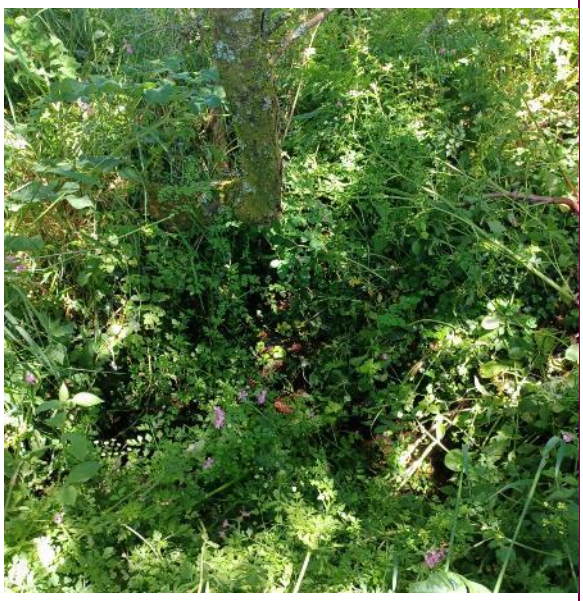
Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P3	Spring	Install monitoring point to increase chance of year round sampling	///evolving.safety.imprints	50.1747644	-5.5762267

ID	Sample Location	Area overview
P3	 **Sample location P3**	 **Area overview P3**

Tregerest

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
S2	Well	Install monitoring point to increase chance of year round sampling	///habit.quibble.gullible	50.133111	-5.6225
P4	Surface Water	None	///music.shame.tiling	50.132748	-5.62262
P5	Borehole	None	///planting.unsigned.motivates	50.132156	-5.6278

ID	Sample Location	Area overview
S2	 **Sample location S2**	 **Area overview S2**

ID	Sample Location	Area overview
P4	 **Sample location P4**	 **Area overview P4**
P5	 **Sample location P5**	 **Area overview P5**

Bossiliack

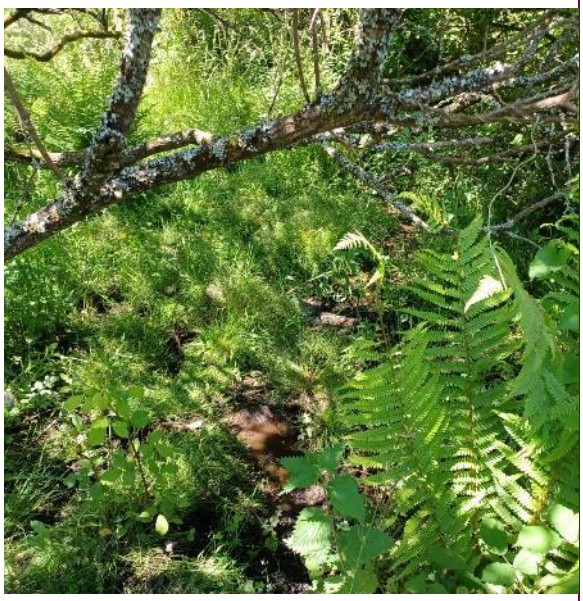
Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P6	Spring	Install monitoring point to increase chance of year round sampling	///arrive.agency.ecologist	50.149431	-5.59729
P7	Spring	Install monitoring point to increase chance of year round sampling	///momentous.tram.insisting	50.1470967	-5.59471

ID	Sample Location	Area overview
P6	 **Sample location P6**	 **Area overview P6**

ID	Sample Location	Area overview
P7	 **Sample location P7**	 **Area overview P7**

Boswarva

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
S3	Spring	Install monitoring point to increase chance of year round sampling	///resonates.rating.fidelity	50.146709	-5.60756
P8	Spring	Install monitoring point to increase chance of year round sampling	///reconnect.napped.spinning	50.146655	-5.60772
S4	Spring	Install monitoring point to increase chance of year round sampling	///novels.couch.message	50.146574	-5.60886
P9	Spring	Install monitoring point to increase chance of year round sampling	///lights.label.patrolled	50.143799	-5.60768

ID	Sample Location	Area overview
S3	 **Sample location S3**	 **Area overview S3**
P8	 **Sample location P8**	 **Area overview P8**

ID	Sample Location	Area overview
S4	 **Sample location S4**	 **Area overview S4**
P9	 **Sample location P9**	 **Area overview P9**

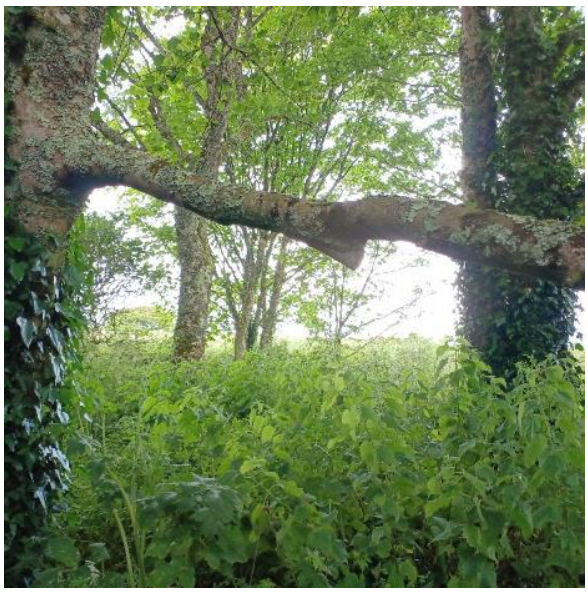
Lanyon

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P10	Spring	None	///soothing.stands.twinkling	50.157813	-5.60095

ID	Sample Location	Area overview
P10	 **Sample location P10**	 **Area overview P10**

Embla

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P11	Spring	None	///broke.gravy.newsstand	50.178027	-5.52918
P12	Spring	None	///skater.users.warned	50.178862	-5.52479
S5	Surface Water	None	///elated.beaks.tour	50.1787	-5.52463

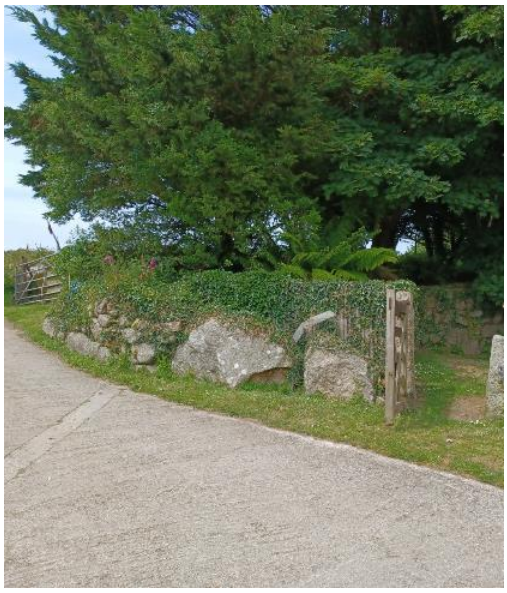
ID	Sample Location	Area overview
P11	 **Sample location P11**	 **Area overview P11**

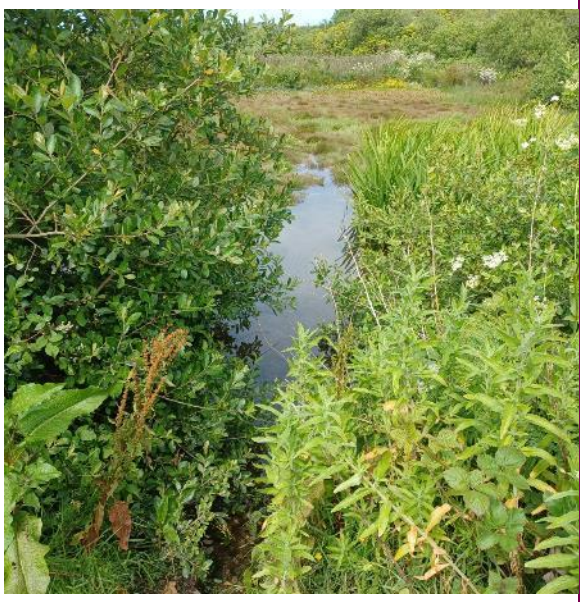
ID	Sample Location	Area overview
P12	 **Sample location P12**	 **Area overview P12**
S5	 **Sample location S5**	 **Area overview S5**

Bussow Moor

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
S6	Spring	None	///kneeled.ruby.questions	50.192041	-5.51022
S7	Spring	None	///clubs.deeply.roadways	50.1926982	-5.51041
P13	Well	None	///boxer.rehearsed.loudly	50.194143	-5.51098
P14	Spring	Install monitoring point to increase chance of year round sampling	///manages.outhouse.under	50.19002	-5.50449
P15	Spring	None	///assess.isolated.lamenting	50.191987	-5.50436

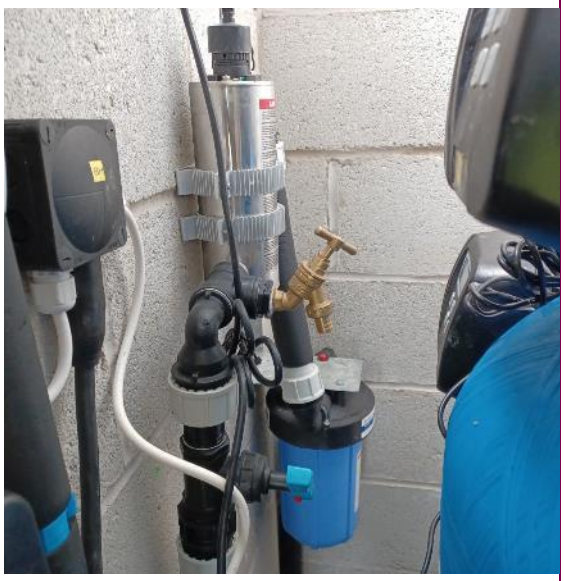
ID	Sample Location	Area overview
S6		

ID	Sample Location	Area overview
	Sample location S6	**Area overview S6**
S7	 **Sample location S7**	 **Area overview S7**
P13	 **Sample location P13**	 **Area overview P13**

ID	Sample Location	Area overview
P14	 **Sample location P14**	 **Area overview P14**
P15	 **Sample location P15**	 **Area overview P15**

Bodrifty

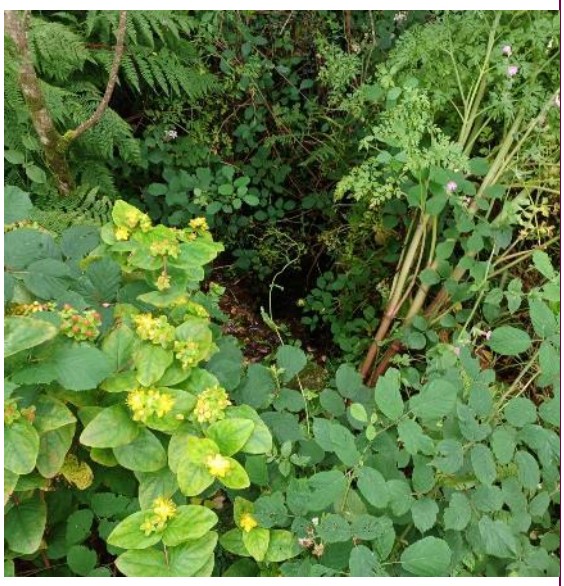
Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P16	Spring	None	///etchings.began.patio	50.164497	-5.58899
P17	Spring	None	///jams.supper.slam	50.164012	-5.57948

ID	Sample Location	Area overview
P16	 **Sample location P16**	 **Area overview P16**
P17		

ID	Sample Location	Area overview
	Sample location P17	**Area overview P17**

Tredinneck

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
P18	Spring	None	///fever.enhancement.owner	50.157362	-5.57294

ID	Sample Location	Area overview
P18		
	Sample location P18	**Area overview P18**

Boswens

Location ID	Type	Recommendations	What3Words	Latitude	Longitude
S8	Spring	Install monitoring point to increase chance of year round sampling	///dices.nails.recruiter	50.144176	-5.63458
P19	Spring	Install monitoring point to increase chance of year round sampling	///waltzed.blindfold.quibble	50.143206	-5.63218
S9	Spring	None	///chucked.blacked.spent	50.142343	-5.62982
P20	Spring	Install monitoring point to increase chance of year round sampling	///polka.rentals.prep	50.142774	-5.63075
S10	Spring	None	///slouched.joins.downcast	50.14227 83	-5.6282
P21	Spring	Install monitoring point to increase chance of year round sampling	///syndicate.instant.thundered	50.143286	-5.62788

ID	Sample Location	Area overview
S8	 **Sample location S8**	 **Area overview S8**
P19	 **Sample location P19**	 **Area overview P19**

ID	Sample Location	Area overview
S9	 **Sample location S9**	 **Area overview S9**
P20	 **Sample location P20**	 **Area overview P20**

ID	Sample Location	Area overview
S10	 **Sample location S10**	-
P21	 **Sample location P21**	 **Area overview P21**

Appendix B - Sampling Strategy

Parameters

Anthropogenic land uses during the surveys were typically pastoral including grazing of horses and dairy cattle. Based on the land uses observed, the objectives of the project, and the suggested list of parameters presented by Natural England in the tender documentation the recommended monitoring parameters are shown in Table B1.

Table B1: Recommended Analysis Parameters

Parameter	Analysis Type	Limit of detection	Laboratory Methodology/ Accreditation
pH	Laboratory Analysis	0.1 standard pH Units	Potentiometric / ISO17025
Electrical conductivity	Laboratory Analysis	0.1 µS/cm	Potentiometric / ISO17025
Dissolved Oxygen	Laboratory Analysis	0.001 mg/l	Electrode / None
Nitrate	Laboratory Analysis	0.01 mg/l	Colorimetric / ISO17025
Total Nitrogen	Laboratory Analysis	0.1 mg/l	Digestion (Kjeldahl) / None
Orthophosphate (as P)	Laboratory Analysis	10 µg/l	Discrete Analyser /ISO17025
Ammoniacal nitrogen as N	Laboratory Analysis	15 µg/l	Discrete Analyser /ISO17025
Major Cations (Calcium, magnesium, sodium, potassium)	Laboratory Analysis	0.012 mg/l, 0.005 mg/l, 0.01 mg/l, 0.025 mg/l	ICP-OES / ISO17025

Parameter	Analysis Type	Limit of detection	Laboratory Methodology/ Accreditation
Major Anions (bicarbonate, chloride, sulphate)	Laboratory Analysis	3 mgCaCO3/l, 0.15 mg/l, 0.045 mg/l	ICP-OES, Discrete Analyser / ISO17025
Total Dissolved Solids (wells/boreholes only)	Laboratory Analysis	0.5 mg/l	Gravimetric / ISO17025

Where available all laboratory analysis should be carried out by an independent UKAS accredited laboratory.

Sampling Techniques

All sampling should be completed by appropriately trained and competent staff and in accordance with the relevant British Standards (i.e. BS EN 5667 series on water quality sampling).

Samples from boreholes or wells should be obtained using a dedicated sampling bailer. A single bailer can be allocated to a particular sampling point and re-used, subject to it being rinsed with sample water between uses. Where the sample is to be obtained from a borehole or well used for potable supply, a new disposable bailer should be used on each sampling occasion. Reusable stainless stainless-steel bailers can also be considered for non-potable sampling points subject to effective cleaning between uses.

Where the monitoring point is a well or borehole, the depth to water should be measured prior to sampling using a dip meter. The depth to water should be recorded from ground level if possible or another fixed datum, which is to be recorded. The measurement is to be recorded to the nearest millimetre. If the sampling point forms part of a potable water supply, suitable hygiene practices should be followed, including the thorough cleaning and disinfection of equipment prior to measurement.

It is standard practice to carry out purging of water from boreholes or wells to obtain a representative sample of groundwater. Where a monitoring point is regularly pumped to obtain water, this is not required. If the monitoring point is not regularly pumped, then the purging of the borehole/well is recommended before sampling. It is recommended to purge and discard three times the volume of water contained within the borehole/well. Where this is not feasible, alternative sampling methods such as low-flow sampling, or the use of diffusion samplers should be considered. These methods generate significantly less waste water, although it is considered that this could be discarded to ground nearby.

It may be possible to obtain water samples from taps connected to the pumping and treatment infrastructure of potable supplies. Samples of ‘raw’ water should be obtained before the water has been subject to any filtration or treatment.

The sampling of surface water or standing water should be made directly into laboratory supplied containers where possible. Where this is not possible, for example due to safety reasons, a telescopic sampling pole with stainless steel sampling cup should be used. The cup should be rinsed with clean water between uses and then again rinsed with the sampled water before collecting the final sample.

Samples should be immediately transferred to laboratory supplied containers, be kept cool and be delivered to the laboratory under an appropriate chain of custody. The laboratory should be UKAS accredited for the sample analysis required and UKAS accredited techniques should be used for the required analysis where available.

Sampling Frequency

In order to provide a baseline of groundwater quality, and observe seasonal variations, it is recommended that monthly sampling is carried out for a period of 3 years. Following this, the sampling frequency could be reduced to quarterly if no significant land use changes or seasonal variations are observed.

Sampling Point Enhancement

A number of sampling locations have been highlighted as requiring some additional infrastructure to allow them to remain viable. These are primarily springs, and their discharge at the surface may be ephemeral.

The installation of a vertical monitoring well may allow these locations to be sampled for longer periods of the year. A typical installation would consist of a hole driven into the soils using a large diameter hand auger or a narrow trial pit being excavated. A narrow diameter, (e.g. 50mm internal diameter), slotted section of well-screen would be inserted and surrounded with clean filter gravel. A cap would then be placed on the top to prevent ingress of rainwater or wildlife. It is not recommended that a permanent locking cover is installed as this would require the use of concrete which may impact the results of future sampling from that location. The installation of any monitoring points which require breaking ground should be subject to appropriate precautions in relation to buried services. It is expected that these works can be undertaken with hand tools only without the need for any plant, such as excavators.

A cross section of an example groundwater monitoring point is shown in Figure B1 and an example above ground cover is shown in Figure B2.

Figure B1: Example monitoring point enhancement

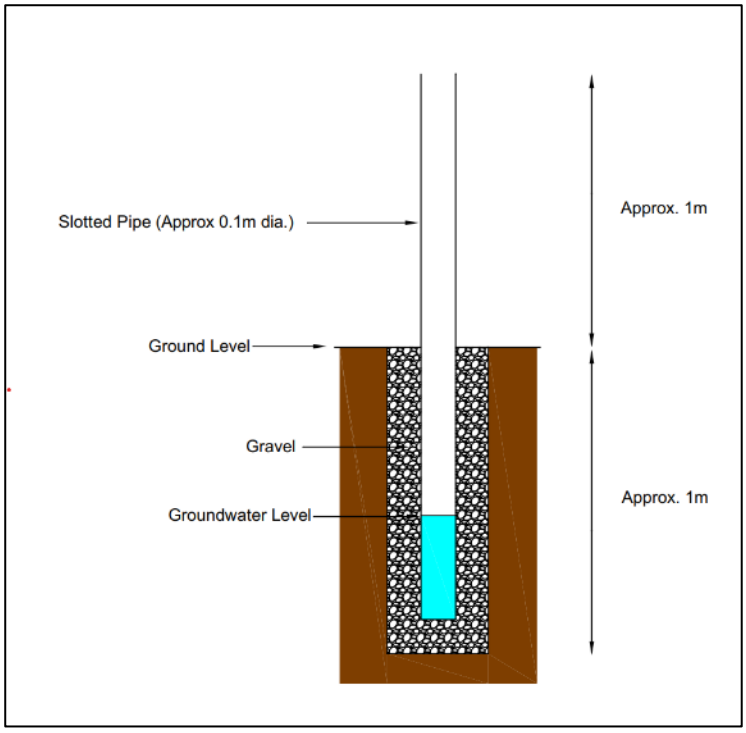


Figure B2: Example of above lockable ground monitoring point cover

Appendix C – Unsuitable Locations

Mire	Justification	Lat	Long
Bodrifty	Does not feed into mire	50.171693	-5.587146
Bodrifty	Readily accessible to livestock.	50.169321	-5.584408
Bodrifty	Septic tank immediately upgradient	50.164632	-5.587858
Bodrifty	No viable sampling location identified	50.162071	-5.579651
Bostraze & Cryor	Part of infrastructure for water for cattle, could not trace source of water	50.136387	-5.650779
Bostraze & Cryor	Surface water, could not identify groundwater source	50.13379	-5.6492367
Bostraze & Cryor	Readily accessible to livestock.	50.132722	-5.649137
Bostraze & Cryor	Readily accessible to livestock.	50.133611	-5.649137
Boswens	No viable sampling location identified	50.143367	-5.627799
Bussow Moor	No viable sampling location identified	50.199076	-5.50731
Bussow Moor	Groundwater fed lake/pond, may not be representive	50.193065	-5.50929
Bussow Moor	Addit dsicharge from former mine workings, may be contaminated by this	50.193739	-5.509795

Mire	Justification	Lat	Long
Bussow Moor	No viable sampling location identified	50.191044	-5.511691
Bussow Moor	No viable sampling location identified	50.190802	-5.506509
Embla	Readily accessible to livestock.	50.176733	-5.525088
Embla	Readily accessible to livestock.	50.177353	-5.525088
Embla	Not accessible due to vegetation	50.178512	-5.524709
Embla	Surface water with other inflows	50.178431	-5.524077
Embla	Outlfow from ponds so may not be representative	50.178296	-5.52374
Embla	Outlfow from ponds so may not be representative	50.18083	-5.525889
Lanyon	No viable sampling location identified	50.16288	-5.601452
Tredinneck	No viable sampling location identified	50.161317	-5.576157
Tredinneck	Landowner stated the flow may be result of burst water main	50.159242	-5.575737
Tredinneck	No viable sampling location identified	50.158137	-5.576199
Tregerest	Well could not be located	50.135093	-5.626789

Mire	Justification	Lat	Long
Tregerest	No viable sampling location identified	50.1348983	-5.62439
Tregerest	Water storage infrastructure present, source not identified	50.134824	-5.622538
Tregerest	Well likely infilled or collapsed	50.134824	-5.622496
Tregerest	Surface water with other inflows	50.131266	-5.623001

References

Buss, S (2023) West Penwith Moors and Downs SSSI Groundwater Quality Modelling. A Report prepared for Natural England. Document Number 2023-011-003-003.

Miles, E., & Gasca, D. 2021. West Penwith Ecohydrological Investigation and Characterisation Phase 3 2020-21 – Site Visit Report. A Report for Natural England. *Natural England Commissioned Reports*. Report number NECR402.

www.gov.uk/natural-england