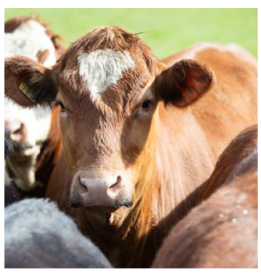
ROTHAMSTED RESEARCH

Biotechnology and Biological Sciences Research Council

North Wyke Farm Platform

Design, Establishment and Development



User Guide

Version 1.0

The North Wyke Farm Platform: Design, Establishment and Development

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Description: The North Wyke Farm Platform (NWFP) was established in 2010 to study and improve grassland livestock production at the farm-scale. The NWFP uses a combination of environmental sensors, routine field and lab-based measurements, and detailed management records to monitor livestock and crop production, emissions to water, emissions to air, soil health, and biodiversity. The rich NWFP datasets help researchers to evaluate the effectiveness of different grassland (and arable) farming systems, which in turn, contributes to the development of sustainable, resilient and net zero land management strategies. This document serves as a user guide to the open datasets. It describes the site characteristics and gives details of the phases involved in the design, establishment, and ongoing development changes to the NWFP. This document is associated with other dedicated user guides that detail the collection, and quality control processing of all the datasets produced on the NWFP.

Site: North Wyke, Okehampton, Devon, UK. Geographic location: 50.76944, -3.90138; 50°46'10" N, 3°54'05" W.

Funding: Rothamsted Research receives strategic funding from the UK Biotechnology and Biological Sciences Research Council (BBSRC). The NWFP has been supported by grants BB/J004308/1, BBS/E/C/000J0100 and is currently supported by grant BBS/E/RH/23NB0008 (2023-28).

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Preface

The North Wyke Farm Platform (NWFP) National Bioscience Research Infrastructure (NBRI) represents a large investment by BBSRC in the future, to not only study but also improve grassland livestock (and arable) systems. It is a national research asset linked to real-world farming. It is a world-class facility and a key member of the Global Farm Platform network http://www.globalfarmplatform.org/), through which the NWFP attracts researchers from different communities and disciplines seeking to develop sustainable and resilient ruminant production systems. The NWFP provides access to a range of in situ instrumentation across 15 hydrologically isolated (sub-) catchments to better address key issues in sustainable and resilient agriculture related to, for example:

- A reduction in energy and greenhouse gas emissions for both environmental and economic reasons.
- Using plants to manage soils and hydrology.
- Efficient nitrogen and phosphorus cycling in grassland and arable systems.
- Resilience of soil biota and their functions in land-use change.
- Impact of land management on carbon cycling and storage.
- Water resource use efficiency.
- Systems modelling to design optimal grassland and arable production systems.

Past and Current Farm Systems

The platform currently consists of three individual outdoor systems or 'farmlets', two of which are livestock (beef and sheep) pasture-based and one is arable (wheat, oats). Each farmlet is approximately 21 ha and consists of five component catchments. Catchments comprise single or multiple fields, that are heavily monitored to provide mixed resolution data on all inputs, outputs, and events. Currently, there is a housed (fourth) system where cattle are reared indoors from weaning to slaughter.

The timeline for the system of each farmlet is as follows:

- From April 2011 to March 2013, all three pasture-based livestock farming systems were as one (permanent pasture) with no separate treatments in operation. This is the baseline period.

- From April 2013 to September 2015, two of three systems gradually transitioned into the first system change period, one re-sown with high sugar grasses (**Red farmlet**), the other re-sown with high sugar grass, white clover mix (**Blue farmlet**). The third continued as permanent pasture (**Green farmlet**) and will always do so, for long-term monitoring.

- From September 2015 to April 2019, the first system change period was in full operation across all three livestock farming systems and pasture treatments.

- From April 2019, the first system change period embarked on a transition to a second system change period where the **Red farmlet** transitioned to an arable system with the aim of growing human edible crops. Given the transition to arable cropping, cattle and sheep production are no longer associated with this system. Instead, cattle previously linked to the system are permanently housed from weaning to slaughter. This represents a fourth (**Brown farmlet**) system for evaluation of more intensive finishing. Sheep production is only focussed on the green and blue systems.

For more information and updates, click on the links below:

Core Remit and Hypotheses

North Wyke Farm Platform Website

1 Introduction

The NWFP consists of three individual (outdoor) systems or 'farmlets' each of which is approximately 21 ha (since modifications implemented on 13th August 2013) and has been designed to test the productivity and environmental sustainability of different temperate grazing livestock (and arable systems) at appropriate farm and land management scales (Figure 1).

From April 2011 to March 2013, all three farmlets were permanent pasture-based livestock farming systems with no separate treatments in operation. This is the baseline period. Subsequent system change periods have followed for one or two farmlets.

For the first system change period (approximately 2013 to 2019), the three farming systems (or treatments) on the platform were: (i) permanent pasture: improvement through use of inorganic fertilisers (**Green farmlet**) – i.e. no change from baseline; (ii) increased use of legumes: replacing nitrogen fertilisers with biological fixation using sown legume and grass mixtures (**Blue farmlet**); and (iii) planned reseeding: regular renewal, providing opportunities for introducing innovative grass varieties with desirable traits such as high sugar and deep roots (**Red farmlet**).

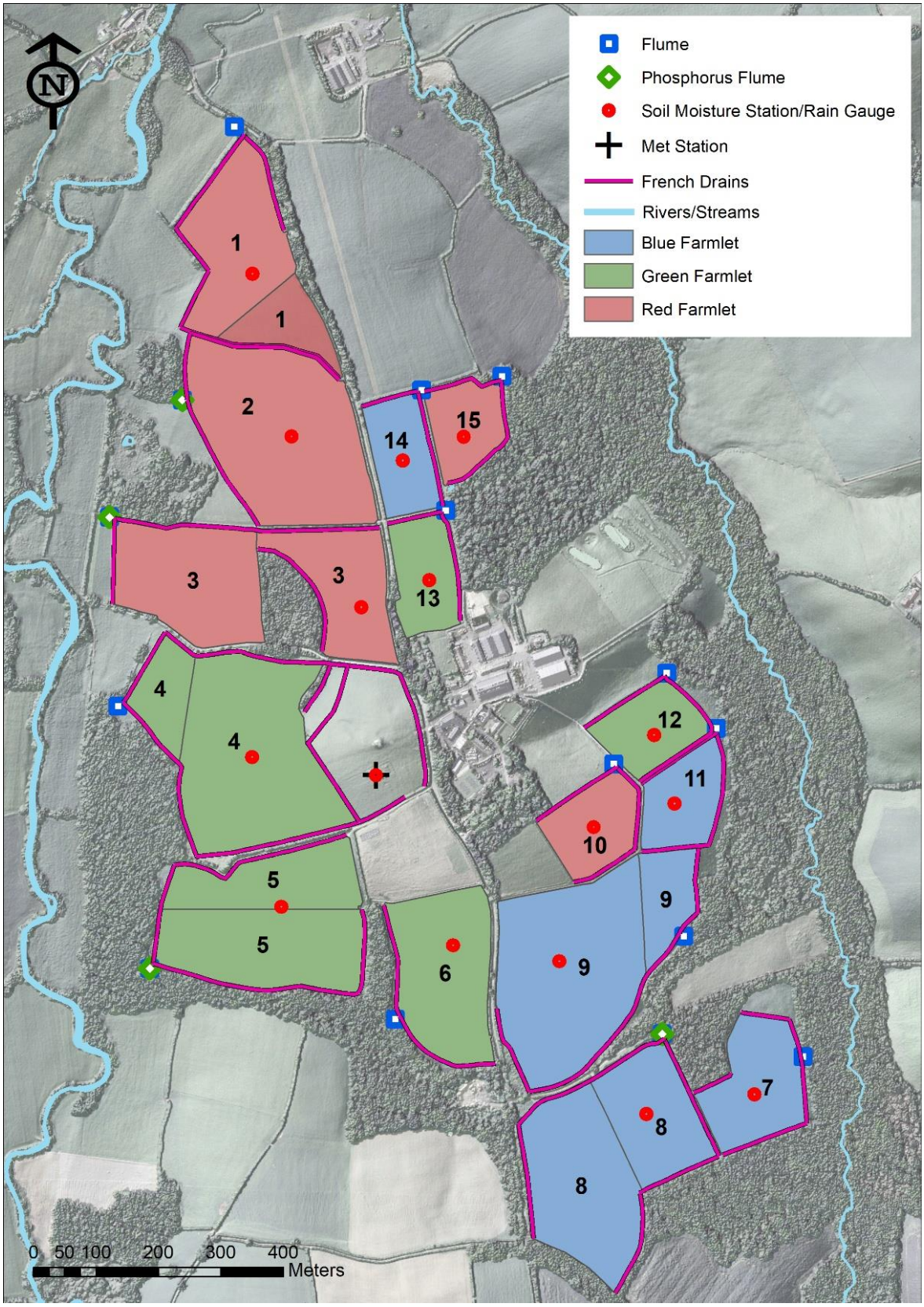
Post 2019, a second treatment change period was introduced, where the **Red farmlet** transitioned to an arable system growing human edible crops. Additionally, a new fourth system was established where cattle that would have grazed the **Red farmlet** are permanently housed from weaning to slaughter (**Brown farmlet**).

Each of the three outdoor farmlets contains five (sub-) catchments (15 in total), with each catchment hydrologically isolated through a combination of topography and a network of 9.2 km of drains constructed around the perimeters of each catchment. The drainage network is made up of 800 mm deep trenches containing perforated drainage pipe and backfilled to the surface with 20-50 mm clean, carbonate-free granite chips. The trench bed and outer face are lined with plastic damp proof plastic membrane. This type of construction is commonly referred to as a French drain [French, 1859].

Each of the sub-catchments was allocated to one of the three outdoor farmlets according to some or all the following conditions:

1. Expert knowledge of the physical properties of the North Wyke site.
2. The need for a degree of spatial connectivity between the five sub-catchments of each farmlet.
3. Historical farm practice.
4. Farm / research operational requirements.

Figure 1. Map of NWFP showing systems as of 2015-2019 (first system change period [1]).



[1] *Green farmlet = permanent pasture, Blue farmlet = high sugar grass/clover; Red farmlet = high sugar grass, and later converted to arable in autumn 2019 (start of second system change period). In November 2017, phosphorus was measured at catchment or flume 3 in addition to flumes 2,5, & 8. From autumn 2023 onwards phosphorus will be measured on all catchments. Numbers represent catchment number. Note some catchments consist of multiple fields.*

2 Site Details

2.1 Location

The NWFP is located on the Rothamsted Research, North Wyke Campus in South West England (50°46'10" N, 3°54'05" W; 50.76944, -3.90138) (Figure 2) on a ridge at 120 – 180 m above sea level, where the land slopes down on the west to the River Taw and on the east to one of its tributaries, the Cocktree stream, with an average annual rainfall of 1021 mm for the 40-year period 1981 to 2020, the monthly distribution of which is shown in Figure 3.

Figure 2. Location of the NWFP.

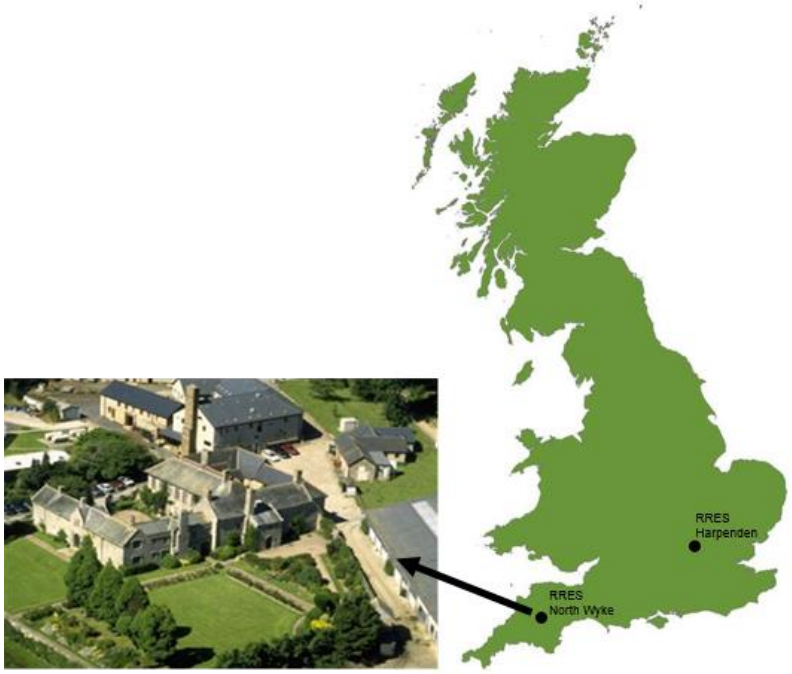
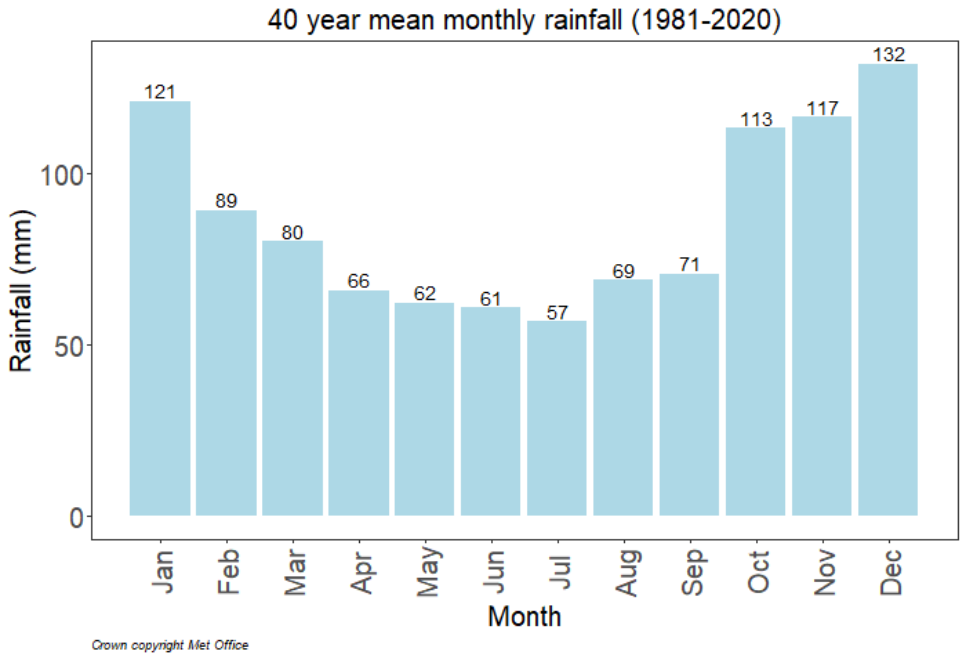
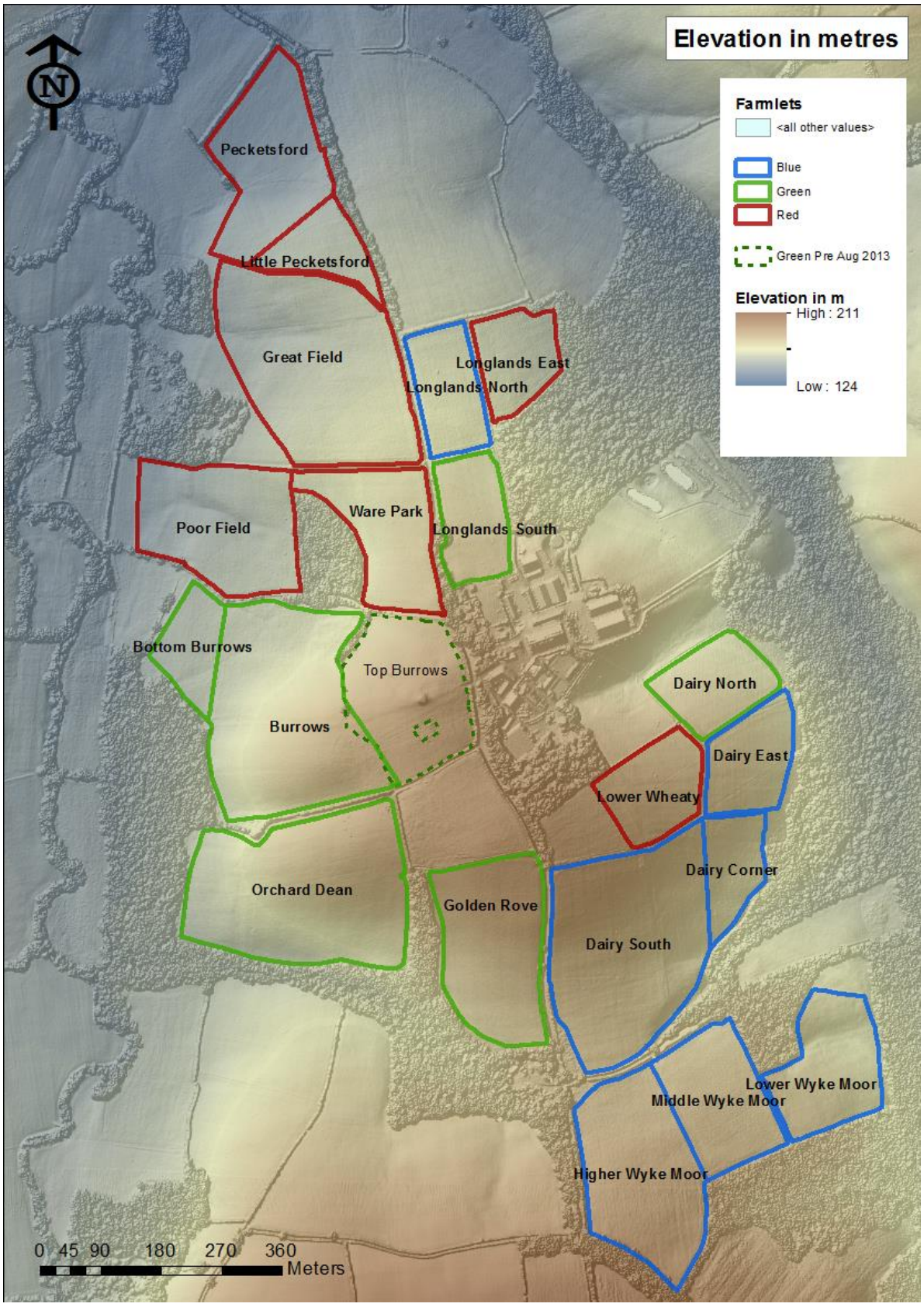


Figure 3. 40 year mean monthly rainfall (1981-2020).



LiDAR data are available [Ferraccioli et al., 2014] providing both a digital surface model (DSM) and a digital terrain model (DTM) of the NWFP (Figure 4).

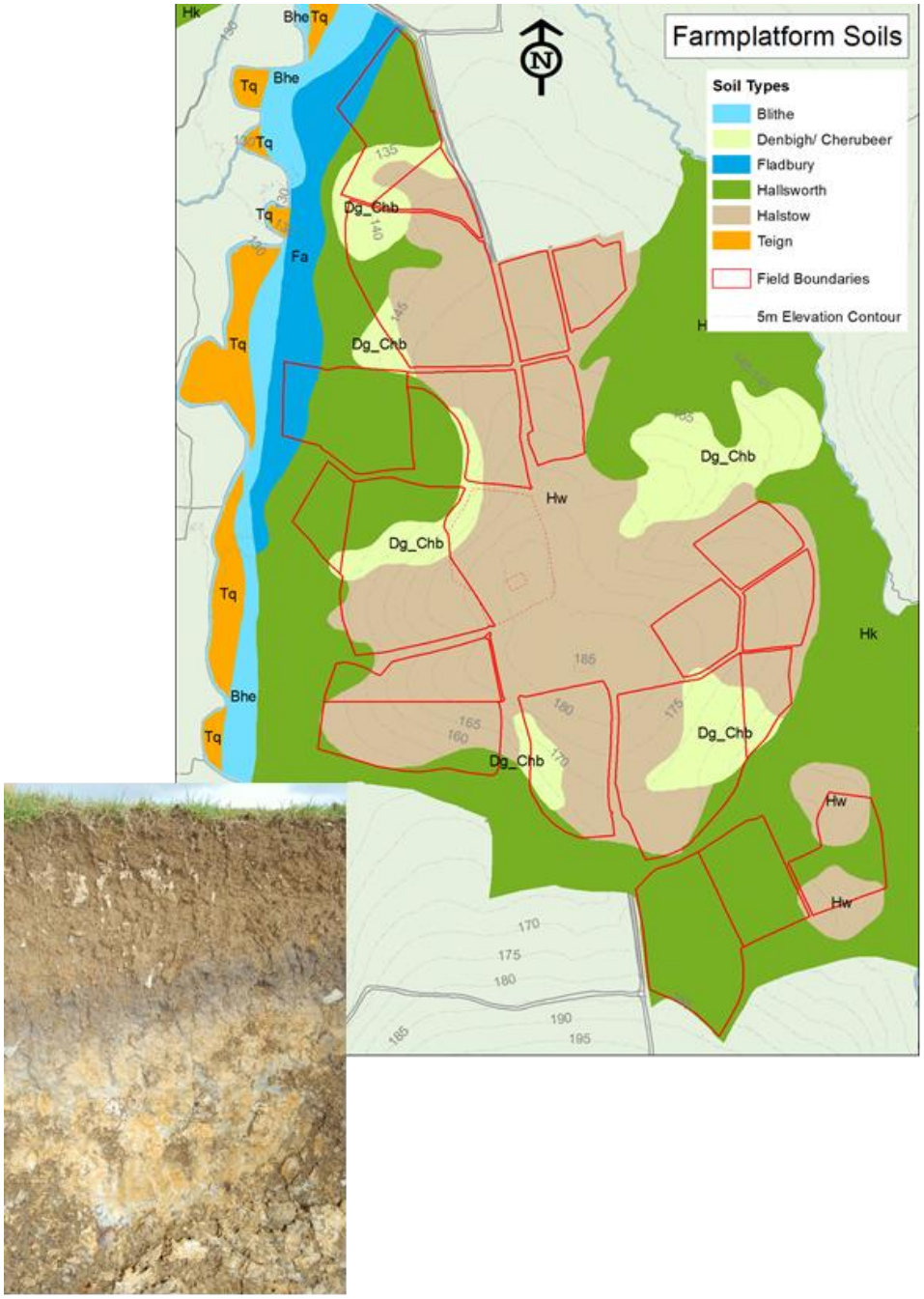
Figure 4. Topographic representations of the NWFP (shown pre-Orchard Dean division)



2.2 Soil

A key feature of the site is the presence of clay-rich sub-soils beneath the sub surface horizons. The soil is predominantly of two similar series, Hallsworth (Dystric Gleysol) and Halstow (Gleyic Cambisol), that comprise of a slightly stony clay loam topsoil (approximately 36% clay) overlying a mottled stoney clay (approximately 60% clay), derived from carboniferous culm measures [Harrod T.R and Hogan D.V, 2008]. Below the topsoil layer, the subsoil is highly impermeable to water and is seasonally waterlogged with most excess water leaving by surface and sub-surface lateral flow across the clay layer to be intercepted by the bounding drainage system at the edge of each sub-catchment. The sub-soils data are depicted in (Figure 5) together with the 15 NWFP catchments and the 21 field boundaries (of the first system change period).

Figure 5. Map of the soils of the NWFP and a typical soil profile.



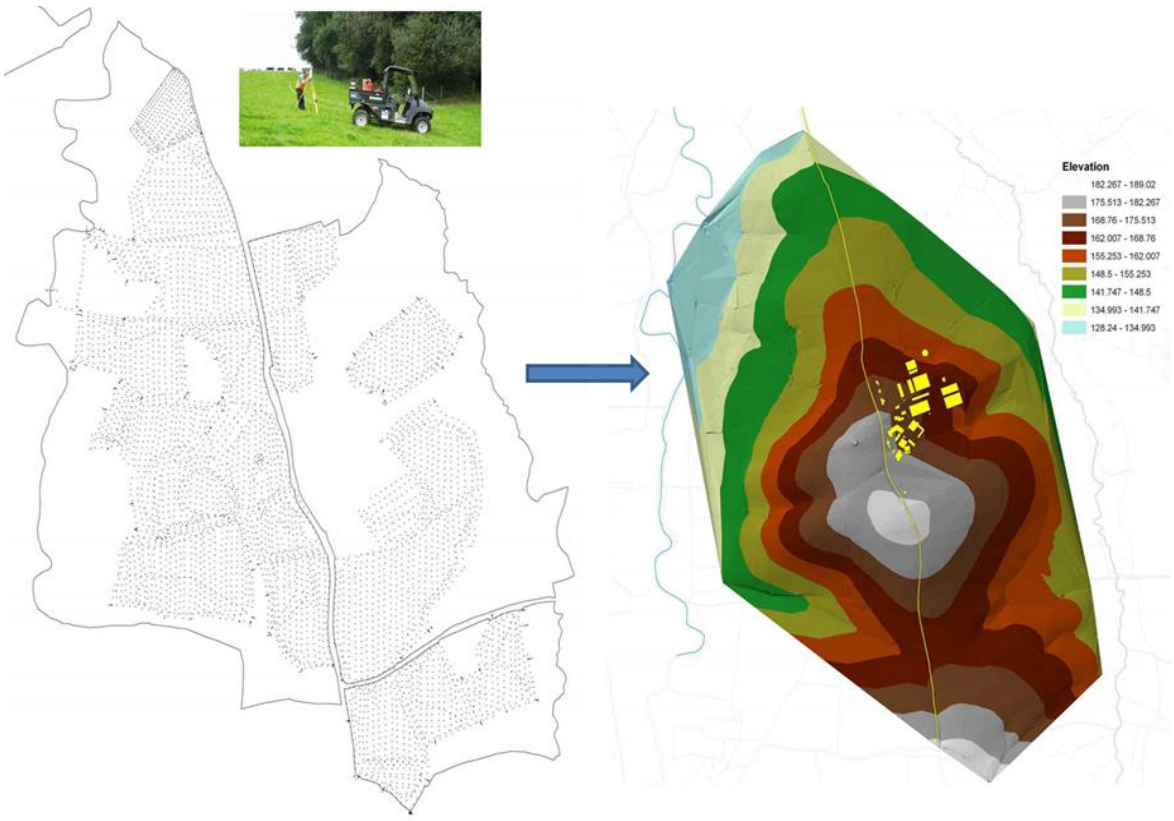
3 Design, Establishment, and Infrastructure

The following sections describe the processes and activities carried out during the construction phase and infrastructure development of the NWFP, the key timelines of which are provided in Appendix A.

3.1 Site Survey and Assessment

Rothamsted Research, North Wyke commissioned JBA [JBA Consulting, Bradford] to carry out an assessment of the surface water and potential groundwater interactions on the land where the experimental areas had been proposed by North Wyke staff, based on their local knowledge, together with reference to existing DTM datasets described previously. To accurately define the topographic boundaries of the proposed area, JBA commissioned Storm Geomatics [Storm Geomatics Ltd, Gloucestershire] to undertake a 15 m gridded global positioning system (GPS) ground level survey of all the fields in question, including some basic surveying of the existing open ditch network. Storm Geomatics undertook the survey in September 2008 followed by a detailed site assessment shortly after by JBA (Figure 6).

Figure 6. Measurement of the topography for the proposed siting of the NWFP.



In particular, the JBA assessment included the following tasks:

1. Identification of how the catchments could be hydrologically isolated in terms of the surface water.
2. Consideration of the possibility of any groundwater interactions within the catchments.
3. Recommendations for the locations and outline specification for a flow monitoring station at the outlet to each block.

3.2 Planning Permission

Prior to obtaining planning permission for the construction of the platform, various conditions had to be met including:

- Obtain Flood Defence Consent from the UK Environment Agency.

- Conduct a Badger Survey to describe and evaluate the status of badgers in the area to identify potential impacts that the proposed works may have on badgers and their setts and provide recommendations to mitigate these impacts.

- Conduct a Tree Species and Condition Survey and Constraints Plan in relation to Root Protection Areas (RPA). Identify location, species, dimensions, age class, condition and remaining contribution in years and produce a Protection Plan and Arboricultural Method Statement which documents how the trees were to be protected from inadvertent damage.

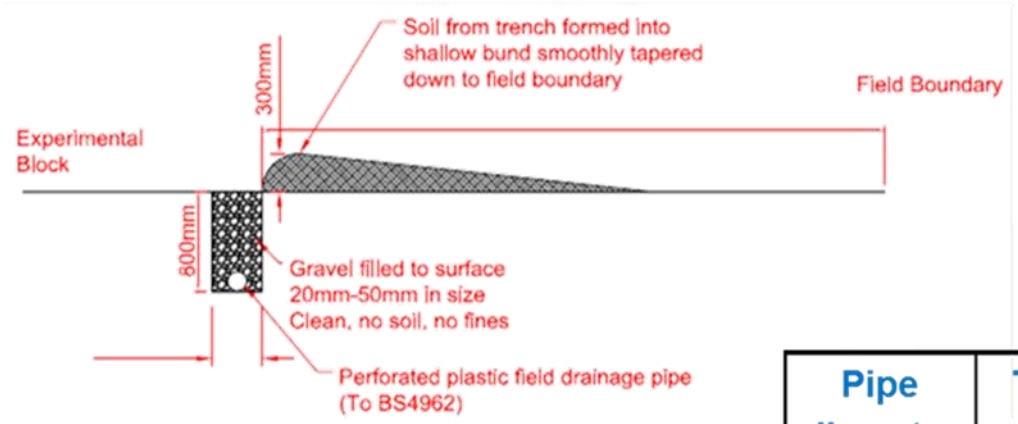
- Conduct an Extended Phase 1 Habitat and Protected Species survey to identify records relating to bat and other notable species [Joint Nature Conservation Committee, 1993] as amended by Institute of Environmental Assessment (1995) with additional emphasis on searching for protected species, their field signs or identifying habitats which may support protected species.

- Conduct an Environmental Impact Assessment including an Archaeological Survey and Groundworks Mitigation Plan.

3.3 Construction of French Drains

Establishment of the NWFP began in 2010. The hydrological monitoring design was based on a predicted 1 in 50-year flood event (using data revised in August 2009), with open channel flow nozzles [H-flumes; http://tracomfrp.com] at the catchment outlets, each sized according to the catchment characteristics. To collect surface and sub-surface lateral flow, French drains totalling 9.2 km in length were constructed by digging trenches to a depth of 800 m, lining them with damp proof membrane, and placing a perforated plastic drainage pipe centrally in the trench bed. The width of the drains was dependent on the drainage pipe diameter + 100 mm each side (Figure 7) and to facilitate this, eight different digger bucket sizes were fabricated.

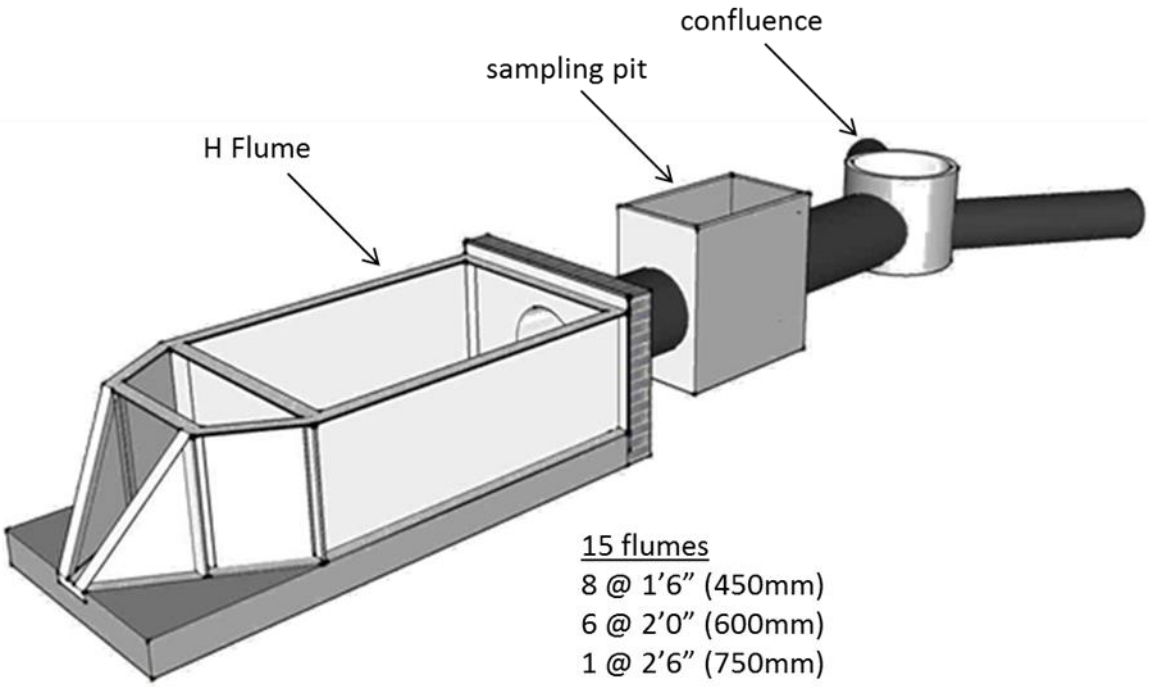
Figure 7. Design of French drains, pipe diameters, and an example of a completed drain.



Pipe diameter (mm)	Trench width (mm)
100	300
160	360
200	400
225	425
300	500
375	575
400	600
450	650

The trenches were backfilled using 5056 tonnes in total of 20 – 50 mm clean granite stone. All the flumes receive water supplied by two branches of the drains and where these join in a confluence pit, puddled clay was placed around the pipe to ensure the drainage water is always captured. The water is channelled from the confluence pit via concrete piping and a sampling pit into the flume (Figure 8)

Figure 8. Design of hydrological monitoring system, and number and size of H flumes used.



Where required, the experimental areas have been protected on the upslope boundaries by open ditches and sealed pipes to prevent ingress of surface runoff and external groundwater from adjacent land. Each flume is supplied with mains electric power and a fibre optic cable-based data telemetry system which totals over 5 km in length. Details of the completed drainage network are shown in Figure 9 and Figure 10.

Figure 9. Network of French drains – section lengths (m).

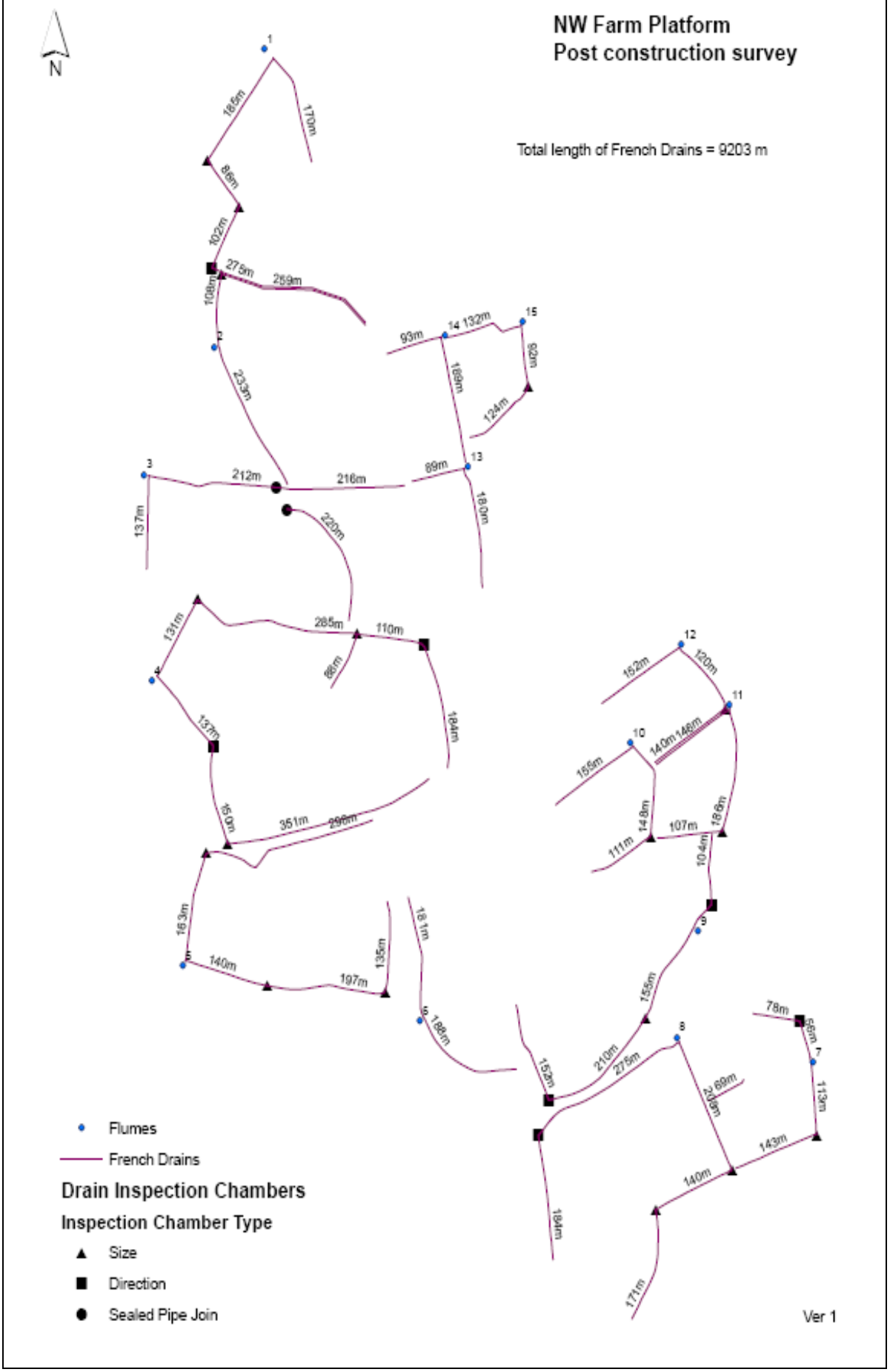
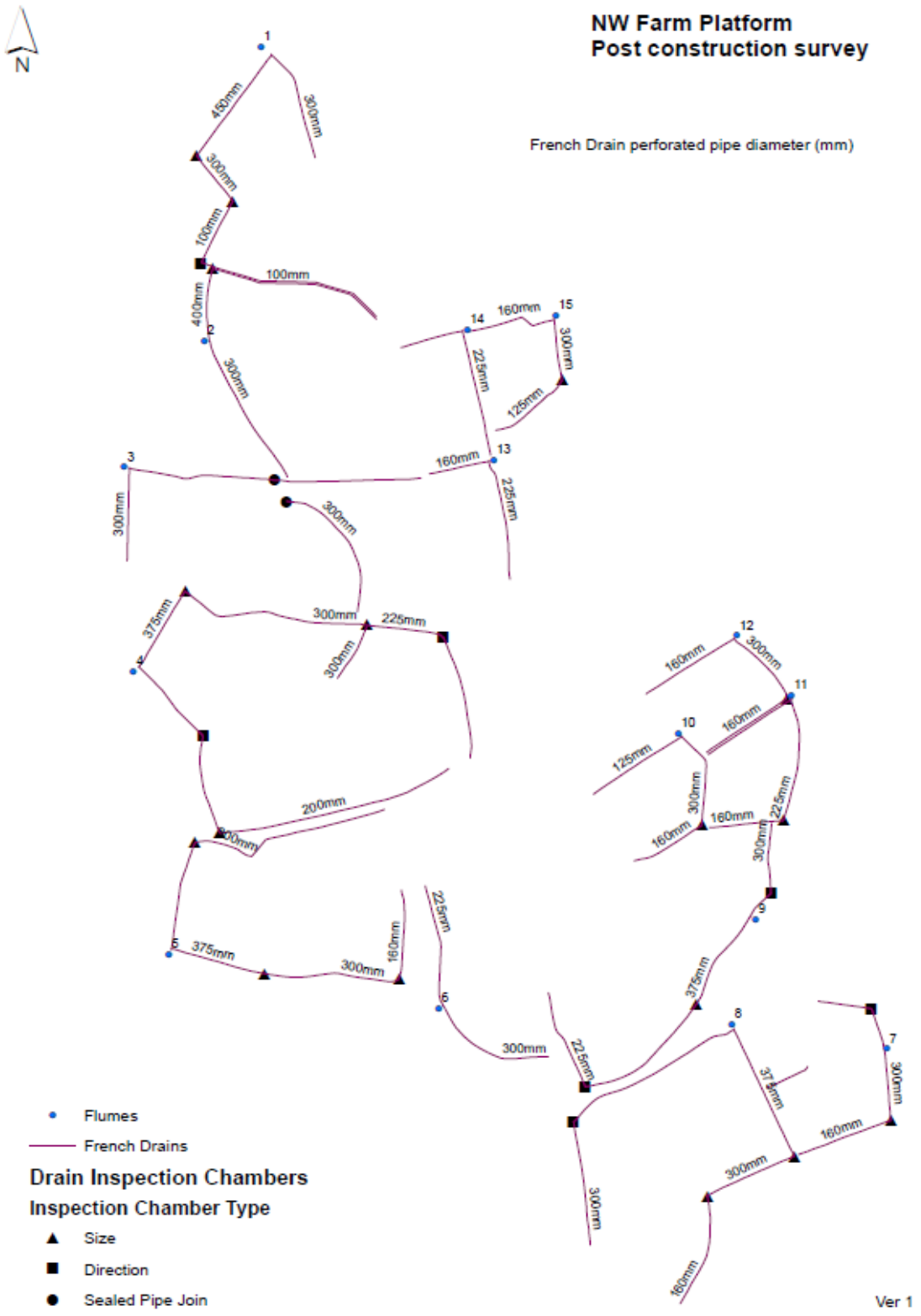


Figure 10. Network of French drains – pipe diameter (mm)†.



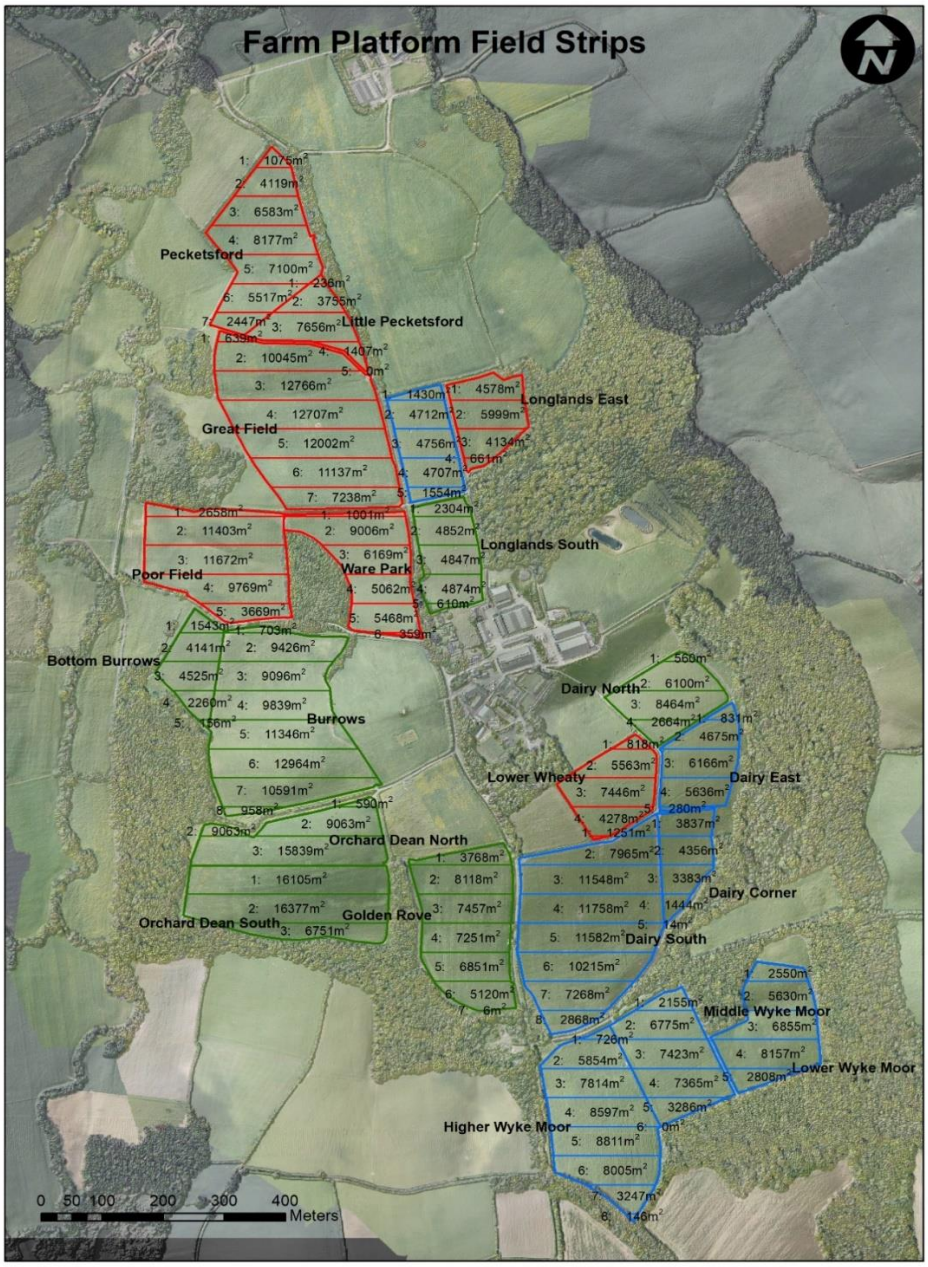
†*Bespoke inspection chambers were installed where pipe size or direction changed.*

3.4 Field and Catchment Areas

Once completed, livestock fencing was put in place to avoid damage and contamination of the surface of the drains by grazing animals. The exclusion of these areas has resulted in slight differences in the operational zones contributing to agronomic and hydrology data (Appendix D). The exact areas have been calculated using GPS and a geographic information system (GIS).

Within each NWFP field, virtual fence lines have been identified using GPS, which allow for the fields to be temporarily split up into (typically two) sections using movable fences. This is to facilitate management of areas used for grazing and silage production and was set in operation in 2017. In the Data Portal these areas are identified as field strips and are illustrated in Figure 11. Note, this is not to facilitate strip grazing, but to just divide fields into two.

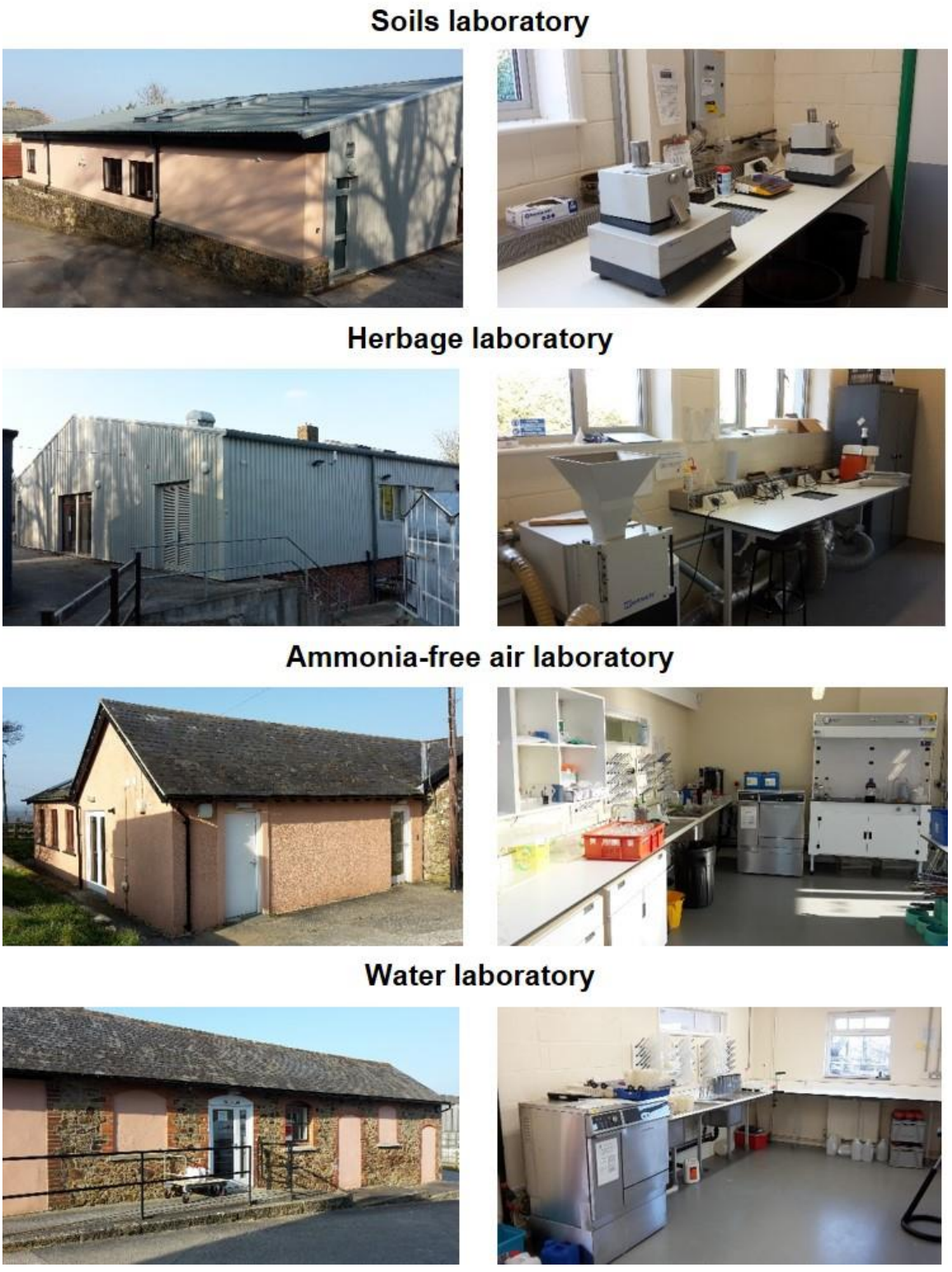
Figure 11. Map of NWFP showing field strip demarcations and areas.



3.5 Laboratory Facilities

In 2010, as part of the platform's development, separate laboratories (Figure 12) were created to handle soil, herbage, air, and water to ensure the quality control over sample separation and facilitate efficient workflow.

Figure 12. Dedicated soils, herbage, air and water laboratories at North Wyke.



3.6 Livestock Housing and Associated Facilities

Three new cattle buildings (Figure 14) were built in the winter 2013/2014 which provided dedicated housing, silage clamps and farmyard manure (FYM) middens for each of the three farmlets.

The grass harvested from June 2014 onwards is either stored in the silage clamps or in big bales linked to the farmlet. From 2014 the FYM produced by the cattle during the winter is returned to each respective farmlet (Figure 13).

Figure 14. Dedicated cattle housing, silage clamps and FYM middens at North Wyke, Rowden site.

Figure 13. Spreading FYM on the farmlets.

In 2019, the Orr Small Ruminant Facility (SRF) building was completed which allows both the housing of the sheep during the winter period in their different farmlet groups, and as sub-groups to allow for control of the optimal nutritional requirements for ewes depending on the number of lambs they are carrying (i.e., singles, doubles, triplets). Separation into farmlet groups in the previous sheep building was not possible due to lack of space. Some pens within the SRF have been specifically designed to accommodate goat housing. In addition, the facility contains 24 automated biocontrol units that allow feed intake studies of sheep, and which can be seen on the right in Figure 15.

Figure 15. Orr Small Ruminant Facility.

4 Sensor Deployment (water, soil and MET)

The following sections give a brief overview of the instrumentation and sensor methodologies used for monitoring water, soil, and meteorological (MET) variables. Timelines for installation and updates of the instrumentation are given in Appendix B.

A full description of the sensors, and collection and management of each of these 15-minute datasets is provided in individual User Guides available on the NWFP website. These datasets constitute the most valued and richest datasets collected on the NWFP.

4.1 Water Flume Cabins and Soil Moisture Stations

Until 2015, water flow was measured using bubble flow meters [4230, Teledyne ISCO, New England, USA], but these have since been replaced with pressure level sensors [OTT Hydromet, Loveland, CO., USA]. Other water measurements including nitrate, ammonium, dissolved oxygen, total phosphorus, ortho-phosphate, fluorescent dissolved organic matter, temperature, pH, specific conductivity, and turbidity are measured at 15-minute intervals at each flume. Under prescribed flow conditions, water is drawn up automatically from the sampling pit every 15-minute by a bi-directional peristaltic pump to a purpose designed flow cell fitted with various sensors. The pump and flow cell are housed in a cabin that is sited at each flume (Figure 16).

In addition, rainfall, soil moisture and soil temperature are measured at soil moisture stations (SMS) located at an approximately central point on each catchment or sometimes an approximate central point of a field of a catchment (Figure 1).

Figure 16. One of fifteen flume cabins which are sited at each catchment.

4.2 COSMOS-UK for Soil Moisture

In addition to the soil moisture sensors mentioned above, the NWFP is one of the sites in the UK Centre for Ecology & Hydrology (CEH) Cosmic-ray soil moisture monitoring (COSMOS-UK) network (of around 50 sites in total), and an instrument was installed on the NWFP on Catchment 2 on 10th October 2014 (Figure 17).

More information on the COSMOS-UK network can be found here:
https://cosmos.ceh.ac.uk/

The near real-time data for North Wyke are freely available here:
https://cosmos.ceh.ac.uk/sites/NWYKE

Figure 17. COSMOS-UK Soil moisture monitoring equipment on Catchment 2.

4.3 Installation of Dedicated Meteorological Instruments

In April 2013, May 2014 and April 2015, meteorological equipment [Adcon, OTT HydroMet GmbH, Vienna, Austria] was installed to record the following data at 15-minute intervals:

- Precipitation (mm; installed April 2013)
- Air temperature (^{o}C; installed April 2013)
- Relative humidity (%; installed April 2013)
- Wind speed (km h^{-1}; installed April 2013)
- Wind direction (in degrees; installed April 2013)
- Solar radiation (W m^{-2}; installed in May 2014)

In April 2015, a more accurate Pluvio rain gauge [Adcon, OTT HydroMet GmbH, Vienna, Austria] was installed that can provide precipitation (mm) data at 1 min intervals but is currently reported at 15-minute intervals. These data complement those recorded by the tipping bucket rain gauges on each of the 15 NWFP catchments.

Co-located next to the dedicated meteorological instrumentation (see Figure 1) are official UK Meteorological Office instruments which collect daily data only. North Wyke has hosted these instruments since 1981, however these data are not available on the NWFP Data Portal, but monthly climate averages can be obtained from:

https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcj0z3b55.

5 Land Management Changes

A detailed timeline of all minor and major land management changes is given in Appendix C.

5.1 Change in size of Burrows - Catchment 4

For data relating to the period 21st March 2011 until 12th August 2013, Catchment 4 consisted of 3 fields, Bottom Burrows, Burrows and Top Burrows, which made up a total area of around 11 ha. As the Green farmlet (25 ha) was larger than both the Red farmlet (21.4 ha) and the Blue farmlet (20.8 ha), it was decided to remove Top Burrows, which had an area of 3.47 ha, from the Farm Platform in 2013, in order that all farmlets were of a similar size. Additional French Drains were constructed to intercept and divert water draining from Top Burrows away from Flume 4. The changes to the Burrows Catchment are shown in Figure 18. In addition, the shape of the Burrows field changed shape slightly and as a result, this decreased in area from 6.5 ha to 6.4 ha and these changes were implemented from 13th August 2013 onwards. Therefore, any data before 13th August 2013 relates to the 'old' Catchment 4 configuration, including Top Burrows. It is important that this change is taken into consideration when using any data pre- or post- 13th August 2013 relating to Flume 4 or the fields contributing to this catchment.

Figure 18. Changes to field contributing to Burrows Catchment 4.

Original Burrows Flume 4 Fields, consisting of Bottom Burrows, Burrows and Top Burrow. The magenta lines represent the French drains flowing into Flume 4

Post Top Burrows split off Flume 4 Fields, consisting of Bottom Burrows and Burrows. The magenta lines represent the French drains flowing into Flume 4

5.2 Division of Orchard Dean - Catchment 5

Catchment 5 (Orchard Dean) was originally constructed as one field as shown in Figure 4 and Figure 18. However, in 2015 two fields (Orchard Dean North; NW045 and Orchard Dean South; NW046) were created by the construction of a new fence as shown in Figure 1, Figure 5 and Figure 11. The areas of these fields are shown in Appendix D. The reason for this split, effected from 13th August 2015 onwards, was to create seven fields in each farmlet and facilitate the grouping of triplets of field enterprises (cattle grazing, sheep grazing, cutting). However, this triplet system became redundant when the Red farmlet converted to arable.

5.3 Moving from Baseline to First System Change Managements

Over a two-year period from 1st April 2011 to 31st March 2013, beef and sheep systems were operated using the same management guidelines on the three farmlets to measure baseline productivity on the existing permanent pasture.

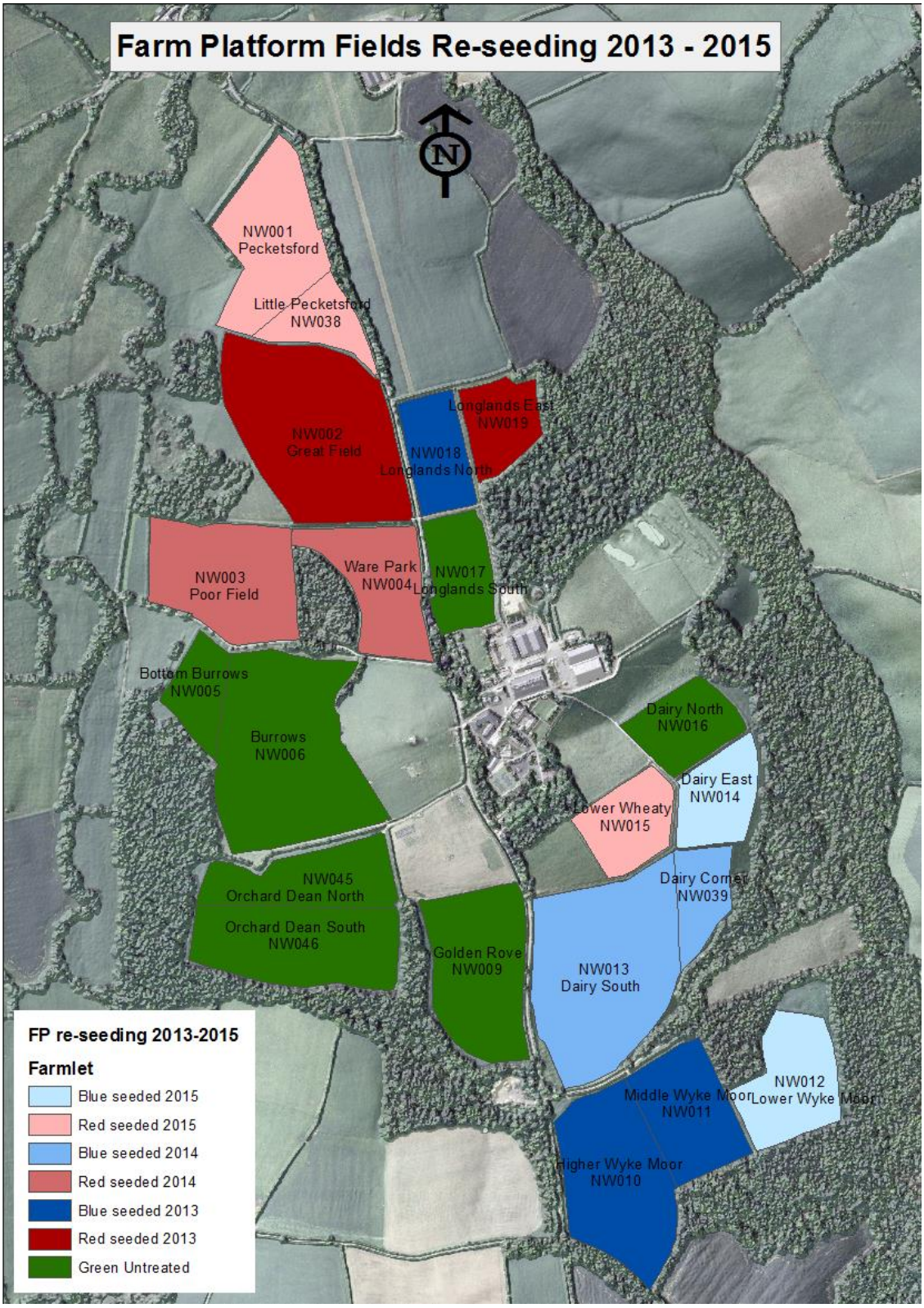
From 1 April 2013, two of the farmlets entered a “transition” phase, where they progressively moved towards the following treatments of the first system change period: (i) increased use of legumes (replacing nitrogen fertilisers with biological fixation using sown legume and grass mixtures) (**Blue farmlet**); (ii) planned reseeding: regular renewal, providing opportunities for introducing innovative varieties with desirable traits, e.g., high sugar grasses (**Red farmlet**)**.** This transition took 2 years, and the two new systems were in full operation by the end of the 2015 grazing season.

The farmlets assigned to the new treatments are shown in Figure 19. Individual catchments within the two re-seeded farmlets (Red and Blue) were ploughed and re-seeded in 2013, 2014 or 2015 with either: (a) perennial ryegrass (AberMagic), (b) perennial ryegrass (AberMagic) + white clover (AberHerald), (c) festulolium (Prior) or (d) festulolium (Prior) + white clover (AberHerald) (with the latter two options in the Longlands fields only). Thus, the transitional phase from baseline to this post-baseline period covered the 28-month period 1st April 2013 to 31st August 2015.

Catchment 14 (Longlands North; Blue Farmlet) was over sown with a white clover mixture in May 2018.

Further details on the reseeding events such as sowing rates etc. are given in Appendix F, Appendix G, and Appendix H. Detailed information on all field event and livestock management can be found in the User Guides entitled ‘NWFP_UG_FieldEvents_Data.pdf’. and ‘NWFP_UG_Livestock_Data.pdf’.

Figure 19. Reseeding schedule from 2013-2015.



5.4 Conversion of Red farmlet from Grassland to Arable

In the autumn of 2019, the Red farmlet was converted from a grassland to an arable system, as part of the second system change period and with a planned rotation of winter wheat, winter wheat, oats, or beans. The existing grass sward was sprayed off, ploughed, and sown with the first rotation of a milling quality winter wheat (variety: Crusoe).

The cattle that would have grazed the Red farmlet, are from here on, housed till finishing, and this currently continues year-on-year to represent a fourth indoor (Brown) farmlet for evaluation of more intensive finishing. The sheep and lambs grazed some of the Red farmlet catchments up until the conversion took place and were then removed from the system. Henceforth, outdoor cattle and sheep production are only carried out on the Green and Blue farmlets in this second system change period, until a third system change period is instigated (likely 2024 to 2025).

Where catchments have a French drain along the boundary, best practice is observed by leaving a ~5 m wide grass buffer strip along the length of the drain to reduce the risk of sprayed herbicide/pesticide entering the drains and hence downstream receiving watercourses. The productive field areas for arable cropping are given in Appendix E.

Note that Catchment 1 now consists of a single field – ‘Pecketsford (whole)’, so the NWFP has 20 fields total for the second system change period.

6 The “Triplet Management System” (first system change period)

The triplet system for management of the farmlets is shown in Figure 20 and Figure 21 and fully came into operation during 2016. The rationale for this system is to be able to make comparisons between farmlet enterprise management on an as equivalent areal basis as possible. Prior to 2016, due to the reseeding phases, this was not always achievable. As an example of difficulties that could arise, in 2013, the Green cattle were allocated to Burrows and Blue cattle to Dairy South (6.38 and 6.44 ha respectively; both ‘C’ triplets). The closest match in area in the Red Farmlet (6.65 ha; ‘C’ triplet) was Great Field. However, that was due to be resown following cutting for silage. Instead, the alternative Poor Field / Ware Park (‘B1 / B2’ triplet) was used. The sheep were allocated to the small fields (‘A and D’ triplets) with the smallest (‘E’ triplet) as spare. The weaned lambs were allocated to the ‘F’ triplet. Since 2016, such issues do now not arise as presented in Figure 20 and Figure 21. Furthermore, since the grassland to arable conversion that took place in 2019, the Red farmlet is no longer part of this triplet management system, so only a twin management system continued.

Figure 20. An example of the triplet system for management of the farmlets.

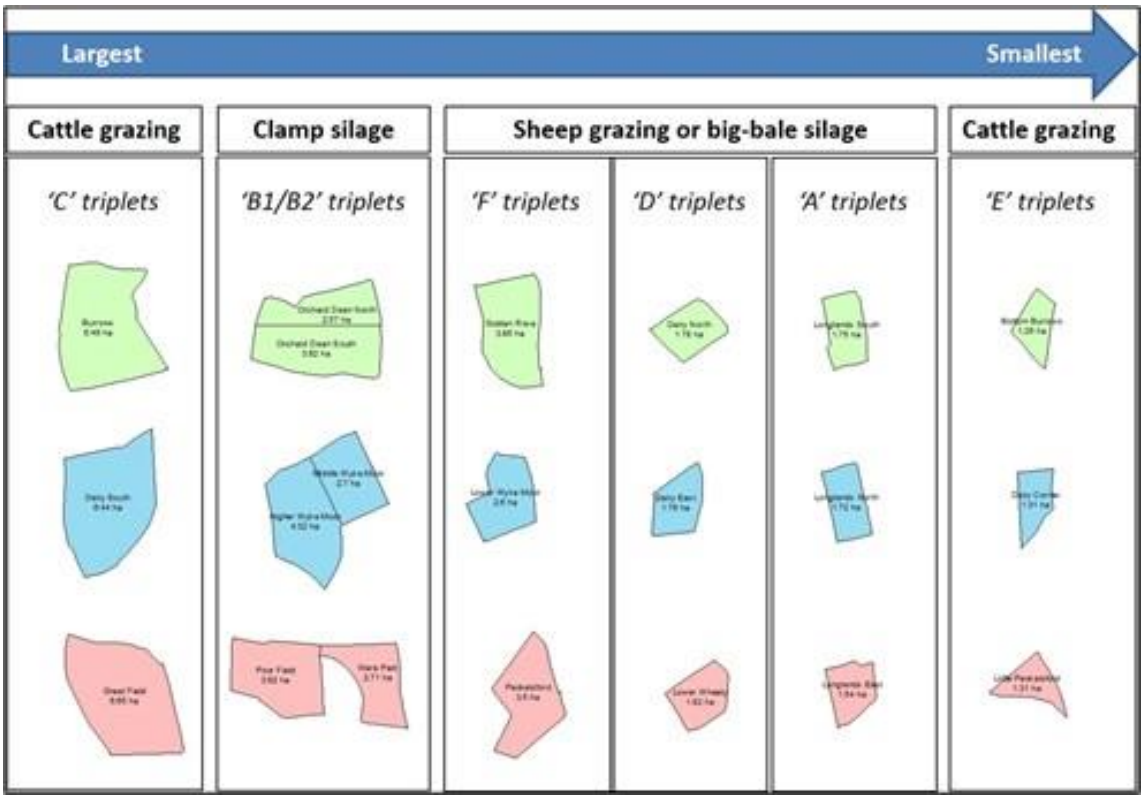
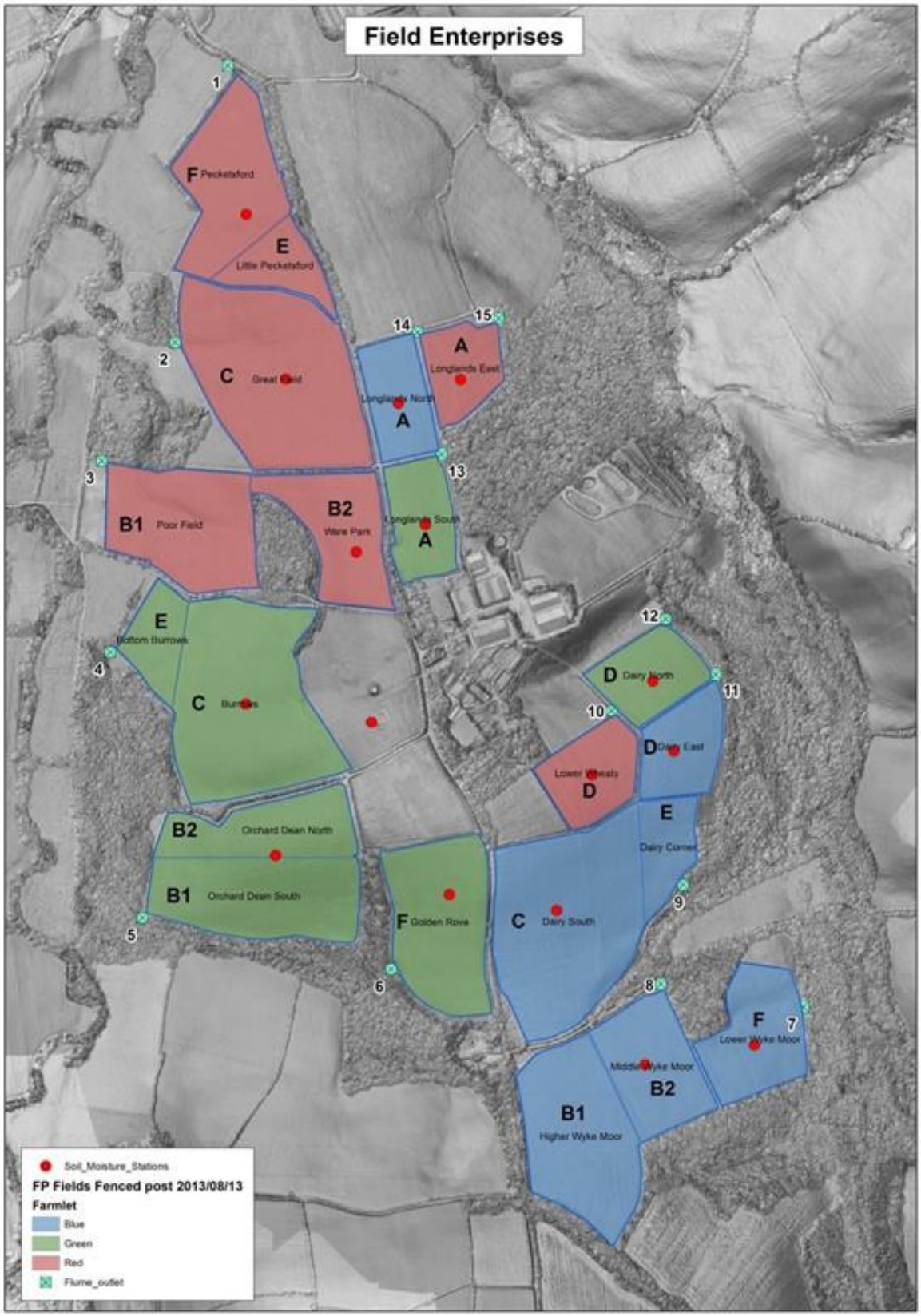


Figure 21. Map of NWFP showing 'triplet' management of the farmlets [2].



[2] *N.B. Since 2019, the Red farmlet is no longer part of the system.*

7 Citing the Data

If you choose to use any of datasets provided by the NWFP in a publication, please cite:

- *Orr, R. J., Murray, P. J., Eyles, C. J., Blackwell, M. S. A., Cardenas, L. M., Collins, A. L., Dungait, J. A. J., Goulding, K. W. T., Griffith, B. A., Gurr, S. J., Harris, P., Hawkins, J. M. B., Misselbrook, T. H., Rawlings, C., Shepherd, A., Sint, H., Takahashi, T., Tozer, K. N., Whitmore, A. P., Wu, L. and Lee, M. R. F. (2016). The North Wyke Farm Platform: effect of temperate grassland farming systems on soil moisture contents, runoff and associated water quality dynamics. European Journal of Soil Science, 67, 4, 374-385. (doi:10.1111/ejss.12350).*

In addition, if using data from the baseline period please cite:

- *Takahashi, T., Harris, P., Blackwell, M. S. A., Cardenas, L. M., Collins, A. L., Dungait, J. A. J., Hawkins, J. M. B., Misselbrook, T. H., McAuliffe, G. A., McFadzean, J. N., Murray, P. J., Orr, R. J., Rivero, M. J., Wu, L. and Lee, M. R. F. (2018). Roles of instrumented farm-scale trials in trade-off assessments of pasture-based ruminant production systems. Animal, 12, 8, 1766-1776. (doi:10.1017/S1751731118000502).*

- *Orr, R. J., Griffith, B. A., Rivero, M. J. and Lee, M. R. F. (2019). Livestock Performance for Sheep and Cattle Grazing Lowland Permanent Pasture: Benchmarking Potential of Forage-Based Systems. 9, 2, 101-118. (doi:10.3390/agronomy9020101).*

For the datasets used, please cite the latest version of the relevant User Guide PDF document(s), listed in the table below, that describe the establishment and development of the NWFP, and the various datasets produced in detail. The link to these can be downloaded from the NWFP website. Note that the User Guide entitled 'NWFP_UG_Design_Develop.pdf' should be cited irrespective of the dataset used.

Data used	Main title of User Guide PDF document
All datasets	NWFP_UG_Design_Develop.pdf
15-minute time-series datasets (water, soil moisture, meteorology)	NWFP_UG_Hydrology&WaterQuality_Data.pdf NWFP_UG_SMS_Data.pdf NWFP_UG_MET_Data.pdf
Greenhouse gases	NWFP_UG_EC_GHG_Data.pdf NWFP_UG_GreenFeed_Data.pdf
Field surveys	NWFP_UG_FieldSurvey_Data.pdf
Livestock	NWFP_UG_Livestock_Data.pdf
Field events	NWFP_UG_FieldEvents_Data.pdf

Also, please include the following sentences in the acknowledgments section:

"The North Wyke Farm Platform is a UK National Capability supported by the Biotechnology and Biological Sciences Research Council (BBS/E/RH/23NB0008)."

"We acknowledge the interests of the Ecological Continuity Trust (ECT), whose national network of LTEs includes the experiment on which this research was conducted."

8 References

Ferraccioli, F., Gerard, F., Robinson, C., Jordan, T., Biszczuk, M., Ireland, L., Beasley, M., Vidamour, A., Barker, A., Arnold, R., Dinn, M., Fox, A., Howard, A. (2014). LiDAR based Digital Terrain Model (DTM) data for Southwest England. NERC Environmental Information Data Centre. [doi: 10.5285/e2a742df-3772-481a-97d6-0de5133f4812].

French, H. F. (1859). Farm drainage: the principles, processes, and effects of draining land with stones, wood, plows, and open ditches, and especially with tiles. New York: Orange Judd & Company.

Harrod, T.R., Hogan, D.V. (2008). The soils of North Wyke and Rowden. http://www.rothamsted.ac.uk/farm-platform-national-capability/data-portal-guides-and-information.

Institute of Environmental Assessment (1995) Guidelines for Baseline Ecological Assessment. E&FN Spon, An Imprint of Chapman and Hall. London.

Joint Nature Conservation Committee (1993). Handbook for Phase 1 Habitat Survey: A technique for environmental audit. (reprint), Peterborough.

9 Appendices

Appendix A. Timeline of key events for construction of the NWFP.

Date	Event
August 2008	Drainage Survey
September 2008	Topographic Survey: >6000 points
October 2008	Hydrological Design [Draft report v5 (31 Oct 08).pdf]
August 2009	Revised flow estimates [Revised flow estimates (18 Aug 09).doc]
August 2009	EA Flood Defence Consent received
September 2009	Badger Survey
October 2009	Extended Phase 1 Habitat Survey
October 2009	Tree Species & Condition Survey
December 2009	Environmental Impact Assessment
March 2010	Planning Consent given
May - October 2010	Construction of French Drains and Flumes
July - August 2010	Fencing & Tracks completed
August - December 2010	Mains electricity and fibre-optic IT infrastructure installed
February - March 2011	Flume cabins installed

Appendix B. Timeline of sensor installation and sensor updates (water, soil and MET only).

Date	Event
April 2011 - October 2011	Data sensors and telemetry equipment installed
05 January 2011	Start of collection of field event data
21 March 2011	Start of collection of livestock data
31 October 2011	Start of collection of soil moisture data
01 October 2012	Start of collection of water flow and properties
April 2013	Dedicated meteorological instruments installed
26 April 2013	Start of collection of meteorological data for whole site
31 March 2013	End of baseline data collection
May 2014	Solar radiation sensor added to meteorological site
10 October 2014	CEH COSMOS-UK soil monitoring station on Catchment 2
April 2015	Pluvio rain gauge added to meteorological site
7-14 September 2015	Pressure transducers installed to replace bubbler flowmeters
June - November 2015	Adcon Soil Moisture Sensors - A51760 model replaced with A51730 model
4 Feb 2015	Phosphax analysers measuring both total and ortho-phosphate from here onwards
May- September 2016	Upgrade of YSI 6600V2 multi-parameter sonde to YSI Exo. Turbidity units changed from NTU to FNU. New loggers installed. Everything up and running by 29/10/16. Flume loggers were changed from Adcon A723 to OTT netDL for data transfer via the fibre optic network
November 2017	Phosphax installed in Catchment 3
March 2021	All Phosphax instruments decommissioned
October 2021 - October 2022	Installation of Bluemon Total P / Ortho-P cabinet analysers on all 15 catchments. Data not available on Data Portal till 2023

Appendix C. Timeline of land management and changes.

Date	Event
01 April 2013	Lower Wheaty and Longlands North swapped treatments
13 August 2013	Change in area of Catchment 4 (Burrows)
July - August 2013	Reseeding of Red farmlet catchments: 2 (Great Field) with perennial ryegrass (AberMagic) 15 (Longlands East) with festulolium (Prior)
	Reseeding of Blue farmlet catchments: 8 (Higher & Middle Wyke Moor) with perennial ryegrass (AberMagic) & white clover (AberHerald) 14 (Longlands North) with festulolium (Prior) & white clover (AberHerald)
July - August 2014	Reseeding of Red farmlet catchments: 3 (Poor Field & Ware Park) with perennial ryegrass (AberMagic)
	Reseeding of Blue farmlet catchments: 9 (Dairy South & Dairy Corner) with perennial ryegrass (AberMagic) & white clover (AberHerald)
July - August 2015	Reseeding of Red farmlet catchments: 1 (Little Pecketsford & Pecketsford) with perennial ryegrass (AberMagic) 10 (Lower Wheaty) with perennial ryegrass (AberMagic)
	Reseeding of Blue farmlet catchments: 7 (Lower Wyke Moor) with perennial ryegrass (AberMagic) & white clover (AberHerald) 11 (Dairy East) with perennial ryegrass (AberMagic) & white clover (AberHerald)
09 May 2018	Catchment 14 (Longlands North) over sown with white clover mixture: Aberpearl (40.0%) Aberherald (40.0%) Aberace (wild white clover, 20.0%)
August - October 2019	Conversion of all Red farmlet catchments from grassland to arable. Sprayed with herbicide, ploughed, and sown with winter wheat (variety = Crusoe). See Appendix E for cropping areas. Pecketsford and Little Pecketsford now known as Pecketsford (whole).
October 2020	Red farmlets sown with winter wheat (variety= RGT Skyfall).
October 2021	Red farmlets sown with winter oats (variety = Mascani)
Late September-October 2022	Red farmlets sown with winter wheat (variety = Crusoe). Minimum tillage used (no ploughing) - shallow disk/tine cultivator, herbicide spray and min-till drill.

Appendix D. Name of field, field number and area contributing to each catchment flume on the three NWFP farmlets as of 2015.

Red Farmlet	Field Names	Field Numbers	Fenced area (ha)	Total Fenced area (ha)	Total Hydrological area (ha)
Catchment 1 Pre-autumn 2019[3]	Pecketsford	NW001	3.50	4.81	5.00
	Little Pecketsford	NW038	1.31		
Catchment 1 Post-autumn 2019[3]	Pecketsford (whole)	NW047	4.81	4.81	5.00
Catchment 2	Great Field	NW002	6.65	6.65	6.79
Catchment 3	Poor Field	NW003	3.92	6.62	4.03
	Ware Park	NW004	2.71		2.81
Catchment 10	Lower Wheaty	NW015	1.82	1.82	1.94
Catchment 15	Longlands East	NW019	1.54	1.54	1.62
Total				**21.4**	**22.2**
Green Farmlet	**Field Names**	**Field Numbers**	**Fenced area (ha)**	**Total Fenced area (ha)**	**Total Hydrological area (ha)**
Catchment 4 Pre-Aug 2013[4]	Burrows	NW006	6.39	11.12	11.55
	Bottom Burrows	NW005	1.26		
	Top Burrows	NW007	3.47		
Catchment 4 Post-Aug 2013[4]	Burrows	NW006	6.49	7.75	8.08
	Bottom Burrows	NW005	1.26		
Catchment 5 Pre / Post Aug 2015[5]	Orchard Dean North	NW008 / NW045	2.55	6.47	6.73
	Orchard Dean South	NW008 / NW046	3.92		
Catchment 6	Golden Rove	NW009	3.86	3.86	3.95
Catchment 12	Dairy North	NW016	1.78	1.78	1.87
Catchment 13	Longlands South	NW017	1.75	1.75	1.81
Total pre-Aug 2013				**25.0**	**25.9**
Total post-Aug 2013				**21.6**	**22.4**
Blue Farmlet	**Field Names**	**Field Numbers**	**Fenced area (ha)**	**Total Fenced area (ha)**	**Total Hydrological area (ha)**
Catchment 7	Lower Wyke Moor	NW012	2.60	2.60	2.71
Catchment 8	Middle Wyke Moor	NW011	4.32	7.02	7.33
	Higher Wyke Moor	NW10	2.70		
Catchment 9	Dairy South	NW013	6.45	7.75	7.91
	Dairy Corner	NW039	1.30		
Catchment 11	Dairy East	NW014	1.76	1.76	1.85
Catchment 14	Longlands North	NW018	1.72	1.72	1.78
Total				**20.8**	**21.6**
Total NWFP Area pre-Aug 2013†				**67.2**	**69.7**
Total NWFP Area post-Aug 2013†				**63.8**	**66.2**

[3] *At the start of the NWFP, Catchment 1 consisted of 2 fields, Pecketsford and Little Pecketsford, but following conversion of the Red farmlet to arable, the fields were combined and renamed Pecketsford (whole). See section 5.4.*

[4] *At the start of the NWFP, Catchment 4 consisted of 3 fields, Bottom Burrows, Burrows and Top Burrows, which made up a total area of around 11 ha. As the Green farmlet (25 ha) was considerably larger than the Red farmlet (21.4 ha) and the Blue farmlet (20.8 ha), it was decided to remove the Top Burrows field, which has an area of 3.47 ha, from the platform, for all farmlets to be of a similar size. To isolate the Top Burrows field, additional French Drains were constructed to intercept and divert water draining from Top Burrows away from Flume 4. completed 13 August 2013.*

[5] *See section 0*

Appendix E. Name of field and cropping area contributing to each catchment flume on the Red farmlet as of autumn 2019.

Red Farmlet	Field Names	Total Cropped Area (ha)
Catchment / Flume 1	Pecketsford (whole)[6]	4.45
Catchment / Flume 2	Great Field	6.34
Catchment / Flume 3	Poor Field	3.65
	Ware Park	2.49
Catchment / Flume 10	Lower Wheaty	1.59
Catchment / Flume 15	Longlands East	1.37
Total		**19.89**

Appendix F. Details of reseeding in 2013 for first system change period.

Field Name	Catchment / Flume No.	Farmlet	Fenced area (ha)	Species	Variety	Sowing rate (kg/ha)	Sowing rate (kg/field)	Total Mix (kg/field)	Date sown
Great Field	2	Red	6.65	Perennial Ryegrass	AberMagic	30	199.5		30-Jul-13
Longlands East	15	Red	1.54	Festulolium	Prior	40	61.5		07-Aug-13
Higher Wyke Moor	8	Blue	4.31	Perennial Ryegrass	AberMagic	25	107.8	122.8	31-Jul-13
				White Clover	AberHerald	3.5	15.1		
Middle Wyke Moor	8	Blue	2.71	Perennial Ryegrass	AberMagic	25	67.8	77.2	31-Jul-13
				White Clover	AberHerald	3.5	9.5		
Longlands North	14	Blue	1.72	Festulolium	Prior	35	60.1	66.1	07-Aug-13
				White Clover	AberHerald	3.5	6.0		

[6] *formerly Pecketsford & Little Pecketsford*

Appendix G. Details of reseeding in 2014 for first system change period.

Field Name	Catchment / Flume No.	Farmlet	Fenced area (ha)	Species	Variety	Sowing rate (kg/ha)	Sowing rate (kg/field)	Total Mix (kg/field)	Date sown
Poor Field	3	Red	3.92	Perennial Ryegrass	AberMagic	30	117.6		21-Aug-14
Ware Park	3	Red	2.71	Perennial Ryegrass	AberMagic	30	81.2		21-Aug-14
Dairy South	9	Blue	6.44	Perennial Ryegrass	AberMagic	25	161.0	183.6	22-Aug-14
				White Clover	AberHerald	3.5	22.5		
Dairy Corner	9	Blue	1.31	Perennial Ryegrass	AberMagic	25	32.7	37.3	22-Aug-14
				White Clover	AberHerald	3.5	4.6		

Appendix H. Details of reseeding in 2015 for first system change period.

Field Name	Catchment / Flume No.	Farmlet	Fenced area (ha)	Species	Variety	Sowing rate (kg/ha)	Sowing rate (kg/field)	Total Mix (kg/field)	Date sown
Pecketsford	1	Red	3.50	Perennial Ryegrass	AberMagic	30	105.0		11-Aug-15
Little Pecketsford	1	Red	1.31	Perennial Ryegrass	AberMagic	30	39.2		11-Aug-15
Lower Wheaty	10	Red	1.82	Perennial Ryegrass	AberMagic	30	54.6		11-Aug-15
Lower Wyke Moor	7	Blue	2.60	Perennial Ryegrass	AberMagic	25	65.0	74.1	7-Aug-15
				White Clover	AberHerald	3.5	9.1		
Dairy East	11	Blue	2.60	Perennial Ryegrass	AberMagic	25	44.0	50.1	12-Aug-15
				White Clover	AberHerald	3.5	62.0		