URS

Waste Water Study

Summer Farm Sites, Crossways, West Dorset

March 2013

Prepared for:
Pro Vision Planning and Design

UNITED KINGDOM & IRELAND

REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
1	February 2013	v1 – first draft	Clare Postlethwaite Senior Consultant	Carl Pelling Principal Consultant	Carl Pelling Principal Consultant
2	March 2013	FINAL	Clare Postlethwaite Senior Consultant	Carl Pelling Principal Consultant	Carl Pelling Principal Consultant

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SUMMARY

There would be a maximum estimated reduction in N run-off from the allocated development of 1,454 kg/year. The proposed development would produce an estimated 157.5 m^3/d.of wastewater, which is estimated to create an average additional N loading of 1,782.5 kg/year. This would be partially offset by the reduction in N runoff caused by taking the Summer Farm sites, out of agricultural use, which would result in a net increase of 328.5 kg/year.

This 328.5 kg/year shortfall, calculated using average N run-off values, represents roughly 110 dwellings. Therefore while the proposed 600 dwellings may not be suitable for the Summer Farm site, a lower number of dwellings could be accommodated. It is therefore recommended that the current proposal for 600 houses be reduced to roughly 490.

1 INTRODUCTION

This report has been prepared in support of the land at Summer Farm at Crossways, West Dorset, which has been allocated for development within the West Dorset, Weymouth and Portland Pre-submission draft Local Plan. The land is located south of Warmwell Road on the urban edge of Crossways, a village approximately 8 km east of Dorchester, in the catchment of the River Frome. The land is divided into nine fields, referred to as:

- Gravel Pit Field– 4.38 ha
- Cinema/Village Hall – 3.53 ha
- Summer Paddock – 0.88 ha
- Summer Farm House – 3.48 ha
- Dick of the bank – 2.25 ha
- Bowditch – 5.24 ha
- Starve All – 5.23 ha
- Lagoon – 1.94 ha
- Coombe – 4.98 ha

The total area of the proposed development land is 31.91 ha, as shown in Figure 1 (section 5). For the majority of the fields, this is the total area of the field. However, for Summer Paddock the management area rather than the total area of the field has been used, as the total field area includes area of farmyard due to the lack of a permanent fence separating the two areas.

The site lies within a Nitrate Vulnerable Zone (NVZ), which has been designated to protect the features of Poole Harbour Special Protection Area (SPA), SSSI and Ramsar site, into which the River Frome flows. The Harbour was designated to protect the large numbers of wading birds and waterfowl; at least 14 species of bird regularly attain levels in excess of 1% of their total British population. However, the Harbour suffers from nutrient enrichment, particularly from nitrogen (N) (which is usually the limiting factor in saline waters) and as such is periodically subject to excessive algal growth during the summer months. Natural England notes the following with regards to nutrient enrichment and algal growth in Poole Harbour:

> *'Estuarine Feature Macro-algal mats with a biomass exceeding 2KG/m² can have a detrimental effect on the benthic invertebrate populations living within intertidal sediments. An assessment of algal mat data collected by the Environment Agency in July 2008 and 2009 found over 10% the intertidal mudflat had >2kg/m2 of algal cover. Using this criteria this unit is unfavourable in terms of nutrient enrichment. Recovery depends on sufficient measures being taken to reduce the nutrient load*

into Poole Harbour so as to ensure that features of the site are in favourable condition with respect to effects from nutrient enrichment.'[1]

It is proposed that the allocated development would be served by the existing Dorchester Sewage Treatment Works (STW), which discharges treated effluent to Poole Harbour via the River Frome. Any additional flows treated by the STW would result in additional nitrate loading discharged from the STW, which could exacerbate the existing problems caused by elevated N levels in Poole Harbour.

In light of the above issues, Summer Farm wished to explore options for sustainable development at the land at Crossways, to meet the requirements for no increase in the N discharged to the Harbour. This report should be read with reference to the precedent set by the Duchy of Cornwall's Phases 3 and 4 Poundbury developments in Dorchester, which were granted planning permission in September 2011. In addition, a similar study was carried out in September 2012 for proposed development land to the north of Crossways, at Woodsford Farm.

The Planning Committee report[2] for the Phase 3 and 4 Poundbury developments noted an objection raised by Natural England:

> *'the application failed to provide sufficient information to be able to satisfactorily demonstrate that any additional nutrient loading on Dorchester sewage treatment works, alone or in combination with other proposed plans or projects, would not have an adverse impact on the Poole Harbour Special Protection Area (SPA) / Ramsar site; and*
>
> *the applications would increase the wastewater loading on Dorchester sewage treatment works and in the absence of improved treatment or other mitigation would act to increase nutrient loading and pressure on water quality in the River Frome SSSI'.*

In order to overcome this objection, the Duchy of Cornwall provided the following mitigation:

'*The Duchy of Cornwall is committed to permanently changing the management of its landholdings to reduce levels of nitrogen discharging to the River Frome to a level that fully offsets the estimated increase of 3.7 Tonnes/yr nitrogen resulting from the development, unless or until alternative mitigation is put in place, and thereby achieve nutrient neutrality'*[3].

[1] http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt13&category=S&reference=1000110, accessed 26062012
[2] Development Control Committee report 1/D/09/001363, 15 September, 2011
[3] Poundbury, Dorchester Phases 3&4, Environmental Statement (Volume 3) Duchy of Cornwall, 2011.

2 WASTE WATER TREATMENT AND DISPOSAL FROM THE PROPOSED DEVELOPMENT

2.1 Wastewater generation

Crossways is a large village to the west of Dorchester, which developed from a World War 2 fighter base and then become an important area for sand and gravel extraction. It has a population of just over 2,000. The draft Plan[4] allocates between 1,200 and 1,500 new dwellings and 7.2 ha of employment land at Crossways, as follows:

CRS 1. LAND AT CROSSWAYS

i) Crossways will have a significant level of growth over the plan period. This will include at least 7.2ha of employment land and between 1,200 to 1,500 new homes on land shown on the proposals map, through the development of:

- *land to the north (to be developed primarily for housing with some small-scale employment and community uses),*
- *land to the south-east (to be developed for a mix of housing, employment and community uses), and*
- *land to the south-west (to be developed for employment uses as a key employment site).*

Although the distribution of development across all the allocated strategic sites at Crossways is still to be determined, for the purposes of this initial assessment, it is assumed that for the Summer Farm land, approximately 600 dwellings, ranging from 1-4 bedrooms, are proposed.

Using an assumed occupancy rate of 2.1 people per dwelling and an estimated water usage of 125 litres per head per day[5] (l/h/d), the estimated water consumption[6] from the proposed development would be approximately 157.5 m^3/d.

Information was requested from Wessex Water[7] on the current consent to discharge and measured dry weather flow (DWF) at Dorchester STW, to which the land at Crossways drains.

[4] West Dorset, Weymouth & Portland Draft Local Plan Pre-Submission Draft , Weymouth & Portland Borough Council, 2012
[5] This equates to 120 litres per head per day in accordance with the Part G of the Building Regulations, plus an estimated 5 litres per head per day for external water consumption i.e. gardening, car washing etc
[6] Estimation is based on indicative type of development and number of dwellings proposed only
[7] Dave Ogborne, Planning Liaison Manager, Wessex Water, personal communication, 15th August 2012

2.2 **Table 2: Dorchester STW – current situation**

Biological treatment	
Dry Weather Flow (m^3)	9,450
Current PE	31,883 (summer)
Flow to Full treatment (l/s)	294
95%ile Max. conc. of BOD (mg/l)	25
Absolute Max. conc. of BOD (mg/l)	50
95%ile Max. conc. of Ammoniacal Nitrogen (mg/l)	5
Absolute Max. conc. of Ammoniacal Nitrogen (mg/l)	20
An. Mean Max. conc. of Total P (mg/l)	1
95%ile Max. conc. of Suspended Solids (mg/l)	30
Settled Storm Sewage	
Dry Weather Flow (m^3)	9,450
Storm/Emergency discharge	
Dry Weather Flow (m^3)	3,900
Measured values	
Mean measured STW average daily flow (m^3/d)	8,534

2.3 **Effects on Dorchester STW discharge**

Dorchester STW is currently consented to treat a Dry Weather Flow (DWF) of 9,450 m^3/d. The measured STW average daily flow is 8,534 m^3/d, which leaves 916 m^3/d of the consented DWF available for additional flows. The estimated flow from the proposed development is 157.5 m^3/d and could therefore be accommodated within the existing DWF consent at Dorchester STW (subject to Wessex Water approval). As the additional flow from the proposed development is less than 2% of the current DWF, it is probable that the STW would also have the required process capacity to treat the additional flow from the proposed development, although this would need to be confirmed by discussion with Wessex Water.

The connection to Dorchester STW would be subject to Wessex Water's agreement and further study on the existing plant process capability.

2.4 **Total Nitrogen Loading**

For this assessment, it is assumed that the proposed development sewage would be treated to meet the N current effluent quality of within range of 9 – 13 mg/l prior to discharge to the River Frome.

The Dorchester STW annual N loading data for 2011 was provided by Wessex Water[8]. Extrapolating from the current average flow of 8,534 m^3/d and the 2011 N load of 80.61 - 111.5 t/yr[9], an additional 157.5 m^3/d of treated wastewater discharged from the proposed development would result in an

[8] Dave Ogborne, Planning Liaison Manager, Wessex Water, pers. comm., 15th August 2012
[9] Table 6.5 Investigations Report : DM# 1452696

additional N load of between 1,495 and 2,070 kg/year – an annual average of 1,782.5 kg/year.

Table 3: Estimated N loading for Dorchester STW & proposed development

Development	Assumed N Effluent Concentration (mg/l)	N (kg/year)
Existing Dorchester STW	9 - 13	80,610 – 111,500 (assumed average 96,055)
Proposed development (Summer Farm)	9 - 13	1,495 and 2,070 (assumed average 1,782.5)
Total N loading (proposed development + Dorchester STW)	-	82,105 – 113,570
Average N loading	11	97,837.5
Estimated percentage additional N load to Dorchester STW	-	<2 %

3 COMPARISION OF NITROGEN LOADINGS FROM CURRENT VS PROPOSED LAND USE

3.1 Current nitrogen run-off from agricultural land

An Export Coefficient Modelling (ECM) approach was used to estimate the loss of N from Summer Farm. ECM is a semi-distributed approach which calculates mean annual total N loading delivered to a water body (freshwater or marine) as the sum of the nutrient loads exported from each nutrient source in the river basin. For livestock, the export coefficient expresses the proportion of the wastes voided by the animal which will subsequently be exported from stock houses and grazing land in the river basin to the drainage network, taking into account the amount of time each livestock type will spend in stock housing, the proportion of the wastes voided which are subsequently collected and applied to the land in the river basin, and the loss of nitrogen through ammonia volatilisation during storage of manures.

In this exercise, average livestock numbers were used based on stocking information provided by Summer Farm. The stocking comprises 70 suckler cows with 70 heifer and steer calves, and 5 bulls. The stocking rate for grazed fields was therefore calculated proportionally based on field area. See Appendix A below for the detailed Technical Report of the modelling.

Losses from nine fields totalling 31.91 ha were estimated individually, based on grazing and cropping regime, fertiliser and atmospheric inputs. Full details of the modelling are provided in Appendix A, with a summary of results provided in this section.

The overall average loss of N was calculated based on farming practices between 2010 and 2012 and was calculated as 1,454 kg N yr^{-1}, or 45.58 kg N ha^{-1} yr^{-1}. The estimated losses from the nine fields over each of the fields are given in Table 4 below.

Table 4 Estimated losses of N from Summer Farm, 2010-2012

Field	2012 Cropping	N Loss (kg)	kg N ha-1
Gravel Pit	Grazed	171.7	39.2
Cinema/Village Hall	Grazed	138.4	39.2
Summer	Grazed	34.5	39.2
Summer Farmhouse	Grazed	136.4	39.2
Dick o' th' Banks	Grazed	88.2	39.2
Bowditch	Cut/Grazed	218.5	41.7
Starve All	Grazed	205.0	39.2
Lagoon	Grazed	76.0	39.2
Coombe	Grazed	232.5	46.7
		TOTAL 1,301.2	**AVERAGE 40.8**

Field	2011 Cropping	N Loss (kg)	kg N ha-1
Gravel Pit	Cut/Grazed	202.86	46.32
Cinema/Village Hall	Cut/Grazed	174.61	49.47
Summer	Grazed	43.53	49.47
Summer Farmhouse	Grazed	172.14	49.47
Dick o' th' Banks	Grazed	111.30	49.47
Bowditch	Cut/Grazed	259.20	49.47
Starve All	Grazed	242.23	46.32
Lagoon	Cut/Grazed	95.96	49.47
Coombe	Kale	76.69	15.40
		TOTAL 1,378.5	**AVERAGE 43.2**
Field	**2010 Cropping**	**N Loss (kg)**	**kg N ha-1**
Gravel Pit	Grazed	249.54	56.97
Cinema/Village Hall	Grazed	204.29	57.87
Summer	Grazed	44.33	50.37
Summer Farmhouse	Grazed	186.26	53.52
Dick o' th' Banks	Grazed	120.43	53.52
Bowditch	Maize	266.19	50.80
Starve All	Grazed	263.45	50.37
Lagoon	Maize	98.55	50.80
Coombe	Grazed	250.86	50.37
		TOTAL 1,683.9	**AVERAGE 52.8**

3.2 Suitable Accessible Natural Green Space

The proposed development will need to provide Suitable Accessible Natural Green Space (SANGs) land, given the proximity to the Dorset Heaths SPA. In order to maximize the environmental and sustainability benefits of the proposed development, by providing a range of habitats, approximately 23.4 ha of SANGS is proposed (see Figure 2 below).

Approximately 9.2 ha of the proposed SANG (an area known as Skippet Heath) comprises heathland not actively used for agricultural purposes. The remainder of the proposed SANG land (14.2 ha) would be taken out of agricultural use and converted to amenity grassland, which would not be subject to fertiliser application. As the remainder of the SANG land would be taken from Starve All, Lagoon, Coombe and Bowditch fields, as shown in Figure 2 below, the reduction in nitrate run-off from the creation of SANG area would be the average given above i.e. 1,454 kg N yr^{-1}, or 45.58 kg N ha^{-1} yr^{-1}.

3.3 Effect of proposed development on nitrogen loadings

There would be a maximum estimated reduction in N run-off from the allocated development of 1,454 kg/year. The proposed development would produce an estimated 157.5 m^3/d.of wastewater, which is estimated to create an average additional N loading of 1,782.5 kg/year. This would be partially offset by the reduction in N runoff caused by taking the Summer Farm sites, out of agricultural use, which would result in a net increase of 328.5 kg/year.

This 328.5 kg/year increase in N loading, calculated using average N run-off values, represents roughly 110 dwellings. Therefore while the proposed 600 dwellings does not allow nutrient neutrality to be achieved for the Summer Farm site, a lower number of dwellings could be accommodated. It is therefore recommended that the current proposal for 600 houses be reduced to roughly 490.

3.3.1 *Potential ecological effects on Poole Harbour*

The Habitats Regulations Assessment (HRA) of the South West RSS was undertaken in February 2007, with an update published in July 2008. The HRA could not conclude that no adverse effects would occur with regard to Poole Harbour as a result of the proposed growth within the RSS. Although the Government has announced its intention to revoke the Regional Strategies through the Localism Act 2011, the conclusions of the HRA in relation to Poole Harbour are still considered relevant here; particularly given the National Planning Policy Framework states within paragraph 218 that ‘local planning authorities may also continue to draw on evidence that informed the preparation of regional strategies to support Local Plan policies, supplemented as needed by up-to-date, robust local evidence’. The HRA noted specific issues in Poole Harbour with nutrient enrichment.

An update to the 2007 HRA was provided in 2010 by the HRA of Purbeck District Council's Core Strategy pre-submission consultation[10]. The 2010 HRA noted that one effect of the higher nutrient levels in the Harbour is the growth of macro-algal mats (mostly *Ulva* and *Enteromorpha* spp.) covering the intertidal flats. Surveys carried out in 2010[11] showed that seven of 80 mudflat sites surveyed in Poole Harbour had over 70% cover of macro-algal growth. The HRA could not conclude that that no adverse effects would occur with regard to Poole Harbour and it noted that in order to ensure additional STW discharges arising from proposed developments would not have an adverse effect on the Poole Harbour, mitigation measures such as the installation of nutrient stripping at one or more STWs, or measures to reduce nutrient inputs to the Harbour from other point or diffuse sources would be required.

In addition to the above HRAs, Wessex Water has also carried out investigations[12,13] in conjunction with the Environment Agency relating to nitrogen discharges into the River Frome and Poole Harbour. The investigation on the River Frome concluded that the relationship between River Frome phosphorus levels and River Frome flows confirms that sewage is no longer the dominant source of nutrients and that diffuse sources, or small point sources, are the major sources.

The investigation on Poole Harbour examined the contribution of Wessex Water's assets to nutrient levels in Poole Harbour, which indicated that dissolved available inorganic nitrogen (DAIN) concentrations in Poole Harbour are decreasing locally in response to reduced inputs, specifically relating to the discharge consent revision at Poole STW. Overall, STW discharges accounted for 13% of the DAIN load to the harbour. The River Frome (53%) and the River Piddle (31%) conveyed the greatest loads to the Harbour, although 89% of the load conveyed by the Frome and 98% of that conveyed by the Piddle arose from non-STW sources (2006-2010 data).

Despite the conclusion of the investigation that only a small proportion of the N-loading in the harbour originates from STW sources, it is assumed from the 2007 and 2010 HRA that the situation with regards to Poole Harbour has not changed since Natural England raised its objection to the Poundbury development, i.e. no increase in N levels as a result of development would be permitted.

[10] Purbeck Core Strategy pre-submission consultation Habitats Regulation Assessment, Footprint Ecology & David Tyldesley and Associates, 2010
[11] Intertidal invertebrates and biotopes of Poole Harbour SSSI and survey of Brownsea Lagoon, A report to Natural England, Bournemouth University, Herbert, R., Stillman, R.A., Ross, K. & Hubner, R, 2010
[12] AMP5 Wastewater Nutrient Investigations: River Frome, Final Report no #1391325v4, Cascade Consulting, April 2012
[13] AMP5 Wastewater Nutrient Investigations: Poole Harbour SSSI, Final Report no: #1388653v3, Cascade Consulting, April 2012

4 SUGGESTED MITIGATIONS MEASURES

The West Dorset, Weymouth & Portland Draft Local Plan Pre-Submission Draft[14] was agreed by West Dorset District Council and Weymouth & Portland Borough Council for consultation in June and July 2012. The Local Plan is the main basis for making decisions on planning applications and covers the period until 2031.

To protect the Poole Harbour Special Protection Area from nutrient loading the draft Local Plan contains Policy ENV2: Wildlife and Habitats, which states:

i) Nationally or internationally designated wildlife sites (including proposed sites and sites acquired for compensatory measures), and protected species will be safeguarded from development that could adversely affect them.

ii) Development will not be permitted unless it can be ascertained that it will not lead to an adverse effect upon the integrity of the Dorset Heaths International designations. The following forms of development (including changes of use) will not be permitted within a 400m buffer around protected heathland:

- *Residential (C3 or C4 of the Use Classes Order) development that would involve a net increase in homes;*
- *Tourist accommodation including built tourist accommodation, caravan and camping sites;*
- *Sites providing accommodation for Gypsy and Traveller and Travelling Show People (permanent and transit); and*
- *Equestrian-related development that may directly or indirectly result in an increased adverse impact on the heathland.*

Between 400 metres and 5km of a protected heathland, new residential development (C3 or C4 of the Use Classes Order) will be required to take all necessary steps on site to avoid or mitigate any adverse effects upon the internationally designated site's integrity or, where this cannot be achieved within the residential development, to make a contribution towards mitigation measures designed to avoid such adverse effects taking place. Measures will include:

- *Provision of open space and appropriate facilities to meet recreation needs and deflect pressure from heathland habitats;*
- *Heathland support areas;*
- *Warden services and other heathland management;*
- *Access and parking management measures; and*
- *Green infrastructure.*

iii) Development will not be permitted unless it can be ascertained that it will not lead to an adverse effect upon the integrity of the Poole Harbour International designations. New development will be required to incorporate

[14] West Dorset, Weymouth & Portland Draft Local Plan Pre-Submission Draft , Weymouth & Portland Borough Council, 2012

measures to secure effective avoidance and mitigation of the potential adverse effects of nutrient loading on the ecological integrity of the Poole Harbour internationally designated sites.

iv) Elsewhere, development that would adversely affect nature conservation interests, including Sites of Nature Conservation Importance, Local Nature Reserves, ancient woodlands, veteran trees and hedgerows, and key wildlife corridors will be resisted.

v) Development of major sites will be expected to demonstrate no net loss in biodiversity, through the retention or restoration of habitats and features within the site, the planting of trees and woodlands, the management of open space for biodiversity, and taking opportunities to help connect and improve the wider ecological networks.

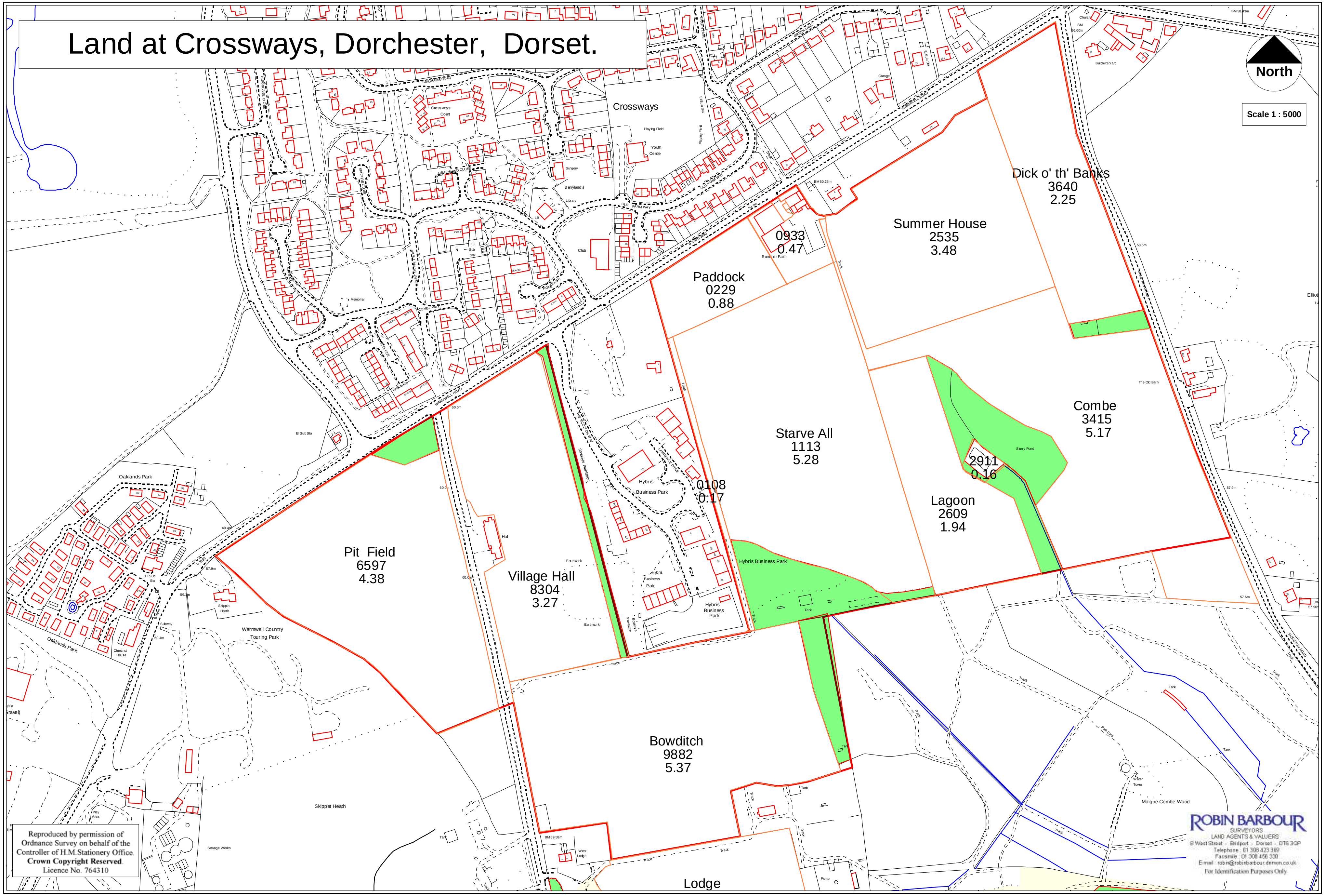
Section iii of this policy requires that mitigation measures be implemented to prevent adverse effects from nutrient loadings.

As discussed in section 2.3 above, no net increase in N run-off of would result from the allocated development on the Summer Farms site at Crossways if the number of proposed dwellings were limited to approximately 490. There are additional mitigation measures that could be implemented, such as tree planting under the English Woodland Grant Scheme. Such schemes can be investigated further once West Dorset District Council has confirmed the housing allocation at Crossways and the proposed development numbers have been confirmed.

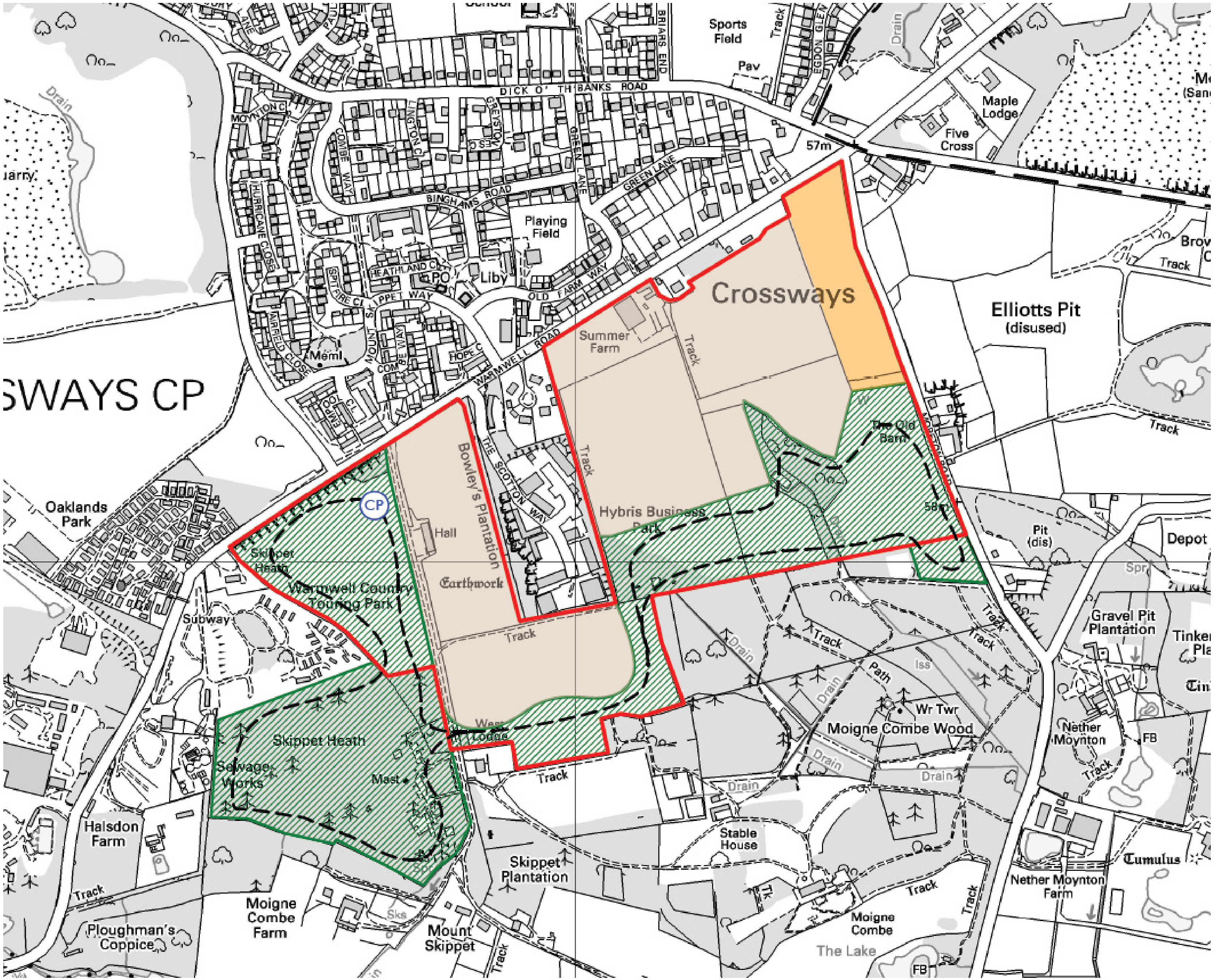
5 FIGURES

1.1 Figure 1 – Proposed development area

Land at Crossways, Dorchester, Dorset.



1.2 Figure 2 – Proposed SANGS area



REV:	DATE:	AMENDMENTS:	DRAWN:	CHECKED:
#	28.10.12		RD	JR
A	17.10.12	Areas and notation changes	RD	JR
B	18.10.12	Footpath scale altered	RD	JR
C	19.10.12	Footpath scale altered and SANGS area revised	RD	JR

SANGS 22.2ha

Residential 18.6ha

Employment 2.4ha

CP Car parking for visitors to SANGS

Potential footpath network

CLIENT:
Major General J.H.M. Bond

PROJECT:
Land South of Warmwell Road, Crossways

DRAWING:
Proposed SANGS Plan

SCALE: **1:5000 @ A3** DWG NO: **1305/LP02**

DATE: **Oct 12** REV: **C**

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6 APPENDIX A - TECHNICAL REPORT: ESTIMATED LOSSES OF NITROGEN FROM MOIGNE COOMBE FARM 2010-2012

Estimated Losses of Nitrogen from Moigne Coombe Farm 2010-2012

January 2013

Soil, Water and Catchment Management
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Email: SWCM@Hillmans.plus.com

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Figures

Tables

1 Introduction and approach

SWCM undertook modelling for URS Infrastructure and Environment UK Ltd. to estimate the average annual nitrogen (N) losses from several fields located to the south of Summer Farm, Crossways, Dorset (Grid Reference SY 771883) as shown in Figure 1.1 (farmed by Moigne Coombe Farm).

The area is approximately 31.9ha of grassland and is used mainly to graze a suckler herd. Some fields are reseeded; a few used to grow fodder crops such as kale and maize; and some are permanent pasture. The grass fields are usually cut for one or two crops, and the aftermath is usually grazed.

1.1 Approach

An Export Coefficient Modelling (ECM) approach was used to estimate the loss of N from Moigne Coombe Farm. ECM is a semi-distributed approach which calculates mean annual total N loading delivered to a water body (freshwater or marine) as the sum of the nutrient loads exported from each nutrient source in the river basin.

ECM approaches have been employed in many studies of diffuse agricultural pollutants such as nitrates or phosphates (e.g. Johnes, 1996; Haygarth *et al*. 2003) and is based on the following equation:

$$L = \Sigma Ei [Ai (Ii)] + P$$

Where:

- L is the sum of the annual loss of nitrogen for n land use type
- Ai is the area occupied by land use type i (or number of livestock type i)
- Ii is the annual nitrogen input to land use type i (or number of livestock type i)
- Ei is the export coefficient for land use type i (or number of livestock type i)
- P is the input of nitrogen from precipitation

The export coefficient (Ei) expresses the rate at which nitrogen or phosphorus is exported from each land use type in the river basin.

The approach in this study was to use information from a sub-model within a previous national modelling framework described by Haygarth, *et al.* (2003). The overall model used separate groups of coefficients for each one of 6 major geoclimatic regions in England and Wales.

The sub-models for each of these regions represent major landscape units with broadly similar climate, geology, soil types, topography and natural vegetation cover which have, therefore, broadly similar ranges of nutrient export potential (and nutrient retention capacity) as a function of flow volume, timing and routing from land to stream. They demonstrate, at this regional to national scale, quasi-homogenous sensitivity to the cycling, retention and export of nutrients as they move from land to stream.

A summary of the key characteristics used for the region around Crossways are given in Table 1.1 for reference.

1.1.1 Livestock

For livestock, the export coefficient expresses the proportion of the wastes voided by the animal which will subsequently be exported from stock houses and grazing land in the river basin to the drainage network, taking into account the amount of time each livestock type will spend in stock housing, the proportion of the wastes voided which are subsequently collected and applied to the land in the river basin, and the loss of nitrogen through ammonia volatilisation during storage of manures.

In this exercise, average livestock numbers were used based on stocking information provided by Moigne Combe Farm. The stocking comprises 70 suckler cows with 70 heifer and steer calves, and 5 bulls. The stocking rate for grazed fields was therefore calculated proportionally based on field area.

Faecal output (and therefore N returns) from young and old livestock are different, but standard ECM approaches typically assume a N output of 70.2 kg N ca^{-1} yr^{-1}. To allow for the high proportion of young livestock at Moigne Coombe Farm, published values (Table 1.2) for livestock N output were used to calculate weightings for mature and young animals.

1.1.2 Fertiliser and atmospheric loadings

Information on cropping and fertiliser (organic and inorganic) applications were also provided by Moigne Coombe Farm for the years 2010, 2011 and 2012 to allow loadings of N-fertiliser to be input to the ECM.

Inputs of atmospheric-N were taken from regional values published by Defra, (2010) and were assumed to be 14 kg N ha^{-1} yr^{-1} in each year modelled.

1.2 Limitations of approach

Export coefficient models are constructed using data collected on the spatial distribution of land-use and fertilisers applied to each land-use type; the numbers and distribution of livestock and human populations in the catchment; and the input of nutrients to the catchment through N fixation and atmospheric deposition.

There are, of course, limitations with any approach that aims to model nutrient transfers at the catchment and national scales:

- Export coefficients do not predict nutrient concentrations in watercourses
- There is some uncertainty of the extent to which the export model can predict future change based entirely on the variables employed
- There is no linkage between nutrient concentrations/loads and the ecological health of waterbodies

Export coefficients are ideally derived from field scale experiments and calibrated at the catchment outlet of the area to be evaluated. However, where time and resources are constrained, the model still can provide an effective means of evaluating the impact of land-use and land management on water quality, by using literature-derived data or expert judgement to determine the loss of nutrients from each identifiable source to the stream.

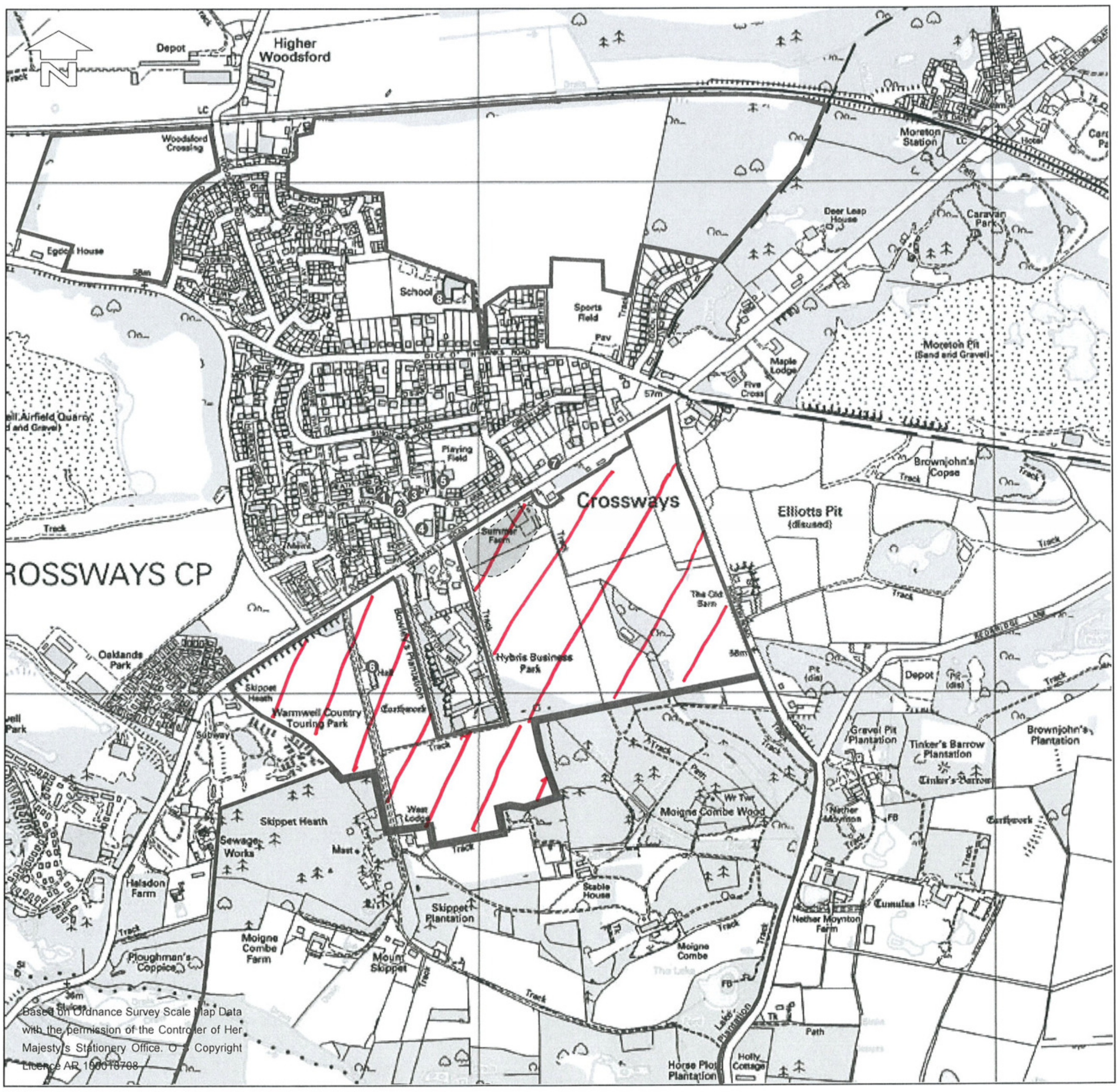
The approach used here is therefore uncalibrated (except against the rivers used to derive the coefficients in the first place) and must be seen as giving only an approximation of the loss of N from Moigne Combe Farm.

The amount and relative contribution of point and diffuse sources to the overall total nutrient load varies considerably between catchments, depending on the local biogeochemistry, geomorphology and the anthropogenic activities within the catchment (Defra, 2002).

Generally, point sources tend to dominate during the summer seasons, with diffuse sources making a significant contribution during winter, when runoff and drainage from agricultural land mainly occur.

However, export coefficient models produce yearly loadings, and therefore the project was, (at this stage), only able to produce an annual source apportionment. It did not take into account seasonal variations by apportioning different load fractions during different seasons or months.

Nevertheless, ECM are relatively simple to construct, and offer a useful preliminary tool for estimating the impact of land use on water quality.



Source: Pro-Vision Planning and Design, Winchester

Figure 1.1 Plan of proposed development at Moigne Coombe Farm, Crossways

Table 1.1 Geoclimatic characteristics of the region around Crossways, Dorset

Climate	Moderately dry in the UK context
Geology	Permeable, sedimentary with moderately sloping land
Soils	Mixed, varying depths, fertile, often calcareous
Land Use	Mixed arable/dairying region on permeable geology.

Source: Haygarth *et al*. (2002)

Table 1.2 Nitrogen and excreta produced by cattle

Cattle	Total N produced (kg/year) (notes a, b)	Volume of excreta (m^3/month)	Animal numbers per ha to comply with maximum N loading (170 kg/ha N per year)
1 calf (all categories) up to 3 months	1.4 (note c)	0.21	121
1 dairy cow from 3 months and less than 13 months	29 (note d)	0.60	5.9
1 dairy cow from 13 months up to first calf	61	1.20	2.8
1 dairy cow after first calf (over 9000 litres milk yield)	115	1.92	1.5
1 dairy cow after first calf (6000 to 9000 litres milk yield)	101	1.59	1.7
1 dairy cow after first calf (up to 6000 litres milk yield)	77	1.26	2.2
1 beef cow or steer (castrated male) from 3 months and less than 13 months	28 (note c)	0.60	6.1
1 beef cow or steer from 13 months and less than 25 months	50	0.78	3.4
1 female or steer for slaughter 25 months and over	50	0.96	3.4
1 female for breeding 25 months and over weighing up to 500 kg	61	0.96	2.8
1 female for breeding 25 months and over weighing over 500 kg	83	1.35	2.0
1 non-breeding bull 3 months and over	54	0.78	3.1
1 bull for breeding from 3 to 25 months	50	0.78	3.4
1 bull for breeding 25 months and over	48	0.78	3.5

Source: Defra,

a) Includes an allowance for N losses from livestock housing and manure storage

b) Different units are used for cattle less than 13 months – see notes c & d below

c) Total N produced (kg) during the two months that the animal is in this category

d) Total N produced (kg) during the ten months that the animal is in this category

2 Results and discussion

Table 2.1 shows results of the estimates of N losses from Moigne Coombe farm for the years 2010 to 2012.

Losses from nine fields totalling 31.91 ha were estimated individually, based on grazing and cropping regime, fertiliser and atmospheric inputs. The overall average loss of N was 1,454 kg N yr^{-1}, or 45.58 kg N ha^{-1} yr^{-1}.

The largest total loss of N was for the year 2010, when 1,684 kg N ha^{-1} yr^{-1} was estimated to be lost and the smallest in 2012 (1,301 kg N ha^{-1} yr^{-1}). However, within these results, it should be borne in mind that available records show no applications of fertiliser at all (mineral or organic) in the year 2012 (though the fields were still grazed at normal rates). Thus, when considering losses of N across the period of study, the years 2010 and 2011 are likely to be more representative.

For comparison, Figure 2.1 shows the range of nitrate lost from various grassland and arable crops under the Pilot Nitrate Sensitive Areas programme. The results for grassland (c. 50 kg N ha^{-1} yr^{-1}) show the results from this exercise are within published values.

It should be noted that the loss of N from agricultural land is very weather dependent, with largest losses in wet seasons and especially when nitrate is not being utilised by growing crop (i.e. winter). Thus, autumn is typically recognised as a peak season for total loads of nitrate from agricultural land as the soil wets up, drainage commences and crop growth slows.

The years 2010-2011 are considered to be atypical in terms of weather as it was characterised by extreme drought. Theoretically, this would result in a large pool of nitrate being available for leaching in the soil as a result of poor crop growth and limited drainage, which could be lost with any subsequent heavy rainfall. However, the ECM exercise for this report uses average rainfall/runoff statistics and therefore these anomalies are not modelled.

Figure 2.1 Nitrate leached from crops grown under the Pilot Nitrate Sensitive Areas under 'good nitrate practice' (economic optimum allowing for manure according to contemporary RB209) Source: Defra, (2002)

Table 2.1 Estimated losses of N from Moigne Coombe Farm, 2010-2012

Field	2012 Cropping	N Loss (kg)	kg N ha^{-1}
Gravel Pit	Grazed	171.7	39.2
Cinema/Village Hall	Grazed	138.4	39.2
Summer	Grazed	34.5	39.2
Summer Farmhouse	Grazed	136.4	39.2
Dick o' th' Banks	Grazed	88.2	39.2
Bowditch	Cut/Grazed	218.5	41.7
Starve All	Grazed	205.0	39.2
Lagoon	Grazed	76.0	39.2
Combe	Grazed	232.5	46.7
		TOTAL 1,301.2	AVERAGE 40.8

Field	2011 Cropping	N Loss (kg)	kg N ha^{-1}
Gravel Pit	Cut/Grazed	202.86	46.32
Cinema/Village Hall	Cut/Grazed	174.61	49.47
Summer	Grazed	43.53	49.47
Summer Farmhouse	Grazed	172.14	49.47
Dick o' th' Banks	Grazed	111.30	49.47
Bowditch	Cut/Grazed	259.20	49.47
Starve All	Grazed	242.23	46.32
Lagoon	Cut/Grazed	95.96	49.47
Combe	Kale	76.69	15.40
		TOTAL 1,378.5	AVERAGE 43.2

Field	2010 Cropping	N Loss (kg)	kg N ha^{-1}
Gravel Pit	Grazed	249.54	56.97
Cinema/Village Hall	Grazed	204.29	57.87
Summer	Grazed	44.33	50.37
Summer Farmhouse	Grazed	186.26	53.52
Dick o' th' Banks	Grazed	120.43	53.52
Bowditch	Maize	266.19	50.80
Starve All	Grazed	263.45	50.37
Lagoon	Maize	98.55	50.80
Combe	Grazed	250.86	50.37
		TOTAL 1,683.9	AVERAGE 52.77

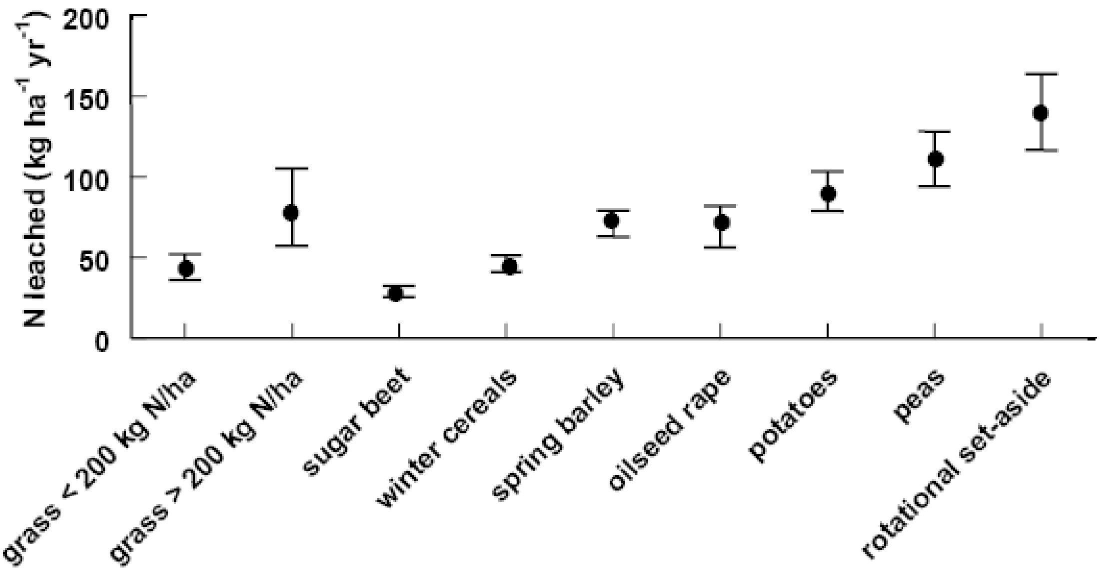


Figure 2.1 Nitrate leached from crops grown under the Pilot Nitrate Sensitive Areas under 'good nitrate practice' (economic optimum allowing for manure according to contemporary RB209) Source: Defra, (2002)

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