Soils report 2 – Danny Bermingham, Doonbeg

Introduction

This Dairy farm is located to the south east of the village of Doonbeg, Co. Clare (Plate 1). It is approximately 47 hectares in size. It is at the highest point only 16 metres above sea level. Annual precipitation is an average of 1185 mm from the met station 2.0 km away. Slopes are generally <2 degrees and the Doonbeg River flows for 0.9 km across the southern end of the farm (Plate 2). The Cree River flows to within 10 metres of the northern part of the farm.

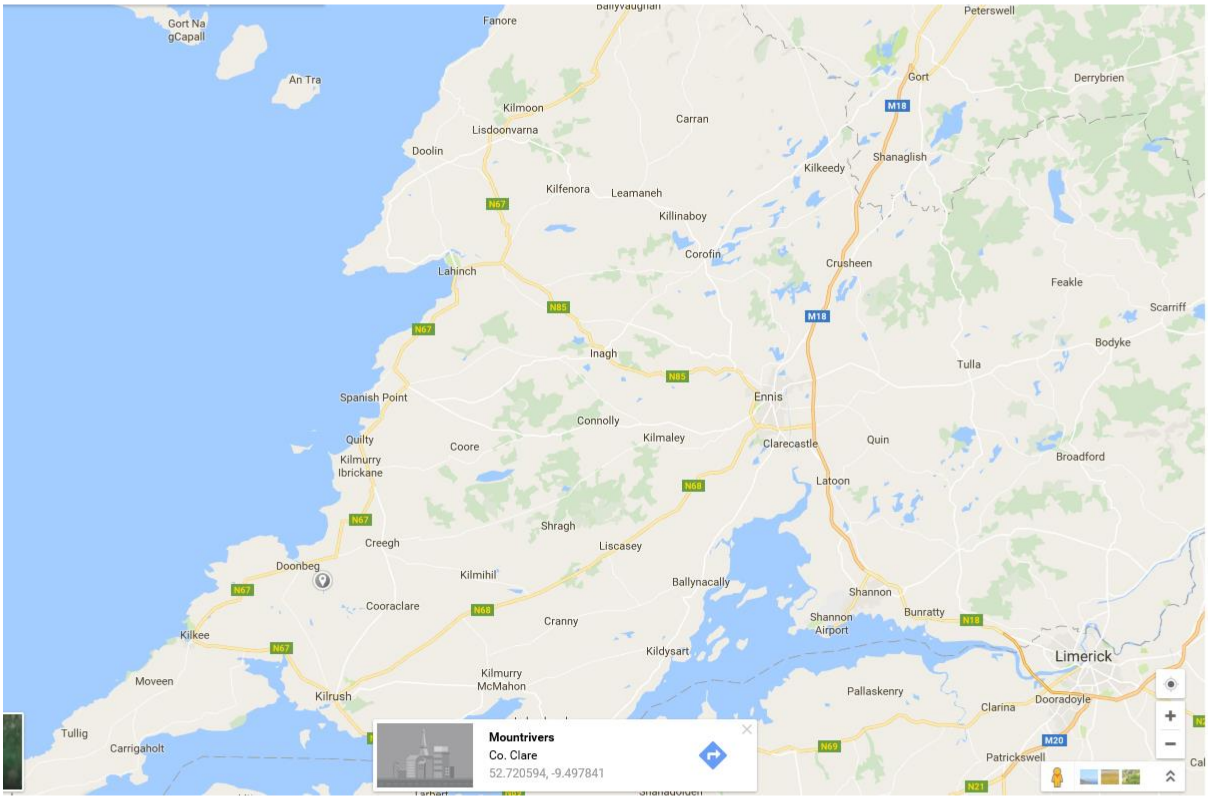

Plate 1. Berminghams farm south east of the village of Doonbeg in the townland of Mountrivers, Co. Clare.

The area has high rainfall and a large area of peat is present on the eastern side of the farm. Some of this had been planted with conifers. Turf is still extracted over a large part of this area also. With the presence of two rivers in the area, groundwater would be expected to play a significant part of the drainage problem. Many of the paddocks have had drainage measures in the past and some of it is reclaimed cutaway peat.

The topographic area is known as the Loop Head Peninsula. The landscape consists of gently undulating hills with long solifucted slopes. Altitude seldom exceeds 10 m. The general geology of the area is sandstone and shale derived from sand and mud deposited in a narrow ocean basin. More specifically it is described as the Gull Island formation, containing grey siltstone and sandstone (Sleaman et al 1997, GSI) .

The glacial drift in this area is very similar to the bedrock in which it is found. There is however some dilution due to the proximity of carboniferous limestone bedrock to the east. This becomes less apparent the further west you inspect. The soils therefore can be of very mixed origin and constitution due to multiple glaciations particularly the Elster, Saale and Weichesel (21,000 bp) glaciations.

Following the glaciations and ice disappearance open grassland cover dominated. With improving climate (8,800-8,300 bp), birch scrub began to be replaced by pine forest. Then about 5,500 bp, oak wood replaced the pine forests. A change to wetter climatic conditions about 3,000 B.C. is reflected in a great extension of the peat bogs and a decline in the forest cover. The Neolithic farmers about the same time; commenced the destruction of the forests which has continued up to the present. The original wooded landscape gradually gave way to more open countryside (Finch et al 1971).

Historical soil information

The Soils of County Clare (Soil Survey Bulletin No. 23) was produced by the National Soil Survey of Ireland by An ForasTaluntais, covering the area of the farm (Finch et al 1971). In the map produced with this book, the area of the farm is dominated by peat (over 90 % coverage). The peat was described in two series, Allen (1B) and the cutover Allen (1G). The remainder of the area suggested small patches (less than 500 m^2) of a Surface-water Gley, series Kilrush (71). It was described as a gley composed of drift of shale origin. It was noted that it had a very high clay content. Within 3 km of the farm there were polygons of Abbeyfeale series (62a) a podzolised gley over drift of shale and sandstone origin. There would be the potential of this soil arising on greater inspection of the farm area. Another soil series Tuillig was found in a large area to the north west of the farm. It was a Brown Earth with gleying again found in drift composed of shale.

Inspecting the more recent Irish SIS (Creamer et al, 2014) map,a Peat association dominates most of the area (Plate 3). This peat is made of two series of blanket peat, Aughty and Aughty drained, the former being poorly drained and the latter being imperfectly drained. An alluvial association, Boyne is attributed to the channel of the Doonbeg River. Boyne is described as a Typical Alluvial Gley, formed of silty river alluvium. This soil would be of recent origin and relatively free draining with drainage measures. To the north west of the Cree River there is a polygon of the Stagnic Brown Earth, Moord. This soil is found on drift with siliceous stones. This area continues between the two rivers south of the national road. The Moord soil series would be imperfectly to moderately drained.

The old national soil survey soils series Tullig has now been rationalised to Moord. The series Abbeyfeale has been rationalised to Kilrush, in the Irish SIS. Essentially the main difference between the two surveys is the emphasis of the Alluvial soils in the area, which is judicious considering the farm is between two rivers. The subsequent auger campaign described below found many examples of all three soil associations and their soils series, from the Irish SIS description.

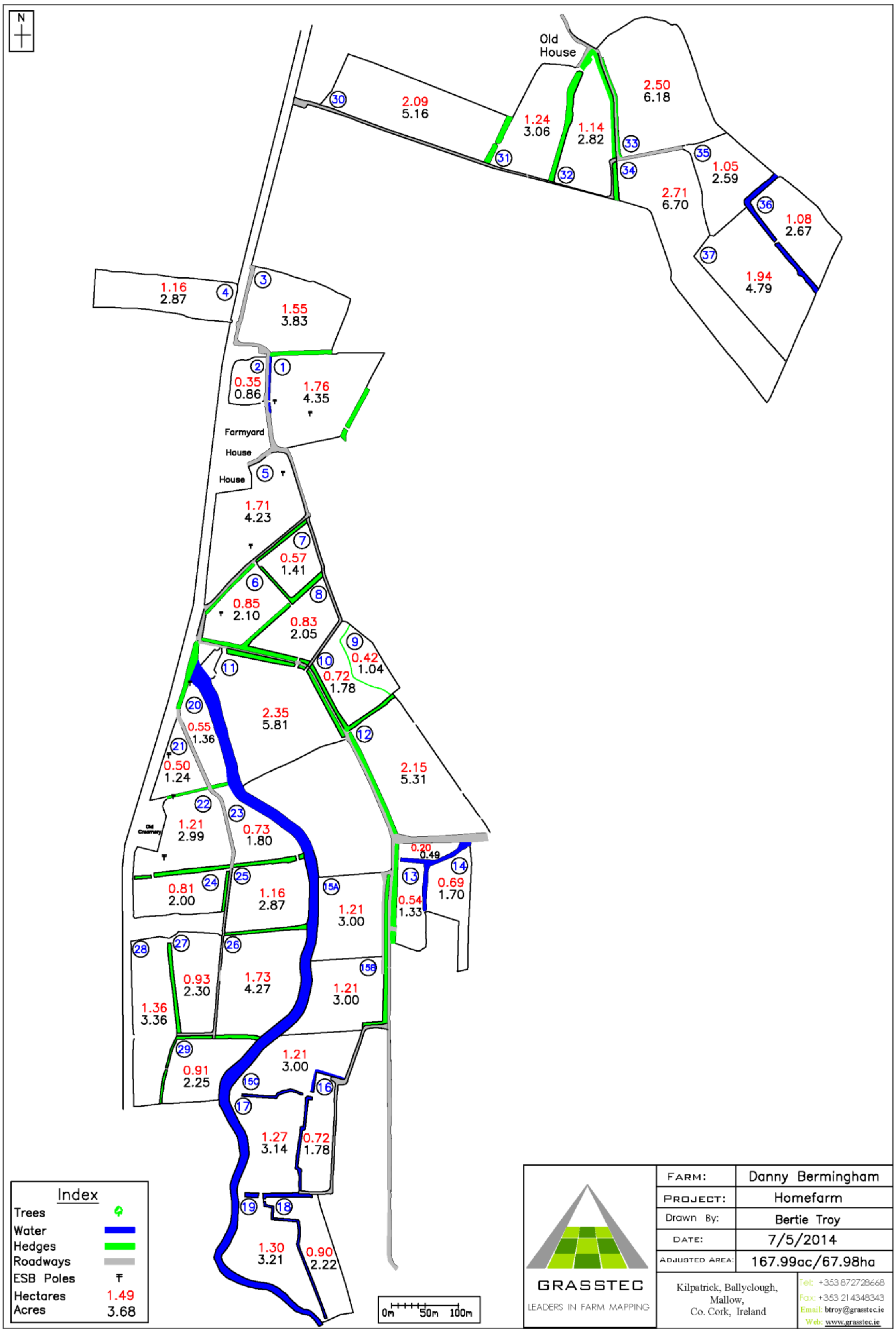

Plate 2. Paddock arrangement on the Doonbeg farm, County Clare.

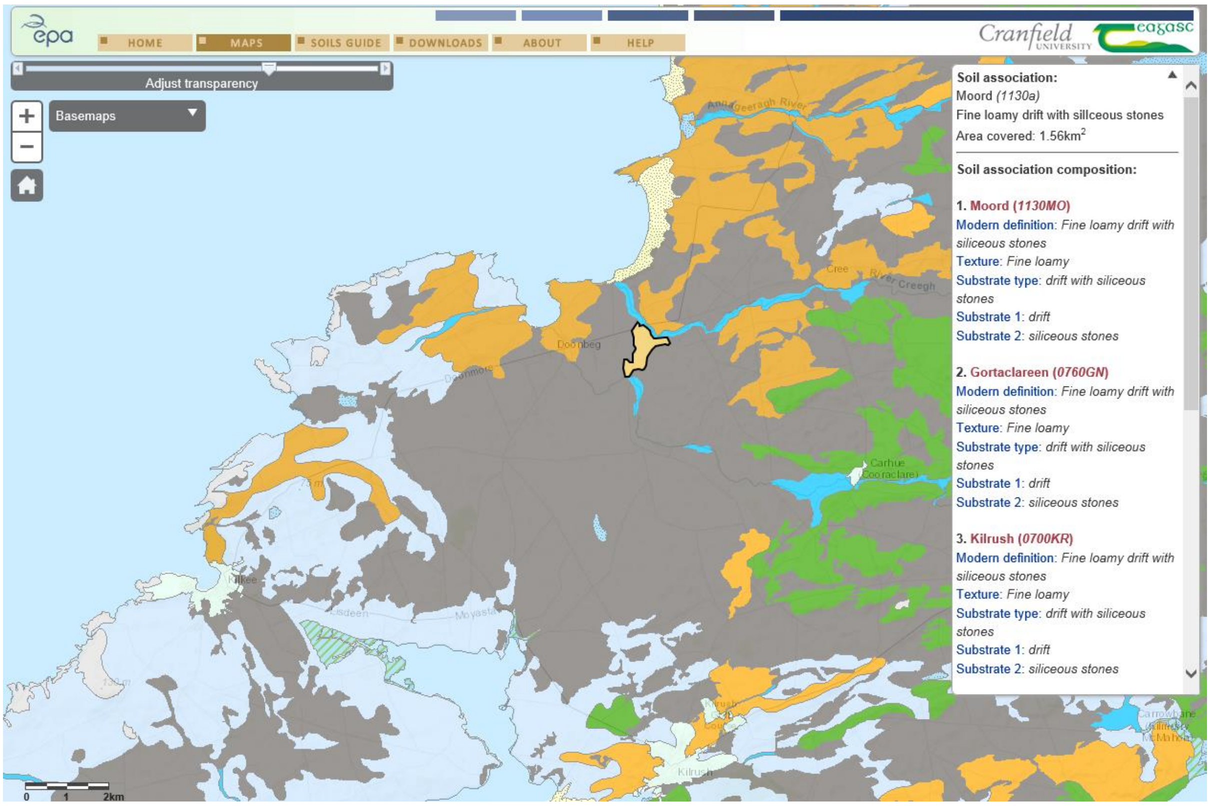

Plate 3.Moord association on the Irish SIS. The blue area to the south is Boyne (Alluvium) the remainder of the farm area is peat, dark grey (Aughty and Aughty drained).

Auger campaign

<u>Method</u>

An auger bore was carried out on average every hectare to investigate the soil physical features. In practice more or less augers were used based on landscape complexity. Their resulting distribution was an even coverage in this area (Plate 4). The Dutch auger was driven into the soil to a depth of 1 metre if possible. The soil features were described and recorded on a field tablet. Horizon type, depth, texture, colour, mottling, structure, roots and stones were recorded along with many more physical attributes detailed in the Irish SIS soil profile handbook (Simo et al 2014).

<u>Humic/Organic layers</u>

A humic layer was noted in almost two thirds of the augers suggesting long periods of stagnation, where organic material builds up as it cannot break down and accumulates in the upper horizons. The stagnation occurs due to the high amounts of rainfall in the area and the shallow inclines not providing enough relief for runoff (Plate 5). In this scenario the water tries to percolate downwards but is impeded by increased soil bulk density with depth. This is also confounded by the higher clay and silt contents found in the sub soils (Bt and Btg horizons). There is reduced porosity as a result and the water cannot move downwards quickly, leading to a perched water table. Another reason for the humic layer is the remnant organic material from reclaimed cutover peat. This layer has condensed over time and has become earthy as the peat has dried out and the organic material has become completely decomposed.

Humic layers were noted in paddocks 30a, 30b, 33b, 35, 37, 34a, 4, 4b, 3, 2, 9, 7, 8, 10, 12a, 12b, 11a, 14, 13, 14b, 15a, 15b, 17, 16, 18, 19, 22, 24, 27, 28a, 28b and 29. Most augers also had common to many mottles in the horizon below the humic layer indicating long periods of anaerobic conditions. Here the microbes use iron and manganese as electron acceptors, which become soluble in the process. As oxygen returns the iron and manganese become oxidised and are deposited on the soil surfaces, leading to the mottling within the horizon. It is not surprising that 20 of the augers were described as Surface-water Gleys (Table 1). Nine were described as Alluvial Gleys. These were found either side of the Doonbeg River.

If the conditions are particularly bad for many years the humic layer develops into peat (> 40 cm) and becomes more acidic exacerbating the breakdown process further. Peat was found in the following paddocks: 12 a 12 b 16 17 18 19, 9, 10, 4, 3 and 13. In some of these augers a silt layer was found just below the peat/earthy layer on this farm ~10cm in depth, suggesting ponds or shallow lakes may have been in place before the peat formation.

With the high susceptibility of these soils (Gleys and Peats) to stagnation, poaching is prominent in most paddocks.Where the drainage measures have been employed (paddock 30), the problems have reduced allowing for increased management (reseeding) due to drier conditions (Plate 5). In many areas the paddocks are reclaimed cutover peat and sward establishment is still proving difficult to manage (Plate 6a & b). Some areas are still left fallow as scrub following the cutting of peat (Plate 7a).

Watertable

In some augers the persistence of a high groundwater table was the dominating factor Paddock 4a, 4b, 7, 10, 12a 12b, 18 and 19 (all peats). Most augers had the water tablebetween 45 and 65 cm. Paddock 19 a however was very shallow 35cm. Paddocks 30a, 30b and 33b were described as Groundwater Gleys. This was due to the clay contents reducing with depth allowing the fluctuating water table to rise easily. These points did have a surface water problem also, but the groundwater was considered a greater problem, these paddocks have fared better as a consequence in relation to the drainage measures.

The Alluvial soils were all found on either side of the Doonbeg River (11, 15a, 15b, 15 c, 20, 23, 25, 26, and 29). Paddock 15a was relatively free draining, but all the other alluvial soils were gleyed due to a fluctuating groundwater table. They tended to have peaty upper horizons, with amorphous peat dominating. Some tree fragments were present.

Bedrock and stones

Shallow stones impeded the use of the auger in paddocks 1 and 6 both keyed out as Typical Surface-water Gleys in their description. Generally drift or alluvial material dominated the substrate of these soils. Surface stones were prominent in a small paddock, 2, between round bales storage and the farmyard. The farmer noted that this was not natural and likely to be imported due to mixing over the years and infilling in the area.Some piles of shale were seen in local reclaimed fields. Small sheds/walls were also built from sandstone. Bedded shale (known locally as pencil) was spoken about and seen in places. This was likely transported in situ for drainage. Shattered shale was noted down at small bridge near Doonbeg River where excavator was working.

Shell fragments

In paddocks 24 and 27 there was a reaction to 10% HCl due to the presence of $CaCO_3$, on closer inspection small shell fragments could be seen from molluscs (Plate 8). This buried horizon could be of former marine origin, the sea lies only 2.5 km away to the North West. The matrix itself did not react and is not calcareous. None of the soils on the farm were developed on Limestone drift, the farm is to the extreme west of the limestone bedrock in the east of the county. These two paddocks were described as Humic Brown Earths and did not have severe drainage problems. A Luvisol was found in paddock 28 a, with an increase in clay in the 2nd horizon without any problems in relation to stagnation as a result. The elevation here is slightly higher on the western edge of the farm, allowing for greater natural drainage

In conclusion there were 30 Surface-water gleys, 11 peats, 9 Alluvial, 3 Groundwater gleys, 2 Brown Earths and one Luvisol described in the auger campaign (Table 1). A drainage class was assigned based on the description of Schulte et al (2015) in relation to the soil moisture deficit hybrid model.

Plate 4. Distribution of the auger bores on the Doonbeg, Heavy soil farm, county Clare.

Plate 5. The main body of the farm has less than 2 degrees incline. Paddock 30 Reseeded, north end

Plate 6.(a)Paddock 34A reclaimed peat, rushes still evident. Plantation forestry in the background.(b) Paddock 10 reclaimed cutover peat, more recently established.

Plate 7 (a).paddock17, scrub resulting from cutover peat- (b). Paddock 15b River deposit – alluvial floodplain, looking east from Doonbeg River.

Plate 8 Paddock 24 has a reaction to HCl due to CaCO3 fragments in the 2nd horizon (broken shell fragments in dark grey material).

Table 1. Field observations of soil type during the auger campaign on Doonbeg Heavy Soil Farm. Paddocks are listed with Subgroup and Soil series based on the Irish SIS (Creamer et al 2014).

Paddock	SUBGROUP	SERIESNAME	Drainage class
30a	0636 HumicStagnic Groundwater Gley	Corlea	Poorly
30b	0636 HumicStagnic Groundwater Gley	Corlea	Poorly
31	0700 Typical Surface-water Gley	Drumkeeran	Poorly
32	0700 Typical Surface-water Gley	Drumkeeran	Poorly
33a	0700 Typical Surface-water Gley	Kilrush	Poorly
33b	0660 Humic Groundwater Gleys	Tourmakeady	Imperfectly
35	0760 Humic Surface-water Gleys	Cluggin	Imperfectly
37a	0760 Humic Surface-water Gleys	Cluggin	Poorly
37b	0760 Humic Surface-water Gleys	Gortaclareen	Imperfectly
34a	0760 Humic Surface-water Gleys	Gortaclareen	Poorly
34b	0700 Typical Surface-water Gley	Kilrush	Poorly
36	0700 Typical Surface-water Gley	Kilrush	Imperfectly
4a	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
4b	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
3	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
2	0760 Humic Surface-water Gleys	Gortaclareen	Poorly
1	0700 Typical Surface-water Gley	Drumkeeran	Poorly
5	0700 Typical Surface-water Gley	Coolykereen	Poorly
6	0700 Typical Surface-water Gley	Kilrush	Poorly
8a	0760 Humic Surface-water Gleys	Gortaclareen	Poorly
7	0760 Humic Surface-water Gleys	Gortaclareen	Poorly
8b	0760 Humic Surface-water Gleys	Gortaclareen	Poorly
10 + 9	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
12a	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
12b	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
11a	0572 Gleyic Drained Alluvial Soil	Clohamon	Imperfectly
11b	0500 Typical Alluvial Gley	Lyre	Poorly
13	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
14	0760 Humic Surface-water Gleys	Ballygree	Poorly
15a	0500 Typical Alluvial Gley	Lyre	Moderately
15b	0560 Humic Alluvial Gley	Kilcullen	Moderately
15c	0500 Typical Alluvial Gley	Lyre	Moderately
17	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
16	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
18	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
19	0170 Drained Ombrotrophic Peat Soils	Aughty drained	Imperfectly
21	0700 Typical Surface-water Gley	Kilrush	Moderately
20	0500 Typical Alluvial Gley	Lyre	Moderately

23	0500 Typical Alluvial Gley	Boyne	Poorly
22	0760 Humic Surface-water Gleys	Cluggin	Poorly
24	1160 Humic Brown Earth	Ashgrove	Imperfectly
25	0500 Typical Alluvial Gley	Vicarstown	Poorly
27	1160 Humic Brown Earth	Ashgrove	Imperfectly
28a	1000 Typical Luvisol	Dunboyne	Moderately
26	0500 Typical Alluvial Gley	Vicarstown	Poorly
29	0500 Typical Alluvial Gley	Lyre	Poorly
28b	0760 Humic Surface-water Gleys	Gortaclareen	Poorly

Representative soil profile pits

Using the auger survey as a guide, four pits were selected to represent the dominant soils on the farm and to investigate the principal drainage restrictions identified. Paddock 31 was to represent the soils in the northern part of the farm that had been recently drained. Paddock 15b was chosen to represent the Alluvial soils along the Doonbeg River. Paddock 27 was to represent the most dominant soil type on the farm Surface-water Gley. Paddock 1 was the shallower version of the Surface-water Gley.

Plate 9. Location of soils pits on the Doonbeg farm. The most northerly 31, in the centre 1, to the south and west 27 and 15b to the east of the Doonbeg River.

Plate 10. Paddock 31 Groundwater Gley, series Kilpierce

Plate 11. Manganese coats (black concentrations) in the Apg horizon of Paddock 31.

Table 2. Soil Profile description of paddock 31, Doonbeg Farm.

Horizon depth (cm)	Horizon designation	Description
26	Apg	Dark grey colour, abundant red mottles throughout. Silt clay loam. Many manganese coats.
48	Btg	Light orange/grey colour, abundant mottles. Increase in clay content, clay loam. Weathered stones present
75	Cg1	Grey brown colour, many mottles. Increase in silt content. Dead medium roots. Silt loam.
140	Cg2	Grey colour, many mottles. Angular stones. Compacted. Clay loam.

Paddock 31 was located to the east of the recently drained field. It is a Groundwater Gley, in which the fluctuating water table dominates the water relations in this pit. The Cg1 horizon allows the watertable rise more quickly than the Btg, There appears to be common rise and fall in the Cg1 horizon with the gleyed matrix present there. The silt loam texture would have greater porosity than the horizons above and below, it may act as a conduit for lateral flow. There is also a perched water table with the high clay content Btg horizon (38 %). Consequently there is mottling throughout the profile. The structure of this profile pit was weak in the Apg and massive in the lower horizons. Therefore pore space was greatly reduced and permeability restricted.

Plate 12. Paddock 15b. Humic Alluvial Gley, series Feale

Table 3. Soil Profile description paddock 15b, Doonbeg Farm.

Horizon depth (cm)	Horizon designation	Description
38	Oa	Black amorphous peat, preserved wood fragments
75	Btg	Brown Grey colour, common mottles, siit loam. No stones, dead roots present.
108	CG	Gley blue colour, sulphurous smell, silt loam. High packing density, compacted.
140	Cr	Gley blue colour, silt loam. Water table at 110 cm. High packing density, compacted, Abundant stones.

This soil has very low capacity for vertical drainage. The bulk density rose steadily with depth the only considerable jump was from pure peat to the organo-mineral layer below it (0.37 to 0.98 g/cm3). The profile is saturated with water for long periods of time. It does not appear to rise and fall regularly as the mottles are not many or abundant. The Gley colouring of the lower horizons and the sulphurous smell are indicative of extreme gleying. The surface peat may dry out but the lower horizons are anerobic most of the time.

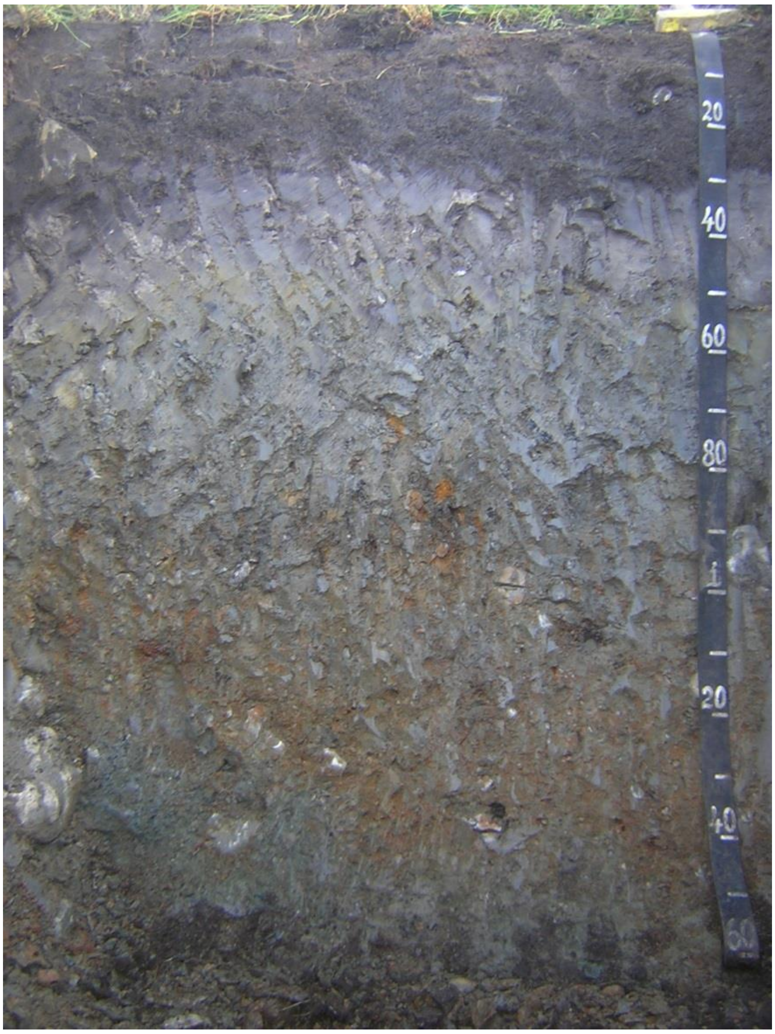

Plate 14. Paddock 27, Humic Surface-water Gley, series Ballygree.

Table 4. Soil Profile description paddock 27 Doonbeg Farm.

Horizon depth (cm)	Horizon designation	Description
30	Ap	Brown black colour, many root mottles. Clay loam, manganese concretions, compacted
57	Btg	Grey brown colour, common mottles, Silt clay loam, manganese coats. Compacted clay patches in places, weathered stones. High packing density
85	Cg1	Gley blue colour, many mottles, silt loam. Manganes coats. Many stones, compacted, dead roots.
140	Cg2	Gley blue colour, abundant mottles, silt loam. Cemented, very high density. Abundant stones

This profile has high clay (36 %) in the Btg horizon, this prevents vertical drainage which is exacerbated by the high packing density of the horizon and the subsequent horizon. The lowest horizon is cemented. However the intense mottles of horizon 3 indicate some fluctuations of the ground water tabbel. The accumulation of organic material at the top of the profile indicates that anaerobic conditions are common and organic matter breakdown is restricted. The manganese concretions in the Ap indicated a regularly fluctuating perched water table.

The auger for paddock 27 indicated a Humic Brown Earth, however the pit details indicate that this paddock is more dominated by a Humic Surface-water Gley.

Plate 15. Manganese concentrations in horizon 1, Paddock 27, Doonbeg farm.

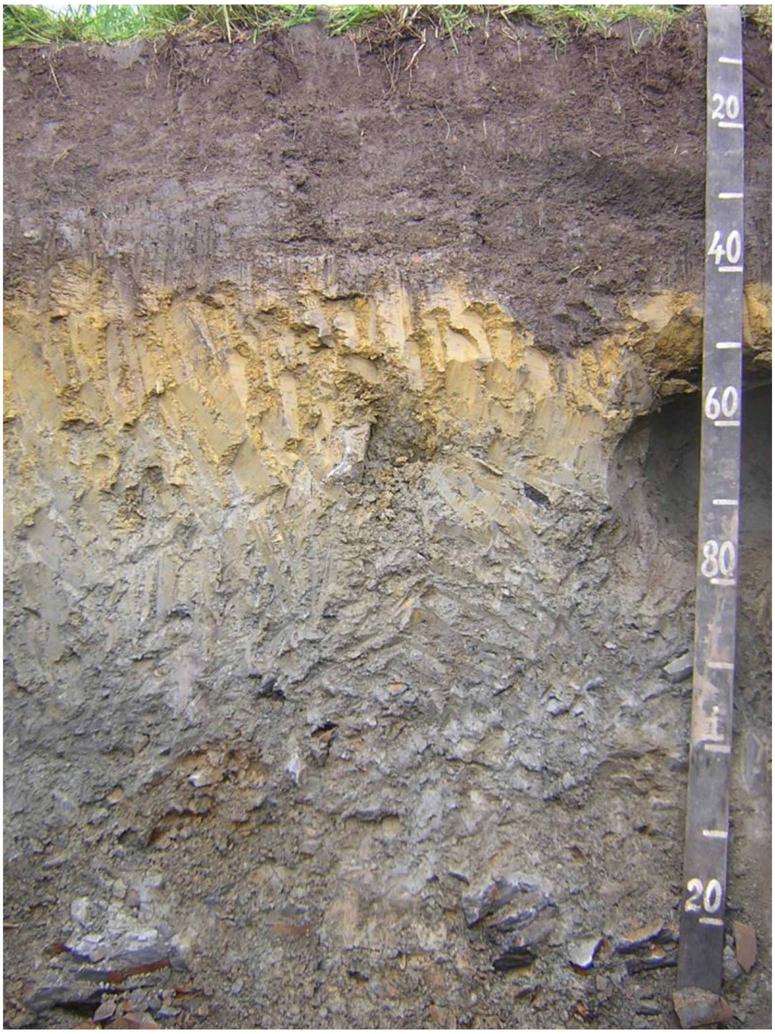

Plate 16. Paddock 1, Humic Surface-water Gley, series Gortaclareen.

Table 5. Soil Profile description paddock 1 Doonbeg Farm.

Horizon depth (cm)	Horizon designation	Description
15	Cg	Dark brown colour, crumbly structure, no mottles or stones. Clay loam. Humic.
42	Apg	Brown grey colour, many mottles, common stones, Clay loam. Manganese coats. Shell fragments. High packing density.
58	Btg	Orange light brown colour, common mottles, no stones, silt loam. Compacted, dead roots. Plastic.
84	Cg	Grey light yellow colour. Many mottles, many stones, silt loam. Weakly cemented. Dead roots. Massive structure.
130	R	Shattered shale bedrock

The principal difference between paddock 1 and paddock 27 is the shallow bedrock in this case. There is again a humic horizon in this case with no mottles or stones. It appears to be a very shallow and more recent deposition of glacial till. A dense 2nd horizon with high packing density is present, this may have been deeper and was eroded by the consequent deposition above. The shell fragments would reduce the acidity of this horizon. The dead roots in horizon 3 are a result of increased compaction, which may have resulted from the deposition of horizon 1. This is the case in horizon 4 with more dead roots. This has become weakly cemented under pressure against the shattered bedrock beneath this horizon. Mottles are common throughout and water percolation is very limited with the high packing densities and cemented horizons.

Plate 17. Manganese concretions and shell fragments in Apg horizon, Paddock 1, Doonbeg farm.

Conclusions

Over all the soils in this farm are poorly structured, based on very dense glacial till, which has silt loam and clay loams dominating. There is silty clay in places. The heavy rainfall creates a serious drainage issue. The soils suffer from both perched surface water tables and groundwater tables in many cases. Generally the Surface-water Gleys dominate, with the perched water table restricting the productivity greatly. There is low hydraulic conductivity in the common Btg horizons, which maybe slightly higher in the deeper silt loams, but then there are problems with the density and compaction at this level. The cutover peats whilst they may suffer from surface water ponding with rain events more quickly than the more permeable mineral soils, they tend to recover more quickly following dry periods. The increased porosity of their earthy nature following drainage allows this. The mineral soils, at lower points in the farm, tend to take longer to recover and have more restricted productivity.

The alluvial soils are very similar to the mineral soils and effectively act as Surface-water Gleys. Some of the drained Alluvial soils have deep A horizons, loam texture classes and are relatively free draining. The Brown Earths found in the south west of the farm are moderately drained and have good soil structure.

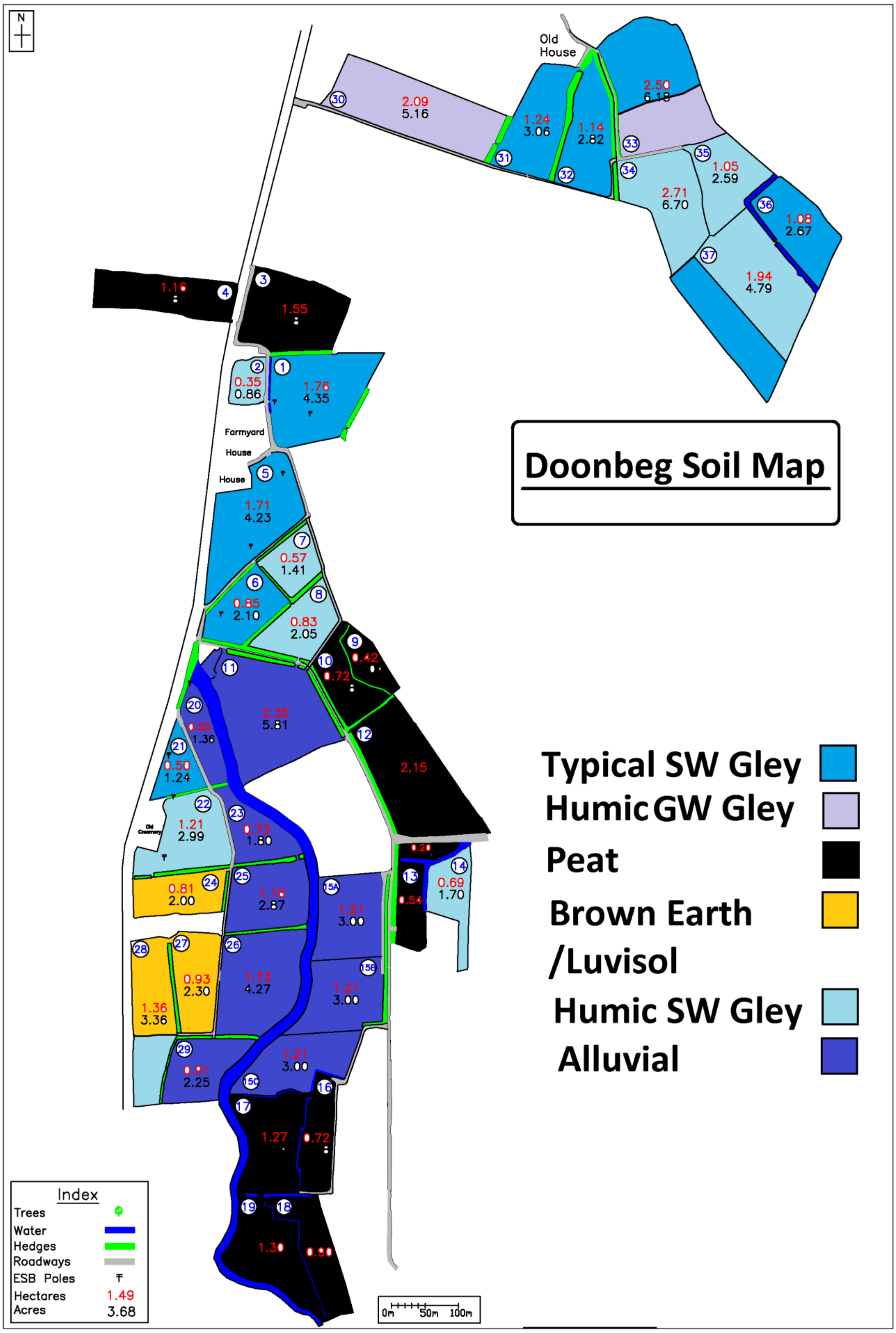

Plate 18. Distribution of soils on the Doonbeg HSP farm based on the 2015 auger campaign and pit excavations, coupled with laboratory data from field sampling.

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Appendix.

Table 6. Laboratory data for samples taken from soil pits at Doonbeg farm.

Label	Paddock	Sample	Clay (%)	Silt (%)	Sand (%)	Dry Density (g/cm^3)	Bulk Density (g/cm^3)	Gravimetric Moisture Content (%)	Total Exchange Capacity (meq/100 g)	pH	Organic Matter (%)	Estimated Nitrogen Release (#'s N/acre)
DB 1	1	HZ1	30	38	32	0.82	1.38	67.69	21.52	6	11.25	126
DB 2	1	HZ2	30	42	28	1.15	1.59	38.37	20.41	7.7	7.65	113
DB 3	1	HZ3	28	62	10	1.29	1.84	42.63	7.44	7.7	1.49	50
DB 4	1	HZ4	16	58	26	1.63	1.96	16.33	6.11	7.7	0.79	32
DB 5	15b	HZ1	35	36	29	0.37	1.04	184.56	11.90	5.3	59.13	> 130
DB 6	15b	HZ2	25	67	8	0.98	1.61	65.39	9.97	4.5	5.08	100
DB 7	15b	HZ3	26	62	12	1.47	1.93	31.23	7.57	4.6	1.04	41
DB 8	15b	HZ4	16	59	25	1.79	2.12	13.95	6.03	4.5	0.88	35
DB 9	27	HZ1	30	37	33	0.77	1.31	69.45	22.31	7	22.38	> 130
DB 10	27	HZ2	36	49	15	1.38	1.82	32.18	12.21	7.3	2.28	66
DB 11	27	HZ3	27	62	11	1.50	1.91	16.87	9.55	7.4	0.94	38
DB 12	27	HZ4	26	50	24	Too many stones-no samples			13.54	5.3	0.81	32
DB 13	31	HZ1	34	45	21	1.11	1.61	45.69	13.24	5.7	6.33	107
DB 14	31	HZ2	38	49	13	1.23	1.73	41.27	8.64	6	2.18	64
DB 15	31	HZ3	29	59	12	1.65	2.04	19.33	11.66	5.7	1.02	40
DB 16	31	HZ4	27	50	23	Too many stones-no samples			14.88	6	0.85	34

Table 6, continued.

Label	Paddock	Sample	S* (ppm)	P* (mg/kg)	Bray II P (mg/kg)	Ca* (mg/kg)	Mg* (mg/kg)	K* (mg/kg)	Na* (mg/kg)	Ca** (%)	Mg** (%)	K** (%)	Na** (%)
DB 1	1	HZ1	32	100	133	2888	240	137	77	67.1	9.29	1.63	1.56
DB 2	1	HZ2	33	22	13	3637	109	84	79	89.1	4.45	1.06	1.68
DB 3	1	HZ3	18	3	2	1261	63	48	48	84.74	7.06	1.65	2.81
DB 4	1	HZ4	12	6	9	1050	41	34	48	85.92	5.59	1.43	3.42
DB 5	15b	HZ1	20	22	37	1105	114	44	50	46.43	7.98	0.95	1.83
DB 6	15b	HZ2	27	23	9	444	132	42	51	22.27	11.03	1.08	2.22
DB 7	15b	HZ3	33	8	9	202	185	65	50	13.34	20.37	2.2	2.87
DB 8	15b	HZ4	12	20	100	208	85	77	60	17.25	11.75	3.27	4.33
DB 9	27	HZ1	29	19	27	4032	77	42	96	90.36	2.88	0.48	1.87
DB 10	27	HZ2	26	8	3	2126	78	40	75	87.06	5.32	0.84	2.67
DB 11	27	HZ3	24	3	3	1442	178	54	78	75.5	15.53	1.45	3.55
DB 12	27	HZ4	47	18	30	938	317	52	65	34.64	19.51	0.98	2.09
DB 13	31	HZ1	17	16	12	1469	175	45	81	55.48	11.01	0.87	2.66
DB 14	31	HZ2	18	2	2	979	190	38	70	56.66	18.33	1.13	3.52
DB 15	31	HZ3	31	2	2	870	401	57	75	37.31	28.66	1.25	2.8
DB 16	31	HZ4	15	16	18	863	838	62	89	29	46.93	1.07	2.6

Table 6, continued.

Label	Paddock	Sample	Other Bases** (%)	H** (%)	B* (mg/kg)	Fe* (mg/kg)	Mn* (mg/kg)	Cu* (mg/kg)	Zn* (mg/kg)	Al* (mg/kg)
DB 1	1	HZ1	5.4	15	0.78	329	40	1.87	5.46	707
DB 2	1	HZ2	3.7	0	0.69	124	16	0.68	0.59	721
DB 3	1	HZ3	3.7	0	0.24	161	3	2.68	0.44	857
DB 4	1	HZ4	3.7	0	< 0.20	155	1	4.42	3.17	812
DB 5	15b	HZ1	6.8	36	0.45	545	140	0.37	0.75	285
DB 6	15b	HZ2	8.4	55	0.27	509	26	0.56	0.61	1333
DB 7	15b	HZ3	8.2	53	0.31	522	18	6.2	4.83	957
DB 8	15b	HZ4	8.4	55	0.6	1125	18	15.95	7.94	677
DB 9	27	HZ1	4.4	0	0.61	187	37	1.07	0.79	249
DB 10	27	HZ2	4.1	0	0.24	134	10	3.03	< 0.4	561
DB 11	27	HZ3	4	0	0.21	291	44	6.04	2.1	823
DB 12	27	HZ4	6.8	36	0.25	347	140	6.1	2.95	718
DB 13	31	HZ1	6	24	0.35	351	12	1.03	0.67	956
DB 14	31	HZ2	5.4	15	0.21	308	7	1.89	0.52	995
DB 15	31	HZ3	6	24	< 0.20	119	30	3.25	1.48	824
DB 16	31	HZ4	5.4	15	< 0.20	195	138	1.38	1.33	652