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Supplementary Environmental Information

Old Little Humber Farm: Wet Grassland Creation, Management and Monitoring Plan

Supplementary Information EX 28.2

June 2012
Revision: 0
Thomson Ecology

Project No.: NABL101 / 003 / 001

June 2012

Old Little Humber Farm Wet Grassland Creation

Wet Grassland Creation, Management and Monitoring Plan

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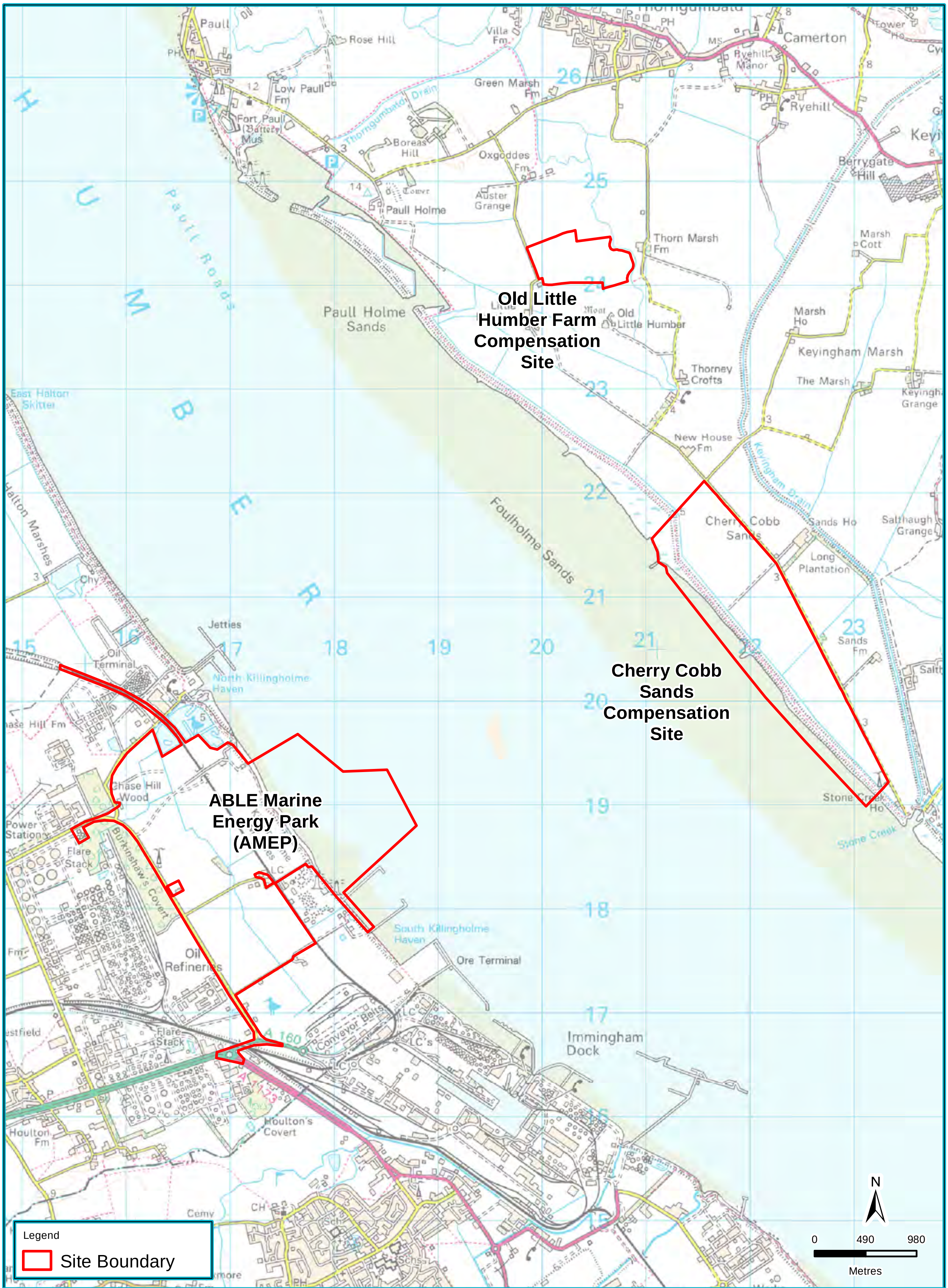

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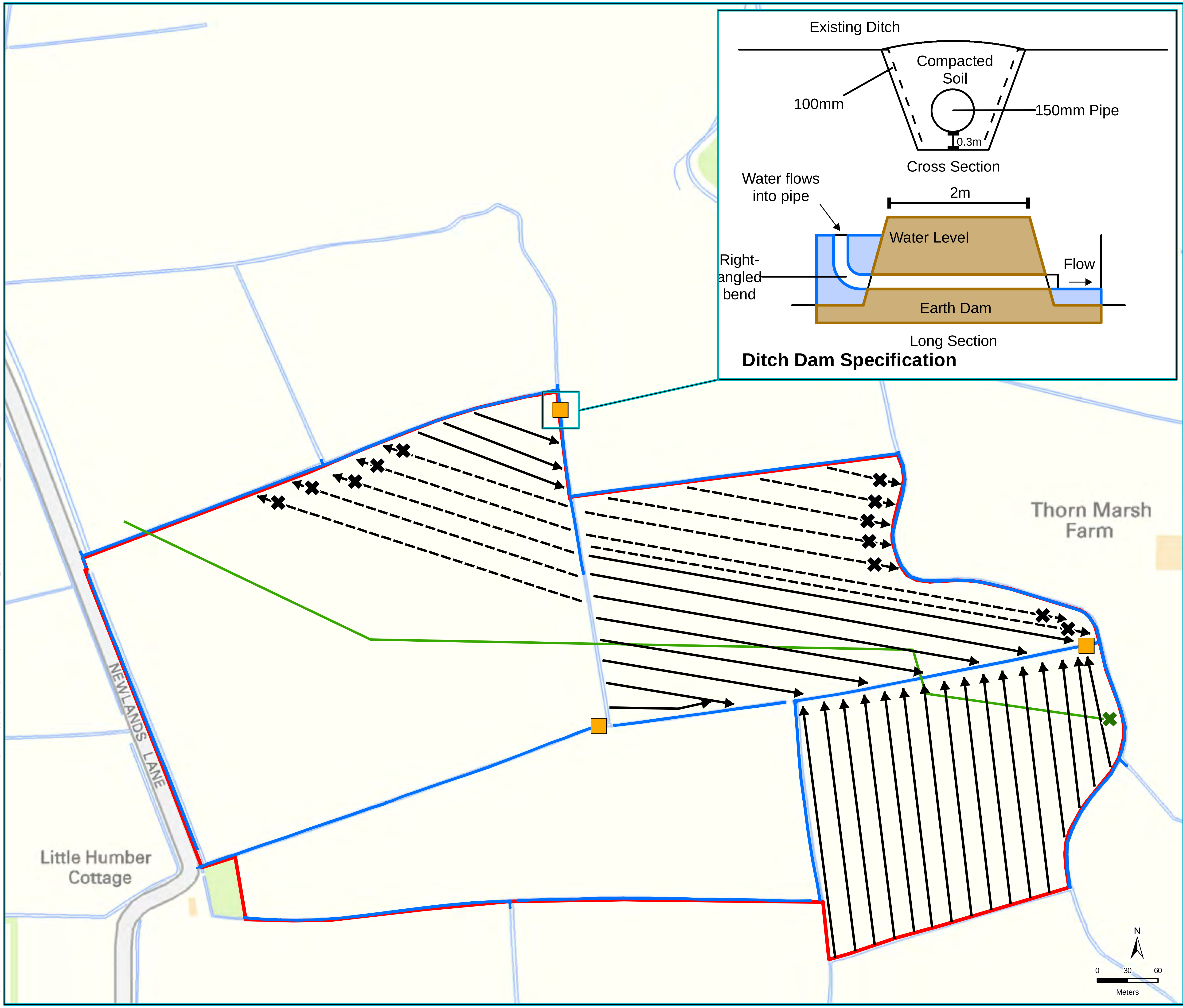

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Legend

- Ditches from Topo Survey
- Field Drain Block
- Ditch Dam Location
- Field Drain
- Field Drain to be Blocked Off
- Utility to be Blocked Off
- Site Boundary

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Figure Title: Ditch Dam Locations	

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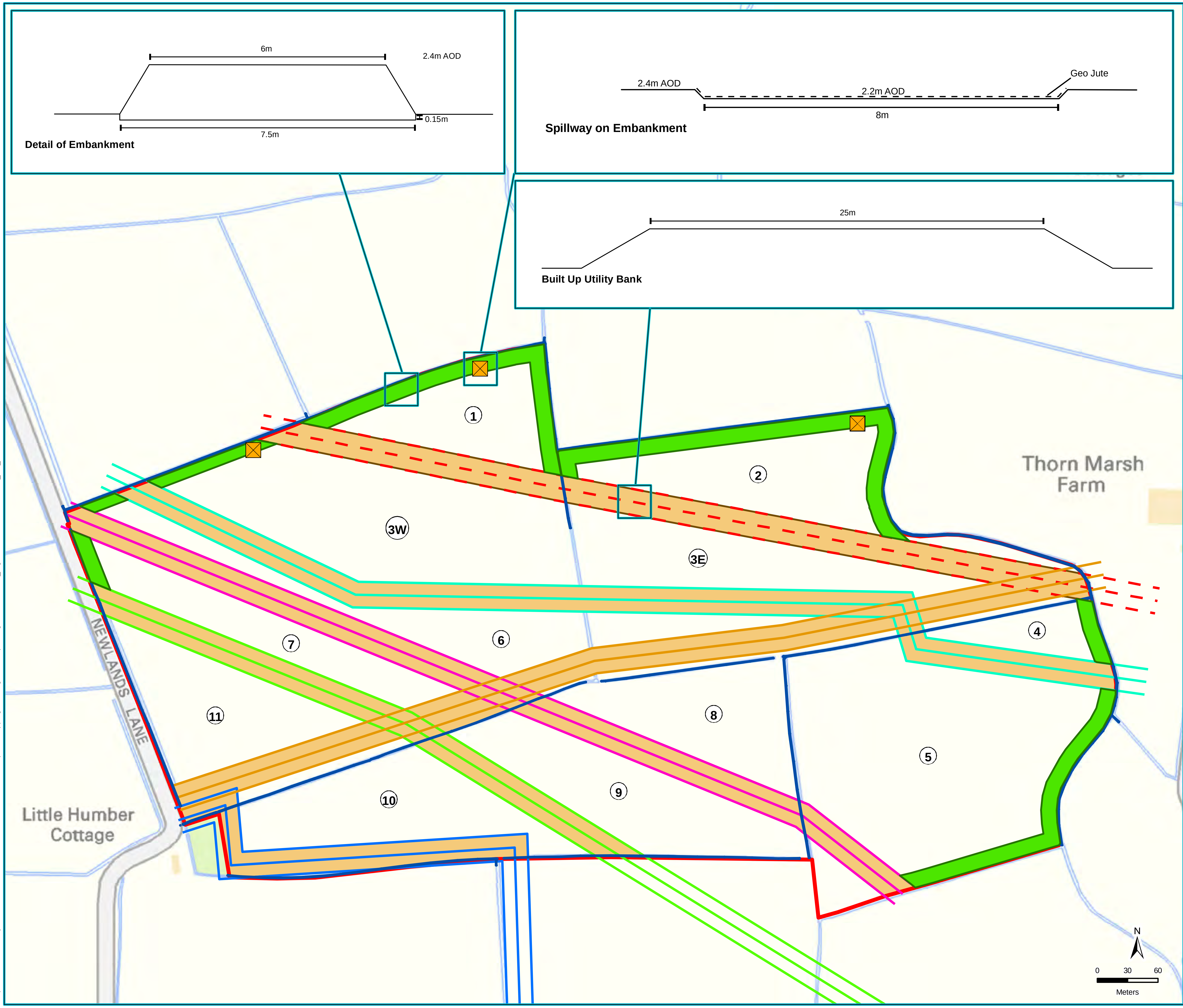

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Legend

- Spillway
- Embankment
- Build up of Utilities
- Ditches from Topo Survey

Services

- 1967 Gas Pipeline
- 1985 Gas Pipeline
- 2009 Gas Pipeline
- 2007 Humber Wind Consent
- Nova Scotia Water Pipe
- Old Little Humber Water Pipe
- Site Boundary

Drawing Ref	NABL101/9992/1
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Drawn: TD	Checked: NS
Date: 26/06/2012	Date: 26/06/2012
Client	Able Humber Ports Ltd
Figure Number	3
Figure Title	Embankment and Utilities Embankment

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Filepath: S:\Leeds\Projects\NABL101 OLHF Habitat Creation Yorkshire\Reports\Mapping\Working\Final Report Figures\NABL101_Figure4ProposedSiteAreas_TD_220612.mxd

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Legend

- Ditches from Topo Survey
- Dry Surface
- Scrape
- Water Storage Area
- Wet Grassland

Services

- 1967 Gas Pipeline
- 1985 Gas Pipeline
- 2009 Gas Pipeline
- 2007 Humber Wind Consent
- Nova Scotia Water Pipe
- Old Little Humber Water Pipe
- Site Boundary

Drawing Ref	NABL101/9993/1
Scale at A3	1:3,500
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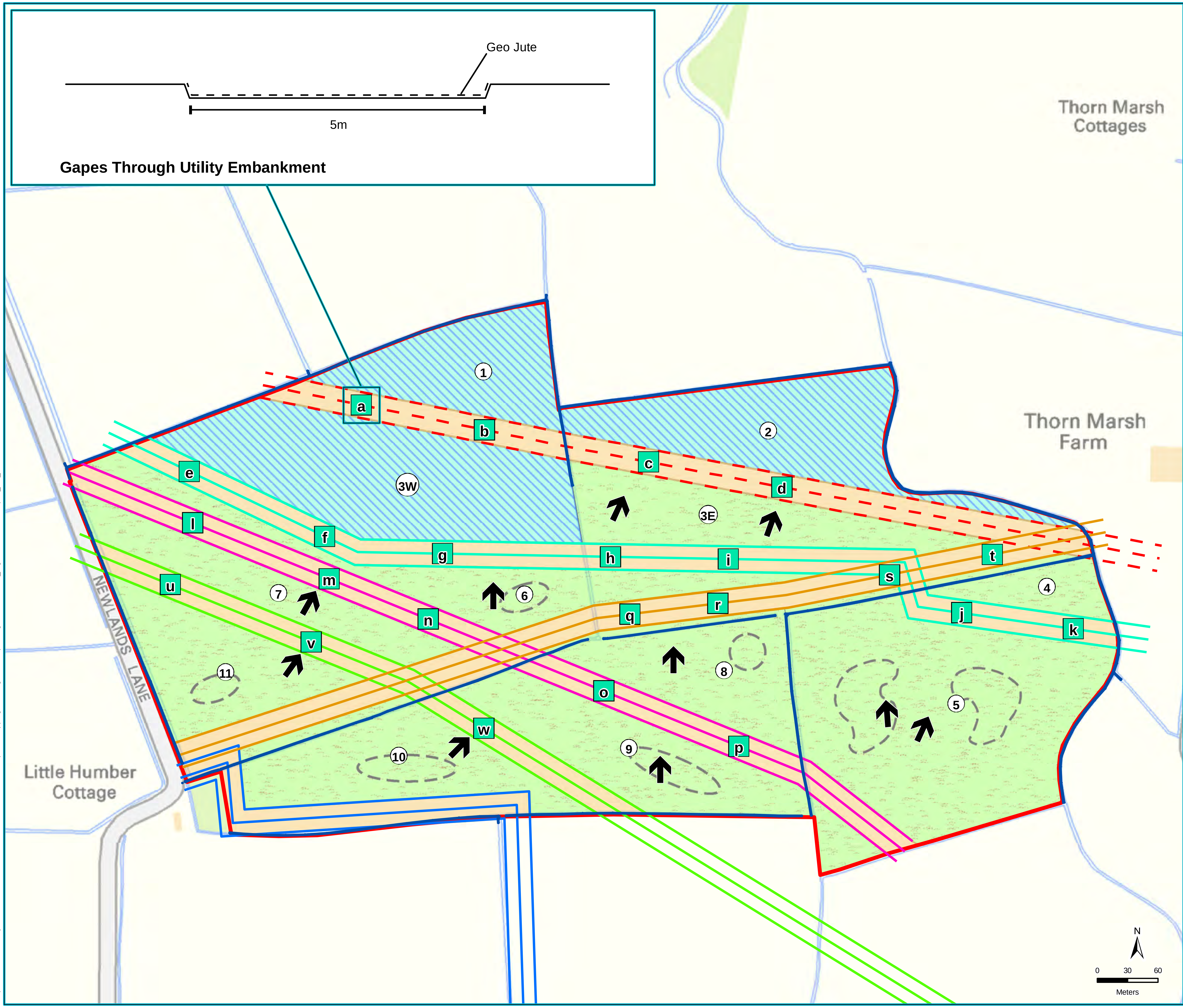
Client	Able Humber Ports Ltd
Figure Number	4
Figure Title	Water Storage Areas, Wet Grassland and Scrapes



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Legend

- Ditches from Topo Survey
- Gapes through Utility Embankment
- Direction of Fall
- Dry Surface
- Scrape
- Water Storage Area
- Wet Grassland

Services

- 1967 Gas Pipeline
- 1985 Gas Pipeline
- 2009 Gas Pipeline
- 2007 Humber Wind Consent
- Nova Scotia Water Pipe
- Old Little Humber Water Pipe
- Site Boundary

Drawing Ref	NABL101/9994/1
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Date: 26/06/2012	Date: 26/06/2012
Client	Able Humber Ports Ltd
Figure Number	5
Figure Title	Position of Gapes in Utility Embankments and Direction of Falls

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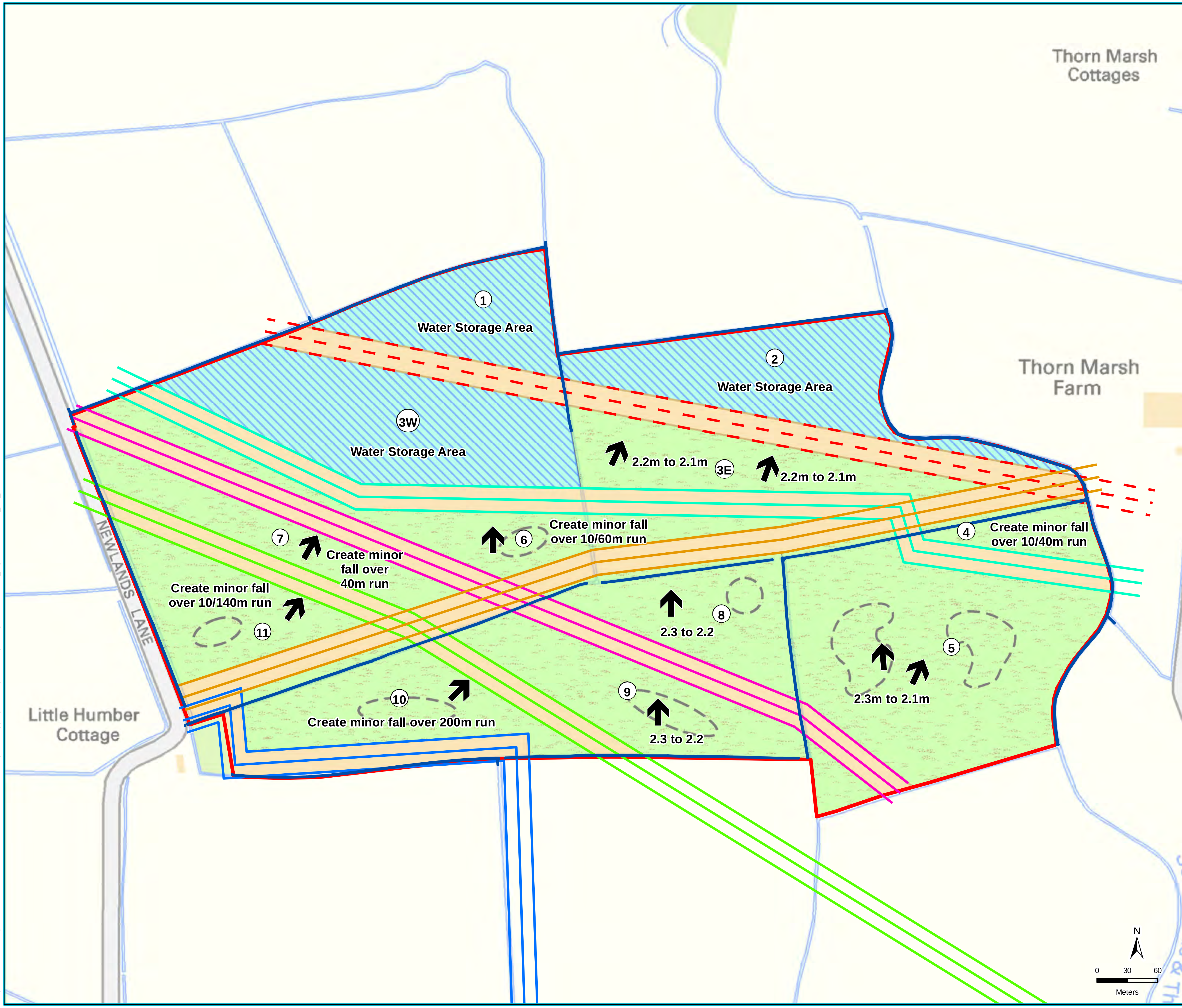

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Legend
- Ditches from Topo Survey
- Direction of Fall
- Dry Surface
- Scrape
- Water Storage Area
- Wet Grassland

Services
- 1967 Gas Pipeline
- 1985 Gas Pipeline
- 2009 Gas Pipeline
- 2007 Humber Wind Consent
- Nova Scotia Water Pipe
- Old Little Humber Water Pipe
- Site Boundary

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Date: 26/06/2012	Date: 26/06/2012
Client: Able Humber Ports Ltd	
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Figure Title: Site Levels	

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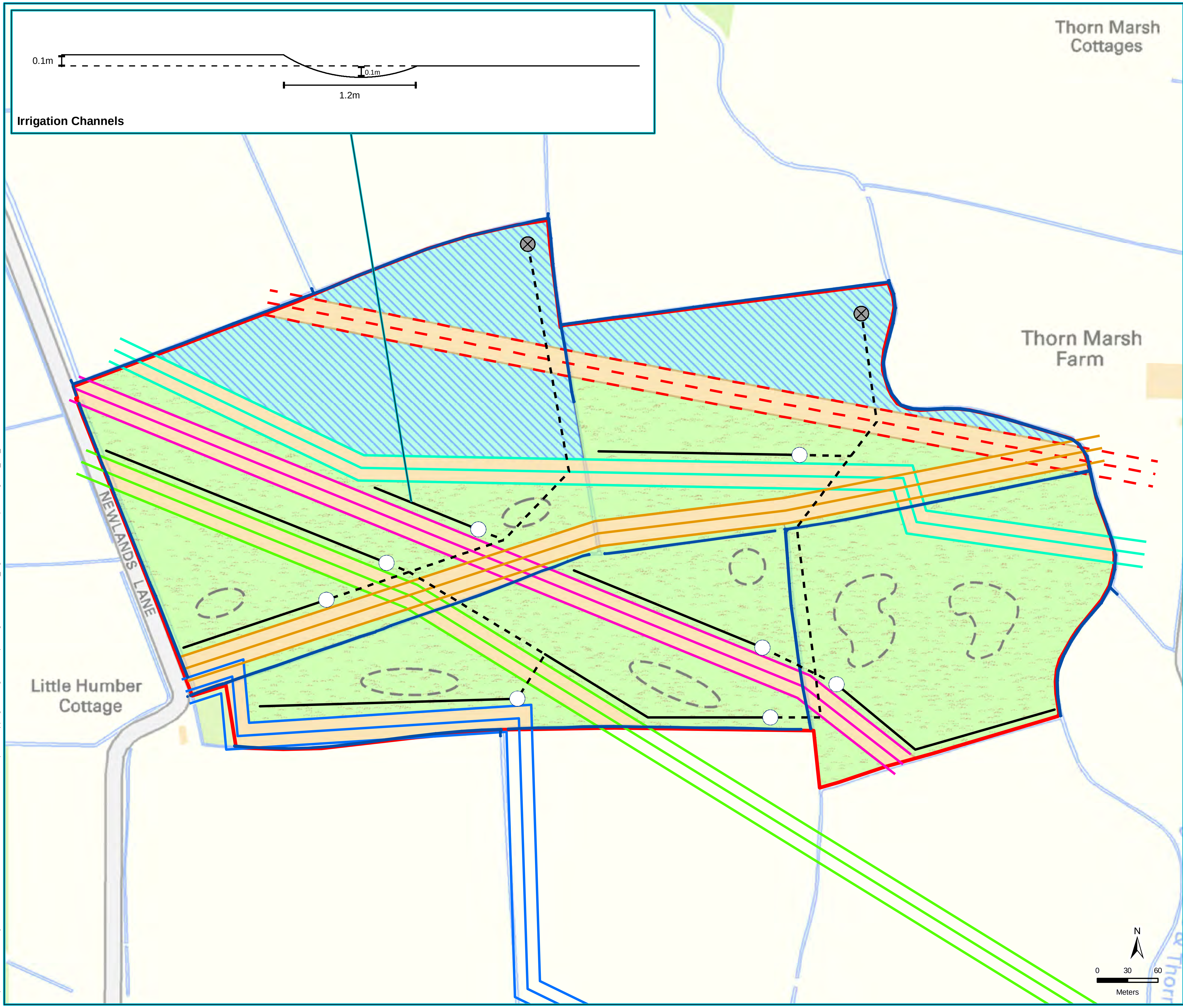

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Legend

- Wind Pump
- Irrigation Channel
- Irrigation Pipeline
- Ditches from Topo Survey
- Dry Surface
- Scrape
- Water Storage Area
- Wet Grassland

Services

- 1967 Gas Pipeline
- 1985 Gas Pipeline
- 2009 Gas Pipeline
- 2007 Humber Wind Consent
- Nova Scotia Water Pipe
- Old Little Humber Water Pipe
- Site Boundary

Drawing Ref	NABL101/9995/1
Scale at A3	1:3,500
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Date: 26/06/2012	Date: 26/06/2012
Client	Able Humber Ports Ltd
Figure Number	7
Figure Title	Position of Wind Pumps, Irrigation Channels and Pipelines

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1. Introduction

1.1 Development Background

1.1.1 Able Humber Ports Ltd propose to build a Marine Energy Park, to be known as Able Marine Energy Park (AMEP), comprising deep water heavy quays, large industrial buildings for manufacturing and assembly of marine energy components, and extensive areas of open storage for marine energy components along with offices and administrative buildings.

1.1.2 The proposals described above are hereafter referred to collectively as 'the development'.

1.1.3 The development will be located on a 245ha area of land on the Killingholme Marshes and North Killingholme Haven on the south bank of the Humber Estuary, see Figure 1. The area affected by the development is hereafter referred to as 'the AMEP site'.

1.1.4 The development proposals include the reclamation of 45ha of land from within the Humber Estuary. As the area to be reclaimed is within a European designated Special Area of Conservation (SAC) and Special Protection Area (SPA), new intertidal habitat will be created to replace that being lost from the estuary. This habitat will be created by realigning the existing flood defences at Cherry Cobb Sands, an area of arable land directly opposite the AMEP site. This area is hereafter referred to as the 'Cherry Cobb Sands site' (see Figure 1).

1.1.5 The Cherry Cobb Sands site is located on the northern bank of the Humber Estuary. It is within the middle estuary and located between Paull Holme Strays managed realignment site to the northwest and Stone Creek to the south-east (see Figure 1). The Cherry Cobb Sands site is currently arable land.

1.1.6 A further 38ha area of arable land at Old Little Humber Farm will be temporarily reverted to wet grassland to benefit feeding and roosting estuary birds, especially black-tailed godwit, until such time as the Cherry Cobbs Sands site meets its compensation objectives. This area is hereafter referred to as the 'Old Little Humber Farm site' (see Figure 1).

1.1.7 The Old Little Humber Farm site lies 1.5 km to the north-west of Cherry Cobb Sands, and currently comprises arable land, hedgerows and drainage ditches.

1.1.8 A development consent order (DCO) is currently being sought by Able Humber Ports Ltd from the Infrastructure Planning Committee (IPC). The application was submitted on 19th December 2011 and Able UK Ltd. was notified by the IPC of the acceptance of the Able Marine Energy Park application for examination on the 12th January 2012.

1.2 Ecology Background

1.2.1 A Phase 1 habitat survey of the site was undertaken by Applied Ecology Ltd in 2011 (see Applied Ecology, October 2011). The site was found to comprise arable fields bordered by intact and defunct species-poor hedgerows and wet and dry ditches. Further surveys were recommended for great crested newt, water vole, badger and reptiles only if habitat suitable for them was to be destroyed or significantly disturbed by any future management.

1.2.2 A terrestrial invertebrate biomass survey was undertaken by Thomson Ecology in spring 2012 (see Thomson Ecology Report Ref: NABL101/001/002). The site was found to support a mean average wet biomass of 7.59g/m^2 and a mean average dry biomass of 1.08g/m^2. The objectives for macro-invertebrate biomass at the site are 40.35g/m2 wet weight and 7.94g/m2 dry (ash-free) weight in line with Annex 35.6 of the Environmental Statement (ES). The soil macro-invertebrate content therefore needs to be increased by approximately 430% to meet these objectives.

1.2.3 Soil and hydrological surveys were also undertaken by Thomson Ecology in spring 2012 (see Thomson Ecology Report Ref: NABL101/002/001). The soil survey found the soil on site to be of the soil series 'Newchurch' – a soil with a high clay and silt content. The climate assessment and hydrological surveys found the water balance on the site to be a product of the rainfall and evaporation amounts as there is no run of rainfall onto the site from surrounding areas. The ditches and field drainage at present are an efficient system of removing excess water away from the site. Once the transpiration exceeds rainfall then the soil goes into deficit; this occurs, on average, throughout the months of June to October. It will therefore be necessary to change the drainage and catchment run-off to retain water during the excess period for use in the period of deficit.

1.3 The Brief and Objectives

1.3.1 Able UK Ltd commissioned Thomson Ecology on 6th March 2012 to produce a report detailing the creation, management and monitoring of wet grassland habitat at the Old Little Humber Farm site. The brief was to:

- Provide a report to include detailed designs for the creation of wet grassland for black-tailed godwits, and a management plan and monitoring strategy; and
- Provide digitised mapping to accompany the report.

2. Site Objectives

2.1.1 The following objectives will be incorporated into the site design to ensure that the wet grassland to be created at Old Little Humber Farm is suitable for black-tailed godwits:

Soil moisture regime

- The water table should be high to concentrate invertebrates at the surface and to ensure that the soil remains soft enough to be probed by waders (ideally the water table would be at 10cm below surface);
- The site should be wet throughout the months of August to April; and
- Shallow scrapes should be created with a 'drawndown zone' of open mud habitat.

Layout

- The site should remain open with a long unobscured view – landscaping or ponded areas should not be so deep as to impact upon the godwit's open vista across the site; and
- The site should comprise a mix of drier and wet areas.

Invertebrates

- The site should aim to achieve a high density of soil macro-invertebrate fauna of 40.35g/m2 wet weight or ash-free dry weight of 7.94g/m2 as specified in Annex 35.6 of the ES.

Grassland management

- The wet grassland will require grazing by livestock.

3. Wet Grassland Design

3.1 Design Background

3.1.1 The soil and hydrology report (Thomson Ecology Report Ref: NABL101/002/001) provides background information on the soil and hydrology of the site. As set out in this report, the drainage and catchment run-off conditions would need to be changed to provide the soil moisture conditions required through a system which retains the excess rainfall throughout the autumn/winter period to replenish through the critical period of late summer/early autumn.

3.1.2 A summary of the changes to drainage and catchment run-off which are required is as follows:

- The water draw-down and loss through the outfall ditch system must be curtailed. This can be achieved by damming ditches but this must be achieved without affecting the outfall from the surrounding fields;
- The field drainage system must also be effectively blocked. Where the field drains run into ditches which are to be blocked, the drains themselves do not need to be sealed off as they are effectively blocked by impeded water. Where the field drains run into ditches not to be blocked, each individual field drain will need to be sealed off; and
- Once this work is complete, the loss of water from the site will be the amount lost through evaporation, plus any additional leakage. Given the soil type on site (a slowly permeable clay) the leakage can be managed by surface rolling to reduce infiltration. This will allow the effective water table to rise and the soil to remain wet for a longer period.

3.1.3 There are a number of utilities running throughout the site, including gas and water pipelines and an electricity cable route due to be installed this summer. It has been confirmed that the utilities pipelines/cable routes will need to remain dry i.e. the soil moisture content cannot be significantly changed in the immediate area along the pipelines/cables therefore this has been incorporated into the design.

3.2 Site Design

Ditch System

3.2.1 It is proposed to install three blocking points (dams) within the ditch system to control water loss from the site, the locations of which are shown in Figure 2. These locations have been selected after consultation with the Internal Drainage Board (IDB) and should ensure there is no impediment to drainage in the surrounding fields.

3.2.2 The blocking points will not completely block the ditch, but rather allow the water level within the ditches to be controlled through the use of a sluice system. The sluice system will allow water to be released if this is required after a period of heavy rainfall, when flooding could present a problem. The sluice system is shown in detail on an insert on Figure 2 and in summary comprises of a length of plastic piping, which is either rigid with a swivel end or flexipipe, which is laid through an earth dam. The upstream end of the pipe can moved up or down to the desired water level, allowing excess water to be released if required.

Field Drainage

3.2.3 It is proposed to block the field drainage system as shown in Figure 2. It can be seen that the field drains draining into South Ends and Thorney Crofts Drain and also into the ditch at the north of the site will be individually blocked. The remainder of the drains will not be individually blocked as drainage through these drains will be impeded by the blocking of the ditches in to which they flow.

Site Landscaping (Earthworks)

3.2.4 Together with the impediment of the field drainage and outfall ditch system, landscaping will need to be undertaken on site to create areas for water storage and a system for wetting areas in late summer. The landscaping will comprise four elements as follows:

- A shallow embankment (bund) with spillways;
- Three water storage areas;
- Embankments along the utilities with gapes;
- Levelling within open areas; and
- Scrapes.

Shallow Embankment (Bund)

3.2.5 A shallow embankment, or bund, will be created along the northern and eastern boundary of the site as shown in Figure 3. This will assist in ponding water in the lower areas of the site. The embankment height will be approximately 2.4m OD with side slopes at 2:1 as shown in Figure 3. The increased height of the bund compared to the surrounding ground is given in Appendix 1 - Table 1 and varies between 0.3 -0.4m in height, which will give only a minor change to the open appearance of the area. Soil from the excavation of the water storage areas (see Section 4.2.8 below) will be used to construct the bund (approximately 4140m^3 - see Appendix 1, Table 1).

3.2.6 Three spillways will be constructed along the bund; the location and construction of these spillways is shown on Figure 3. These will ensure that excess stored water can drain out of the water storage areas and a top water level will be maintained at 2.2m OD.

Water Storage Areas

3.2.7 The shallow embankment will cause surface water to flow to the area adjacent to the embankment, forming three water storage areas from the excess winter rainfall.

3.2.8 The three water storage areas are shown on Figure 4. They will be excavated as shown in Appendix 1 – Table 2 with a maximum dig depth of 0.6m. The total volume of soil excavated from these areas will total approximately 23,620m^3. Appendix 1 - Table 3 shows the water storage capacity of each area which totals approximately 28,200m^3.

3.2.9 The predicted run off and direct rainfall supplying these areas is approximately 24,416m^3 in an average year leaving an excess storage capacity of approximately 3800m^3 to increase the water holding capacity on site in wetter years.

Utilities Embankments with Gapes

3.2.10 To ensure the utilities running through the site do not become waterlogged, and to provide access to the utilities, the remaining soil used in the excavation of the of the water storage areas will be used to raise the level above the utilities right of way as shown in Figure 3 and Appendix 1 – Table 4. This work will require approximately 19737m^3 of soil. There will be a slight shortfall between the amount of soil excavated for the water storage areas and the amount required for the bund and utilities ridges, however the shortfall can be made good through the general land levelling work.

3.2.11 The utilities embankments will fill another function on the site, which is to ensure there is variation in the topography of the site through a shallow ridge system. This will allow varying moisture regimes across the site and ensure there are drier areas which are important winter refugia for a range of invertebrates. During construction of the embankments up to 20 tonnes/hectare of organic matter should be incorporated into the top layers to increase the organic content of the soil for invertebrates.

3.2.12 A series of 23 gapes (shown as a-w on Figure 5) will be constructed along the ridges of the embankments to allow run-off from periods of excess rainfall to flow to the water storage areas. The positions of these gapes and details of their construction are shown in Figure 5 and the OD height of each gape is shown in Appendix 1 Table 5.

Levelling

3.2.13 The ridge system over the utilities effectively divides the site into 11 open areas (1 to 11 on Figure 6) between the embankments. Each of these areas will need to be levelled as shown in Figure 6 with falls as shown in Appendix 1 – Table 6.

3.2.14 The levelling will allow the excess rainfall to be directed via the gapes in the ridges to the three water storage areas. During the levelling, the topsoil should be loosened to 150mm minimum and up to 20 tonnes/hectare of organic matter should be incorporated into the open areas (excluding the water storage areas).

Scrapes

3.2.15 A series of scrapes can be incorporated into the open wet grassland areas of the site as shown in Figure 4. These can be created through very minor excavations of no more than 0.15m to produce variation in vegetation structure and habitats on site which will benefit soil invertebrate fauna.

Site Irrigation

3.2.16 It will be necessary to develop an irrigation system for the site in order to provide a moisture regime suitable for black-tailed godwits. It is proposed to use two wind powered pumps to power the irrigation system.

3.2.17 Table 7 in Appendix 1 details the total run-off which will be stored in the water storage areas (approximately 24,416m^3). The irrigation requirement to meet the moisture demand is given in Appendix 1, Table 8 (approximately 23,970m^3). There should therefore be sufficient water stored in the water storage areas to complete the irrigation schedule. The schedule is designed to apply 150mm of water to the open areas of the site through the period late July to late November, as required.

3.2.18 The two wind powered pumps will each be 5m in diameter, stand 8-10m in height and have an output of 10m Head. With an estimated 4m/s average wind speed they will each pump some 80/90m^3 of water per day. This equates to 30,600m^3 over the irrigation period, which will supply sufficient irrigation to the site during the application period.

3.2.19 The pumps will deliver water to the required areas via a 100mm pipeline. The position of the wind pumps and the pipelines are shown on Figure 7. In each of the open areas of the site an irrigation channel will be positioned and constructed as shown in Figure 7 and connected to the delivery pipe. The channel will be laid with a minor fall (approximately 1000:1) away from the feed point with a sealed end and the level of the adjacent land will ensure the water runs on to the open field area from the irrigation channel. Water delivered via the wind pump and pipe system will run down the channel causing it to fill and then over top across the run off platform on the open field side producing a surface irrigation effect.

3.2.20 It should be noted that this system will require attention to have been paid to the levels achieved during construction of both the open fields and the irrigation channels. Secondly, the system will need regular attention to change the direction of flow to the different areas by switching on and off the pipe outlets. Site management is discussed further in Section 5.2.

Site Design Summary - Site Soil and Water Conditions

3.2.21 Once the full design is in place the site should begin to function as follows:

- The three water storage areas will fill during the winter months (starting from mid/late October and continuing to fill until mid-April). At the end of the period the reservoirs will be close to capacity (2.2m OD water level). The level will slowly drop due to evaporation and irrigation abstraction until October when the water level will be low giving a condition where the bottom soil of the reservoirs will be saturated with some shallow ponding;
- The utilities ridges will be wetting through the winter months (starting from mid/late October and continuing to get wetter until mid-April). As they are elevated, they will drain off onto the surrounding lower open field areas and will therefore remain close to field capacity until early May. During this period on the utilities ridges there will be approximately 200 to 300mm of wet soil well below saturation followed by a further depth of at least 300mm close to saturation;

- The moisture levels on the utilities ridges will slowly reduce over the months between May through to early October, when the soil water deficit will rise to approximately 60mm (it is not thought the deficit will rise above this as some of the irrigation water from the open fields will help replenish the ridges). During this period the soils on the utilities ridges will dry to approximately 300mm, below this the soil will be close to field capacity to approximately 500mm, and then close to saturated beneath
- The open field sections will wet up during the winter months (starting from mid/late October and continuing to wet until mid-April). Only the surface water will drain off so the field soil will remain saturated with some minor ponding until May. The open field sections will then begin to dry out allowing time for 'growing' of biomass during the period May to July before irrigation begins in mid July. The irrigation system will then retain the soil moisture at or near field capacity until October, when the soil will begin to wet up again.

3.2.22 The site predicted soil and water conditions over the year are summarised in Table 1, below.

Table 1: Summary of Predicted Site Soil and Water Conditions Over One Year

Month	Water Storage Areas	Utilities Ridges	Open Areas
Mid October to April	Replenishing with water from rainfall and run-off	Wetting - close to field capacity by the end of period	Wetting - soil saturated
May to July	Water level beginning to fall	Drying out - soil moisture level reducing	Drying out - soil moisture level falling
July to mid October	Water level continues to fall	Continuing to dry	Soil moisture at or near field capacity through irrigation

3.3 Timing

3.3.1 It is understood the works need to be completed in 2012. The site preparation, earthworks and seeding should be undertaken in the period August to September to avoid the breeding bird season and to ensure optimum soil conditions during the works.

3.4 Hedgerow Removal

3.4.1 Hedgerow removal should be undertaken where hedgerows occur on the field boundaries within the site to ensure there is a large open and unobscured vista across the site. Hedgerows forming the site boundary can remain in place.

3.4.2 Hedgerows should be removed outside the breeding bird season in the period August to February inclusive. They can be removed through cutting at the base of the hedgerow and stumps of up to 20cm in height could remain in place.

3.4.3 To ensure there is no regrowth, stumps should be treated as required with an appropriate herbicide. Any regrowth should not be allowed to grow higher than 30cm in height from ground level.

3.5 Grassland Creation

Soil Preparation for Seeding

3.5.1 During the final stages of the earthworks the soil should be lightly harrowed in preparation for seeding. It may also be beneficial to spray the site with a compound such as 'Roundup' if there are excessive weed problems on the site.

Sowing a Seed Mixture

3.5.2 Once the site has been prepared it can be sown with a suitable seed mixture.

3.5.3 The seed mix must be sown on or very near to the surface. This can be done by broadcasting; e.g. by using a fertiliser spreader, slug pellet applicator or grass seed box, or through the use of a drill.

3.5.4 Seeds of different size or weights may settle out or become partitioned during sowing causing a patchy sowing distribution. A patchy sowing distribution would be preferable on this site, allowing a mosaic of more open areas and more vegetated areas, therefore seed should not be bulked up with an inert carrier to avoid this.

3.5.5 Guidance on the sowing rates (i.e. amount of seed per unit area) is often provided from commercial suppliers depending on the mix of species. After sowing the site should be rolled to ensure good soil to seed contact, however, capping should be avoided.

3.5.6 A different approach to broadcasting or direct drilling the seed mixture is to hydro-seed the site. This is the application of a slurry of seed and mulch which is sprayed over the ground in an even layer. This technique promotes quick germination and maintains moisture levels of the seeds and seedlings.

Seed Mixture

3.5.7 The seed mixture should contain a mixture of wild flowers, grasses and sedges suitable for clay soils, for example EM8 – Meadow mixture for wetlands from Emorsgate Seeds, with an additional tussocky sedge species such as bottle sedge (*Carex rostrata*), and additional grass species such as creeping bent (*Agrostis stolonifera*) (available from Emorsgate Seeds) and marsh foxtail (*Alopecurus geniculatus*) (available from HedgeNursery).

4. Management & Monitoring Plan

4.1 Wet Grassland

Grazing Regime

4.1.1 Appropriate management of the grassland is important as black-tailed godwits require an open vista with relatively low level vegetation.

4.1.2 Appropriate grazing will provide the necessary sward height and will ensure a varied vegetation structure is maintained (compared to mowing) and will additionally benefit the soil through input of organic matter and an increase in biomass of dung invertebrate fauna on site.

4.1.3 Cattle are the preferred grazed animal for wet grassland sites for the following reasons:

- They are more tolerant of wet conditions than sheep, and generally easier to manage with wet fences (i.e. boundary drainage channels);
- They are relatively unselective in their grazing compared with sheep and are therefore ideal for removing long or rank vegetation;
- They are particularly suited to the management of sites which require summer grazing as they do not graze flowers preferentially;
- They are well suited to the control of taller grasses such as reed sweet grass and reed canary-grass; and
- Being much heavier animals than sheep, cattle cause more poaching which can help create niches for invertebrates, providing the stock density is not too high.

4.1.4 Grazing by horses could also be considered at low stocking densities to avoid problems with poaching, overgrazing and eutrophication.

4.1.5 An approximate stocking density for the 38ha site to create a mosaic of short swards and tussocks would be 0.3 livestock units per hectare per year. For the 38ha site, 11.4 livestock units per year would therefore be required. One cow represents a livestock unit coefficient of approximately 0.5 therefore the number of livestock units per year would equate to around 23 cows per year. As the site will be grazed for a period of around 4 months this would equate to around 69 cows grazing over a four month period. Further information on grazing management and stocking densities can be found in Treweek *et al*. (1997).

4.1.6 The grassland should be grazed in spring 2013 following the sowing of the seed in autumn 2012, providing vegetation has established over the winter and early spring period. Grazing should be at a density of 0.2 livestock units per hectare per year and occur in the months of April to June in 2013. This would equate to around 60 cows over the 3 month period, using the same calculations as section 4.1.5, above.

4.1.7 In 2014 and in subsequent years the site should be grazed at a density of 0.3 livestock units per hectare per year throughout the months of April to July, which would equate to around 69 cows grazing over the four month period.

4.1.8 Adjustments may be required to the timing and levels of stocking depending on the establishment of the grassland and sward conditions.

4.1.9 It should be noted the site will need to be stock fenced, where drainage ditches do not provide a sufficient barrier to stock.

Weed removal

4.1.10 Agricultural weeds may present a problem in the establishment of the grassland. Problem agricultural weeds and arable crop should be spot-treated with an appropriate herbicide or controlled with a weed wiper if required.

4.1.11 Conservation-friendly weed-wipers, such as the 'Ecowipe' and 'Rotawipe' will ensure a targeted application without ground contamination and no spray drift. They also ensure a large proportion of the herbicide is applied to the underside of the plant, protecting it form being washed off by rain.

Fertilisers/Herbicide

4.1.12 No broad herbicides or fertilisers should be used on the grassland. Care should be taken on the adjoining arable land to ensure fertiliser or herbicide does not drift onto the grassland areas during application. Retaining and maintaining the boundary hedgerows where they are present will reduce the likelihood of herbicide or fertiliser drift.

4.2 Hydrology Management

Irrigation System

4.2.1 During the first year of utilisation of the irrigation system, regular visits will need to be undertaken to ensure the irrigation system is functioning as it should by switching on and off the pipe outlets to the different areas.

4.2.2 Visits should be undertaken twice or three times weekly to check the moisture status of the soil in the different open sections and to change the direction of flow in the irrigation system if required. This will need to be undertaken in the period July to October 2013 and the aim will be to ensure all areas are irrigated in an even manner. In subsequent years, it may be possible to undertake less frequent visits, once the irrigation system is functioning well.

Overall site management

4.2.3 A site manager will need to be appointed to make regular visits to the site to ensure there are no problems with the design and functioning of the site. This is particularly important in the first functioning year of use. It is suggested that fortnightly visits are made to the site in the first year of use outside of the irrigation period, when more frequent visits will need to be made as outlined above.

5. Monitoring Schedule

5.1 Background

5.1.1 The monitoring schedule for the site will be set out in full in the Environmental Management and Monitoring Plan (EMMP) which will be produced in consultation with Natural England. This will include monitoring of black-tailed godwit use of the site and terrestrial soil macro-invertebrate monitoring.

5.1.2 A suggested approach for the terrestrial invertebrate monitoring is outlined in Section 6.2 below, in line with the methodology used for the baseline survey.

5.2 Terrestrial Invertebrate Monitoring

Timing

5.2.1 Terrestrial invertebrate monitoring should be undertaken yearly from 2013 onwards. As the initial baseline survey was undertaken in late April 2012, it is suggested the yearly monitoring should be undertaken in April or May each year.

Methodology

Soil Collection

5.2.2 The same eight transect locations should be used as previously used for the baseline surveys in 2012 (see Thomson Ecology Report ref: NABL101/001/002). Should the transect cross the new water storage areas, which will be flooded in spring, the transect should be moved either to one side of the ponded area, or start past the ponded area further towards the centre of the field to ensure it is possible to obtain a sample from each location on the transect. As far as possible, however, the transect location should remain the same as those undertaken in 2012 to ensure consistency and enable an accurate reflection of changes to the invertebrate biomass between the years.

5.2.3 In line with baseline monitoring, the transects should be two hundred metres long and a soil sample should be collected by a surveyor at 20m intervals along each transect. This means a total of 80 samples (ten per transect) should be collected.

5.2.4 Each sample of soil collected should be 25 x 25 x10cm. The samples should be bagged in double bags and sealed tightly to prevent invertebrates from escaping. Air should also be sealed within the bag to keep the invertebrates alive until the laboratory sampling is undertaken. Each sample should be clearly labelled with the transect number, sample number, date and time and surveyor initials and stored in a cool place for no more than ten days before the laboratory analysis in undertaken.

Macro-Invertebrate Biomass Analysis

5.2.5 Each sample should be sorted for a 20 minute timed period and any macro-invertebrates encountered should be collected. Once the 20 minute time period is finished, no further sorting should be undertaken of the soil sample.

5.2.6 The number of macro-invertebrates found for each sample should be noted and then they should be preserved in boiling water. The wet weight of each sample of macro-invertebrates should then be taken by extracting the macro-invertebrates from the water and weighing using a balance accurate to two decimal places.

5.2.7 The macro-invertebrates from each sample should then be dried in a laboratory drying oven for a period of four hours and weighed again using a balance accurate to two decimal places to provide the ash-free dry weight.

5.3 Water Level Monitoring

5.3.1 Monitoring of water levels of the ditches and water storage areas will be required to provide data on the overall functioning of the site. A water level logger could be used to record water levels in these areas. This would remain permanently in place and data can either be physically downloaded at monthly intervals, or the logger could be connected to a satellite device which would allow data to be collected remotely.

5.4 Soil Moisture Monitoring

5.4.1 Monitoring of soil moisture will also be required to provide data on the overall functioning of the site. This could be undertaken through the collection of soil samples across the site on a monthly basis. The wet weight of each soil sample could be measured before the soil is then fully dried and the dry weight then measured. The difference between the sample weights would therefore equate to the measurement of soil moisture.

5.4.2 Alternatively, soil moisture measurements could be undertaking using a piezometer, which would remain permanently in place in the soil column, and linked to a data logger, or using hand-held soil moisture probes on a monthly basis across the site. Both these methods however, would be less accurate than the collection and drying of soil samples. Soil moisture should be recorded to at least 300mm depth.

5.5 Botanical Monitoring

5.5.1 Botanical monitoring will be required to accurately record vegetation structure and composition. This will inform the grazing and hydrological management together with providing information on the value of the site for invertebrates.

5.5.2 The vegetation composition i,e, the number of species and percentage cover of each species, should be measured in a series of permanent quadrats of 1x1m. Transects should be used, similar to those used for the soil invertebrate monitoring, to randomly select a series of sample points throughout the site. The transect and sample point locations should be permanently marked, and also GPS co-ordinates taken, to ensure the survey can be repeated in the same locations.

6. References

6.1.1 Treweek, J., Drake, M., Mountford, O., Newbold, C., Hawke, C., Jose, P., Self, M. and Benstead, P (Eds) (1997) *The Wet Grassland Guide: Managing floodplain and coastal wet grassland for wildlife*, RSPB, 1997.

7. Appendix 1

Table 1: Volumes of soil required for the shallow embankment

Section	Bund Length (m)	Crest Width (m)	Height of Bund (m)	Soil Volume (m^3)
1	300	10	0.4	1200
2	400	10	0.4	1600
3	100	10	0.4	400
4	50	10	0.4	200
5	100	10	0.4	400
6	40	10	0.4	160
7	60	10	0.3	180
			Total	**4140**

Table 2: Volume of dig for the water storage areas

Section	Finished OD (m)	Dig Depth (m)	Area (m^2)	Volume Excavated (m^3)
1	1.6	0.4	10000	4000
2	1.6	0.4	15000	6000
3W	1.6	0.6	22000	13620
			Total	**23620**

Table 3: Volume of water stored with spillway set at 2.2m

Section	Finished OD (m)	Water Depth (m)	Area (m^2)	Volume Stored (m^3)
1	1.6	0.6	10000	6000
2	1.6	0.6	15000	9000
3W	1.6	0.6	22000	13200
			Total	**28200**

Table 4: Volumes of soil required for the utilities embankments

Utility	Length of embankment (m)	Ridge width (m)	Added height (m)	Volume of soil (m^3
1967 Gas	700	25	0.4	7000
2009 Gas	890	25	0.3	6675
Nova Scotia Water Pipe in 3	100	25	0.3	750
Nova Scotia Water Pipe in 6	400	25	0.2	2000
Nova Scotia Water Pipe in 11	190	25	0.2	950
2007 Humber Wind Consent	720	25	0.15	2700
1985 Gas in 10	200	25	0.15	750
1985 Gas in 11	190	25	0.15	715
			Total	**19737**

Table 5: Height of utilities embankment gapes

Gape	Section crossed	Height of spillway OD (m)
a, b	3W to 1	2.0
c, d	3E to 2	1.9
e, f, g	6 to 3W	2.0
h, i	6 to 3E	2.0
j, k	5 to 4	1.9
l, m, n	7 to 6	2.1
o, p	9 to 8	2.2
q, r, s	8 to 6	2.0
t	4 to 3W	2.0
u, v	11 to 7	2.3
w	10 to 9	2.2

Table 6: Direction of falls

Section	Direction of Fall	Approximate Falls OD (m)	Remarks
1	NA	NA	Water storage area
2	NA	NA	Water storage area
3W	NA	NA	Water storage area
3E	NNE	2.2 to 2.1	-
4	N	-	Create minor fall over 10/40m run
5	NNE	2.3 to 2.1	-
6	NNE	-	Create minor fall over 10/60m run
7	NE	-	Create minor fall over 40m run
8	NE	2.3 to 2.2	-
9	NE	2.3 to 2.2	-
10	ENE	-	Create minor fall over 200m run
11	NE	-	Create minor fall over 10/140m run

Table 7: Areas of open areas and utilities and run off volumes

Section	Area (m^2)	Excess Rain (m)	Run off (%)	Volume of Reservoir (m^3)
Water Storage Areas				
1	10000	0.24	100	2400
2	15000	0.24	100	3600
3W	22700	0.24	100	5448
Totals	**47700**	**0.24**	**100**	**11448**
Open Areas				
3E	14500	0.24	22	766
4	3500	0.24	22	185
5	44000	0.24	22	2332
6	19500	0.24	22	1030
7	12800	0.24	22	676
8	18000	0.24	22	950
9	16200	0.24	22	855

Section	Area (m^2)	Excess Rain (m)	Run off (%)	Volume of Reservoir (m^3)
10	16100	0.24	22	850
11	15200	0.24	22	802
Totals	**159800**	**0.24**	**22**	**8438**
Utilities Embankments				
1967 Gas	17500	0.22	20	
1985 Gas	22200	0.22	20	
2007 Humber Wind Consent	21250	0.22	20	
Nova Scotia Water Pipe	21250	0.22	20	
1985 Gas	13750	0.22	20	
Old Little Humber Water Pipe	7000	0.22	20	
Totals	**102950**	**0.22**	**20**	**4530**
GRAND TOTAL	**310450**			**24416**

Table 8: Irrigation requirement

Section	Area (m^2)	Irrigation Requirement (m)	Volume for Irrigation (m^3)
3E	14500	0.15	2175
4	3500	0.15	525
5	44000	0.15	6600
6	19500	0.15	2925
7	12800	0.15	1920
8	18000	0.15	2700
9	16200	0.15	2430
10	16100	0.15	2415
11	15200	0.15	2280
Totals	**159800**	**0.15**	**23970**