North Thames Estuary and Marshes

Vascular Plant and Charophyte Survey 2022

September 2023

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Foreword

Land parcels across the North Thames Estuary & Marshes were surveyed in 2022 to determine their quality for vascular plant and collect evidence to assess the case for designation as a Site of Special Scientific Interest (SSSI). The report does not itself make a case for designation, rather it provides an objective record of survey findings to support Natural England's independent assessment of special interest. Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Executive summary

Abrehart Ecology Ltd was commissioned by Natural England to undertake a botanical survey of rare and uncommon species which had previously been recorded in the survey area. A walkover survey of twelve survey compartments from Tilbury Fort to Mucking village was undertaken. The study aimed to update the records and assess the number and distribution of species across the survey area. Records were made from the twelve areas from May to September 2022.

Summary of overall botanical value:

Apera spica-venti – 1 record in North Mucking compartment.

Apium graveolens – 4 records from two compartments, small number of plants at each location.

Artemisia absinthium – 19 records in the grasslands closer to the Thames from three compartments, SW, i3 and Tilbury Fort.

Artemisia maritima – 7 records, found in only two compartments, Tilbury Fort and SSSI Unit 2.

Asplenium adiantum-nigrum – 14 records from Tilbury Fort.

Asplenium ruta-muraria – 13 records in brickwork at Tilbury Fort.

Bolboscheonus laticarpus– 8 records, presumably planted around the Warren Fishery lake in the Mucking compartment.

Bupleurum tenusissimum – 53 records from two compartments, Coalhouse Fort and Tilbury Fort. The majority of the records were at Tilbury and scattered across the whole of this compartment.

Carex divisa – 18 records from four compartments.

Carex divulsa leersii - 1 record from St John and Baptist church graveyard Mucking Compartment.

Catapodium marinum – 2 records from Tilbury Fort.

Cerastium semidecandrum – 2 records from two compartments, ‘SW’ and Tilbury Fort.

Ceratophyllum submersum – 1 record from the Warren Fishery lakes in the Mucking compartment.

Clinopodium nepeta – 9 records from Parish Church of St Catherine, Coalhouse.

Cochlearia anglica – 16 records from across the survey area in the mid saltmarsh zone.

Crepis biennis – 17 records from across the survey compartments.

Cynoglossum officinale – 6 records from across the LTC4 compartment.

Cyperus longus - 1 record from within the Warren Fishery lakes in the Mucking compartment.

Dactylohiza incarnata – recorded in SSSI Unit 1 only

Dactylorhiza x grandis - recorded in SSSI Unit 1 only

Hippophae rhamnoides - 1 record of one plant in Compartment C (Enovert landfill).

Hordeum marinum – 136 records from across the survey compartments, mainly in the southern portion.

Lepidium latifolium – 49 records from across the survey compartments.

Limbardia crithmoides – 116 records from across all the saltmarsh compartments and including Tilbury Fort.

Limonium humile – I record in SSSI unit 2.

Limonium vulgare – 16 records in the upper saltmarsh zones in compartments Mucking, Unit 3 and SW.

Lotus angustissimus – only found at Stanford Le Hope cemetery.

Lotus tenuis – 164 records from across the survey area.

Marrubium vulgare – 2 records from the SW survey area.

Medicago polymorpha – 18 records from Tilbury and Coalhouse Forts.

Medicago sativa ssp. varia – 1 record from the path side in SW survey area.

Mryiophyllum spicatum – 1 record from the high tide roost lagoons in East Tilbury Quarry (Walsh) compartment.

Oenanthe crocata – 3 records from within the Warren Fishery lakes in the Mucking compartment..

Oenanthe lachenalii – 5 records from two compartments, in the edges of *Bolboscheonus maritima* of borrow dykes, East Tilbury Quarry (Walsh) and North of Coalhouse.

Oxybasis chenopodioides – 40 records from seven compartments across the survey area.

Parapholis incurva – 46 records from four compartments across the survey area.

Polypogon monspeliensis – 116 records from eight compartments across the survey area.

Potamogeton pusillus – 9 records from the high tide roost lagoons in the East Tilbury Quarry (Walsh) Compartment.

Puccinellia fasciculata – 5 records from Coalhouse Fort only.

Puccinellia rupestris – 9 records from two areas, Coalhouse Fort and i3.

Ranunculus baudotii – 38 records from four compartments across the survey area.

Ranunculus sarduous – 69 records from three compartments, Mucking, Walsh and Tilbury Fort.

Rumex hydroplanthum – 2 records from the reed on an island in Gobions Lake, Mucking compartment.

Rumex palustris – 4 records from Compartment C (Enovert landfill).

Rumex pulcher – 15 records from Coalhouse Fort and Tilbury Fort only.

Ruppia maritima – 32 records from Tilbury Fort only.

Sagina maritima – 1 record from an ant mound at Tilbury Fort.

Salvia verbenaca – 27 records from Tilbury Fort and the Parish Church of St Catherine graveyard, Coalhouse.

Senecio aquatica – 1 record from Compartment C (Enovert landfill)

Spiranthes spiralis – 2 records from SSSI Unit 1.

Spartium junceum – 1 plant on the side of the footpath near LTC4.

Spartina maritima - 1 record only from a saltmarsh in SSSI Unit 3.

Stuckenia pectinata – 12 records from Tilbury Fort only.

Trifolium fragiferum – 5 records from Tilbury Fort and Coalhouse Fort only.

Trifolium glomeratum – 1 record from Tilbury Fort.

Trifolium squamosum – 61 records from Tilbury Fort, SSSI Unit 1 and compartment D (Walsh quarry).

Verbena officinalis – 8 records from two compartments, Tilbury Fort and Mucking Wetlands.

Vicia villosa – 16 records from five compartments across the survey area.

X Agropogon lutosus – 2 records from Compartment C (Enovert landfill).

Zannichellia palustris – 72 records from five compartments across the survey area.

In addition to the above vascular plant species– 6 records of the section 41 rust *Puccinia bupleuri* were found at Tilbury Fort.

No charophyte species were found during the survey.

Non-native species

Cotula australis – sixteen records from two areas, the majority were from Tilbury Fort.

Crassula helmsii – five records from two areas in North Mucking.

Table 1: Number of individuals of each species found during survey with Threat Status and location. Blank cells indicate where species were not present at time of survey.

Species name	Threat Status	A - Mucking	B - Thameside	C - Enovert	D - Walsh	E - Coalhouse	L - North of coalhouse	SSSI Unit 1	Units 2, 3, 4	LTC Area 4	i3, G2, Squirrels	Tilbury Fort	F, SW	Misc
Apera spica-venti		1												
Apium graveolens		2										2		
Artemisia absinthium	LC										4	3	12	
Artemisia maritima	NT - England								5			2		
Asplenium adiantum-nigrum	LC											14		
Asplenium ruta-muraria	LC											13		
Bolboscheonus laticarpus		7												
Bupleurum tenusissimum	VU (A2c)					8						45		
Carex divisa	VU (A2c)	8				8	1					1		
Carex divulsa leersii		1												
Catapodium marinum	LC											2		
Cerastium semidecandrum	LC											1	1	
Ceratophyllum submersum		1												
Clinopodium nepeta	LC													9
Cochlearia anglica	LC					3			1			4	8	
Cotula australis											1	15		
Crassula helmsii		3												
Crepis biennis	LC	7						6			3		1	
Cynoglossum officinale	NT									4			2	
Cyperus longus		1												
Dactylorhiza x grandis														
Dactylorhiza incarnata	(WL)													
Hippophae rhamnoides	LC			1										

Species name	Threat Status	A - Mucking	B - Thameside	C - Enovert	D - Walsh	E - Coalhouse	L - North of coalhouse	SSSI Unit 1	Units 2, 3, 4	LTC Area 4	i3, G2, Squirrels	Tilbury Fort	F, SW	Misc
Hordeum marinum	VU					20						116		
Lepidium latifolium	LC	4		4							2	20	20	
Limbardia crithmoides	LC	20		2					24			1	69	
Limonium humile									1					
Limonium vulgare	NT - England	4							2				11	
Lotus angustissimus	NT													1
Lotus tenuis	LC	34		30	35		6	14		7	22	10	6	
Marrubium vulgare	LC												2	
Medicago polymorpha	LC							10				7	1	
Medicago sativa ssp varia													1	
Mryiophyllum spicatum					1									
Oenanthe crocata		3												
Oenanthe lachenalii					4		1							
Oxybasis chenopodoides		1			4	2					15	18		
Parapholis incurva		4				23						17	2	
Polypogon monspeliensis		17		26	30	1					14	8	4	15
Potamogeton pusillus					9									
Puccinellia fasciculata						5								
Puccinellia rupestris						5					4			
Puccinia bupleuri						3						3		
Ranunculus baudotii					11		1					22		4
Ranunculus sarduous		34			11							24		
Rumex hydroplanthum				2										
Rumex palustris				4										
Rumex pulcher						13						2		
Ruppia maritima												32		

Species name	Threat Status	A - Mucking	B - Thameside	C - Enovert	D - Walsh	E - Coalhouse	L - North of coalhouse	SSSI Unit 1	Units 2, 3, 4	LTC Area 4	i3, G2, Squirrels	Tilbury Fort	F, SW	Misc
Sagina maritima														
Salix purpurea					1									
Salvia verbenaca												23		4
Senecio aquatica		1												
SM13c saltmarsh									3					
Spartina maritima									1					
Spartium junceum													1	
Spiranthes spiralis								2						
Stuckenia pectinata												12		
Trifolium fragiferum						3						2		
Trifolium glomeratum												1		
Trifolium squamosum					3		1	9				48		
Verbena officinalis		5										3		
Vicia villosa			3		3						1		6	
X Agropogon lutosus				2										
Zannichellia palustris				13	9		9				10	31		1

Contents

Background

Natural England is considering the enlargement of Mucking Flats & Marshes Site of Special Scientific Interest (SSSI) in order to recognise the national importance of a series of additional habitats and the species which they support. The proposed enlargement would be an important contribution towards nature recovery in the Thames Estuary. The Tilbury Fort to Mucking Flats and Marshes corridor on the Essex side of the River Thames is a key area for biodiversity. Efforts have been made over some years to influence land use change towards nature conservation after uses to further strengthen these qualities.

The area includes post-industrial habitats with restored landfill/quarry and flooded pits, historic grazing marsh and arable farmland. It has a riverside setting, which supports a range of transitional habitats from the inter-tidal zone to coastal grasslands, scrublands and pockets of woodland. Several water bodies are also present with fringing scrub. Some areas are under active nature conservation management, but many areas have other primary land uses, with incidental wildlife value.

Natural England has commissioned an up-to-date field survey to provide records for vascular plants and charophytes of conservation importance within the survey area (see Appendix 1). This survey will add to the existing body of evidence to enable Natural England to determine whether there are species present which qualify for selection under the Guidelines for the Selection of Biological SSSIs, Part 2: Detailed Guidelines for Habitats and Species, Chapter 11 and Chapter 15 for vascular plants and charophytes respectively.

Field survey methodology

The field survey involved walking the survey compartments at appropriate times of year to obtain maximum coverage of the survey areas, targeting habitats and plant communities likely to support potentially qualifying species. Data and sample collection were undertaken by two surveyors, including an experienced on-site surveyor (Toby Abrehart FLS MCIEEM FISC5) and a second team member responsible for recording, health and safety, and assisting with sample collection, Daniel Anderson BSc (Hons), Alister Killingsworth BSc (Hons) MSc GradCIEEM) and Dr Simon Forster BSc PhD. Surveyors used their experience of recording plants to identify and search for suitable habitats to target populations of plants of conservation concern. A grapnel was used for open water ditches and pools. All target species encountered were recorded. Records were supported with photographs and grid references. Photography was utilised where possible to enhance understanding of the survey area and plant populations. Where there was doubt over the identification of a plant, specimens or photos as appropriate were sent to national experts for confirmation. The focus of this survey was primarily species previously recorded in the survey area (see Appendix 2) but not to survey for them exclusively. Any other potentially qualifying species were also recorded.

Sample point locations

Survey locations were chosen once on site to allow the most suitable habitats for the species list provided to be surveyed for rather than be restricted to previous sample locations. Maps of land surveyed within each compartment are provided in Appendix 3.

Key terms are defined below:

Area: Covers the whole survey area as provided in maps by Natural England.

Compartment: One of twelve distinct parcels of land within the 'Area'.

Site: A portion of a compartment often with an individual separate name.

Record: a record of a certain species at that location, which may be only a single plant, may be a group of plants or a stand., Additional notes are provided in the accompanying spreadsheet.

Timing

Three survey trips between May and the end of August were suggested to find vascular plant and charophyte species, some of which would be more conspicuous at different times of the year in the variety of settings covered in the survey area. Seventeen days were spent in the field from 3rd May to 12 September 2022. The field surveyor determined the ideal times to undertake surveys at specific locations, including early in the season for habitats vulnerable to drought, midsummer for aquatic macrophytes and charophytes and late summer for coastal species, and other times as appropriate.

Presence/absence, nil records, and coverage

The surveyor recorded locations of the notable species as presence/absence with accompanying information on population size (specified in more detail in the accompanying survey spreadsheet). For greater understanding of nil records of rare species with previous known records in a locality, comments are provided on time spent searching, habitat suitability and survey coverage.

Biocontrol

As sampling comprised moving from one system to another, the check, clean, and dry methods were employed as standard. However, protocol also included changing of nets and trays from one survey area to another. Prior to entering a new waterbody, the net and trays from one survey area were washed in a solution of Virkon and left to dry. A clean and dry set was then used in the new waterbody. This prevented species or pathogens being transmitted from one area to another. On return to the laboratory the nets were washed again in Virkon solution and left to dry for at least one day before being taken into the field. On site, in addition to the nets, only waterproof boots entered the waterbody, and these too were washed in Virkon at the end of sampling effort within a marsh system.

Health and Safety

Not all survey areas had been visited by Natural England staff and some areas were industrial in character. Appropriate risk assessments were carried out in discussion with site staff. Some sites were near residential areas, and horses or other stock may have been encountered. Health and safety regarding work in or near to water was considered, together with lone working procedures when lone working was undertaken. Appropriate safeguards in working around deep water and on friable and possibly slippery slopes, steep banks, coastal mud, tidal zones, and any other hazards noted during prior or dynamic risk assessment were put in place.

Efforts were made to ensure that all landowners and their agents were fully sighted with the Natural England plans, and that any specific procedures and inductions as requested were adhered to.

Limitations

Some of the surveys were carried out in sub-optimal conditions due to access issues, meaning that the surveys were carried out later in the year when the flowering season of some species was over. The survey start date meant that many of the vernal (Spring) species were no longer visible or identifiable during this survey effort.

The summer of 2022 was also very hot and dry, with almost no rain for three months. This had a significant effect on the flowering period and duration of many of the species searched for. Some of the habitats were ephemeral. In the first surveys in May 2022, the water of several of the ponds and ditches was receding. In the second survey period several of these were dry and the aquatic vegetation was drying or fully dry.

With greater access to more of the survey areas earlier in the recording season a larger number of species could have been found.

Results

Compartment A: Mucking Wetlands A1- A7

This area comprised a range of habitats including old gravel pits, grazing marshes, sea walls and reclaimed mudflats. The west supported an area of reedbeds and grazing marshes to the north of the St John the Baptist Church. The central portion of the compartment was old gravel pits that are now used as fishing lakes. The area to the south of The Warren Fishery was tall grasslands and reedbeds with small water bodies. The southern boundary was a creek feeding into the Thames just south of the realigned mudflats. The southern edge of the compartment was bordered by a sea wall with a mudflat developing to the southeast. In the northeast of the compartment was a small lagoon that was bordered with reed and sea club-rush.

Access was restricted in some parts of the compartment with no access to the fishing lakes to the east of Wharf Road, the reedbeds and small pools south of The Warren Fishery and the reedbeds to the west of the fishery. The reedbeds are unlikely to support any of the species listed in Appendix 2. They were visually searched with binoculars from vantage points around the edge.

The main species found within this compartment are associated with sea wall communities. Species previously recorded within the compartment but not found during this survey were:

Mentha pulegium – not found anywhere along the zone where previously recorded. The vegetation appeared too robust and will have swamped it out.

Bupleurum tenuissimum – previously found in the north-east (A3) of the compartment, between the high tide line and the sea wall. All areas were extensively searched. As with other compartments in this survey the habitat was very dry.

Trifolium squamosum – was not found at the location previously recorded. Very dry conditions limited plant growth in this compartment. It was searched for in many other places too but not found.

Table 2: Compartment A: Mucking Wetlands survey results.

Species	Number of records	Comments
Apera spica-venti	1	Only one plant.
Apium graveolens	2	Found in two locations around the fishing lakes (A5), a small number of plants were present – probably more were scattered around the edges and within the reedbeds at the compartment.
Bolboscheonus latifolius	7	This was likely to have been planted in many locations around the fishing lakes to the west (A5). There were more stands present than were recorded but those noted give a general distribution across the compartment.
Carex divisa	8	This was found in two distinct locations (A3 and A7). There was continued presence around the eastern lagoon (A3) in similar numbers to where it was previously recorded. The other location was the grazing marsh to the north of St John the Baptist

Species	Number of records	Comments
		Church, where only a small colony was recorded. This was due to the time of year visited and that the area had been well grazed. It is likely to be present more extensively across the marsh.
Carex divulsa leersii	1	Several plants growing across a small number of the graves in the south of the St John the Baptist Church graveyard..
Ceratophyllum submersum	1	There was very limited macrophyte cover in the fishing lakes. A small area of this species was present in the north of the lakes. It probably is more frequent than indicated in this survey. The lakes have had blue dye added to reduce algal growth.
Crepis biennis	7	This was found in two main areas along the sea wall grasslands (A3). It formed a near continuous colony in both areas with many hundreds of plants in each section. The sea walls were mown in late June, but all plants had set seed by then.
Cyperus longus	1	Only recorded in one location at the fishing lakes (A5), assumed planted.
Lepidium latifolium	3	Three main stands were found on the south of the eastern lagoon (A3).
Limbardia crithmoides	20	This was scattered all along the upper saltmarsh edge across the compartment with the exception of where sea wall repairs had been carried out.
Limonium vulgare	4	This was only recorded as a small number of plants (<10) in four distinct groups along one section of sea wall (A2 and A3).

Species	Number of records	Comments
Lotus tenuis	34	This was commonly found in the short grasslands around the sea wall. This species continued to flower into September.
Oenanthe crocata	3	This was only found as three small stands around the fishing lake (A5), <10 plants at each location.
Oxybasis chenopodioides	1	One small stand of around 20 plants was found in the gravels of a fishing platform (A5).
Parapholis incurva	4	This was rare in each location, with only around 20 plants at each spot. *Parapholis strigosa* was more frequent (A2 and A3).
Polypogon monspeliensis	18	This was present in similar habitat to *Lotus tenuis* scattered sparsely along the base of the sea wall with a more continuous swath in the northeast.
Ranunculus sarduous	34	This was present in similar habitat to *Lotus tenuis* along the base of the sea wall and behind the wall in the west. This was scattered very sparsely along the base of the sea wall and a more continuous swath in the northeast.
Senecio aquatica	1	Only one plant found in the *Carex divisa* marsh in the west of the compartment (A7).
Verbena officinalis	5	Found in two distinct locations (A3), both within the well-trodden gravels adjacent to paths.

Compartment B: Thameside Nature Discovery Park

This area encompassed land managed by Essex Wildlife Trust. It is a former quarry and restored landfill site. The vegetation is dominated with maturing grasslands with a small amount of Elm hedging on the northern edge of the compartment. There was a small area

of saltmarsh on the northern edge of the compartment adjacent to the channel which was dominated with *Puccinellia maritima* and had an outer edge of *Spartina anglica* with a band of *Bolboscheonus maritima* along the upper saltmarsh edge.

Access was not restricted at this compartment but walking across some of the area revealed unsuitable habitat for the majority of the target species of interest. Many areas were searched with binoculars to identify suitable habitat. If seen they were then inspected. None of the species listed in Appendix 2 have previously been recorded in this compartment. The two species found here were associated with the path side grassland communities.

Table 3: Compartment B survey results.

Species	Number of records	Comments
Vicia villosa	3	A small number of plants on the edge of a path leading to the Thames were found. It is most likely to be found much more frequently across other areas of the main grassland.
Lepidium latifolium	1	Small stand of plants by the gateway.

Compartment C1-C5 and Gobions Lake: Enovert landfill

This area comprises restored quarry and landfill sites and Gobions lake (also known as Golden Gates Lake). The majority of the compartment was dominated with maturing grasslands and developing scrub. There are areas in the middle of the compartment where some chalk open habitat (C2) has been created. In the east of the compartment there was an area that has been recently restored and where vegetation was starting to colonise. Four water bodies are present. These were mainly old settling ponds and newly created lagoons, the largest of which was Gobions Lake. The majority of these water bodies were reed fringed with large areas of open water. All of this compartment is saline in character with those areas closest to the River Thames the most saline.

Gobions lake was accessed by boat to search the islands in the middle of the lake. All other waterbodies were explored along the shore edges using grapnels. Access was not possible in areas which were being actively worked. However, these areas did not support any plant species. The main species found are associated with sea wall, grassland edges, tracksides, reedbeds and open water communities. None of the species listed in Appendix 2 have previously been recorded in this compartment.

Table 4 – Compartment C1-C5 and Gobions Lake survey results.

Species	Number of records	Comments
Hippophae rhamnoides	1	Only one plant was found on the edge of the compartment above the high tide line in the line of developing scrub.
Lepidium latifolium	4	A small number of scattered stands were found across the compartment on the sides of the track or in the developing grasslands.
Lotus tenuis	30	This was found across the compartment often in good numbers following the paths and tracks. Generally absent from the more developed grassland areas.
Polypogon monspeliensis	26	A common component in the developing grasslands shortly after restoration. In the older restored land the numbers were greatly reduced though still present throughout the sward. A significant number of large robust plants were growing along the edge of the track leading back to the offices.
Rumex hydroplanthum	2	This was found in two places within a single island in Gobions Lake. Three plants were present in each location.
Rumex palustris	4	<10 plants were found in one area of the recently restored eastern side of compartment C4.
X Agropyron littoralis	2	Scattered colonies were found along the wet track edge within the abundant *Polypogon monspeliensis*.
Zannichellia palustris	13	This was the dominant plant in the three smaller water bodies on compartment C1.

Photo 1. C1 Pond 1. © Abrehart Ecology 2023

Photo 2. C1 Pond 2. © Abrehart Ecology 2023

Photo 3. C1 Pond 2. © Abrehart Ecology 2023

Photo 4. Gobions Lake south shore. © Abrehart Ecology 2023

Compartment D: East Tilbury Quarry (Walsh)

This compartment comprised a restored gravel quarry and landfill site, a borrow dyke at the base of the sea wall and a newly created area of shallow scrapes/lagoons, deeper water and islands used as a high tide roost for waders. The high tide roost was created in the autumn of 2021 and accordingly had limited macrophyte cover. *Zannichellia palustris* is present as scattered stands across the lagoons.

Access was unrestricted across the compartment. Two waterbodies at the north of the compartment were no longer present and had been infilled during restoration. All areas of the recently established grasslands were searched. They supported very few to none of the target species listed in Appendix 2. Much of the land around the high tide roost has been recently disturbed. Here there were abundant ruderal species with *Polypogon monspeliensis* most commonly found. This compartment is saline in character with those areas closest to the River Thames the most saline.

The main species found here are associated with sea walls, trackside edges, open water, borrow dykes and open vegetation communities. Species previously recorded within this compartment but not found during this survey were:

Bupleurum tenuissimum – previously found in the grasslands on the sides of the track behind the sea wall C1). This area was extensively searched. As with other compartments in this survey the habitat was very dry.

Table 5 – Compartment D survey results.

Species	Number of records	Comments
Lotus tenuis	35	This was found across the compartment often in good numbers and scattered throughout the sward. It followed the paths and tracks around the compartment and was in general absent from the more developed grassland areas.
Myriophyllum spicatum	1	A single plant was noted in the high tide lagoons.
Oenanthe lachenalii	4	These were scattered along one section of ditch and at very low numbers within the *Bolboscheonus maritima* on the edge of the borrow dykes.

Species	Number of records	Comments
Oxybasis chenopodoides	4	A small number was found at the high tide roost scattered along the shore edge, in between several *Chenopodium rubrum*.
Polypogon monspeliensis	30	A common component in the developing grasslands shortly after restoration. In the older restored land the numbers were greatly reduced though still present through the sward.
Potamogeton pusillus	9	This was commonly scattered in the high tide roost lagoons, and otherwise scattered all across the compartment.
Ranunculus baudotii	11	A common plant found scattered across the open water of the high tide roost lagoons.
Ranunculus sarduous	11	This was found across the high tide roost lagoon islands and along the edge of the track behind the sea wall.
Salix purpurea	1	A single plant was found in the edge of one of the high tide roost lagoons.
Trifolium squamosum	3	Scattered plants were found along the longer grass by the vehicle tracks behind the sea wall.
Vicia villosa	3	Small numbers of plants were found along the grasslands of the bank edges.
Zannichellia palustris	9	This was commonly found in the water bodies on the compartment, especially the high tide roost lagoons.

Photo 5. High tide roost lagoon. © Abrehart Ecology 2023

Photo 6. Pond 7 Borrow dyke. © Abrehart Ecology 2023

Photo 7. Pond 6. © Abrehart Ecology 2023

Compartment L2-L9: Fields East of Coalhouse Battery

Access to this compartment was limited to the main tracks behind the sea wall and into the Campsite. The majority of the land that was not accessed was grazed improved grassland. The area along the edge of the access tracks was a range of semi disturbed and maturing coastal grasslands with the campsite supporting a large expanse of grassland with limited flowering plants.

The area surrounding and to the north of the fort was horse grazed throughout and dominated by a range of grass species with *Hordeum secalinum* a common component. Phragmites australis was scattered across this area with *Bolboscheonus maritima* common in some of the ditch margins. Open water was present in the ditch in the north of the compartment. Aquatic macrophytes were present in some of the water bodies present, with *Zannichellia palustris* most frequent and *Ranunculus baudotii* common in the ditches.

The main species found here are associated with sea wall grasslands, the dyke to the north of the campsite and associated grasslands. Species previously recorded within this compartment but not found during this survey were:

Bupleurum tenuissimum – previously found in the grasslands on the sides of the track behind the sea wall. This area was extensively searched. As with other compartments in this survey the habitat was very dry in 2022.

Table 6 – Compartment L2-L9 survey results.

Species	Number of records	Comments
Carex divisa	1	A small stand was present on the edge of the mown path on the northern edge of the campsite (L7). It is probably much more widely present in the grasslands of the campsite.
Lotus tenuis	6	This was found across the campsite often in good numbers creating a scattered sward of this species.
Oenanthe lachenalia	1	One stand was found on the northern bank of the cleared ditch.
Polypogon monspeliensis	1	This was found on the northern bank of the recently cleared ditch at the campsite.

Species	Number of records	Comments
Ranunculus baudotii	1	This was commonly scattered in the ditch to the north of the campsite (L7)..
Trifolium squamosum	1	A single plant was present growing in the bark chip laid across a culvert (L7).
Trifolium squamosum	9	All the plants found were along the outer edge of the compartment along the side of the track running inside the sea wall.
Zannichellia palustris	9	Found all along the recently cleared ditch in the north of the campsite (L7).

Photo 8. Campsite ditch - L7.
© Abrehart Ecology 2023

Compartment Unit 1 of Mucking Flats and Marshes SSSI

This area comprised scrub, open grasslands, developing lichen heath and sea wall. In the summer of 2022 the southern end of the Unit was destroyed by a fire. By September the grasses were starting to come through and the area was beginning to green up again.

Access was not restricted, though consideration was given to nesting birds. The main species found here were associated with the grasslands. Species previously recorded within this unit but not found during this survey were:

Bupleurum tenuissimum – previously found on the side of the track running through the centre of the unit and on the edge of the sea wall track. Both areas were extensively searched. As with other compartments in this survey the habitat was very dry in 2022.

Polypodium monspeliensis – previously recorded in small scraped pit but was not found this year.

Parapholis incurva – previously recorded on the side of the track running through the unit but not found this year.

Trifolium squamosum – was not found at the location given along the central track. Very dry and limited growth in this part of the unit in 2022. It was searched for in many other places but not found.

Table 7 - Unit 1 Mucking Flats and Marshes SSSI survey results.

Species	Number of records	Comments
Crepis biennis	6	Several stands were scattered through the more mature grasslands on the unit, often as large loose colonies.
Carex divisa	1	Small stand were present in the grasslands in the west of the unit.
Gymnadenia conopsea	1	A small colony was found within the spotted orchid community.
Dactylorhiza X grandis	2	This was found within the spotted orchid community.
Dactylorhiza incarnata	1	This was present scattered with the extensive spotted orchid community, numbers were low, but mostly had finished flowering when visited.
Lotus tenuis	14	This was found across the unit especially in the shorter less robust grasslands in the north and along the edges of tracks.

Species	Number of records	Comments
Medicago polymorpha	10	Small numbers were scattered along the more open grasslands on the sides of the tracks running through the unit.
Spiranthes spiralis	1	This was found within one area in the northeast of the unit, supporting a colony of around 300 plants.
Vicia villosa	3	Many plants were scattered across the unit, but predominately in the north.

Compartment Units 2, 3 and 4 of Mucking Flats and Marshes SSSI

These are all intertidal saltmarsh habitats, with open muds and a small number of pools. Pioneer saltmarsh was present around pools and rills. The sea wall supports a higher marsh in places including *Elytrigia atherica, Artemisia maritima, Aster tripolium* and *Beta vulgaris* ssp*. maritima.* Access was unrestricted but, due to timings and survey effort elsewhere in the area limited time was spent exploring the outer marsh edge. The section of upper saltmarsh near to the sea wall was explored. Many of the areas were visually searched with binoculars from vantage points around the edge. The main species found here are associated with upper saltmarsh and sea wall communities.

Table 8 – Units 2, 3 and 4 of Mucking Flats and Marshes SSSI survey results.

Species	Number of records	Comments
Artemisia maritima	5	This was found in three areas along the upper saltmarsh.
Cochlearia anglica	4	A small number of plants at each location were found within the upper saltmarsh.
Limbardia crithmoides	28	Small stands of this were found occasionally on the outer edge of the saltmarsh or on the hardstanding near to the jetty in the upper saltmarsh zone.

Species	Number of records	Comments
Limonium vulgare	2	This was found in two areas of SM13c saltmarsh.
Limonium humile	1	Three plants were present in the upper saltmarsh.
Spartina maritima	1	A small stand of this was found within the good NVC SM13c saltmarsh.

Compartment E (E1-E5): Coalhouse Fort & surrounds

Compartment E (E1-E5) comprising Coalhouse Fort and surrounding marshes supports a range of habitats. The large Moats around the fort periodically flood into the adjacent lands, creating a set of ephemeral saline pools. The land to the south of the moats was rough tussocky grasslands with a ditch running through it fed from the moats. This had small stands of *Bolboscheonus maritima* along it. The grasslands were dominated with *Elytrigia atherica* with large stands of *Carex divisa* and dry pans supporting *Oxybasis chenopodioides*. The grasslands around the moats were short mown on a regular basis with longer areas closer to the moat edges. The main species found here were associated with the saline affected grasslands. Species previously recorded within this compartment but not found during this survey were:

Poa bulbosa – recorded once in 2009 in the grasslands in the south of the compartment. Not found during this survey. The habitat appeared less suitable to support this species.

Oxybasis glauca – one previous record from the strand line, not found in this survey.

Table 9 – Compartment E1-E5 survey results.

Species	Number of records	Comments
Bupleurum tenusissimum	8	Only found in two areas this year, on the south of the southern moat and the path side leading to the offshore tower.
Carex divisa	8	A large colony in the southern marshes.

Species	Number of records	Comments
Cochlearia anglica	3	Found on the edge of the saltmarsh near to the beaches by the tower.
Hordeum marinum	20	Common across the compartments mainly in the open grasslands of the northern moat.
Oxybasis chenopodoides	2	Well known from one area on the compartment (E1) where management is in place to support it.
Parapholis incurva	23	Common across the compartment, mainly in the open grasslands of the northern moat (E5).
Polypogon monspeliensis	1	One plant on side of path (E1).
Puccinellia fasciculata	5	Small number of plants in the saltmarsh vegetation to the west of the northern moat (E5).
Puccinellia rupestris	5	Small number of plants in the saltmarsh vegetation to the west of the northern moat (E5).
Rumex pulcher	13	Scattered in three areas. The main area to the east of the fort (E5), and two separate colonies along the path to the tower (E1).
Trifolium fragiferum	3	Three large colonies in the short mown grasslands above the saltmarsh edges of the northern moat (E5).

Photo 8. Small Moat - E2. © Abrehart Ecology 2023

Photo 9. Large Moat - E1. © Abrehart Ecology 2023

Photo 10. South Ditch - E1.
© Abrehart Ecology 2023

Compartment: LTC4 (DHL parcel) and i8 (west of Coalhouse Fort)

LTC4 was an area of restored landfill comprising grassland and scattered scrub. There was a ditch running along the northern and eastern sides of the compartment. These maturing grasslands dominated this compartment. They were very dry at the time of the survey. The northern ditch was bordered with brambles on the southern side with scrub and *Bolboscheonus maritima* in stands along the northern edge. The water was filled with bright green algae. The eastern ditch was bordered with *Phragmites australis* and *Atriplex patula*.

Access was initially restricted in some parts of these compartments. Access to the restricted areas was agreed in August, at which time the vegetation had mostly gone over and been burnt off. The main species found here are associated with short grasslands along the sides of the tracks. There were larger areas of *Lotus tenuis* within the LTC4 area, (observed from the footpath in the spring) but access was not possible at that time. The presence of vascular plant species in this compartment is therefore likely to be much more extensive than reported here.

Table 10 – LTC4 and i8 survey results.

Species	Number of records	Comments
Lotus tenuis	7	Numerous plants were scattered across the grasslands and track sides. Many plants were scattered across the main grasslands though these were not accurately recorded due to access issues.
Cynoglossum officinale	4	A small number of plants were found along the side of the track running along the east of the compartment to the Thames.

Photo 11. LTC4 Ditch. © Abrehart Ecology 2023

Photo 12. Australian Tube Worm (*Ficopomatus enigmaticus*) © Abrehart Ecology 2023

Compartment: ‘Ashfields Complex’ and i3 (Goshem’s Farm Conservation Area)

An additional plan to aid interpretation of the survey parcels within this compartment has been provided at Appendix 1 and 4. This denotes the various ash fields as A1, A2, A3, B, C1 and C2 respectively. In the following text these are referred to as Ash. ‘XX’ as required. The original location detail is retained alongside for continuity.

These compartments are all located to the east of Tilbury Port (Appendix 4). The main species found here were associated with maturing grasslands and disturbed and ephemeral habitats. Ashfields generally was an area of sparsely vegetated loose ash. G2 (Ash. A1) specifically is an area of loose ash with limited sparse vegetation dominated with *Polypogon monspeliensis*, with *Blackstonia perfoliata* and *Reseda lutea* common across the area. In the north and eastern slopes of the compartment (G2 mound) there was a maturing grassland with *Arrhenatherium elatius* and large stands of *Securigera varia* throughout. The eastern boundary of lower land at the base of the G2 (Ash. A1) was dominated with *Phragmites australis* and developing scrub. There was a brackish ditch to the east that was dominated with *Bolboscheonus maritima* and *Zannichellia maritima*. The western boundary had another ditch running north south, the water here was very clear but with hydrocarbons evident rising to the surface profusely once disturbed.

‘Squirrels Head’ (northern part of Ash. A3) is a restored grassland and scrub habitat with a large Pylon. Only *Lepidium latifolia* was present. The parking area to the south of ‘Squirrel’s Head’ supported *Polypogon monspeliensis* and *Oxybasis chenopodioides*.

LTC3 (Ash. A2) is a restored area of grassland with an ephemeral pool in the south east. The main vegetation across this area was *Arrhenatherium elatius* grasslands with bramble and developing scrub throughout. The northern edge of the pool was dominated with *Phragmites australis* with stands of *Bolboscheonus maritima* in the southern edges. In the centre of LTC3 (west of i3) was a larger ephemeral pool, the water here was receding, with *Oxybasis chenopodioides* and *Puccinellia rupestris* most notable.

Species previously recorded within these compartments but not found during this survey were:

Chenopodium vulvaria – was not found in any of the areas surveyed, previously recorded from the disturbed soils along the shoreline of the compartment.

Table 11 – Ashfields Complex, Squirrel’s survey results.

Species	Number of records	Comments
Artemisia absinthium	4	A small number of stands found scattered across the compartments Area B and Area A1.
Crepis biennis	3	Found in the northern end of G2 in the grasslands.
Lepidium latifolium	1	Found in one area at LTC Area G2-G3 in the mature grasslands near the Pylon.
Lotus tenuis	22	Scattered across the southern areas mainly in track edges and in the loose material of Ashfields (G2) / Ash. A1.
Oxybasis chenopodoides	16	Found in three areas of this compartment, all in ephemeral saline pool edges of areas Ash B, Ash A2 and Ash A1.
Polypogon monspeliensis	18	Scattered across Area A2, A1 and LTC3.
Puccinellia rupestris	4	A small number of plants were found in the drawdown zone of the ephemeral pool in LTC3.

Species	Number of records	Comments
Vicia villosa	1	Found sparingly in track sides and in the grasslands of LTC3 and Area Ash A1.
Zannichellia palustris	10	Found in the brackish dykes and within the ephemeral pool in LTC3.

Photo 13. West Ditch - G2. © Abrehart Ecology 2023

Photo 14. West Ditch - G2. © Abrehart Ecology 2023

Photo 15. East Ditch - G2. © Abrehart Ecology 2023

Photo 16. Ephemeral Pond north - i3. © Abrehart Ecology 2023

Photo 17. Ephemeral ditch south - i3. © Abrehart Ecology 2023

Compartment: Tilbury Fort and marshes

The area surrounding the fort and inside the inner 'M' shaped moat is all mown grasslands and tall brick walls and taller occasionally mown grasslands. Outside of the moat are a series of ditches, horse grazed marshes and ephemeral pools. The ditches and moats support a limited flora.

The horse grazed marshes were dominated by a range of grass species with *Hordeum secalinum* a common component, *Hordeum marinum* was abundant in the edges of the ephemeral pools and areas close to the ditch/moat edges. These grazed marshes held a wide range of rare species in often very high densities. *Phragmites australis* was scattered across the outer ditches with *Bolboscheonus maritima* common in some of the ditch margins. Across the marshes *Trifolium squamosum* and *Bupleurum tenuissimum* were abundant with the *Bupleurum tenuissimum* supporting the Section 41 rust *Puccinia bupleuri*.

Open water was found in all of the ditches in the May surveys, many had dried by July. Aquatic macrophytes were present in some of the water bodies with *Ruppia maritima* and *Zannichellia palustris* most frequent. *Ranunculus baudotii* was common in the ditches and ephemeral pools in the north and east. .

Grapnal samples were taken from the moats, there was with no emergent vegetation but the aquatic macrophytes were dominated with *Ruppia maritima* and *Chaetomorpha* algae Both were abundant across the survey area. The base of the water body was firm under foot and was accessible in chest waders, as the water was only 50-60cm deep.

This site supported the most species of interest and many of the species were found at a very high density and abundance.

Species previously recorded within this compartment but not found during this survey were:

Salicornia fragilis – previously found on blockwork along the top of the beach. Frequent higher tides (coastal squeeze) may have made this habitat unsuitable at present.

Table 12 – Tilbury Fort and marshes survey results.

Species	Number of records	Comments
Asplenium ruta-muraria	13	Scattered across the wall of the fort and nearby brickwork. Inside and outside the fort wall (TFM 9).

Species	Number of records	Comments
Apium graveolens	2	A small number of plants were found in the *Phragmites* of the SW moat of the fort (TFM 1).
Artemisia absinthium	3	A small number of stands were scattered across the area mainly TFM2.
Artemisia maritima	2	Found in two small areas in the short grazed grasslands on the east bank of the western ditch (TFM1).
Asplenium adiantum-nigrum	14	Found scattered across the wall of the fort and nearby brickwork. Inside and outside the fort wall all in TFM9.
Asplenium ruta-muraria	13	Found scattered across the wall of the fort and nearby brickwork. Inside and outside the fort wall all in TFM9.
Bupleurum tenuissimum	45	This was common across the area. Only a small number of records were made for what was present. Found in each area of grassland and on the edges of the tracks behind the sea defences (TFM 1, 2, 3 and 5).
Carex divisa	1	One plant found on the roadside (TFM1).
Catapodium marinum	2	A small number of plants were found on the dry grasslands near the car park and along the sea wall (TFM9).
Cerastium semidecandrum	1	A small number of plants were found on the dry grasslands near the car park (TFM9).
Hordeum marinum	116	Common across the area often forming the dominant sward near to the moats.

Species	Number of records	Comments
Lepidium latifolium	20	Scattered colonies were present across the area.
Lotus tenuis	10	Found scattered on the sides of the main path in the edges of the grasslands.
Limbardia crithmoides	1	One small stand on the eastern side of the moat was found (TFM2).
Medicago polymorpha	7	Scattered plants were present on the sides of a dry track (TFM2).
Oxybasis chenopodoides	18	Plants were found in three loose colonies, all in ephemeral pools (TFM3 and 5).
Parapholis incurva	17	Common across the area at a lower density to *Hordeum marinum* but often closely associated with it (TFM1, 2, 3 and 5).
Polypogon monspeliensis	8	Found scattered in the occasionally wet ditch at the base of the sea wall defences (TFM9).
Potamogeton pectinatus	12	This was common in the eastern ditch (TFM5).
Ranunculus baudotii	22	Found in all the bodies of water especially those drying (TFM 1, 2, 3 and 5).
Ranunculus sarduous	24	Found across the area in the short grazed grasslands.
Rumex pulcher	2	A small colony was found on the grass bank near to the main gate (TFM9).
Ruppia maritima	32	Found in the larger ditches.
Sagina maritima	1	Found on grazed ant hill (TFM2).

Species	Number of records	Comments
Salvia verbenaca	23	Found in the grasslands on the southern side of the fort and nearby grasslands (TFM9).
Trifolium fragiferum	2	Found in two small patches in the short grazed grasslands (TFM2 and 3).
Trifolium glomeratum	1	Found by car park in gravels (TFM9).
Trifolium squamosum	48	Common across the area (TFM1, 2, 3 and 5).
Verbena officinalis	3	Found on the walls of the fort and nearby grasslands. TFM9)
Zannichellia palustris	30	Common in the western and eastern ditches (TFM1 and 5).

Photo 18. Bill Melroy Creek – TFM5. © Abrehart Ecology 2023

Photo 19. TFM 3 © Abrehart Ecology 2023

Photo 20 – TFM3. © Abrehart Ecology 2023

Photo 21 – TFM3. © Abrehart Ecology 2023

Photo 22 – TFM3. © Abrehart Ecology 2023

Photo 23 – TFM1. © Abrehart Ecology 2023

Photo 23. TFM1. © Abrehart Ecology 2023

Photo 24. Tilbury Fort Creek - TFM1. © Abrehart Ecology 2023

Photo 25. Tilbury Fort Moat NE – TFM1. © Abrehart Ecology 2023

Photo 26. Tilbury Fort Moat S – TFM2. © Abrehart Ecology 2023

Photo 27. Tilbury Fort Moat N – TFM3.
© Abrehart Ecology 2023

Compartments F (inter-tidal) and SW (seawall)

Compartment F is a narrow area of saltmarsh running along the edge of the River Thames. Compartment SW covers the area above the saltmarsh leading up to the impounded sea wall and flood defences between the two forts. The habitat in compartment SW varied from upper saltmarsh to scrub and grasslands. There was a concrete path running the length of the compartment. The grasslands were dominated with *Elytrigia atherica*. The main species found here are associated with sea wall communities.

Species previously recorded within these compartments but not found during this survey were:

Chenopodium vulvaria – not found at any of the locations where previously recorded. Much of the habitat had been extensively disturbed by bottle diggers.

Table 13 – F and SW survey results

Species	Number of records	Comments
Artemisia absinthium	12	A small number of stands were found scattered across the two compartments.

Species	Number of records	Comments
Cochlearia anglica	8	Was present in the outer saltmarsh edges along compartment SW.
Cerastium semidecandrum	1	Was only found once in the short dry grasslands along the low retaining wall south of the road to the car park (TFM9).
Crepis biennis	1	Small area supporting around 10 plants on south side of the path south of the LTC3 compartment.
Cynoglossum officinale	1	Small area supporting two plants on south side of the path.
Lepidium latifolium	20	Found in scattered in several areas along compartment SW, often within the *Elytrigia atherica* grasslands.
Lotus tenuis	6	Found scattered on the sides of the main path in the edges of the grasslands.
Limbardia crithmoides	69	Common on the sides of the saltmarsh between the two forts.
Marrubium vulgare	2	Two plants in the *Elytrigia atherica* grasslands.
Medicago polymorpha	1	A single plant was found on the side of the path.
Polypogon monspeliensis	4	One plant was found on the side of the path.
Medicago varia	1	One plant on the edge of the path south of the LTC3 area.
Spartium junceum	1	A single plant was found on the side of the path.
Vicia villosa	6	Found sparingly on the sides of the path in compartment SW.

Additional records

This section covers records from areas slightly outside the survey compartments shown in Appendix 1. The species found were largely associated with sea wall communities.

Table 14 – Additional records.

Species	Number of records	Comments
Clinopodium nepeta	9	Found scattered across the Parish Church of St Catherine, Coalhouse graveyard and along the nearby footpath to the west of the road
Lotus angustissimus	1	Colony of 40 plants in short turf in the Stanford Le Hope Cemetery.
Polypogon monspeliensis	15	Found in disturbed soils around LTC3.
Ranunculus baudotii	4	Found in edge of ephemeral pond LTC3.
Salvia verbenaca	4	Found scattered across the Parish Church of St Catherine, Coalhouse graveyard and along the nearby footpath.
Sambucas edulis	1	Found on the edge of the path between *Prunus spinosa* scrub in Bowaters.
Zannichellia palustris	1	In ditch at side of Ashfield G2 (Ash. A1).

Discussion

Seventy-five species of locally uncommon and rare plants were recorded as part of this survey and 1,342 records were made of scarce and uncommon species. The summer was exceptionally hot and dry and across the majority of the survey area many of the plants were burnt off by the later visits in June and July. The majority of the records came from Coalhouse Fort and Tilbury Fort. These both supported short grasslands that were either grazed by horses or mown. They both had a significant saline influence in the grassland communities. At Tilbury Fort the quantity of many of the species was impressive. Large tracts of the area supported extensive colonies of a mosaic of *Hordeum marinum, Trifolium squamosum* and *Bupleurum tenuissimum* in bands around the receding water levels.

Overall this survey is likely to have underestimated the botanical interest present due to the late start date and the hot, dry summer.

Sustainability

The sustainability of many of the uncommon plant species found across the sites is varied. Many of the species recorded were species of ephemeral and transitional habitats that require regular disturbance for their survival.

Table 15 Sustainability of populations of species found across the area

Species name	Sustainable population	Comment
Apera spica-venti	No	Ephemeral habitat, since destroyed by sea wall maintenance.
Apium graveolens	Yes	A species of marginal habitat that requires no specific management just areas of less dense emergent vegetation – at no immediate threat
Artemisia absinthium	Yes	Scattered stands found in the long grasslands that require only that the scrub vegetation does not over dominate the habitats. The plants on the coast are likely to be unaffected over time as the coastal influence manages the scrub density through increased salinity
Artemisia maritima	Yes	Found in the upper saltmarsh zone and horse grazed marshes. As long as the grazing continues and the upper saltmarsh zone is left unmanaged then there is no potential threat. There is potential for natural increases in each area
Asplenium adiantum-nigrum	Yes	More common than recorded in this report – the only threat would be if Tilbury Fort walls were repointed.
Asplenium ruta-muraria	Yes	More common than recorded in this report – the only threat would be if Tilbury Fort walls were repointed.
Bolboscheonus latifolius	Yes	This neophyte is expanding across the UK and at this site is likely to be unaffected unless significant works occur around the fishing lake.
Bupleurum tenusissimum	Yes	Found in only two areas though the potential habitat was extensive across all survey areas. It requires areas of disturbed habitat with bare soils, either from tyre tracks or from heavier grazing. It is often considered to be an annual but can be bi-annual. It can often go undetected in a light grass sword in its pre-flowering vegetative state. In 2022 the hot dry weather may have caused a delayed growth in some populations (Coalhouse Fort sea walls). During the survey of Tilbury fort vegetative plants were commonly found in the short grasslands on the upper flat sections of the sea wall. Over the summer these burnt off and never flowered, then the plants on the north slopes started showing through and these flowered along with the plants on the upper zones above the *Hordeum marinum* community, it had a strong

Species name	Sustainable population	Comment
		association with the *Trifolium squamosum*. This species will only persist if the ephemeral habitats are maintained. A previous survey for the section 41 rust *Puccinia bupleuri* (Abrehart 2011) at Coalhouse Fort, *Bupleurum tenuissimum* was much more abundant in many more areas of the site.
Carex divisa	Yes	This was very common and dominant at the southern end of the Coalhouse Fort site. This population is unlikely to reduce unless *Bolboscheonus maritima* increases with increased salinity in the marshes. The population at the side of the road gully at Tilbury fort, although it has been present for a long time, may be at risk from spraying of road works.
Carex divulsa leersii	No	A small population that is growing around some gravestones, the rough grassland is at risk of being cleaned up, this would likely remove this population.
Catapodium marinum	Yes	This was found in very low numbers in the dry grass on the tops of the west gun line walls.
Cerastium semidecandrum	Yes	This was likely to be more common than the survey indicates. The late start to the season and the precociousness of the spring meant than at many sites it was burnt off before the survey started.
Ceratophyllum submersum	Yes	Although only found once, a more extensive survey of the water bodies using a boat may have produced more records, it is often associated with slightly saline water bodies so may become more common than indicated.
Clinopodium nepeta	Yes	All the sites for this species were outside the main survey zone and were centered around the graveyard at Parish Church of St. Catherine. This site has been managed for many years with a mowing regime. The plants have survived this far and will no doubt continue to. The other colony was on the side of the footpath, here again there is regular maintenance mowing, but it still survives and probably benefits from the reduced competition.
Cochlearia anglica	Yes	Found uncommonly on the outer saltmarsh edges this is likely to erode though the seeds will persist in this ephemeral habitat
Cotula australis	Yes	This invasive was found mainly at Tilbury Fort where an eradication programme would easily remove it from this important habitat.
Crassula helmsii	Yes	This invasive was only found in two small populations. This could and should be removed to prevent further spread.
Crepis biennis	Yes	Present mainly in coastal grasslands and sea walls, these are all managed with an annual cut, this seems to reduce competition from other species allowing this to persist in high numbers.

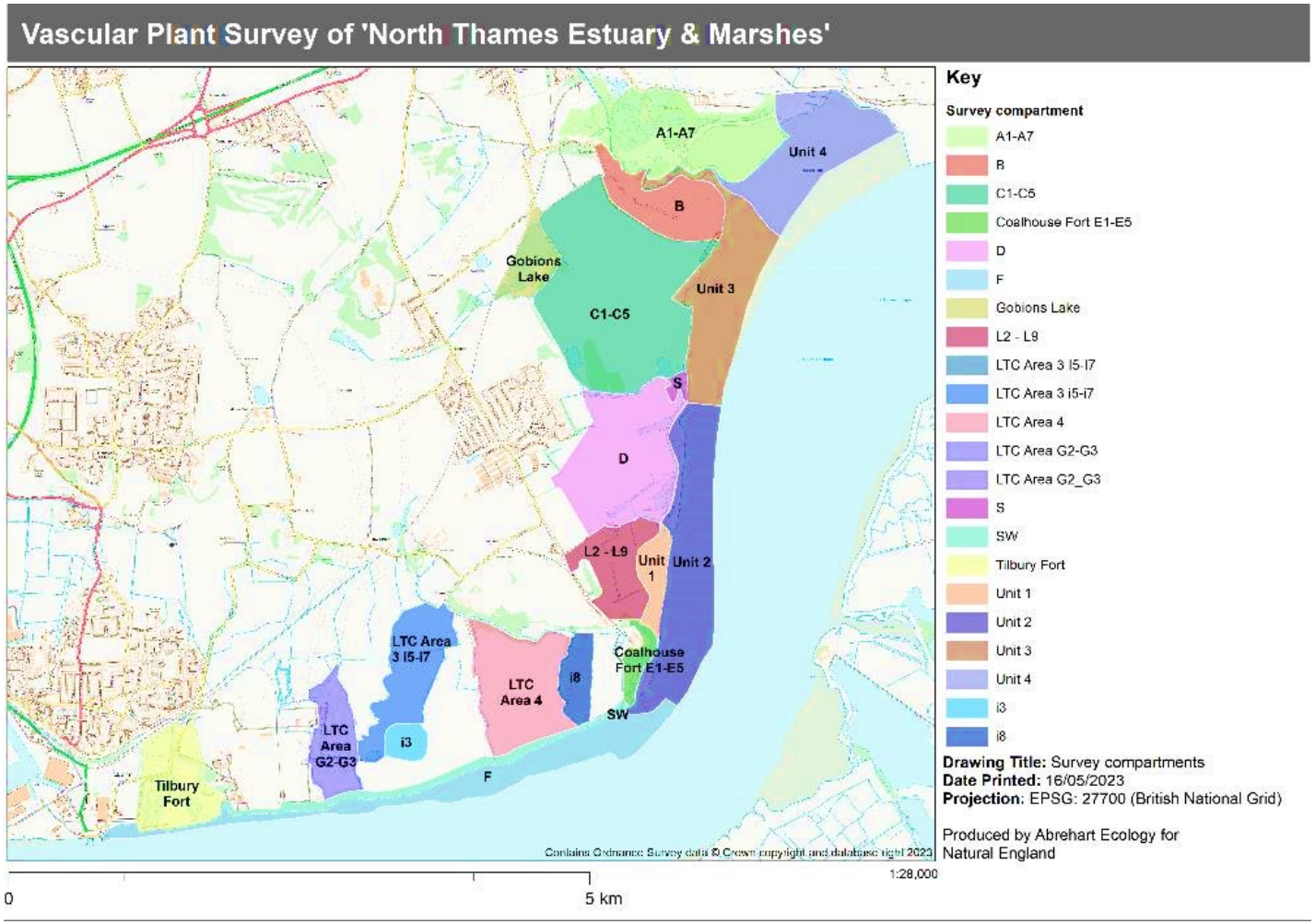
Species name	Sustainable population	Comment
Cynoglossum officinale	Yes	Found rarely in two areas in areas of disturbed habitat by paths. These communities are susceptible to lack of management of the path sides increasing competition.
Cyperus longus	Yes	The only plants were in a single stand that will remain unaffected.
Dactylorhiza x grandis	Yes	Only one area supports this taxon, it is managed by Thurrock Town Council as part of the Coalhouse fort reserve. This is expected to continue to be well managed in the future. A significant fire in the south of the unit is an issue that will need to prevent further north.
Dactylorhiza incarnata	Yes	Only one area supports this taxon, it is managed by Thurrock Town Council as part of the Coalhouse fort reserve. This is expected to continue to be well managed in the future. A significant fire in the south of the unit is an issue that will need to prevent further north.
Hippophae rhamnoides	Yes	Only one plant at the edge of the landfill, is unlikely to be affected in the future, only sea wall works will potentially damage the plant.
Hordeum marinum	Yes	Although only found in two areas, both areas support extensive populations with the population at Tilbury Fort supporting over 1 hectare of plants. It will need to have the flooded section of the site and continued horse grazing to reduce competition of other more robust species. The ephemeral waterbodies and disturbed sea walls are essential for the continued survival of this species.
Lepidium latifolium	Yes	This rapidly expanding halophyte was common in many areas near the sea. There is little chance of this reducing in the future.
Limbardia crithmoides	Yes	This was a common component of the saltmarsh edges, either the outer edge or the upper edges of the saltmarshes. Not at any risk.
Limonium humile	No	Found once and present in the upper saltmarsh, limited risk other than sea level rise pushing the plants into the scrub edge on the sea wall.
Limonium vulgare	Yes	All three populations appear stable in the upper saltmarsh, only risks are with coastal squeeze.
Lotus angustissimus	Yes	Only one population at Stanford le Hope cemetery, in heavily mown grasslands in one spot within the cemetery, no apparent risk as long as the maintenance and mowing regime continues.
Lotus tenuis	Yes	Common across the survey site and at no risk other than from robust vegetation becoming dominant.
Marrubium vulgare	No	Small population of two plants, at risk from increased *Elytrigia atherica* dominating the sward around the plants.
Medicago polymorpha	Yes	Found in three sites, low numbers of plants
Medicago sativa ssp varia	No	Single plant on path side, if the habitat is not disturbed then this will not survive.

Species name	Sustainable population	Comment
Mryiophyllum spicatum	Yes	Found in newly created lagoons near the coast, may well change in density as the lagoon matures
Oenanthe crocata	Yes	Only found at the fishing lakes, three stands were noted but more were likely present in unobserved areas. No specific threats to this population.
Oenanthe lachenalii	Yes	Found in two areas with three small colonies, no more than 10 plants in total, only potential losses would be due to borrow dyke clearances.
Oxybasis chenopodoides	Yes	Found scattered in five areas, never in high densities, though scattered in loose colonies with Chenopodium rubrum. Always found in ephemeral habitats where water has receded in the summer, flowering late in the season.
Parapholis incurva	Yes	Found scattered though often at a high density in small areas of a site. At Tilbury Fort it often formed a near continuous zone above the *Hordeum marinum* swards. Usually in company with *Trifolium squamosum* and *Bupleurum tenuissimum.*
Polypogon monspeliensis	Yes	One of the most common plants in the survey, always found in ephemeral habitats, either in areas of receding waters in pools or in the soils used as capping on the restored landfills. It often formed extensive areas covering a hectare or more on the landfill sites. A couple of years post restoration other more dominant vegetation starts to establish pushing *Polypogon monspeliensis* and other ruderal species out.
Potamogeton pectinatus	Yes	Found in Bill Melroy Creek only, not at any risk
Potamogeton pusillus	Yes	Found in High Tide Roost newly created lagoons, it may reduce in density as the lagoons mature
Puccinellia fasciculata	Yes	Only found at the main known site at Coalhouse Fort. Possibly more frequent than this survey shows but needs to be identified when in flower.
Puccinellia rupestris	Yes	Found twice at the well known site at Coalhouse Fort and in the muds of a receding lagoon at G2, the only risk is in the lagoonal muds becoming vegetated.
Puccinia bupleuri	Yes	This section 41 rust was found at both sites for *Bupleurum tenuissimum*. It was rare at Coalhouse Fort, but there were many fewer plants here to infect. At Tilbury Fort it was more widespread across the site and more common than the three records indicate. At Tilbury it was already infecting the fresh leaves in some areas, whereas normally it establishes on the more mature stems of a near flowering plant. The stresses of the hot dry summer may have made it easier to establish this year.
Ranunculus baudotii	Yes	Common in four sites all coastal ditches or ephemeral water bodies. No risk to these population as long as the habitats remain

Species name	Sustainable population	Comment
Ranunculus sarduous	Yes	This was common in the short mown or grazed coastal grasslands, as long as the management remains the populations should be stable.
Rumex hydroplanthum	Yes	Only three plants were found on the islands within Gobions Lake. Not at risk on the site, growing vigorously from the reedbeds, only site management will affect it.
Rumex palustris	No	Four records in two areas at the recently restored lands at the Enovert sit (C). The sites where this was found will mature rapidly and the plants will be lost. Only intervention to create a regularly disturbed damp habitat will maintain the species.
Rumex pulcher	Yes	Found in two areas the well-known site at Coalhouse fort where it was present in two distinct areas of the site. Within the grasslands to the east of the Fort where it is marked off each year to prevent it from being mown too early. Once it has started to set seed it is mown. The other site is the path edges close on the southern end of the site. Stands of over 20 plants were in three main areas of the path edges, all are cut to maintain the paths. All are managed an monitoured by the site reserve manager. A new population was found at Tilbury Fort, this was in the short regularly mown grasslands near the entrance gates. Site manager is aware of the population, and it should be managed with reduced mowing in the future.
Ruppia maritima	Yes	Found commonly at Tilbury Fort in the moats and ditches. No potential risks to the populations.
Sagina maritima	Yes	Only found once on an ant hill at Tilbury Fort. Likely to be more abundant than this record shows, earlier surveys should produce more records especially at this site.
Salix purpurea	Yes	One plant by the side of the High Tide Roost Lagoon, should remain on site
Salvia verbenaca	Yes	Found abundantly at Tilbury Fort in all the grasslands on the south side of the Fort walls. These grasslands are mown annually and the habitat is well managed. The other population at Parish Church of St. Catherine at Coalhouse is managed by occasional mowing and appears healthy. No risk to either site.
Senecio aquatica	Yes	Only one plant found in a slightly saline grazing marsh, access earlier in the year will probably found more plants present there. Grazed by cattle.
SM13c saltmarsh	Yes	Small area of saltmarsh with frequent *Armeria maritima* in the sward. This community was only found in one area of the site. Stable
Spartina maritima	Yes	Found within the SM13c community, may need monitoring no immediate threat.
Spartium junceum	Yes	Single plant of an introduced species
Spiranthes spiralis	Yes	Found only in Unit 1 at Coalhouse Fort, only around 100 present by the end of the survey season, but recorded in numbers over 200 in

Species name	Sustainable population	Comment
		many years (pers. comm.). One small area supporting this species on the east of the unit. The short grasslands are mown late in the summer to create a low sward for the orchids in September. Very well managed site at no immediate risk other than possible fires and lack of management.
Trifolium fragiferum	Yes	Found at Coalhouse Fort in two large stands in the short-mown grasses near the northern moat. At Tilbury Fort it is found in the horse grazed marshes, this regime of mowing and grazing will maintain the populations. Reduced management will make the sward to dense, and the plants will disappear.
Trifolium glomeratum	Yes	Only found in the gravels of the car park at Tilbury Fort. Only constant disturbance will maintain the habitat required for this species. At no risk at this site.
Trifolium squamosum	Yes	Found in four areas only abundant in two of them. At Tilbury Fort it formed extensive communities on the sea wall and above the *Hordeum marinum* communities in the grasslands with *Parapholis incurva* and *Bupleurum tenuissimum*. At Coalhouse it occurs as a continuous sward below wheel ruts behind the sea wall. This species needs this level of disturbance for continued existence.
Verbena officinalis	Yes	Found at Tilbury Fort in the walls in the south east of the site and in the short grasslands. At Mucking it was found on the side of a busy path where the footfall maintained a short sward. These populations are only at risk from over tidying of the sites.
Vicia villosa	Yes	This was found in several areas as an occasional adventive to the grassland swards by the paths along the Thames path and other paths around the survey areas. As long as there is limited scrub development then this species should stay in numbers around the sites.
X Agropyron littoralis	No	This rare hybrid was found in two areas in the Enovert site, it was found with both parents. Both populations are unlikely to remain as the habitat is ephemeral. But with both parents around the site it may persist somewhere.
Zannichellia palustris	Yes	Common in several of the lakes on the site, many of the lakes are well established and there is little chance of change at them. Not at risk.

Appendix 1.



Survey Area. Contains Ordnance Survey data © Crown copyright and database right 2023

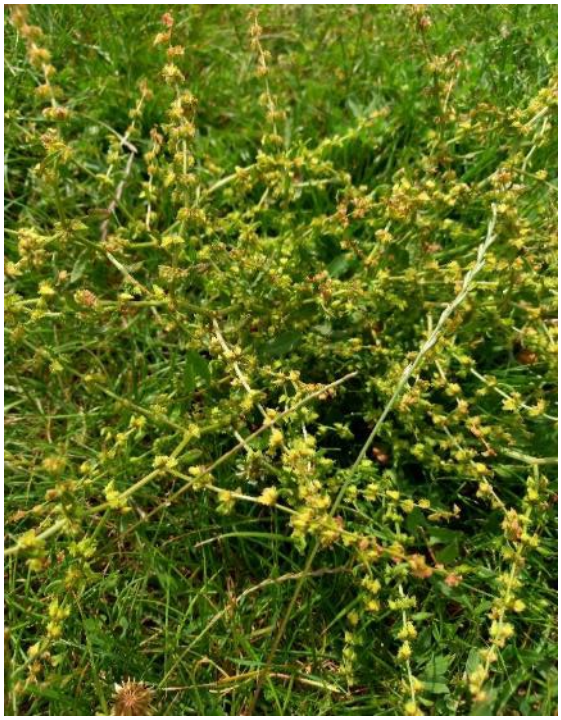
Appendix 2. Photo of the site and plants

***Gymnadenia conopsea* – Unit 1 Coalhouse Fort © Abrehart Ecology 2023**

***Vicia villosa* – scattered across the survey area © Abrehart Ecology 2023**

***Hordeum marinum* – common at Tilbury and Coalhouse Forts © Abrehart Ecology 2023**

***Trifolium subterraneum* – at Tilbury Fort car park © Abrehart Ecology 2023**



***Rumex pulcher* – found new at Tilbury Fort and still at Coalhouse Fort © Abrehart Ecology 2023**

***Carex divisa* – Large colony at Coalhouse, also at Tilbury Fort and East Tilbury Marsh © Abrehart Ecology 2023**

***Cochlearia anglica* – scattered along the shore of the survey area © Abrehart Ecology 2023**

***Marrubium vulgare* – found on sea wall near East Tilbury Fort © Abrehart Ecology 2023**

***Ranunculus baudotii* – Found in many water bodies, ephemeral and permanent © Abrehart Ecology 2023**

***Medicago varia* – found only once on the sea wall © Abrehart Ecology 2023**

***Medicago polymorpha* – scattered in the south of the survey area © Abrehart Ecology 2023**

***Trifolium glomeratum* – found in car park at Tilbury Fort © Abrehart Ecology 2023**

T*rifolium squamosum*, common at Tilbury Fort, less common on all other sea walls © Abrehart Ecology 2023

***Bupleurum tenuissimum* – Common at Tilbury Fort, sparce at Coalhouse Fort © Abrehart Ecology 2023**

***Lotus angustissimus* – found at Stanford le Hope cemetary © Abrehart Ecology 2023**

***Oenanthe lachinellia* – Found in borrow dykes at East Tilbury marshes © Abrehart Ecology 2023**

***Artemisia absinthium* – Scattered in grasslands along the coast © Abrehart Ecology 2023**

Vervain – *Verbena officinalis* – Found at Tilbury Fort and Mucking © Abrehart Ecology 2023

***Lotus tenuis* – Common across most of the survey area © Abrehart Ecology 2023**

Sea Wormwood – *Artemisia maritima* – found at Tilbury Fort and Unit 3 © Abrehart Ecology 2023

***Ruppia maritima* – found at Tilbury Fort**
© Abrehart Ecology 2023

***Apera spica-venti* – Found in disturbed soil at Mucking Marshes**
© Abrehart Ecology 2023

***Bolboscheonus laticarpus* – Planted by fishing ponds © Abrehart Ecology 2023**

***Oxybasis chenopodioides* – Found at the fishing ponds © Abrehart Ecology 2023**

***Zannichellia palustris* – Common in ditches © Abrehart Ecology 2023**

***Polypogon monspeliensis* – abundant in many sites of disturbed soils © Abrehart Ecology 2023**

***Trifolium fragiferum* – found at Coalhouse and Tilbury Forts in short grasslands © Abrehart Ecology 2023**

***Limbardia crithmoides* – common in scattered strands along the saltmarsh edges © Abrehart Ecology 2023**

***Spiranthes spiralis* – only at Unit 1 Coalhouse Fort © Abrehart Ecology 2023**

***Clinopodium nepeta* – found in churchyard and nearby footpath at Coalhouse © Abrehart Ecology 2023**

***Sagina maritima* - found once at Tilbury Fort © Abrehart Ecology 2023**

***Potamogeton pectinatus* – found at Tilbury Fort © Abrehart Ecology 2023**

***Dactylorhiza X grandis* – found at Coalhouse Fort Unit 1 only © Abrehart Ecology 2023**

***Dactylhoriza incanata* – found at Coalhouse Fort Unit 1 only © Abrehart Ecology 2023**

***Puccinellia fasciculata* – found only at Coalhouse Fort © Abrehart Ecology 2023**

***Parapholis incurva* – common in many saline grasslands in the survey area © Abrehart Ecology 2023**

***Puccinellia rupestris* – found at Coalhouse Fort and LTC3 ephermeral pond © Abrehart Ecology 2023**

***Rumex palustris* – found at the Enovert Site in disturbed grounds © Abrehart Ecology 2023**

***X Agropogon littoralis* – found with both the parents at Enovert site © Abrehart Ecology 2023**

***Lepidium latifolium*- Scattered across survey areas © Abrehart Ecology 2023**

Appendix 3.

Table 16: Species previously recorded in the survey area. Cells left blank are where species threat status and rarity are not available

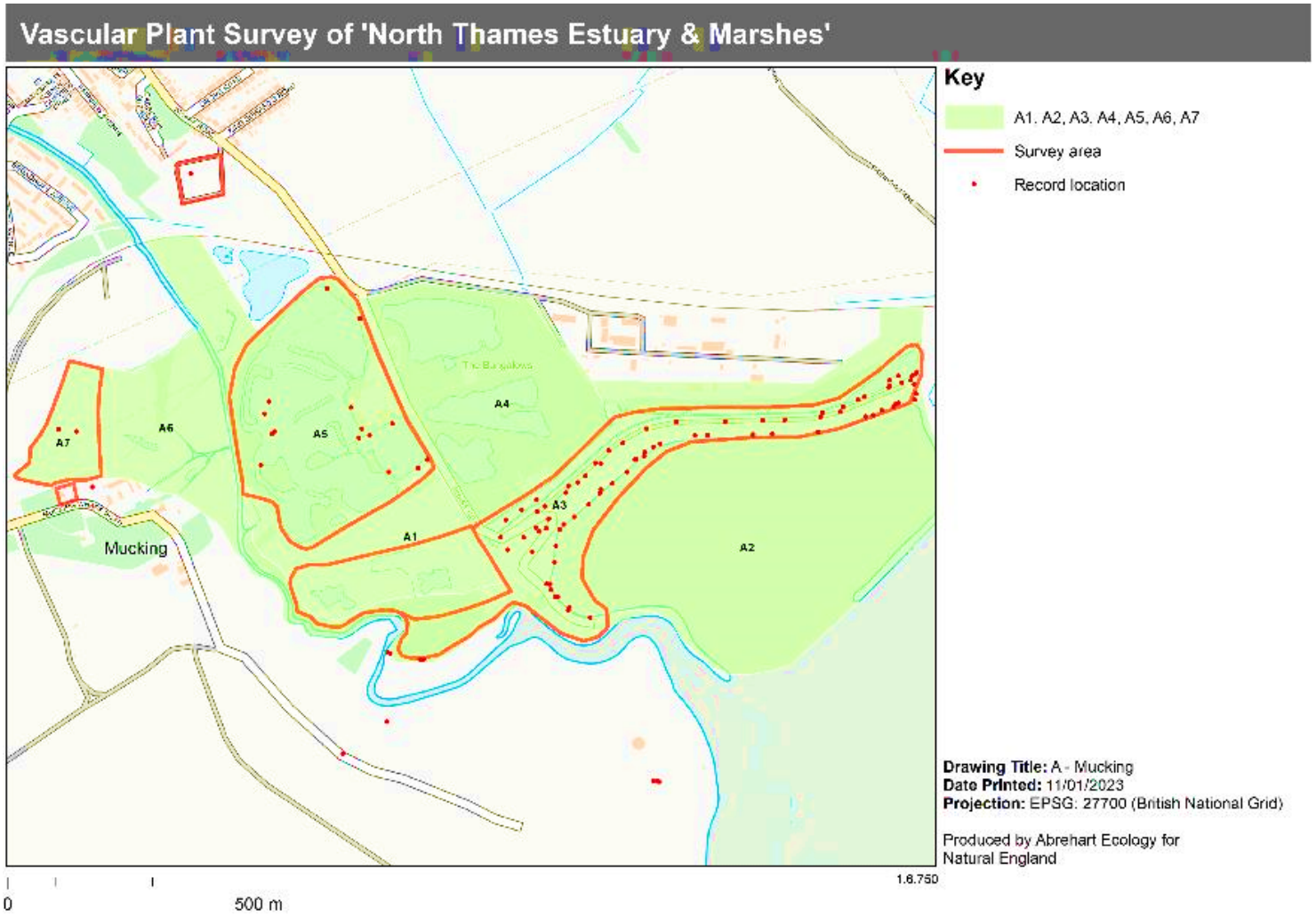
Scientific name	Common Name	Threat Status	Rarity
Althaea officinalis	Marsh mallow	NT	NS
Anacamptis morio	Green winged Orchid	VU	
Artemisia absinthium	Wormwood	LC	Historic Decline
Artemisia maritima	Sea Wormwood	LC GB, NT Eng	
Asplenium adiantum-nigrum	Black Spleenwort	LC	Essex Listed
Asplenium ruta-muraria	Wall rue	LC	Essex Listed
Blitum bonus-henricus	Good King Henry	VU Archaeophyte	Essex Listed
Bupleurum tenuissimum	Slender Hare's ear	VU (A2c)	NS GB (Stroh et al 2013)
Carex divisa	Divided Sedge	VU (A2c)	NS GB (Stroh et al 2013)
Carlina vulgaris	Carline Thistle	LC GB, NT Eng	Essex Listed
Catapodium marinum	Sea Fern grass	LC	Essex Listed
Cerastium semidecandrum	Little Mouse ear	LC	Essex Listed
Chenopodiastrum murale	Nettle leaved Goosefoot	EN	
Chenopodium vulvaria	Stinking goosefoot	EN	Rare
Cochlearia anglica	English Scurvygrass	LC	Essex Listed

Scientific name	Common Name	Threat Status	Rarity
Clinopodium nepeta	Lesser Calamint	LC	NS
Crepis biennis	Rough Hawk's beard	LC	Essex Listed
Cynoglossum officinale	Hound's tongue	NT	Essex Listed
Dactylorhiza x grandis	A hybrid orchid		Essex Listed
Dactylorhiza incarnata	Early Marsh orchid	(WL)	Historic Decline
Erophila verna	Common Whitlowgrass	LC GB, NT Eng	
Galium parisiense	Wall Bedstraw	VU native/alien	NS
Geranium rotundifolium	Round leaved Crane's bill	LC	Essex Listed
Hippophae rhamnoides	Sea Buckthorn	LC	NS prob intro at Essex sites
Hordeum marinum	Sea Barley	VU	NS GB (Stroh et al 2013)
Inula conyzae	Ploughman's spikenard	LC	Essex Listed
Jacobaea aquatica	Marsh Ragwort	LC GB, NT Eng	Essex Listed
Lepidium latifolium	Dittander	LC	previously NS, but not in Atlas 2020
Limbarda crithmoides	Golden samphire	LC	NS GB (Stroh et al 2013)
Limonium vulgare	Common Sea lavender	LC GB, NT Eng	
Logfia minima	Small Cudweed	LC GB, NT Eng	
Lotus angustissimus	Slender Birdsfoot Trefoil	NT	NS

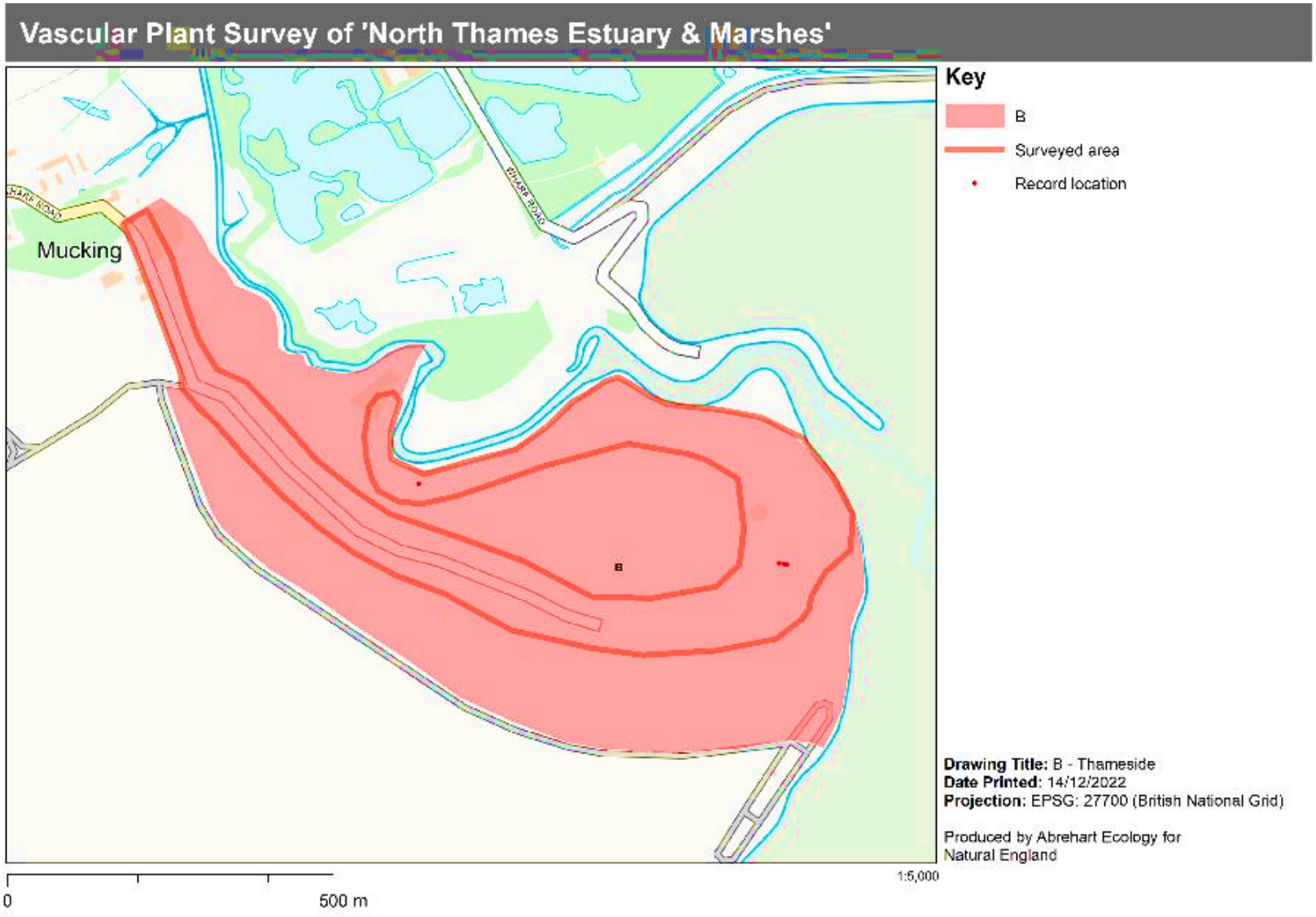
Scientific name	Common Name	Threat Status	Rarity
Lotus tenuis	Narrow leaved Bird's foot trefoil	LC	
Marrubium vulgare	White Horehound	LC	NS GB (Stroh et al 2013)
Medicago polymorpha	Toothed Medick	LC	NS
Moenchia erecta	Upright Chickweed	VU	
Myosotis discolor	Changing Forget me not	LC	Essex Listed
Myosotis ramossisima	Early Forget me not	LC	Essex Listed
Oenanthe lachenalii	Parsley Water dropwort	LC GB, NT Eng	
Origanum vulgare	Wild Marjoram	LC	Essex Listed
Oxybasis glauca	Oak leaved Goosefoot	VU	NS
Oxybasis chenopodioides	Saltmarsh Goosefoot	LC	NS GB (Stroh et al 2013)
Parapholis incurva	Curved Hard grass	LC	NS GB (Stroh et al 2013)
Poa bulbosa	Bulbous Meadow grass	LS	NS
Polycarpon tetraphyllum	Four-leaved Allseed	LC	NS
Polypogon monspeliensis	Annual Beard grass	LC	NS GB (Stroh et al 2013)
Potentilla argentea	Hoary Cinquefoil	NT	
Puccinellia fasciculata	Borrer's Saltmarsh grass	NT	NS
Ranunculus sardous	Hairy Buttercup	LC	

Scientific name	Common Name	Threat Status	Rarity
Rumex hydrolapathum	Water Dock	LC	Essex Listed
Rumex maritimus	Golden Dock	LC	NS GB (Stroh et al 2013)
Rumex pulcher	Fiddle Dock	LC	Essex Listed
Salicornia fragilis	Yellow Glasswort	LC	NS
Salvia verbenaca	Wild Clary	NT	Essex Listed
Sarcocornia perennis	Perennial Glasswort	LC	NS
Saxifraga granulata	Meadow Saxifrage	LC	Historic Decline
Saxifraga tridactylites	Rue-leaved Saxifrage	LC	Essex Listed
Scilla autumnalis	Autumn Squill	LC	NS
Spiranthes spiralis	Autumn Lady's tresses	NT	NS
Stellaria pallida	Lesser Chickweed	LC	Essex Listed
Stratiotes aloides	Water Soldier	LC Native/alien	NS GB (Stroh et al 2013)
Trifolium fragiferum	Strawberry Clover	VU	

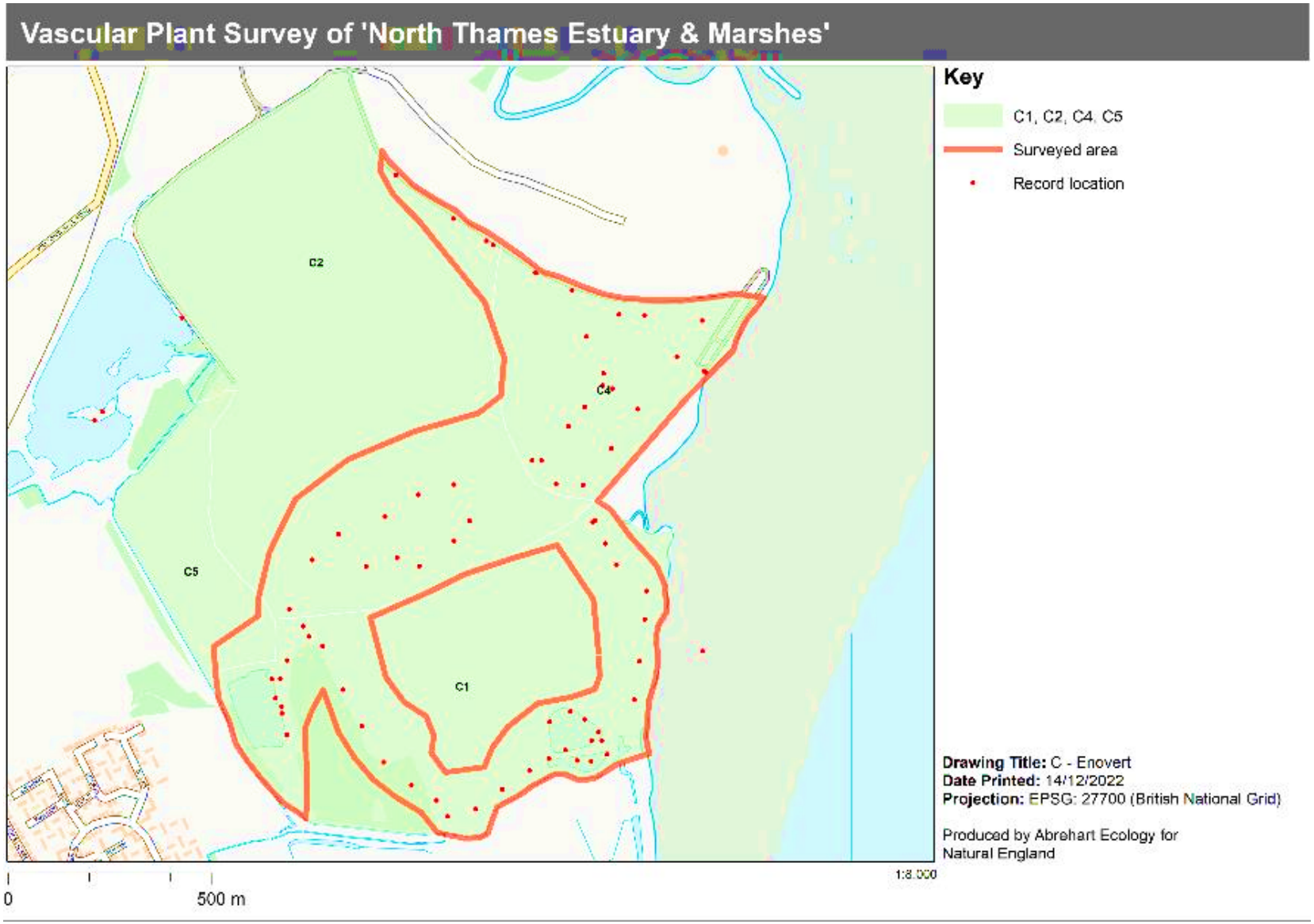
Appendix 4. Areas surveyed within each compartment.



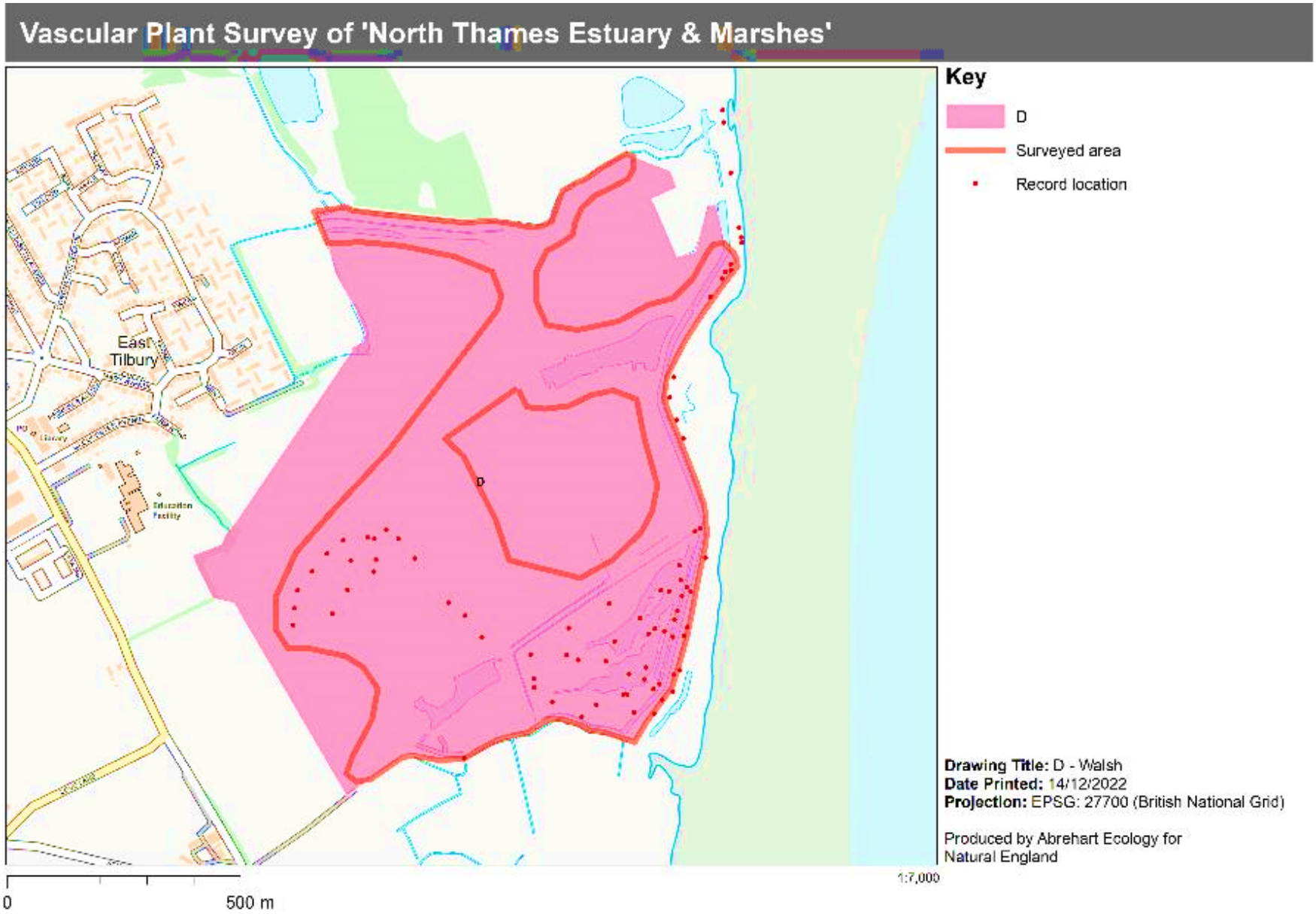
Compartment A: Mucking Wetlands. Contains Ordnance Survey data © Crown copyright and database right 2023



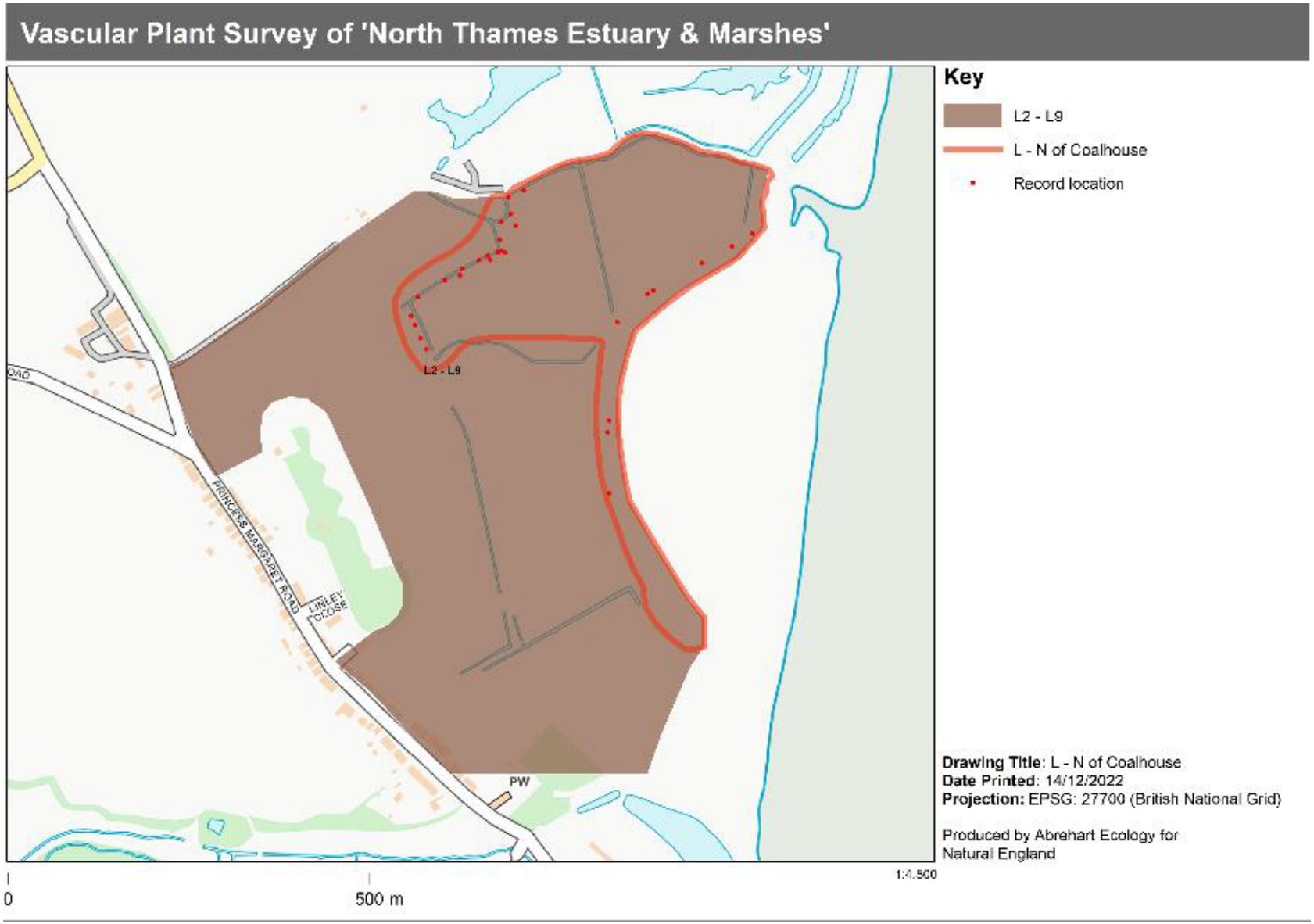
Compartment B: Thameside Nature Discovery Park. Contains Ordnance Survey data © Crown copyright and database right 2023



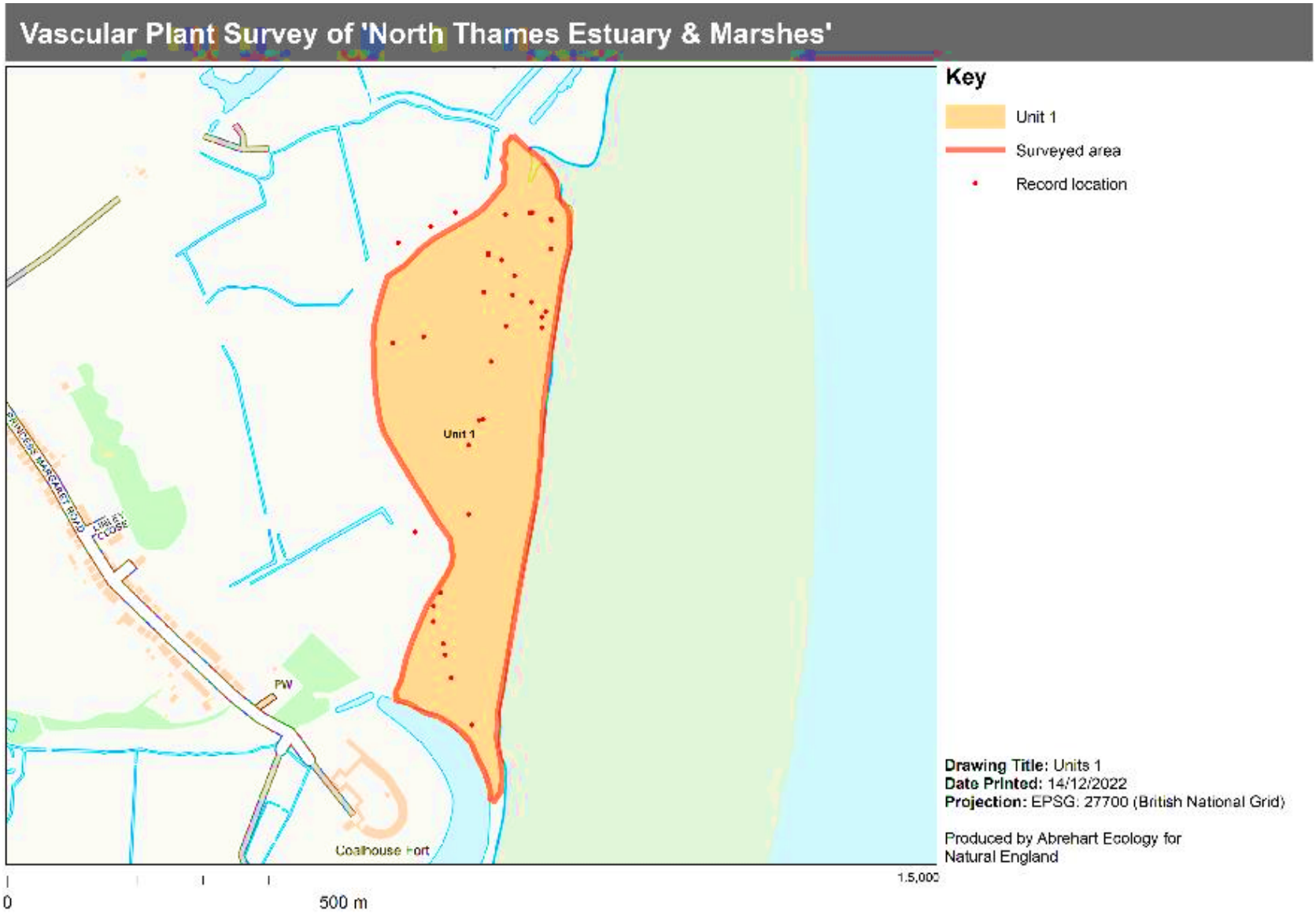
Compartment C: Enovert landfill site. Contains Ordnance Survey data © Crown copyright and database right 2023



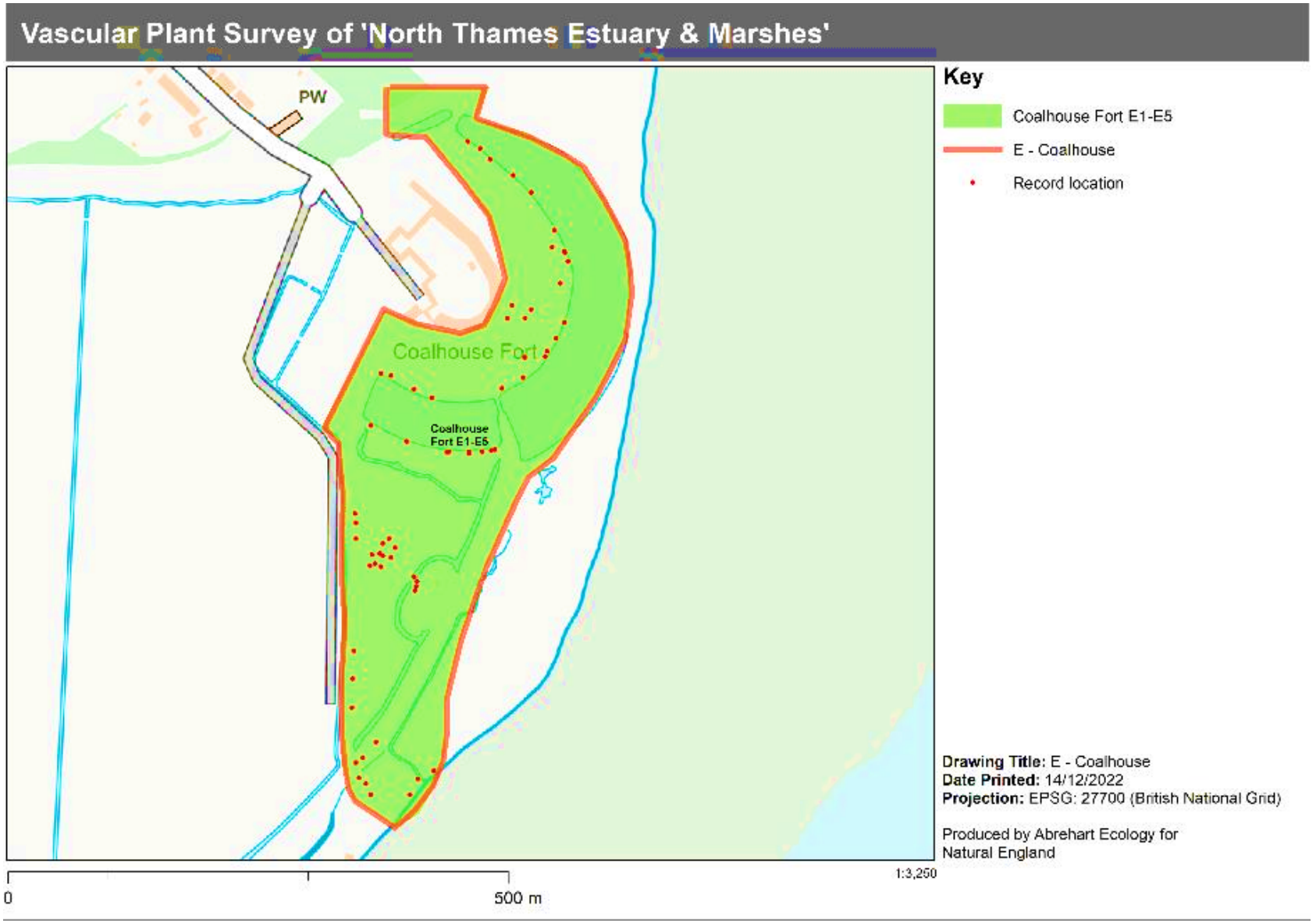
Compartment D: East Tilbury Quarry (Walsh). Contains Ordnance Survey data © Crown copyright and database right 2023



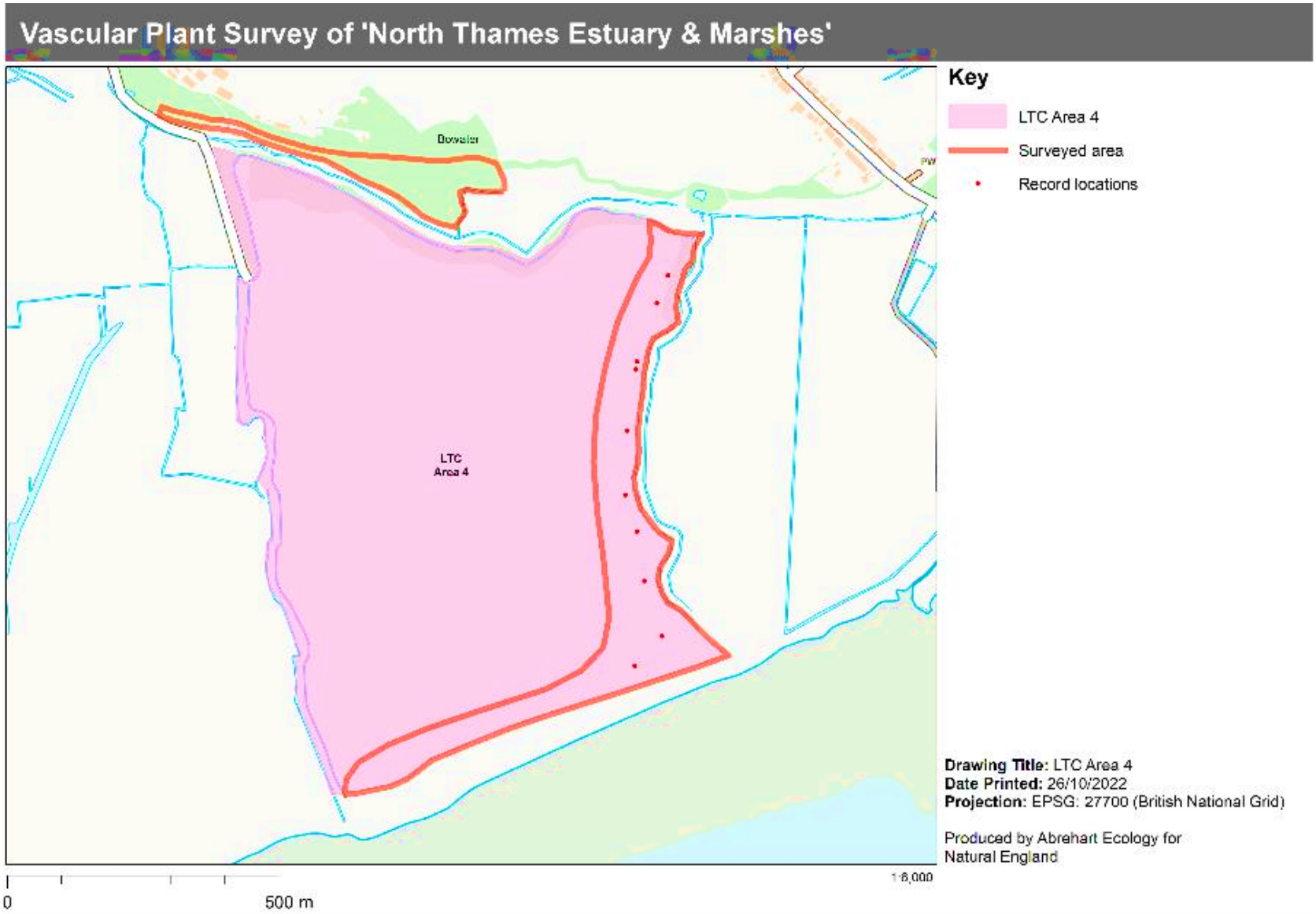
Compartment L: Fields East of Coalhouse Battery. Contains Ordnance Survey data © Crown copyright and database right 2023



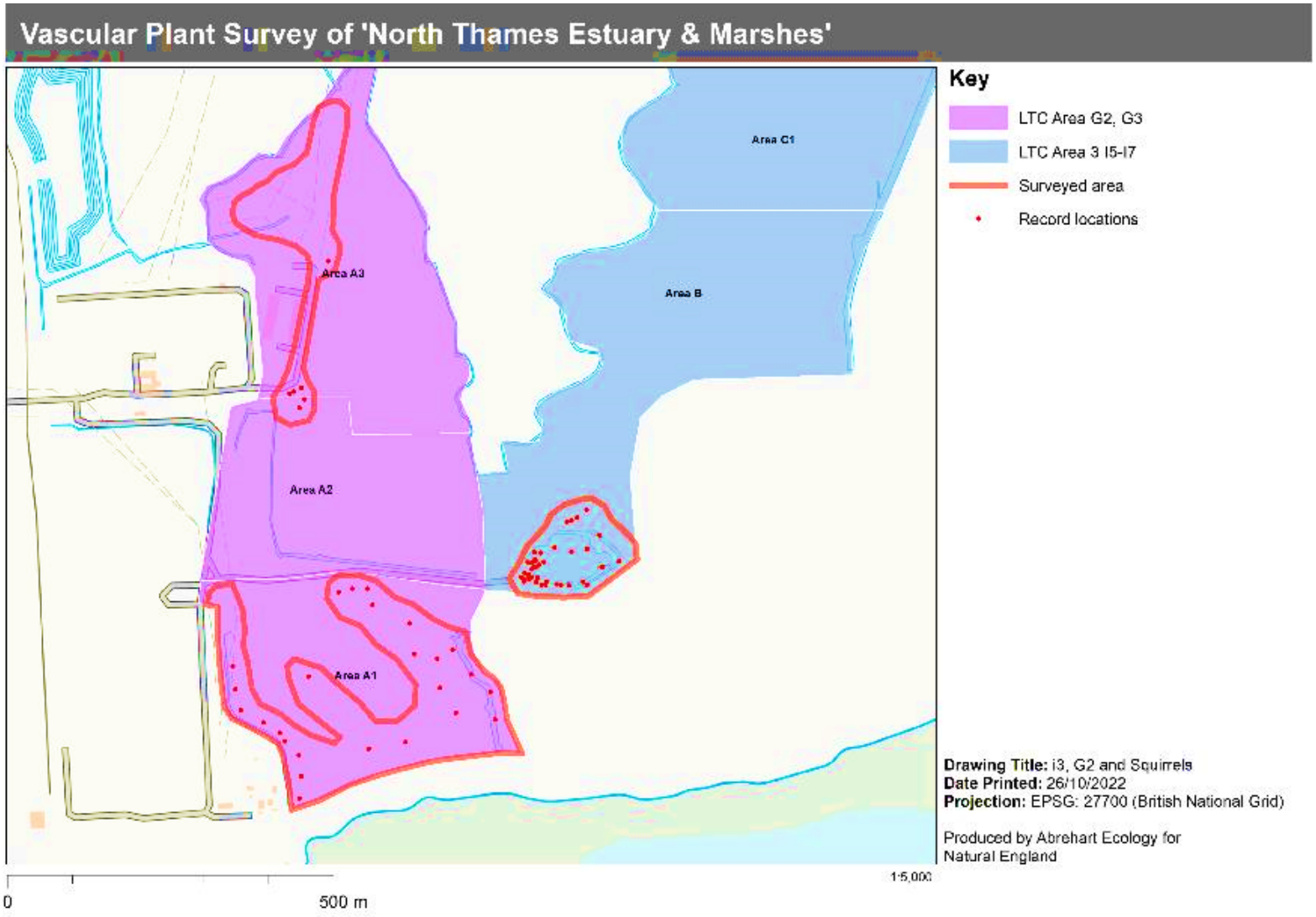
Compartment SSSI Unit 1. Contains Ordnance Survey data © Crown copyright and database right 2023



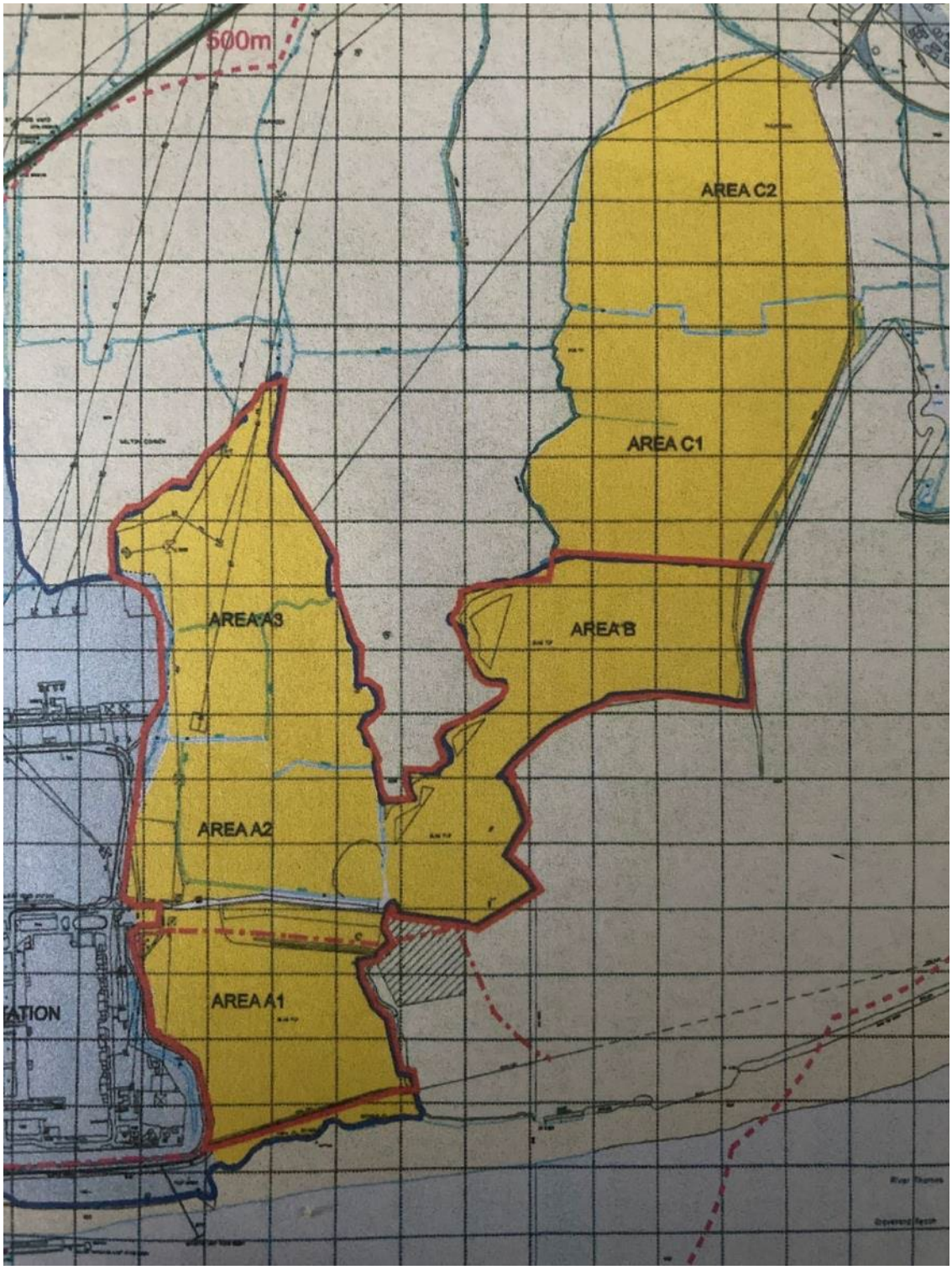
Compartment E: Coalhouse Fort & surrounds. Contains Ordnance Survey data © Crown copyright and database right 2023



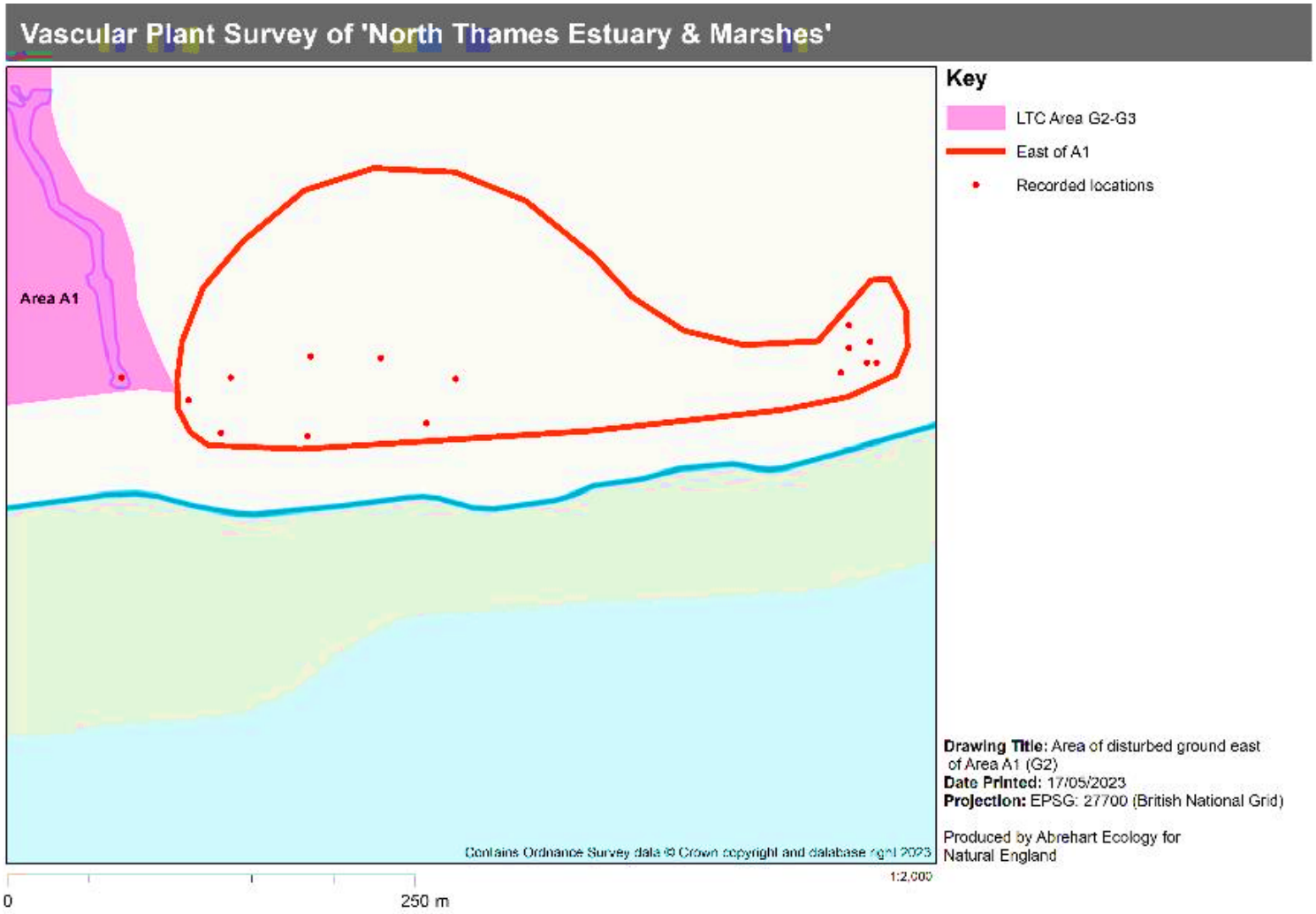
Compartment: LTC Area 4. Contains Ordnance Survey data © Crown copyright and database right 2023



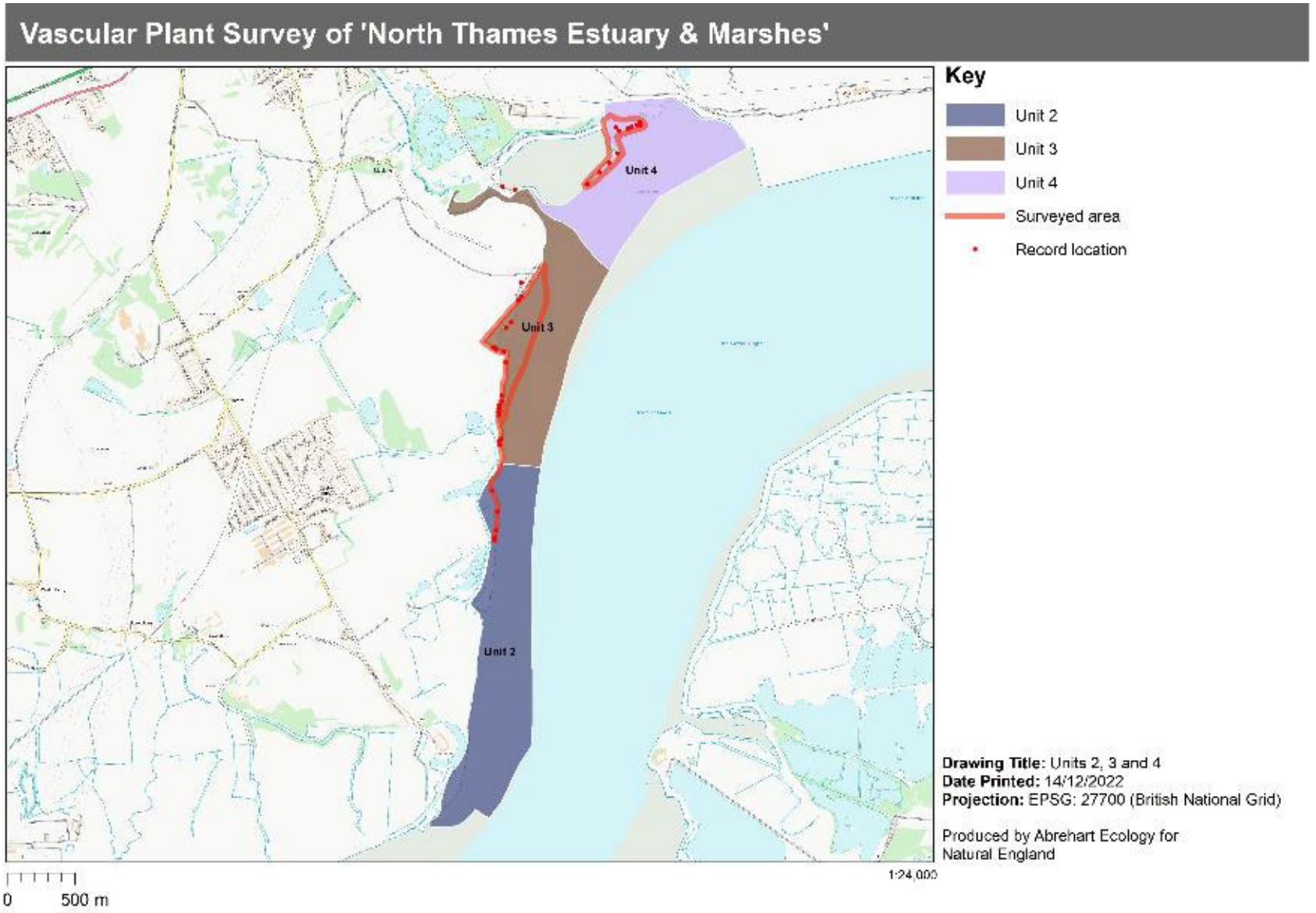
Compartment: Ashfields Complex (Ash. A1, A2, A3 (Squirrel's Head), i3. Contains Ordnance Survey data © Crown copyright and database right 2023



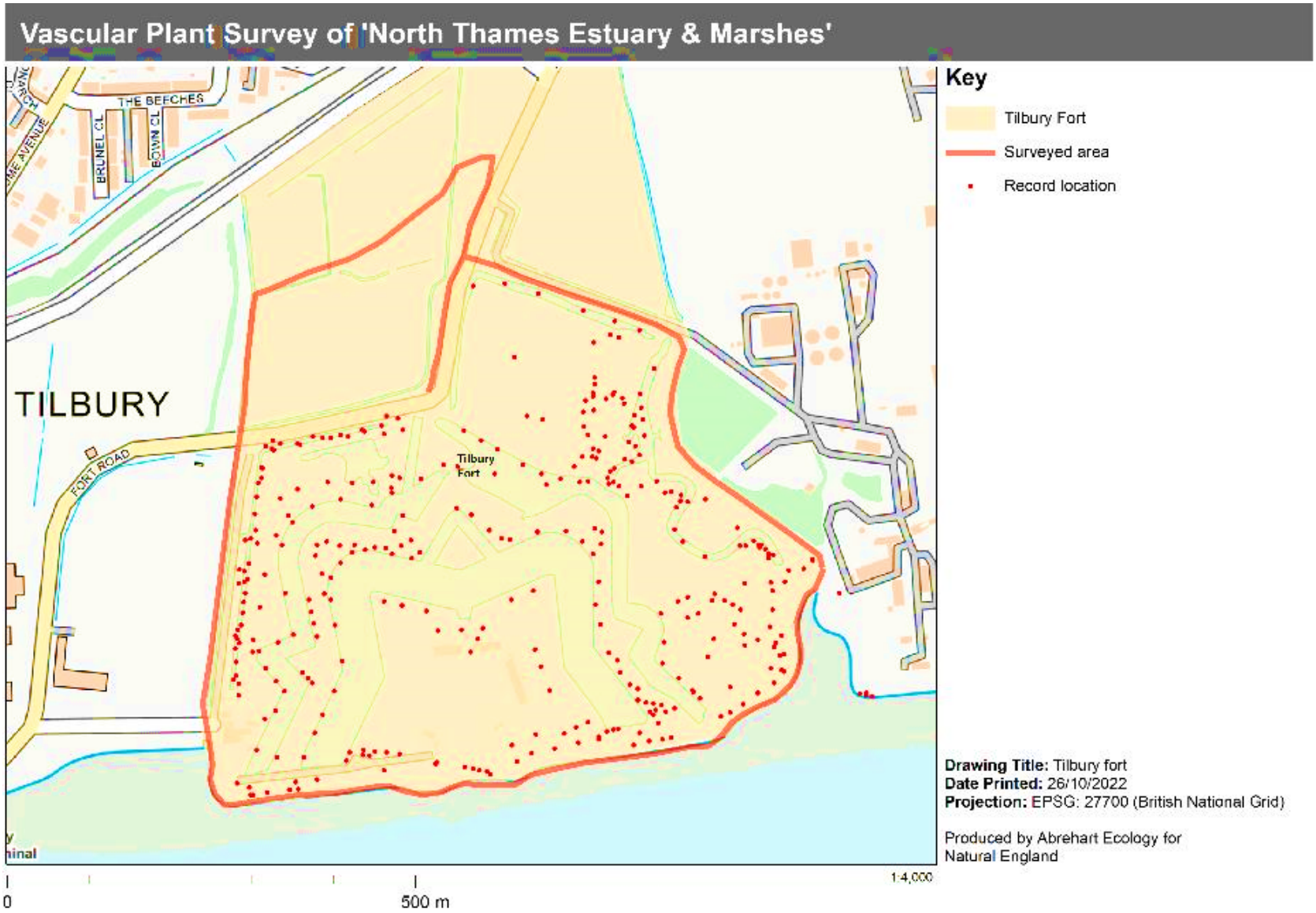
Map of Ashfield's Complex (Area C2, C1, B, A1, A2, A3) © 2007 RWE npower



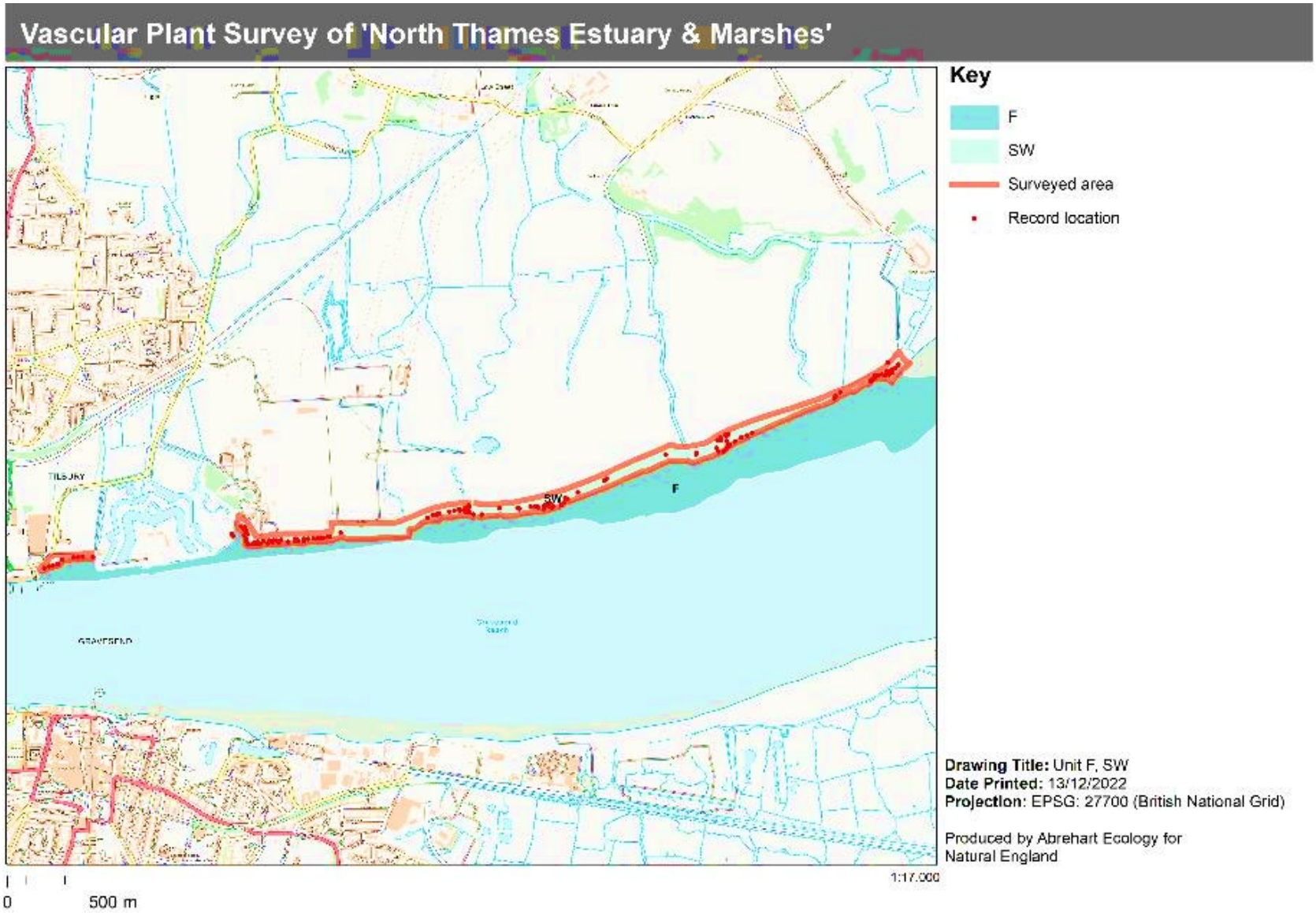
Compartment: East of A1 Contains Ordnance Survey data © Crown copyright and database right 2023



Compartment: SSSI Units 2, 3 and 4. Contains Ordnance Survey data © Crown copyright and database right 2023



Compartment: Tilbury Fort & Marshes. Contains Ordnance Survey data © Crown copyright and database right 2023



Compartment Seawall & Intertidal (SW and F). Contains Ordnance Survey data © Crown copyright and database right 2023

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