4.3 ENVIRONMENTAL SETTING (RECEPTORS)

4.3.1 INTRODUCTION

Information within this section provides an overview of the environmental setting and receptors within 10 km of the Site.

The data on the nature and location of various receptors in the following sections has been sourced from UK government agencies and websites such as Natural England[6], Magic Map Application[7] and the British Geological Survey (BGS)[8].

4.3.2 CDOIF RECEPTORS

The types of receptors considered to be at risk from a MATTE scenario have been identified by the CDOIF guidance. These receptor types are aligned with the original DETR descriptions provided in the original COMAH legislation. The CDOIF guidance [1] expands on the DETR classifications in certain areas, primarily for groundwater, and provides further guidance on the degree of impact which may constitute a range of different MATTE severity level events.

TABLE 4-5 DETR/CDOIF RECEPTOR GROUPINGS

DETR Table Ref.	CDOIF Table Ref.	Receptor Type	Receptor Designation / Description
2	2	Designated Land/Water Sites (Internationally important)	Special Area of Conservation (SAC) Special Protection Area (SPA) Ramsar Site
1	1	Designated Land/Water Sites (Nationally important)	National Nature Reserve (NNR) Site of Special Scientific Interest (SSSI)
3	3	Other designated Land	Areas of Outstanding Natural Beauty (AONB) National Park, etc.
4	4	Scarce Habitat	Biodiversity Action Plan (BAP) habitats Geological features
5a	5	Widespread Habitat - Non-designated Land	Land used for agriculture, forestry
5b	6	Widespread Habitat - Non-designated Water	Water bodies fishing or aquaculture
6	7	Groundwater Source of Drinking Water	Source Protection Zones (SPZ) or interruption of drinking water
6	8	Groundwater – non Drinking Water Source	Aquifers (non-drinking sources), principal and secondary aquifers, depicted by coloured areas on aquifer maps)
6	9	Groundwater in unproductive strata	Groundwater not a pathway to another receptor, depicted by

[6] https://www.natural-england.org.uk/
[7] https://magic.defra.gov.uk/magicmap.aspx (Accessed 18/03/2024)
[8] https://www.bgs.ac.uk/

DETR Table Ref.	CDOIF Table Ref.	Receptor Type	Receptor Designation / Description
			non-coloured areas on aquifer maps Where the groundwater is a pathway for another receptor assess against relevant criteria for the receptor.
7	10	Soil or sediment (i.e. as receptor rather than purely a pathway)	Contamination leading to environmental damage which is not to receptors described previously or which significantly affects the overlying water quality. Environmental damage is considered under the Environmental Liability Directive (ELD).
8	11	Built environment	Grade 1 / Cat A Listed Buildings, scheduled ancient monuments, conservation area, etc.
10	13	Particular species (Note - these criteria apply nationally - i.e. England, Wales, Scotland)	Animal or plant cover which is significant either as a designated species in the designated sites (See above) or as part of a national population but not a reason for a Site designation.
11	14	Marine	Littoral or sub-littoral zone, open sea benthic communities, sea birds and sea mammals
12	15	Fresh and estuarine water habitats	Any non-marine water where there is the potential for an event to cause the deterioration in chemical, biological or physical classification of that water body or where the water is used for drinking and an event could disrupt the supply.

4.3.2.1 INTERNATIONALLY DESIGNATED SITES

Special Protection Areas (SPA)

Mersey Estuary SPA

The Mersey Estuary SPA, located directly east of the Site covers approximately 5,000 ha including large areas of saltmarsh and extensive intertidal sand and mudflats, with limited areas of brackish marsh, rocky shoreline and boulder clay cliffs, within a rural and industrial environment. The intertidal flats and saltmarshes provide feeding and roosting sites for large populations of waterbirds. The site is also important during the spring and autumn migration periods, particularly for wader populations moving along the west coast of Britain.

The SPA is designated under Article 4.1 and Article 4.2 of Directive 79/409/EEC. It hosts over 20,000 waterbirds in the non-breeding season, including great crested grebe (Podiceps cristatus), shelduck (*Tadorna tadorna*), wigeon (*Anas penelope*), teal (*Anas crecca*), pintail

(*Anas acuta*), ringed plover (*Charadrius hiaticula*), golden plover (*Pluvialis apricaria*), grey plover (*Pluvialis squatarola*), lapwing (*Vanellus vanellus*), dunlin (*Calidris alpina alpina*), black-tailed godwit (*Limosa limosa islandica*), curlew (*Numenius arquata*) and redshank (*Tringa tetanus*). It also regularly supports 1% or more of the Great Britain populations of Annex I species Golden plover (*Pluvialis apricaria*), qualifying it under Article 4.1. Additionally, it meets the criteria under Article 4.2 as it hosts 1% or more of the biogeographical populations of regularly occurring migratory species. Some notable non-qualifying species include Bewick's swan (*Cygnus columbianus bewickii*), whooper swan (*Cygnus cygnus*), merlin (*Falco columbarius*), peregrine (*Falco peregrinus*), ruff (*Philomachus pugnax*), bar-tailed godwit (*Limosa lapponica*), and short-eared owl (*Asio flammeus*), occurring in non-breeding numbers of less than European importance (less than 1% of the GB population)[9].

Data from the British Trust for Ornithology (BTO) was unavailable for the Site due to a lack of up-to-date data for the 'Birkenhead Waterfront' and 'New Ferry' intertidal subsections. Instead, a list of designated bird species counts within the Mersey Estuary over a five-year average from 2017/18 to 2021/22 was sourced from the BTO WeBS Report of Wetland Birds[10], and is provided below.

TABLE 4-6 MERSEY SPA DESIGNATED BIRD SPECIES POPULATIONS

SPA Designated Species	5-Year Average Count (2017/18-2021/22)
Dunlin (Calidris alpina alpina)	38,171
Shelduck (Tadorna tadorna)	12,131
Lapwing (Vanellus vanellus)	6,913
Redshank (Tringa tetanus)	4,996
Teal (Anas crecca)	3,140
Black-tailed godwit (Limosa limosa islandica)	3,024
Golden plover (Pluvialis apricaria)	1,881
Curlew (Numenius Arquata)	1,306
Wigeon (Anas penelope)	1,192
Ringed plover (Charadrius hiaticula)	810
Grey Plover (Pluvialis squatarola)	354
Pintail (Anas acuta)	193
Great crested grebe (Podiceps cristatus)	47

Mersey Narrows & North Wirral Foreshore SPA

Mersey Narrows & North Wirral Foreshore SPA, at its nearest point is located approximately 3 km north of the Site on the Birkenhead waterfront. The SPA occupies an approximate area of 2,000 ha and comprises intertidal habitats at Egremont foreshore, man-made lagoons at Seaforth Nature Reserve and extensive intertidal mudflats at North Wirral Foreshore. Egremont is important as a feeding habitat for waders at low tide whilst Seaforth is primarily a high-tide

[9] https://publications.naturalengland.org.uk/file/6485318211469312 (Accessed 18/03/2024)
[10] https://app.bto.org/webs-reporting/numbers.jsp (Accessed 18/03/2024)

roost site, as well as a nesting site for terns. North Wirral Foreshore supports large numbers of feeding waders at low tide and includes important high-tide roost sites. The most notable feature of the site is the high density of wintering turnstone.

The site qualifies under Article 4.1 and 4.2 of Directive 2009/147/EC. It hosts 1% or more of the Great Britain populations of Annex I species Bar-tailed Godwit *(Limosa lapponica*) and Common Tern (*Sterna hirundo*), as well as 1% or more of the biogeographical populations of Knot (*Calidris canutus islandica*). Additionally, it supports over 20,000 waterbirds, with 32,366 individuals recorded in the non-breeding season (5 year peak mean 2004/05 - 2008/09), including Cormorant (*Phalacrocorax carbo*), Oystercatcher (*Haematopus ostralegus*), Grey Plover (*Pluvialis squatarola*), Sanderling (*Calidris alba*), Dunlin (*Calidris alpina alpina*), Bar-tailed Godwit (*Limosa lapponica*), and Redshank (*Tringa tetanus*)[11].

Dee Estuary SPA

The Dee Estuary SPA is located approximately 9.5 km west of the Site. The designated site occupies an approximate area of 14,300 ha and comprises the marine areas of the Dee Estuary SPA and Dee Estuary / Aber Dyfrdwy SAC. Lying on the boundary between England and Wales, the estuary is a large, funnel shaped, sheltered estuary that supports extensive areas of intertidal sandflats, mudflats, and saltmarsh. The site is of major importance for waterbirds. During the winter, the intertidal flats and saltmarshes provide feeding and roosting sites for large populations of ducks and waders[12].

Special Areas of Conservation (SAC)

Dee Estuary SAC

Dee Estuary SAC it located approximately 7 km north of the Site at its closest point along the mouth of the Mersey Estuary. The SAC occupies an approximate area of 15,800 ha and has been designated as a SAC because it hosts the following habitats: mudflats and sandflats not covered by seawater at low tide, Salicornia and other annuals colonising mud and sand, Atlantic salt meadows (*Glauco Puccinellietalia maritimae*), estuaries, annual vegetation of drift lines, vegetated sea cliffs of the Atlantic and Baltic coasts, embryonic shifting dunes, shifting dunes along the shoreline, fixed dunes with herbaceous vegetation and humid dune slacks. The site also supports sea lampreys (*Petromyzon marinus*), river lampreys (*Lampetra fluviatilis*) and petalwort (*Petalophyllum ralfsii*)[13].

Ramsar Sites

Mersey Estuary Ramsar

The Mersey Estuary Ramsar area, situated directly east of the Site, covers approximately 5,000 ha and is designated as Ramsar site number 785. It encompasses the Mersey Estuary SPA and SSSI, featuring large areas of saltmarsh, intertidal sand and mudflats, brackish marsh, rocky shoreline, and cliffs within both rural and industrial settings. Notably, the site hosts internationally significant numbers of various waterbird species, including Ringed Plover (*Charadrius hiaticula*). Human activities such as livestock grazing, hunting, and industrial operations are present. The estuary provides crucial feeding and roosting sites for large

[11] https://publications.naturalengland.org.uk/file/5360161602404352 (Accessed 18/03/2024)
[12] https://publications.naturalengland.org.uk/file/6220652663013376 (Accessed 18/03/2024)
[13] https://sac.jncc.gov.uk/site/UK0030131 (Accessed 18/03/2024)

waterfowl populations, with saltmarsh grazing by sheep and cattle contributing to habitat diversity. Some areas along the northern shoreline consist of boulder clay cliffs with transitional zones featuring *Phragmites australis*. Detailed information on internationally important bird assemblages and species populations is provided in the Mersey SPA section above.

Mersey Narrows & North Wirral Foreshore Ramsar

Mersey Narrows & North Wirral Foreshore Ramsar, at its nearest point is located approximately 3 km north of the Site on the Birkenhead waterfront and is designated as Ramsar site number 2202. The site occupies an approximate area of approximately 2,000 ha and surrounds the top of the Wirral Peninsula, with North Wirral Foreshore running along the northern edge and Mersey Narrows to the east, spanning both sides of the Mersey.

The site comprises intertidal habitats at Egremont foreshore on the south bank, man-made saline and freshwater lagoons at Seaforth on the north bank, and extensive intertidal mudflats at North Wirral Foreshore. Egremont is crucial as a feeding habitat for waders during low tide, while Seaforth serves primarily as a high tide roost site. These areas, separated by approximately 2 km, experience a constant exchange of bird populations. North Wirral Foreshore sustains large numbers of feeding waders during low tide and features important high tide roost sites, consisting of intertidal sands, mudflats, and embryonic saltmarsh.

The site qualifies under Ramsar Criterion 4 because it regularly supports species at critical stages in their life cycles, under Criterion 5 due supporting 20,000 or more waterbirds, and under Criterion 6 by hosting 1% of the individuals in the populations of the *islandica* and *lapponica* subspecies[14]. Detailed information on internationally significant bird assemblages and species populations can be found in the Mersey Narrows & North Wirral Foreshore SPA section above.

Dee Estuary Ramsar

The Dee Estuary Ramsar site spans approximately 14,300 hectares and is situated around 9.5 km west of The Site. This large, sheltered estuary serves as a vital habitat for wintering and migratory waterfowl populations. Notably, it hosts internationally significant numbers of waterfowl and waders. The estuary plays a crucial role in shoreline stabilisation, sediment trapping, and water supply. It features extensive intertidal sand and mudflats, saltmarsh areas, and several notable habitats such as the sandstone islands of Hilbre with their cliff vegetation, maritime heathland/grassland, sand dune systems, and coastal fields historically reclaimed from the estuary.

Additionally, the Dee Estuary Ramsar site includes freshwater lagoons and reedbeds at Shotton, which support the largest common tern breeding colony in Wales, as well as freshwater lagoons at Inner Marsh Farm utilised by waterfowl year-round, particularly in winter. Under Ramsar Criterion 2, the site supports breeding colonies of the vulnerable Natterjack Toad (*Epidalea calamita*). For Criterion 5, it regularly hosts 120,726 individual waterbirds (5 year peak mean 1994/5 – 1998/9) during the non-breeding season. Moreover, Criterion 6 is met by the presence of species / populations occurring at levels of international

[14] https://rsis.ramsar.org/ris/2202 (Accessed 18/03/2024)

importance, such as Redshank (*Tringa tetanus*) and Teal (*Anas crecca*). The Ramsar site number is 298[15].

4.3.2.2 NATIONALLY IMPORTANT DESIGNATED SITES

Sites of Special Scientific Interest (SSSI)

New Ferry SSSI

New Ferry SSSI is situated within the Mersey Estuary, south of Birkenhead on the Wirral Peninsula, with the Site forming its northern boundary and the Bromborough Landfill site to the south. This natural embayment spans approximately 74 ha and features intertidal sand and mudflats interspersed with shingle and cobbles.

The SSSI overlaps with designations such as the Mersey SPA and Ramsar. Throughout the winter, New Ferry hosts nationally important populations of pintail and black-tailed godwit, which rely on the rich invertebrate fauna of the intertidal mudflats. These mudflats are exposed for a significant part of the tidal cycle, providing important feeding opportunities, making New Ferry primarily a low water feeding site.

Towards the southern end of the SSSI, there's an area of pioneer saltmarsh dominated by common cordgrass (*Spartina anglica*), with glasswort (*Salicornia* sp.) and sea aster (*Aster tripolium*) present. Adjacent sandy shingle areas feature sea milkworth (*Glaux maritime*) and sand couch (*Elymus farctus*). Populations of redshank are significant, almost reaching nationally important levels within the area[16].

The SSSI consists of approximately 68 ha of littoral sediment, with Natural England assessing its condition as 'Unfavourable – Recovering.' This designation is due to the decline in Pintail numbers by more than 50% compared to levels at the time of designation. According to Natural England, 'Unfavourable recovering' indicates that while the units/features are not fully conserved, all necessary management mechanisms are in place. However, at least one of the designated feature's mandatory attributes is not meeting its targets. With sustained recovery efforts, the unit/feature is expected to reach a favourable condition over time'.

Mersey Estuary SSSI

The Mersey Estuary SSSI, located approximately 2.5 km to the south, covers an area of approximately 6,700 ha. It is internationally significant for wildfowl, characterised by vast intertidal sand and mudflats, reclaimed marshland, saltmarshes, brackish marshes, and boulder clay cliffs with freshwater seepages. The Manchester Ship Canal delineates part of the southern boundary, separating pools from the main estuary, which serve as important roosting sites for wildfowl and waders during high tide. Throughout winter, the estuary hosts large numbers of these birds.

The site features several areas of saltmarsh, important for bird feeding and roosting. Glasswort (*Salicornia* spp.) is widespread on outer margins, while sea poa (*Puccinellia maritima*) dominates other areas. Stanlow Banks, unlike other saltmarshes, hasn't been grazed, resulting in a more diverse flora, including sea aster (*Aster tripolium*), hastate orache (*Atriplex prostrata*), sea plantain (*Plantago maritima*), annual seablite (*Suaeda maritima*), and scurvy-grass (*Cochlearia* spp.). Some areas transition into brackish marsh dominated by common reed

[15] https://rsis.ramsar.org/ris/298 (Accessed 18/03/2024)
[16] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s2000435 (Accessed 18/03/2024)

(*Phragmites australis*), with sea arrow-grass (*Triglochin maritima*) and great reedmace (*Typha latifolia*) present in parts. On the sandy foreshore, sea sandwort (*Honkenya peploides*) occurs alongside sea milkwort (*Glaux maritima*), while mud rush (*Juncus gerardi*), sand sedge (*Carex arenaria*), and curled dock (*Rumex crispus*) are found along the strand line[17].

The nearest and largest SSSI units to the Site include the littoral sediment deposits Mersey North Bank and Bromborough, Eastham & Ellesmere Port, with Natural England assessing their conditions as 'Unfavourable – Recovering' and 'Favourable,' respectively.

Designations for this SSSI is also covered under Mersey Estuary SPA / Ramsar section above.

Mersey Narrows SSSI

The Mersey Narrows, situated at the mouth of the Mersey Estuary, encompasses Seaforth on the north bank and Egremont Foreshore on the south and occupies an approximate area of 116 ha. Egremont Foreshore, located approximately 3.1 km north of the Site, is vital as a feeding site during low tide, while Seaforth serves as a crucial high tide roost site, especially during high spring tides when rocky shores and man-made structures near feeding areas are submerged.

Egremont, situated on the western bank of the river Mersey north of Birkenhead, extends to the south of Seacombe Ferry, with large areas of sand and mudflats dominating most of its length. However, sandflats become predominant in the northernmost section around Perch Rock, with naturally shelving sandstone outcrops occurring in this area. In contrast, the central and southern sections are composed of boulder clay debris and rubble, supporting dense populations of mussels, barnacles, ragworms, and other invertebrates. This section comprises approximately 25 hectares of littoral sediment assessed by Natural England as having 'Favourable' conditions[18].

Seaforth, located north of the Royal Seaforth Dock on reclaimed land from the sea, includes a complex of open water, saltmarsh, and grasslands, featuring two lagoons.

Designations for this SSSI is also covered under Mersey Narrows & North Wirral Foreshore SPA / Ramsar.

Dibbinsdale SSSI

Dibbinsdale SSSI is located approximately 4.1 km south of the Site, adjacent to the town of Bromborough. The SSSI spans an approximate area of 55 ha along Dibbinsdale Brook with a small area along Clatter Brook. The underlying rocks are Triassic Sandstones of the Sherwood Sandstone Group with dry acidic brown earth soils on the upper slopes and wetter base-rich alluvial soils at the base of the slope.

The main habitats included are semi-natural broad-leaved woodland, which covers most of the site, reed swamp, fen pasture and neutral grassland. This is the largest block of semi-natural woodland of its type in Merseyside and it contains typical examples of ash-wych elm and valley alder woodland, each of which supports a rich flora and fauna. The reed swamp is extensive in places along the stream and dominated by common reed. Other species include reed canary grass, great horsetail (*Equisetum telmateia*), yellow iris, water pepper Polygonum hydropiper

[17] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1001398 (Accessed 18/03/2024)
[18] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s2000436 (Accessed 18/03/2024)

and celery-leaved buttercup (*Ranunculus sceleratus*). Dibbinsdale is significant for its bird population, with 61 species regularly breeding, including tawny owl, kingfisher, green woodpecker, great spotted woodpecker, nuthatch, tree creeper, willow tit, and grasshopper warbler. The area also boasts a rich invertebrate fauna, particularly molluscs associated with the calcareous springs.

The fen pasture is characterised by wood small reed (*Calamagrostis epigejos*), floating sweet grass, creeping bent, common nettle, meadowsweet, soft rush and Indian balsam[19].

North Wirral Foreshore SSSI

North Wirral Foreshore SSSI is located approximately 7.4 km north of the Site between the outer Dee and Mersey Estuaries. The SSSI occupies an approximate area of 2110 ha and comprises of intertidal sand and mudflats and embryonic saltmarsh which is of considerable importance as a feeding and roosting site for passage and wintering flocks of waders, wildfowl, terns and gulls. The embryonic mixed saltmarsh is formed principally from common saltmarsh-grass (*Puccinellia maritima)* and glasswort (*Salicornia europaea*), together with some common cordgrass (*Spartina anglica*). Small populations of wildfowl, including common scoter, scaup and goldeneye, red-throated diver and great crested grebe also frequently winter on this site[20].

Designations for this SSSI is also covered under Mersey Narrows & North Wirral Foreshore SPA / Ramsar.

Thurstaston Common SSSI

Thurstaston Common SSSI is located approximately 8.3 km west of the Site and oocupies an approximate area of 70 ha. The SSSI hosts podzolic soils which support characteristic heathland vegetation including wet heath, dry heath, acidic marshy grassland and birch-oak woodland.

The majority of the heath is dominated by heather Calluna vulgaris with bilberry, wavy hair-grass, gorse, heath grass (*Danthonia decumbens*), tormentil, hairy sedge (*Carex hirta*), pill sedge (*Carex pilulifera*) and heather bedstraw also commonly found. This dry heath community grades into an assemblage of bell heather Erica cinerea and western gorse (*Ulex gallii*) in the driest areas of the heathland. Wet heath and acidic marshy grassland occurs in damp peaty hollows. The wet heath is characterised by cross-leaved heath (*Erica tetralix*) and the acidic marshy grassland is dominated by purple moor-grass with hard rush, soft rush and heath rush.

Thurstaston Common provides an important habitat for passage, wintering and breeding birds. Sparrowhawk, tawny owl, great spotted woodpecker, lesser spotted woodpecker, jay, redpoll and linnet are amongst the birds known to regularly breed on the site[21].

Heswall Dales SSSI

The Heswall Dales SSSI, situated approximately 8.8 km west of the Site occupies an approximate area of 30 ha. The site is underlain by Triassic sandstone over which podsolic soils have developed and consists of a number of small deep water worn valleys. These soils support a fine representative dry heathland community which has been invaded by bracken,

[19] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1002884 (Accessed 18/03/2024)
[20] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1003676 (Accessed 18/03/2024)
[21] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1003730 (Accessed 26/09/2024)

birch-oak woodland and gorse scrub. Damp heath and acidic marshy grassland has developed along some of the natural water courses.

The majority of the dry heath is dominated by heather (*Calluna vulgaris*) with wavy hair-grass, mat-grass, gorse (*Ulex europaeus*) and bilberry also important components of this community. The wetter areas are dominated by purple moor-grass with cross-leaved heath (*Erica tetralix*), sharp-flowered rush, bulbous rush, soft rush and deer grass (*Trichophorum cespitosum*). Common cotton-grass (*Eriophorum angustifolium*) and tawny sedge (*Carex hostiana*) are also important constituents of this community.

Heswall Dales is regarded as the second best example of lowland heath in Merseyside. It is ranked second to Thurstaston Common which is larger and botanically more diverse[22].

The Dungeon SSSI

The Dungeon SSSI, situated approximately 8.8 km west of the Site, spans about 1 hectare and is designated for its geological significance. It comprises a small, wooded ravine near Heswall, featuring a natural stream section through the Tarporley Siltstone Formation of the Triassic-aged Mercia Mudstone Group. At the southwest end, a faulted contact with the older Wilmslow Sandstone Formation is visible. The Tarporley Siltstone section consists of red fine sandstones and siltstones with parallel and rippled bedding, along with salt pseudomorphs. Sedimentary structures suggest deposition in a marine intertidal environment[23].

Meols Meadows SSSI

Meols Meadows SSSI, located approximately 9.1 km northwest of the Site near Moreton, spans an area of about 8 hectares. It extends continuously with the northern boundary of the West Kirby–Bidston railway line, between Arrowe Brook and River Birkett.

The primary habitat consists of damp, unimproved neutral grassland, with level fields separated by ditches containing tall fen vegetation. This site represents the best example of the crested dog's-tail–common knapweed type of grassland in Greater Manchester and Merseyside. It features dominant grass species like red fescue, common bent, and sweet vernal-grass, along with betony, cowslip, pepper saxifrage, green-winged orchid, and dyer's greenweed. Several species present in the meadows are rare in Merseyside, including greater pond sedge, meadow barley, green-winged orchid, cowslip, and pepper saxifrage. Other species of restricted occurrence in the region include quaking grass, yellow oatgrass, meadow cranesbill, dyer's greenweed, and adder's-tongue. Additionally, a locally rare saltmarsh money spider (*Minirialoides trifons*), is also found in the area[24].

Dee Cliffs SSSI

Dee Cliffs, situated roughly 10 km west of the Site, covers an area of approximately 14 hectares. It represents the prime example of clay cliff and bank habitat in Merseyside, along with marl pits hosting diverse flora and fauna, and an area of herb-rich neutral grassland.

[22] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1002996 (Accessed 26/09/2024)
[23] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1002901 (Accessed 26/09/2024)
[24] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1002718 (Accessed 26/09/2024)

The clay cliffs support an open grassland community primarily dominated by red fescue (*Festuca rubra*). The marl pits feature aquatic vegetation, emergent vegetation, marshy grassland, and willow carr, contributing to the site's ecological diversity [25].

Dee Estuary SSSI

Dee Estuary SSSI is located approximately 9.5 km west of the Site and occupies an approximate area of 4,760 ha. Dee Estuary is notably significant for its internationally important wintering waterfowl populations, along with individual waterfowl and tern species reaching national and sometimes international importance levels. Its diverse habitats include intertidal mud and sandflats, saltmarshes, and transitional areas. The area also features hard rocky sandstone cliffs on Hilbre Island and Middle Eye, characterised by cliff vegetation and maritime heathland and grassland. Additionally, it hosts a variety of nationally scarce plant species and populations of the sandhill rustic moth (*Luperina nickerlii gueneei*), a Red Data Book species[26]. The designations for this site are covered under Dee Estuary SPA / SAC / Ramsar sections discussed above.

National Nature Reserves (NNR)

There are no National Nature Reserves (NNR) located within a 10 km radius of the Site.

Marine Conservation Zones and Marine Nature Reserves

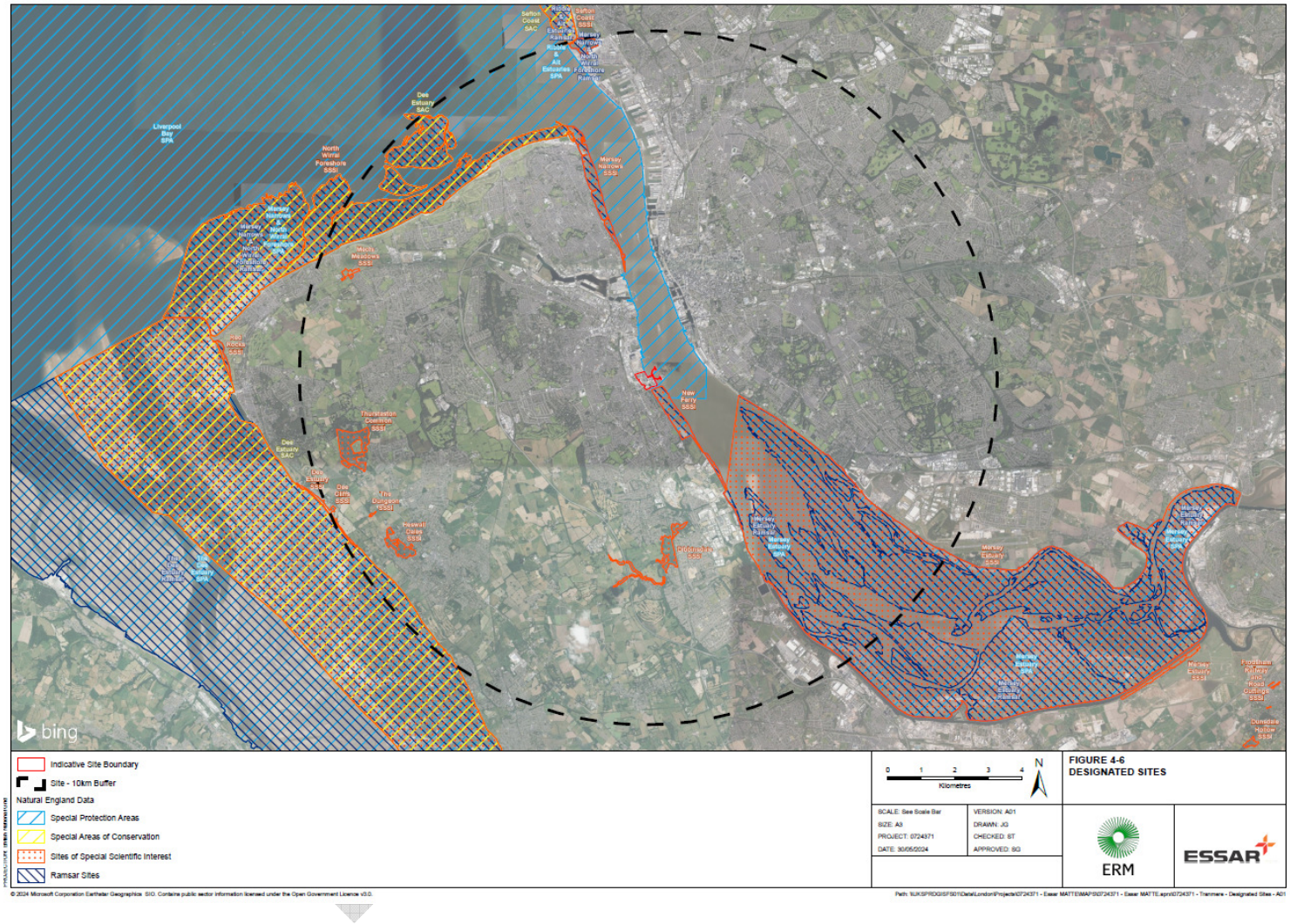
Marine Components of Mersey Narrows and North Wirral Foreshore SPA and Dee Estuary / Aber Dyfrdwy SAC are considered to be covered under the respective SPA / SAC / Ramsar designations.

The Liverpool Bay Special Protection Area is located directly east of the Site and encompasses the marine component of the Mersey SPA / Ramsar designation.

There are no Marine Conservation Zones (MCZ) located within 10 km from the Site.

[25] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1002872 (Accessed 26/09/2024)
[26] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1000595 (Accessed 26/09/2024)

FIGURE 4-6 DESIGNATED SITES



4.3.2.3 OTHER DESIGNATED LAND

Country Parks

Natural England's Country Park open data map viewer[27] identifies five country parks within a 10 km radius of the Site, as shown in Figure 4-7. The closest park to the Site is Bidston Hill Country Park located approximately 4 km northwest. It consists of approximately 50 ha of heathland and woodland with historic buildings and ancient rock carvings. Other notable country parks identified along with their featured are as follows:

- Eastham Woods – located approximately 5 km south of the Site, situated along the banks of the Mersey Estuary. This park is characterised by its broad-leaved woodland, providing a habitat for diverse wildlife and hosting several locally significant mature trees.
- Arrowe Country Park – located approximately 6 km west of the Site and consist of approximately 100 ha of open parkland, ponds and deciduous woodland in the centre of the Wirral Peninsula.
- North Wirral Coastal Country Park – located approximately 7 km north of the Site along the notheran coast of Wirral Peninsula. It comprises of open land, natural foreshore areas, beaches and sand dunes.
- Royden Country Park - located approximately 8 km west of the Site adjacent to Thurstaston Common SSSI. The park comprises of deciduous and conifer woodlands, meadows and heathland habitats.

Ancient Woodland

A total of 17 areas of ancient woodlands were located within 10 km of the Site, and these are shown in Figure 4-7.

The nearest ancient woodland areas potentially considered to be at risk from a MAS are:

- Railway Wood, Patricks Wood, Marsfords Wood, and Footpath Wood – Multiple small patches of woodlands approximately 25 ha in area located approximately 4 km south of the Site. The woodlands are classified as 'Ancient Semi-Natural Woodland'.
- Fulwood Wood – A small patch of woodland of approximately 4 ha located approximately 4 km south-east of the Site, on the eastern banks of the Mersey Estuary. The woodland area is classified as 'Ancient Semi-Natural Woodland'.

Local Nature Reserves (LNR)

Figure 4-7 shows there are six LNRs identified within 10 km of the Site, the closest of which is Dibbinsdale LNR located approximately 4 km to the south of the Site. the LNR comprise of ancient woodlands (Railway Wood, Patricks Wood, Marsfords Wood, and Footpath Wood), meadows, reed swamp, parkland and amenity grasslands. other notable LNRs are described as follows:

- Biston Moss LNR is located approximately 4 km northwest of the Site.
- Allerton LNR and Childwall Woods LNR is located on the eastern bank of Mersey Estuary, at a distance of 8 km southeast and east of the Site, respectively. These reserves encompass habitats such as neutral grasslands and broadleaf woodlands.

[27] https://naturalengland-defra.opendata.arcgis.com/datasets/a11befa8e6dc4227a7082d81bb1ddbdb (Accessed 18/03/2024)

- Heswall Dales LNR and Thurstaston Common LNR is located approximately ~8.8 km and 8 km west of the Site, respectively. The designations of these LNRs are considered to be covered under Heswall Dales SSSI and Thurstaston Common SSSI as discussed in section 4.3.2.2.

RSPB Reserves

The nearest RSPB Reserve next to the Site is a portion of the Mersey Estuary with an approximate area of 1,500 ha located approximately 6.5 km south of the Site. The RSPB Reserve extends from the mouth of Eastham Channel to Ince Banks adjacent to Stanlow Refinery and covers extensive areas of intertidal mudflats. The Dee Estuary RSPB Reserve is located approximately 9.5 km west of the Site and encompasses large areas of estuarine waters and habitats. Sensitive bird species found within these reserves are considered to be covered under the respective SPA / Ramsar / SAC designation within Mersey and Dee estuary.

Areas of Outstanding Natural Beauty (AONB)

There are no AONB identified within 10 km of the Site.

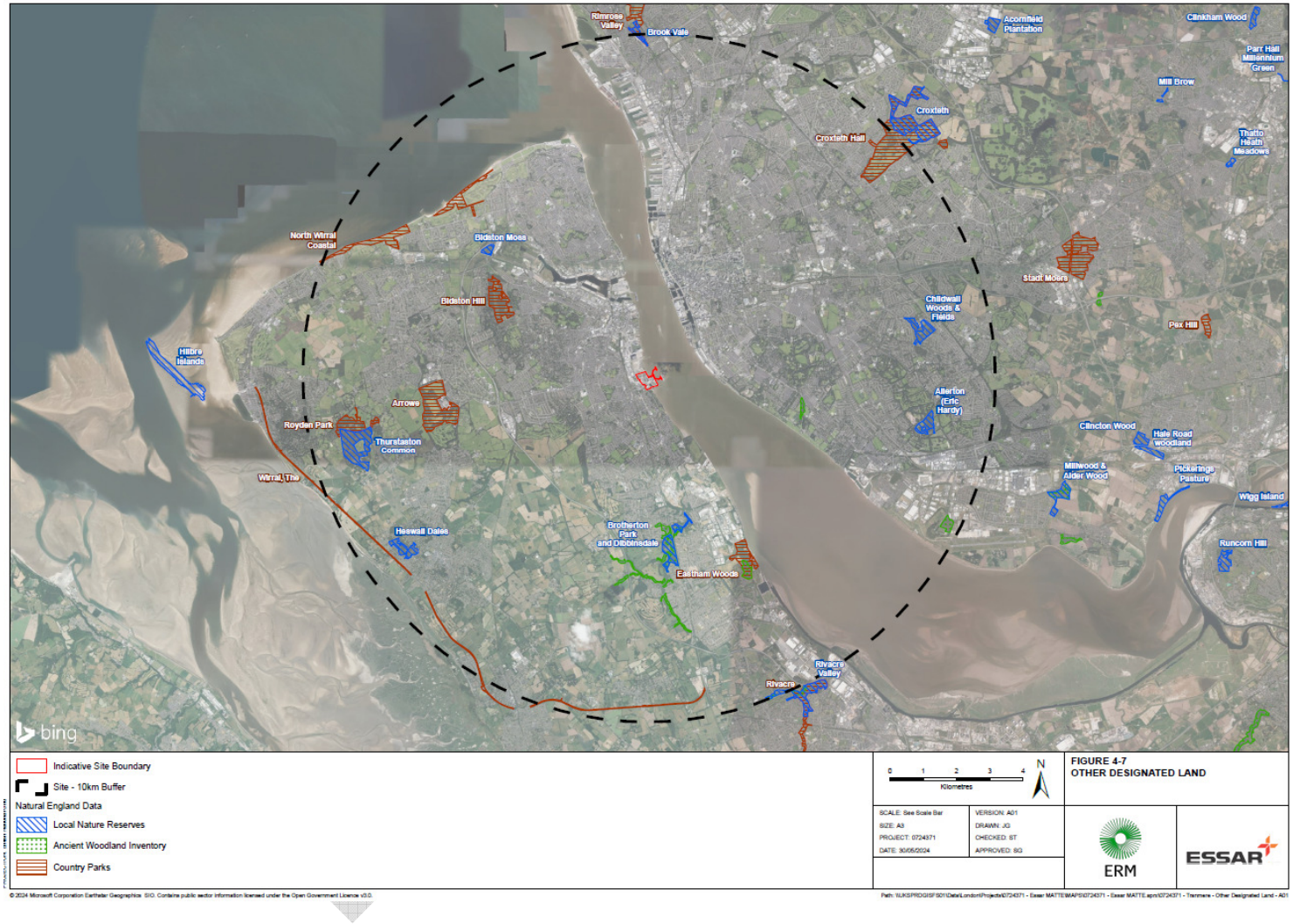
National Parks

There are no National Parks identified within 10 km of the Site.

Heritage Coast

There are no heritage coast areas identified within 10km of the site.

FIGURE 4-7 OTHER DESIGNATED LAND



4.3.2.4 SCARCE HABITATS

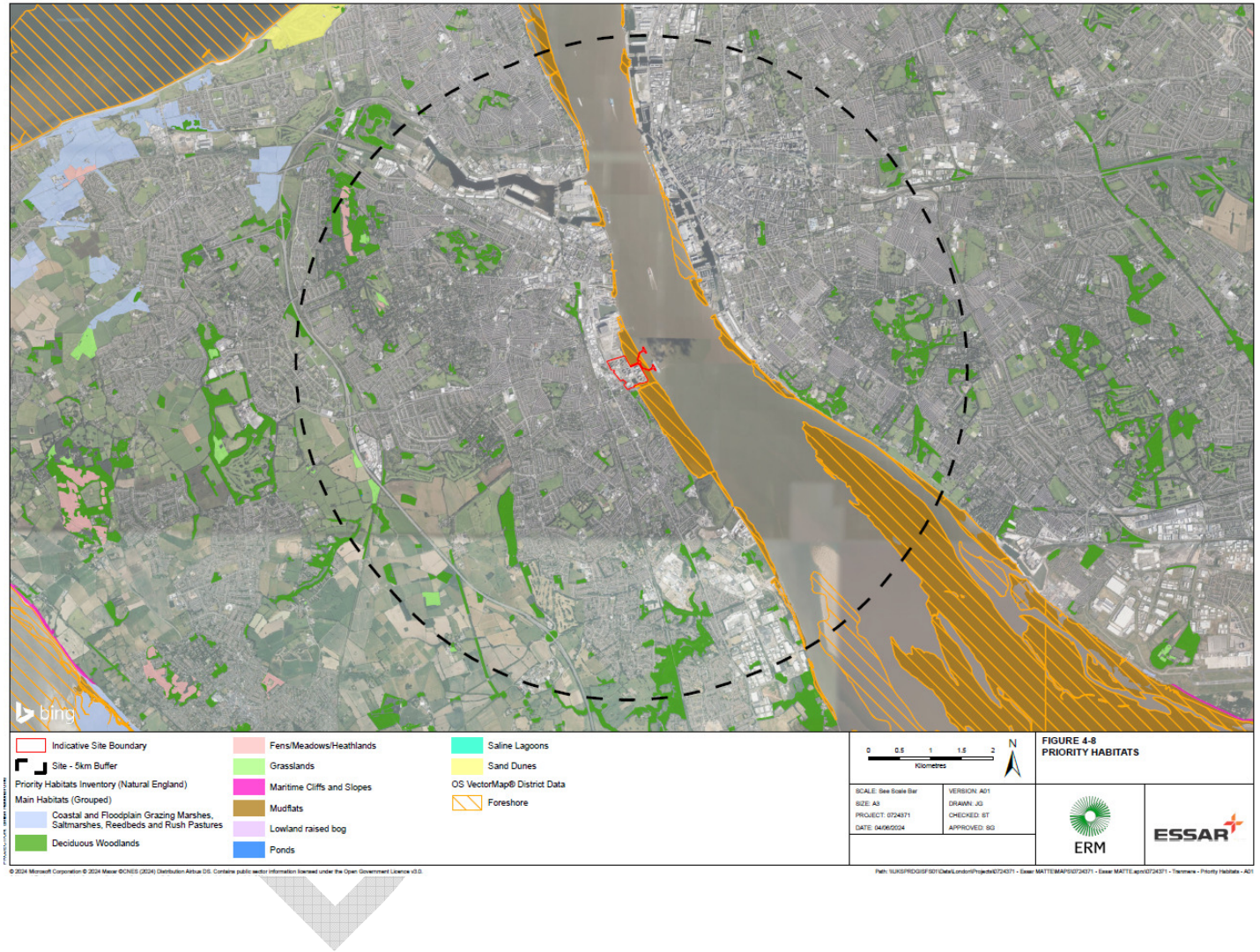
Priority Habitats

Using the list of priority habitats from the MagicMap application[28], the priority habitats identified to be in proximity to the Site are listed below and illustrated in Figure 4-8.

- Intertidal Substrate consisting of sand extends along the coast of the estuary south and north from the Site.
- Mudflat is located directly east of the Site and occupies an area of approximately 80 ha. Approximately 3 km south of the Site, mudflat habitats of Eastham Sands, Poole Hall Sands, Stanlow Banks, Ince Banks and Dungeon Banks occupies more than 2,500 ha within the Mersey Estuary.
- Deciduous Woodland is located 70m south of the Site, in an elongated area of approximately 1.5 ha.
- A small patch of Lowland Dry Acid Grassland is located approximately 3.5 km north-west of the Site an occupies about 1 ha.
- A small patch of Lowland Heathland is located approximately 3.5 km north-west of the Site an occupies about 0.5 ha.
- Nearest Reedbed habitat is located approximately 6 km north-west of the Site and occupies an approximate are of 0.5 ha.
- Coastal and Floodplain Grazing Marsh is located approximately 6 km north-west of the Site and occupies an approximate area of 40 ha.
- Coastal Saltmarsh is located approximately 9.5 km south of the Site and occupies an area of approximately 720 ha along the southern banks of the estuary, north of Ellesmere Port.

[28] https://magic.defra.gov.uk/MagicMap.aspx (accessed 23/02/2023)

Figure 4-8 Priority Habitats



4.3.2.5 WIDESPREAD NON-DESIGNATED LAND

This receptor type is described by the CDOIF guidance as the contamination of >10-100 ha of land, preventing growing of crops, grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances. Alternatively, contamination of 10 ha or more of vacant land.

According to the Living England Habitat Map provided by the MagicMap Application, the Site is situated within a built-up area. The nearest patch of agricultural or arable land that could potentially be affected from an MAS is located approximately 2 km west of the Site. Based on recent satellite imagery, the area north of the site seems to be disused industrial land. To the west lies industrial areas, beyond which residential areas are situated. Additionally, residential areas are located south-west of the Site.

4.3.2.6 WIDESPREAD NON-DESIGNATED WATER

A MATTE to this receptor type is realised when there is contamination of aquatic habitat that prevents fishing or aquaculture or renders it inaccessible to the public (e.g. beaches).

A technical Note prepared for the construction of a new Cruise Terminal [6] provides a baseline characterisation of fishing activity in the Mersey Estuary, with a particular focus on the Birkenhead and Liverpool waterfront. Within the Mersey, two commercial fishermen are known to operate, primarily targeting cod, bass, and flatfish such as flounder, plaice, sole, dab, brill, and turbot. Additionally, some potting for shellfish occurs beyond the river mouth. Charter boats frequently catch species including ling, conger eels, pollack, gurnard, rays, tope, whiting, bull huss, lesser spotted dogfish, smooth hound, mackerel, and pouting. Several fishing grounds identified by commercial fishermen are located near the Site on the Birkenhead and Liverpool Waterfront.

Parts of northern Wirral coast are designated as Shellfish Protected Water Areas in 2022 under the Water Framework Directive (WFD). Additionally, approximately 800 ha adjacent to the Port of Liverpool where the estuary opens into the Irish Sea is designated as Classified Bivalve Mollusc Harvesting Areas. These areas are illustrated in Figure 4-.

Coastal areas of Wirral (Wallasey and Hoylake) located approximately 8 km north-west of the Site is classified as Bathing Waters by the Environment Agency and is considered as a receptor due to public access.

4.3.2.7 GROUNDWATER

Geology

The Site is recorded to be underlain by superficial tidal flat deposits typically described by the British Geological Survey (BGS)[29] as a consolidated soft silty clay with layers of sand, gravel, and peat. The underlying bedrock geology is recorded as the Triassic Wilmslow Sandstone Formation of the Sherwood Sandstone Group and is described as reddish-brown, fine to medium-grained sandstones containing common quartzite pebbles and mudstone clasts towards the top. In addition, the BGS reports the Site is directly underlain by made ground or reworked ground.

[29] https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ (Accessed 01/03/2024)

The WSP ground investigation [7] confirms the majority of the Site is underlain by gravelly made ground situated directly onto sandstone, which in places has an upper weathered extent recorded as sand and gravel layers. Boulder Clay logged as sandy or silty clay is inconsistent across the site and is observed at greater thicknesses in WSP and BGS borehole logs with distance away from the sea wall. Excluding the bunds, the thickness of the made ground generally ranges from 1 to 2 m, and where present on-site, the boulder clay is typically less than 2 m thick, consistent with the thickness observed in BGS boreholes directly north of the Site, while to the south-west of the site the BGS boreholes show it is between 3.4 – 4.7m thick.

Information from on-site borehole logs is summarised in Table 4-7.

TABLE 4-7 GEOLOGY UNDERLYING THE SITE

Geology Strata	Description	Depth to Base (mbgl)
Made ground	Mainly sand and gravel, occasionally clayey or clay.	0.3 – 3
Superficial deposits (Tidal flat deposits)	Interbedded gravelly silty sands, sandy slightly gravelly clays, occasionally with stiff clay with occasional pebbles, slightly sandy slightly gravelly silts, locally with pockets of black amorphous peat.	Absent to 7
Bedrock (Sherwood Sandstone)	Medium to fine grained SANDSTONE	Up to 280

Hydrogeology

Under the Water Framework Directive (WFD) the groundwater beneath the Site forms part of the Triassic Sandstone (Wilmslow Sandstone Formation) groundwater body. The bedrock beneath the Site is categorised as a Principal Aquifer with high intergranular and/or fracture permeability which means that Triassic Sandstone usually provides a high level of water storage and may support water supply and/or river base flow on a strategic scale.

The Superficial deposits are classified as an Unproductive Aquifer. An Unproductive status is assigned when is not possible to provide usable water supplies and are unlikely to have surface water and wetland ecosystems dependent on them. Based on the site level geology encountered in investigation boreholes at the site it is assumed that the superficial deposits are effectively absent.

The bedrock aquifer is classified under the Water Framework Directive (WFD) as having 'Medium Groundwater Vulnerability' which is defined by the BGS as areas that provide some level of groundwater protection. These areas are characterised by moderately leaching soils and the presence of superficial deposits that have a certain impermeability, akin to clays. The Site is not reported to lie within a source protection zone (SPZ) and therefore the groundwater underlying the sites is not considered to currently be a source of public potable supply. Site data suggests the protective tidal flat deposits are essentially absent at the site and therefore the groundwater vulnerability classification may be High.

The hydrogeological summary derived from Section 2.3 of Volume 1 of the 2020 COMAH Report [2] indicate that there are potentially two groundwater bearing units beneath the Site; the made ground and the Triassic Sandstone. Groundwater in the made ground is perched and

is not recorded across the whole Site, i.e. it is likely to be confined to isolated pockets across the Site, perched on Boulder Clay, where present. The underlying sandstone aquifer is considered to be the main water-bearing unit beneath the Site.

Groundwater flow direction is considered likely to be towards the Mersey Estuary.

The NRW Water Watch Wales page classifies the groundwater at the Site as having poor chemical status and good quantitative status (2021)[30]. The Triassic Sandstone is used as a potable water supply with numerous groundwater abstractions to the west of the Site. The nearest potable groundwater abstraction is located in Birkenhead approximately 2 km north-west of the site. The inner (Zone 1) and outer (Zone 2) source protection zones (SPZs) for this abstraction are of limited extent and the total catchment extends to approximately 200m north-west from the site boundary.

According to the UK Government Flood Check Service, the Site is not present in an area that is at risk from groundwater flooding.

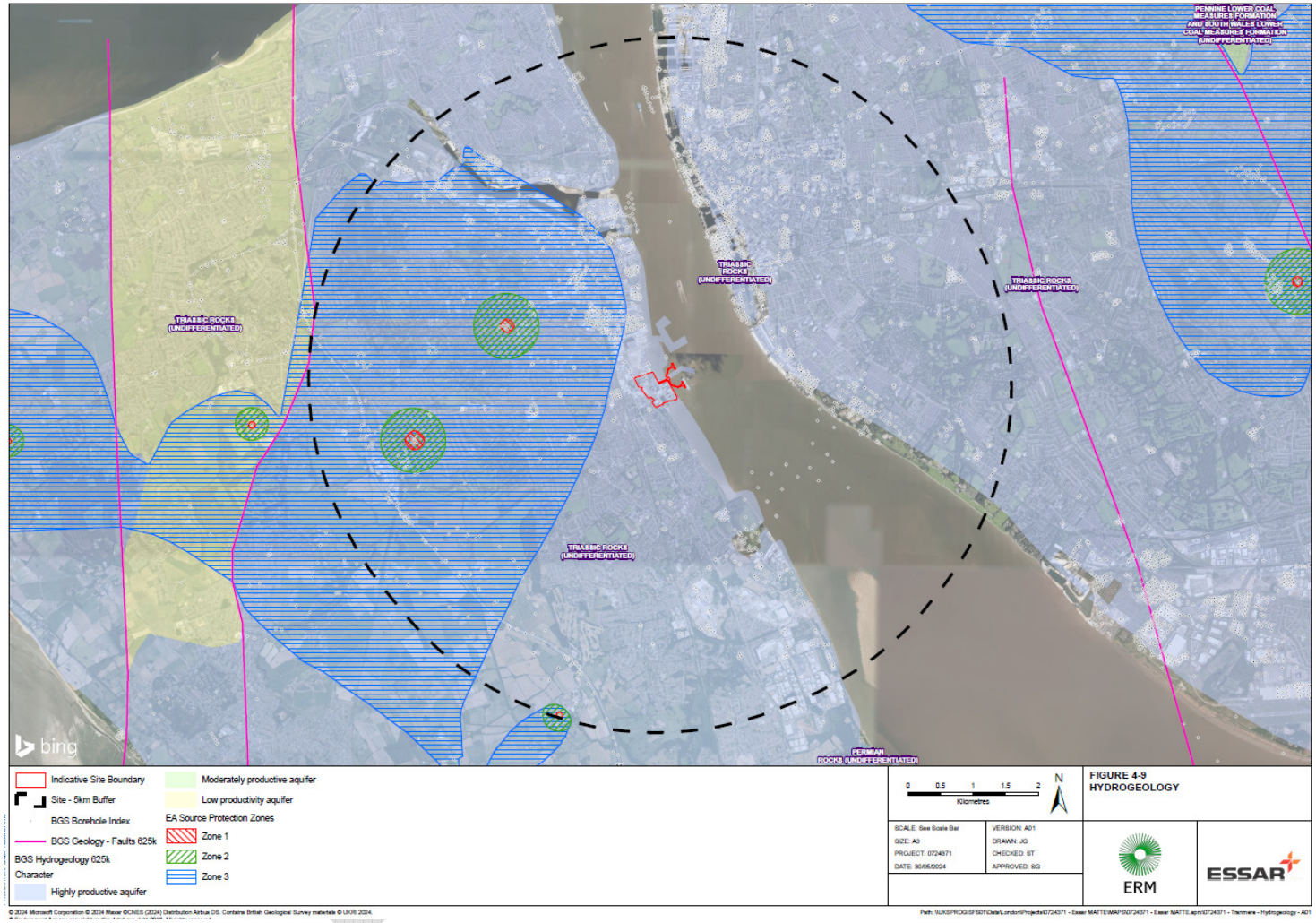
Essar have been advised by the EA that the bedrock sandstone aquifer beneath the Site should be considered as a drinking water source as there is the potential for this to be the case in the future. Evidence from the most recent site investigation undertaken by WSP indicated that groundwater levels are high and sit within the made ground.

Groundwater as a Pathway

Under the CDOIF guidance, groundwater should also be considered as a pathway, not just a receptor. Liquid releases can infiltrate the ground surface, and move into the subsurface and enter shallow groundwater, where the contaminants can follow the local groundwater flow direction, as well as spread laterally towards a receptor. The permeability of the superficial deposits underlying the Site may act as a pathway for contaminants to reach the bedrock which may (in the future) support local water supplies or provide baseflow into the Mersey Estuary.

[30] https://waterwatchwales.naturalresourceswales.gov.uk/en/ (Accessed 01/03//2024)

FIGURE 4-9 HYDROGEOLOGY



4.3.2.8 SOIL OR SEDIMENT

This receptor type is stated to apply where contamination is sufficient to damage >10 ha of land. The Site is situated within a densely built-up area, bordered by both industrial and residential land use. However, recent satellite imagery reveals that the land directly north of the Site appears to be vacant. The estimated area of this parcel is approximately 12 ha and is provided with a hardstanding cover in majority of the areas and does not appear to be accessible to the public.

4.3.2.9 BUILT ENVIRONMENT

Figure 4-10 illustrates the location of the Listed Buildings and Scheduled Monuments (SMs) proximal to the Site.

A MATTE to the built environment is defined as "*Damage to the built environment (e.g. Grade 1/Category A listed buildings, scheduled ancient monuments, conservation areas) such that its designation of importance is withdrawn*."

As Figure 4-10 shows, the nearest Grade I listed building close to the Site is the Remains of Birkenhead Priory located approximately 1.2 km to the north. The nearest Grade II listed buildings to the Site are the Royal Mersey Yacht Club and the Rock ferry Slipway locate directly south of the terminal. However, an impact to a Grade II Listed Building is not considered a MATTE.

Birkenhead Priory is also the closest Scheduled Monument identified to the Site.

Liverpool-Maritime Mercantile City, located approximately 2 km north of the Site is identified as a former World Heritage Site, located at the tidal mouth of the River Mersey where it meets the Irish Sea. The World Heritage Committee delisted the site in 2021[31].

[31] https://whc.unesco.org/en/news/2314 (Accessed 01/01/2024)

FIGURE 4-10 BUILT ENVIRONMENT

4.3.2.10 RED LISTED AND PARTICULAR SPECIES

It is considered that sensitive and/or rare species are already considered as part of the designated sites and are therefore not considered here again. The particular species receptor type is considered to account for the non-designated (all other) species and plant cover in the vicinity of the Site. The red listed species and protected species are considered as per designated species with respect to MATTE thresholds.

The European eel (*Anguilla anguilla*) is listed as "critically endangered" under the International Union for Conservation of Nature (IUCN) Red List and is reported to be present within the MSC. Adult European eels begin their spawning migration from European rivers and coasts during the autumn of each year [8]. Eels are born in the Sargasso Sea, within the Atlantic Ocean. After about three years swimming the Gulf Stream, they reach the UK and Europe as tiny transparent elvers known as glass eels. Here they gradually mature, becoming a darker green/brown in colour with a silvery belly. They inhabit most waterbodies and may even crawl over flooded land to access pools unconnected by streams or ditches. They prefer dark and heavily coloured waters, or waters with plenty of silt and mud at the bottom. They mainly feed at night and generally scavenge for food, preying on dead and dying animals, fish and invertebrates. At between 8 to 18 years the mature eels then head back across the Atlantic to the Sargasso Sea to spawn.

The bullhead is another IUCN protected species and is only found in clean, stony waters and around the brick work at canal locks. It appears to favour fast-flowing, clear shallow water with a hard substrate (gravel/cobble/pebble) and is frequently found in the headwaters of upland streams. However, it also occurs in lowland situations on softer substrates so long as the water is well-oxygenated and there is sufficient cover. It is not found in badly polluted rivers[32]. Although the MSC and River Mersey do not necessarily fit the description of the ideal habitat for this species, it is conservatively assumed to be present in both.

Crucian carp are another IUCN protected species which may be present in watercourses around the Site, although they prefer shallow waters and are found in ponds and slow-flowing rivers and canals. They are extremely hardy fish and can tolerate very cold, polluted waters and low oxygen conditions.

Smelt (*Osmerus eperlanus*) is listed as a UK BAP priority species. According to the report on the Recovery management Plan for species [9], In the 19th and early 20th century, the River Mersey supported a thriving smelt population, sustaining a profitable fishery on Sparling Street. However, by the early 1950s and 1960s, smelt numbers declined due to deteriorating water quality linked to industrial activities in the area. Recent years have seen only a few smelt specimens caught in the Mersey, indicating a potential early stage of natural recovery due to reduced exploitation pressure and improved water quality. The Welsh Dee estuary houses a substantial smelt stock, suggesting it as a probable source for the increasing smelt presence in the Mersey as water quality improves.

The National Biodiversity Network (NBN) was consulted to identify any species that have been observed on at least 10 occasions, located within 1 km of the Site, over the last ten years[33]. These species and the number of observations are presented below:

[32] https://sac.jncc.gov.uk/species/S1163/ (Accessed 03/04/2023)

[33] https://records.nbnatlas.org/ (accessed 19/03/2024)

- Red Admiral (Vanessa atalanta) – 45,589
- Alder Leaf Beetle (*Agelastica alni*) – 43,983
- Painted Lady (*Vanessa cardui*) – 715
- Cuckoo-Spit Insect (*Philaenus spumarius*) – 101
- Small White (*Pieris rapae*) – 96
- Meadow Brown (*Maniola jurtina*) – 75
- Gatekeeper (*Pyronia tithonus*) – 49
- Speckled Wood (*Pararge aegeria*) – 21
- Holly Blue (*Celastrina argiolus*) – 20
- Peacock (*Aglais io*) – 17
- Common Blue (*Polyommatus icarus*) – 15
- Comma (*Polygonia c-album*) – 13
- Large White (*Pieris brassicae*) – 10

Joint Nature Conservation Comittee (JNCC) report that the recorded migratory fish fauna of the Mersey Estuary include sea trout (*Salmo trutta*), flounder (*Platichthys flesus*), common eel (*Anguilla anguilla*), sea and river lampreys (*Petromyzon marinus*) and (*Lampetra fluviatilis*), and Atlantic salmon (*Salmo salar*). Sea and river lampreys and Atlantic salmon are listed as Annex II species under the EU Habitat Directive.

4.3.2.11 MARINE

The Severe MATTE thresholds for the marine receptor consist of impacting;

- >2ha of littoral/sub-littoral zone (considered equivalent to priority habitat Intertidal Substrate Foreshore and Mudflats); or
- >100ha of open sea benthic community; or
- >100 dead seabirds (>500 dead gulls); or
- >5 dead or significantly impaired sea mammals.

Littoral/Sub-Littoral Zones

Under the CDOIF guidance, Appendix 2 Table 11, the original DETR receptor definitions state the marine receptor classification applies to 'non-estuarine marine waters'. It is not considered this receptor type applies to the Mersey Estuary.

The intertidal areas of the Mersey Estuary are considered to be covered under the Priority Habitat Intertidal Foreshore Substrate and Mudflats discussed in Section 4.3.2.4.

Open Sea Benthic Community

This receptor type is located out to sea away from the littoral / sub-littoral areas within proximity to the coastline.

Seabirds

This includes seabirds beyond the species included as part of the designated sites. Wetland Bird Survey portal of the British Trust for Ornithology (BTO) website was consulted to identify

the total seabird core counts for the Mersey Estuary[34]. The counts listed below represent a 5-year average monthly counts (2017-18 to 2021-22).

- Dunlin – 37,882
- Shelduck – 12,131
- Pink–footed Goose – 7,673
- Lapwing – ,6983
- Redshank – 4,996
- Black–tailed Godwit – 3,024
- Ringed Plover – 1,673
- Curlew – 1,306
- Grey Plover – 447
- Shoveler – 253
- Pintail – 210
- Avocet – 155
- Ruff – 51

Sea Mammals

This includes any sea mammals found in the estuary. Dolphins and porpoises are occasionally observed in the area, at the mouths of the estuaries and in Liverpool Bay[35]. All dolphins and porpoises are protected under The Conservation of Habitats and Species Regulations 2010. The common or harbour porpoise and bottle-nosed dolphin are protected under Schedule 5 of the Wildlife and Countryside Act 1981. According to the MagicMap Application, common / harbour porpoises have been observed in Liverpool Bay within 10 km of the Site. On Wirral, grey seal occupies the east side of the West Hoyle sand bank, near to the Hilbre Islands. The Hilbre population do not breed in the Dee. They use the Liverpool Bay area to haul out, feed and moult. Small numbers of seals venture into the Mersey Estuary[36]. These seals are protected under Schedule 4 of The Conservation of Habitats and Species Regulations 2010.

4.3.2.12 FRESHWATER AND ESTUARINE HABITATS

Surface Watercourses

The Site is located on the western bank of the Mersey Estuary and as such there are several surface waters which could plausibly be impacted by a liquid release from the Site, and these are shown in Figure 4-11, and described below. The Site falls within the Wirral Operation Catchment, as indicated by the Environmental Agency's Catchment Explorer. Subsequently, details regarding the water quality of surface water courses within a 10 km radius from the Site were sourced from the Environmental Catchment Data Explorer[37].

- Dibbinsdale Brook – Dibbinsdale Brook is located approximately 2.5 km south-east of the Site and received an ecological classification of 'Poor' and chemical classification of 'Fail' in 2022 under the Water Framework Directive (WFD).

[34] https://app.bto.org/webs-reporting/numbers.jsp?locid=LOC645421 (19/03/2024)
[35] https://www.manchestereveningnews.co.uk/news/uk-news/dozens-fish-shark-species-including-28565523 (Accessed 01/03/2024)
[36] https://www.cheshirewildlifetrust.org.uk/sites/default/files/2018-06/Atlantic%20grey%20seal.pdf (Accessed 01/03/2024)
[37] https://environment.data.gov.uk/catchment-planning/ (Accessed 01/03/2024)

- River Birket – River Birket is located approximately 4.5 km north-west of the Site and received an ecological classification of 'Moderate' and chemical classification of 'Fail' in 2022 under the Water Framework Directive (WFD).
- Rivacre Brook – Rivacre Brook is located approximately 9.5 km south-east of the site and received an ecological classification of 'Moderate' and chemical classification of 'Fail' in 2022 under the Water Framework Directive (WFD).

The CDOIF guidance states that >2 km of a surface watercourse must be impacted so that its chemical or ecological status is lowered by one Water Framework Directive (WFD) classification level for a Severe MATTE, and >10 km for a Major MATTE, and >200 km for a Catastrophic MATTE.

Estuary

Mersey Estuary

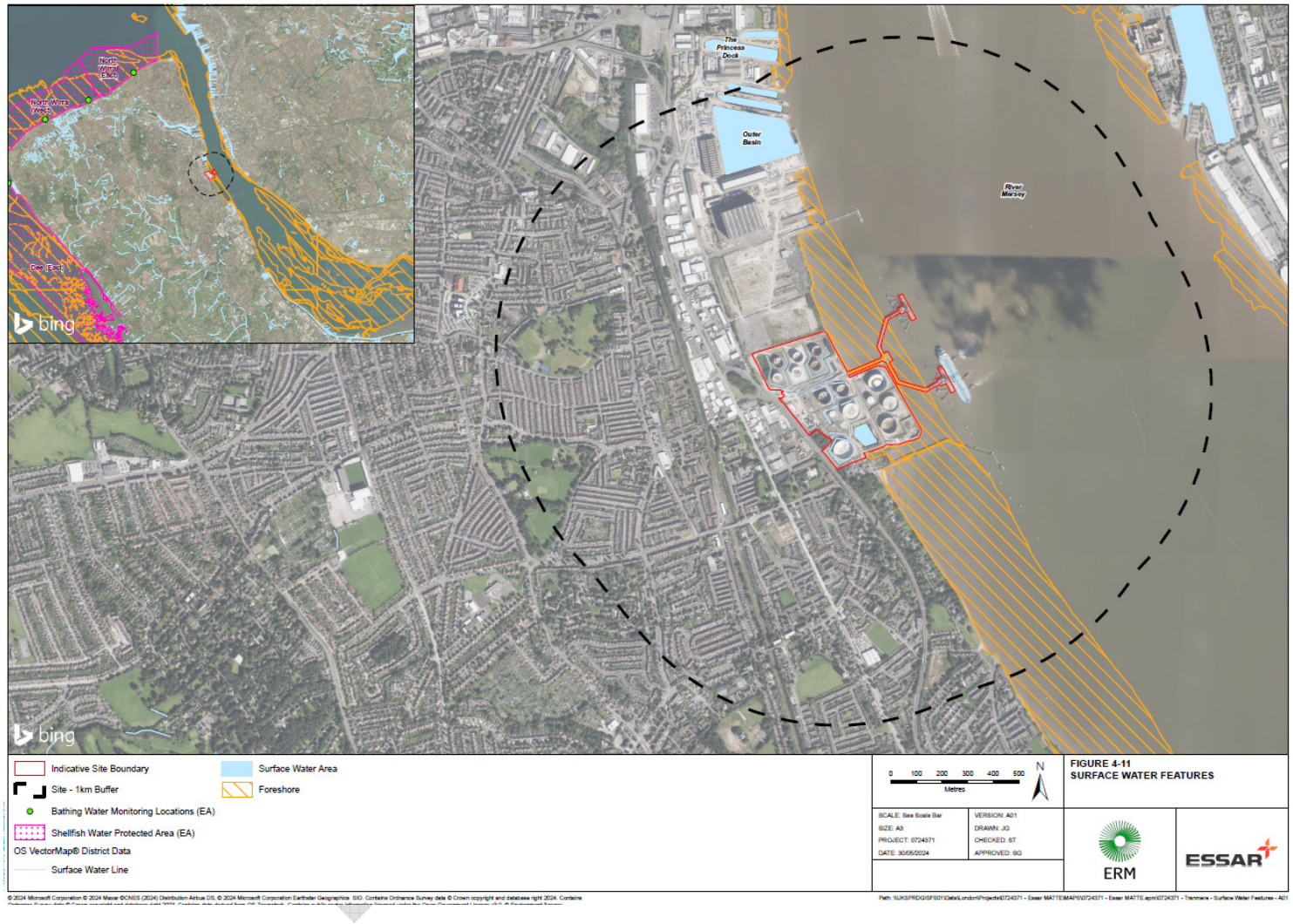
The Mersey Estuary is located to the north of the Site. It extends for 50 km from its tidal limit in Warrington in the east to the Irish Sea in the west. The estuary is widest adjacent to the Site, narrowing downstream to its mouth at New Brighton. River Mersey has the second highest tidal range in the UK, varying from 4 m at neaps to 10 m at spring tides. Strong tidal flows (up to 2.5 m/s on spring tides) are created through the narrow mouth, with associated deep channels[38].

Water Framework Directive (WFD) classifies the estuarine body as having a 'moderate' ecological quality in 2022, but a 'Fail' chemical classification due to elevated levels of Arsenic, Copper, Permethrin, Toluene, Phenol and Zinc concentrations.

The CDOIF guidance states that >2 km of a surface watercourse must be impacted so that its chemical or ecological status is lowered by one Water Framework Directive (WFD) classification for >2 ha to trigger a Severe MATTE, and >20 ha for a Major MATTE, and >200 ha for a Catastrophic MATTE.

[38] https://ntslf.org/about-tides/river-mersey#:~:text=The%20River%20Mersey%20has%20the,1%25%20of%20the%20tidal%20flow. (Accessed 01/03/2024)

FIGURE 4-11 SURFACE WATER FEATURES



4.3.2.13 SUMMARY OF CDOIF RECEPTORS

The identified environmental receptors within 10 km of the Site are summarised in Table 4-8**,** along with a conservative high-level consideration of MATTE potential. Where it is clear, without the requirement for a detailed assessment, that a receptor does not have a plausible S-P-R linkage, it is not considered to have MATTE potential and is excluded from the assessment at this stage. Section 4.5 presents a detailed assessment of the receptors considered to have MATTE potential, with respect to the potential severity of impact.

TABLE 4-8 SUMMARY OF RECEPTORS WITHIN 10KM OF SITE

CDOIF Receptor Type	Receptor	Approximate Distance from Site	MATTE Potential
Designated Land/Water Sites (Internationally important)	Mersey Estuary SPA / Ramsar	Directly south	Yes: A liquid hydrocarbon release has the potential to enter the Mersey Estuary and cause a MATTE to these receptors. The vast majority of the extent of the Mersey SPA / Ramsar is further to the east and south, with large extents at Devil's Bank near Otterspool, and Eastham Sands. Stanlow Banks, Ince Banks and Dungeon Banks are located 5km or more south-east. The intertidal area of Rock Ferry Beach located directly south of the Site also forms part of the designation and is most likely to be impacted by a release scenario. Only a small portion of the Mersey Narrows & North Wirral Foreshore SPA / Ramsar is located within the Mersey Estuary along Seacombe to New Brighton (Egremont foreshore), while the remainder of the designated site is not considered to be at MATTE risk from the Site.
	Mersey Narrows & North Wirral Foreshore SPA / Ramsar	3 km north	
	Dee Estuary SPA / SAC / Ramsar	7+ km north	No: Based on the location and the distance from Site, these receptors are not considered to have a plausible S-P-R linkage.
Designated Land/Water Sites (Nationally important)	New Ferry SSSI	Directly south	Yes: A release from the Site has the potential to impact the SSSI extent at Rock Ferry Beach directly south-east of the Site (the entire SSSI is also part of the Mersey Estuary SPA / Ramsar). The Mersey Estuary SSSI covers the same approximate extent as the wider Mersey Estuary SPA / Ramsar, but also includes the water channels (not just the sand banks and intertidal foreshore areas). It is considered a release could impact this SSSI.
	Mersey Estuary SSSI	2.5 km south	
	Mersey Narrows SSSI	3 km north	Yes: The designation occupies the same spatial extent as the Mersey Narrows & North Wirral Foreshore SPA / Ramsar at the Egremont foreshore, the nearest portion of the SSSI to the Site, and spans an approximate area of 25 hectares. It is considered a release into the estuary could

CDOIF Receptor Type	Receptor	Approximate Distance from Site	MATTE Potential
			move northwards and reach this portion of the SSSI.
	Dibbinsdale SSSI	4 km south	No: The sites are predominantly terrestrial and located 4 km or more away from the Site. A liquid release or thermal radiation originating from the Site is not considered to reach these receptors. As such a credible S-P-R linkage is not considered.
	North Wirral Foreshore SSSI	7.5 km north	
	Thurstaston Common SSSI	8 km west	
	Heswall Dales SSSI	9 km west	
	The Dungeon SSSI	9 km west	
	Meols Meadows SSSI	9 km north-west	
	Dee Cliffs SSSI Dee Estuary SSSI	9.5 km west	
Other Designated Land	Bidston Hill Country Park	4 km north-west	No: These receptors are predominantly terrestrial and are located more than 3.5 km from the Site. A liquid release or thermal radiation originating from the Site is not considered to reach these receptors. As such a credible S-P-R linkage is not considered.
	Eastham Woods Country Park	5 km south	
	Arrowe Country Park	6 km west	
	North Wirral Coastal Country Park	7 north	
	Royden Country Park	8 km west	
	Dibbinsdale LNR	4 km south	
	Biston Moss LNR	4 km north-west	
	Allerton LNR	8 km south-east	
	Childwall Woods LNR	8 km east	
	Thurstaston Common LNR	8 km west	
	Heswall Dales LNR	9 km west	
	Ancient Woodland	4 km south-east	No: The nearest clusters of ancient woodlands are located approximately 4 km south of the Site as part of Dibbinsdale LNR. Based on the distance and barriers in the form of built up areas it is not

CDOIF Receptor Type	Receptor	Approximate Distance from Site	MATTE Potential
			considered a liquid release or thermal radiation would impact this receptor resulting in a MATTE.
	Mersey Estuary RSPB Reserve	6.5 km south	Yes: A liquid release entering the estuary is considered to have the potential to be transported by tidal action to the RSPB Reserve, which extends over an area of approximately 1,500 ha from Bebington to Ellesmere Port.
Scarce (Priority) Habitat Receptors	Mudflat	Directly south	Yes: Rock Ferry Beach located directly south and Tranmere Beach located directly north of the Site along the coast of the estuary are classified as priority habitat mudflats, with an area of approximately 70 ha. These are considered to be at risk from a release incident at Site. Additionally, a continuous approximate 400m width of the estuary coastline is classified as Intertidal Substrate Foreshore (which also overlaps with the mudflats classification) which is also considered to be at risk of a release from Site.
	Intertidal Substrate (Sand)	Directly south, east, and north-east	
	Deciduous Woodland	70 m south	Yes: Deciduous woodland is present to the south of the Site. A thermal radiation event originating from the Site is considered to have the potential to impact this receptor
	Lowland Dry Acid Grassland	3.5 km north-west	No: These terrestrial habitats are not considered to be at risk of impact from a liquid release or thermal radiation event based on the distance separating the Site from these habitats and the absence of a plausible S-P-R linkage.
	Lowland Heathland	3.5 km north-west	
	Coastal and Floodplain Grazing Marsh	6 km north-west	
	Reedbed	6 km north-west	No: Nearest Reedbed habitat is located approximately 5.8 km northwest of the Site in an isolated pond habitat. A plausible S-P-R linkage is not present.
	Saltmarsh	9.5 km south	No: A plausible S-P-R linkage is not considered plausible.
Widespread Habitat - Non Designated Land	Agricultural / Arable Land	2 km west	No: The Site is situated within a mixed residential and industrial setting. No agricultural land is located within the vicinity of the Site that could plausibly be impacted by a MAS.
Widespread Habitat - Non Designated Water	Aquaculture / Fisheries Beaches	Directly south, east and north-west	Yes: Commercial fisheries are known to operate in certain areas of the Mersey Estuary adjacent to the Site. A release from the Site could potentially impact these areas, resulting in them being rendered inaccessible to the public or to fishing and

CDOIF Receptor Type	Receptor	Approximate Distance from Site	MATTE Potential
			aquaculture activities. Additionally, Rock Ferry Beach may be impacted as to become inaccessible to the public. The Classified Bivalve Mollusc Harvesting Areas towards the mouth of the estuary are also considered to be at risk of a release from Site. However, the Shellfish Water Protected Areas along the Wirral where the estuary opens into the Irish Sea, are not considered to be at risk from a release on-site.
Groundwater – Drinking Source	Principal Aquifer	-	Yes: The EA have reported that the aquifer underlying the Site is to be considered to have the potential to supply drinking water in the future. It is considered a liquid release has the potential to penetrate the ground and migrate vertically into this receptor.
Groundwater – Non-Drinking Source	Unproductive Aquifer	-	N/A – See more sensitive Principal Aquifer. Whilst technically there is the potential for some unproductive strata to support perched groundwater it is considered likely to be inconsistent across the site and therefore more appropriate to consider the groundwater unit in its entirety to be a Principal Aquifer.
Soil/Sediment	Surrounding Land	-	No: The land directly north of the Site appears to be vacant. However a plausible S-P-R is not considered likely as it is provided with hardstanding cover in the majority of the areas
Built Environment	Listed Buildings (Grade I)	1.2 km north	Yes: At this stage a thermal radiation or overpressure scenario is considered to have the potential to extend 1.2 km and reach Birkenhead Priory. The next closest receptors of concern are Grade I Listed Buildings located in the centre of Birkenhead, but these are located sufficiently far and protected within a built-up area where the risk of impact is not considered plausible.
	Scheduled Monuments		
Particular Species	Non-Designated Species*	-	No: It is not considered that any species (not already covered by the designated sites or protected species) could be impacted as to result in an impact of >1% of the national population, resulting in a MATTE.
Marine	Littoral/Sub-Littoral Zones	Mersey Estuary	No: Applicable to non-estuarine marine waters. Intertidal areas covered under Intertidal Substrate Foreshore and Mudflats Priority Habitats.

CDOIF Receptor Type	Receptor	Approximate Distance from Site	MATTE Potential
	Open Sea Benthic Community	Mersey Estuary	No: It is not considered plausible for a release from Site to contaminate >100ha of open sea benthic community.
	Seabirds	Mersey Estuary	Yes: At this stage it is considered a release entering Mersey Estuary could impact upon marine seabirds and mammals found within the vicinity of the Site.
	Sea Mammals	Mersey Estuary	
Fresh and Estuarine Habitats	Mersey Estuary	Directly south, east and north-west	Yes: It is considered a release from Site can enter the Mersey Estuary.

**Assumed that sensitive/rare species are already accounted for in the designated/other designated sites.*

4.3.3 FEATURES OF THE SURROUNDINGS THAT MAY INFLUENCE MAJOR ACCIDENTS

The following features may directly influence the potential for an MAS to occur on Site.

4.3.3.1 AIRCRAFT CRASH

Liverpool John Lennon Airport is situated approximately 8 km southeast from the Site. according to the Health and Safety Laboratory (HSL) Report in 2015 [10], the background aircraft crash rate for England is as follows:

- Lighter aircraft – 23.3 x 10^{-6} per km^2
- Small transport aircraft – 3.50 x 10^{-6} per km^2
- Helicopters – 14.1 x 10^{-6} per km^2
- Military aircraft – 7.70 x 10^{-6} per km^2
- Large transport aircraft – 0.3 x 10^{-6} per km^2

This results in a total aircraft crash rate of 48.9 x 10^{-6} per km^2 over 24 years. The Site area is approximately 0.2 km^2.

Therefore, the risk to the Site from an aircraft crash is estimated to be approximately 4 x 10^{-7} per year based on data from 1990 - 2013.

4.3.3.2 TOPOGRAPHY

Topographically, the Site is flat a ranging between 0 and 15 m above Ordnance Datum. Beyond any kerbing and the buildings, the tank bunding are the only aspect which represents a significant change in elevation in the Site profile. There are no specific topographic aspects that are considered likely to contribute to an MAS (e.g. landfall, erosion, etc).

4.3.3.3 EARTHQUAKES

The Site is not located in a seismically active area [11], therefore the probability of an earthquake initiating an equipment failure is remote. The Site is on reclaimed, flat ground and the probability of landslip is considered very small, with no history of any land movement.

4.3.3.4 WEATHER

Average weather data for Wirral / Birkenhead is primarily sourced from 3rd party websites[39].

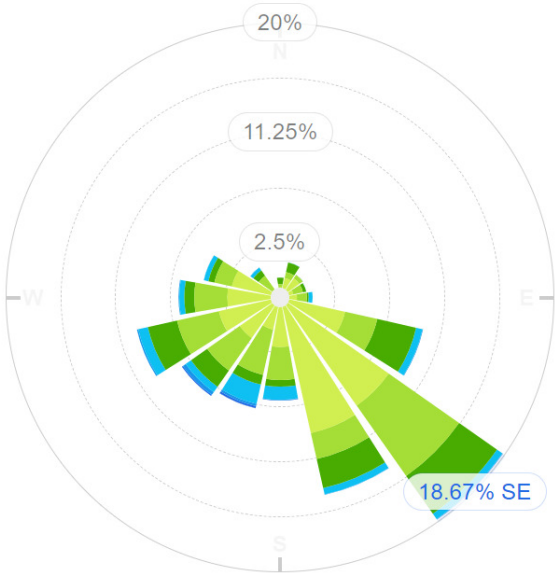
The average atmospheric temperature in Birkenhead varies over the course of the year from 3°C to 20°C and is rarely below -2°C or above 25°C. Birkenhead experiences some seasonal variation in monthly precipitation. Rain falls throughout the year and the month with the most rain is November, with an average rainfall of 71 millimetres. The month with the least rain in is April, with an average rainfall of 38 mm.

The windier part of the year lasts for approximately 5 months, from October to March, with average wind speeds of more than 19.7 km/hr. The windiest month of the year is January with an average hourly wind speed of 23.1 km/hr. The calmer time of year lasts for 6 months, from March to October with an average hourly wind speed of 16.2 km/hr.

The recorded number of lightning strikes to the ground is average for the UK, and all storage vessels are earthed as required by current good practice.

The wind rose for Liverpool John Lennon Airport is presented in Figure 4-12. The most frequent wind direction is from the southeast[40].

FIGURE 4-12 LIVERPOOL JOHN LENNON AIRPORT WIND ROSE



The weather data has significance for the potential consequences of MAS. The frequent strong winds make vapour cloud explosions less likely. A study found that there was no case recorded of a vapour cloud explosion with "high winds" [12].

These factors are also relevant from an environmental impact perspective when considering the risks from airborne pollutants.

[39] https://weatherspark.com/y/37954/Average-Weather-in-Birkenhead-United-Kingdom-Year-Round (Accessed 19/03/2024)
[40] https://wind.willyweather.co.uk/nw/merseyside/liverpool-john-lennon-airport-raf-speke.html (Access 19/03/2024)

4.3.3.5 FLOOD RISKS

The UK Government Flood Check Service[41] shows most parts of the Site are in an area that is considered to be at a high risk of flooding from rivers or the sea. High risk means that each year this area has a chance of flooding of greater than 3.3% (3.30×10^{-2} per year). This considers the effect of flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped or fail.

A majority of the Site is shown to be at a <0.1% risk of flooding from surface water (rainfall) or reservoirs each year. However, the North Interceptor (T6008) is in an area classified as high risk for surface water flooding, while the Crude Storage Tank bunds (T6001-T6006) are indicated to have a low and medium risk.

A flood risk assessment completed in 2021 [13] assessed the expected flooding depths across the Site from surface water flooding and tidal water overtopping for a 1 in 75 yr, 1 in 200 yr, and 1 in 1,000 yr event.

The most significant impact was assessed to be from tidal overtopping. T6019 and the South Interceptor were prone to flooding to a depth of >1m under all scenarios. T6017/T6018 bund, T6001/T6002 bund, the pumphouse, and North Interceptor areas were prone to flooding to depths of 0.5 – 2m across the scenarios. The rest of the Site was not indicated to be at significant risk of flooding from tidal overtopping.

For surface water flooding only the pumphouse and the T6015 bund were indicated to be at risk of flooding to depths of >0.5m, with the rest of the Site being at risk of flooding to depths of <0.5m

The flood risk assessment concluded that only T6001, T6002 and T6020 were at risk of flotation due to being out of service and empty. The other storage tanks are not considered to be at risk of flotation due to the minimum depth of product maintained. It is plausible that flooding of the pumphouse would impact operations, however it is not considered this would result in a MATTE as it is considered Essar would cease pumping operations during the flood event.

At present the risk of tidal overtopping of T6019/T6020 bund is considered to pose an increased MATTE risk through the flotation of the empty T6020 which may impact T6019 resulting in a release of its contents. The flooding HAZID produced for Tranmere indicates in the 0.1% AEP (1 in 1000 year) flood scenario, the maximum flood depth is 4 m, which would exceed the minimum working level in T6019. As such, there is the potential for T6019 to become buoyant and float, and potentially cause a rupture of connecting pipework, resulting in a loss of containment of crude oil.

As mentioned in Section 4.3.2.7, the Site is not considered to be at significant risk of flooding from groundwater.

[41] https://check-long-term-flood-risk.service.gov.uk/risk# (Accessed 01/03/2024)

4.4 REVIEW OF SOURCE-PATHWAY-RECEPTOR POLLUTANT LINKAGES

4.4.1 APPROACH

The following sections look at the plausible pathway linkages of the MAS identified in Section 4.2 to the receptors identified in Section 4.3 in terms of their potential for generating a MATTE.

A conservative approach has been adopted in lieu of quantitative analysis of the potential extent of effects resulting from the identified MAS.

4.4.2 FIRE TRANSMISSION

An initiating event which results in a fire (either from an initiating fire event or explosion) has the potential to result in thermal transfer to combustible material either on or off-site. Fire scenarios have the potential to impact receptors which are within the thermal radiation extents, dependent on the receptor type and level of thermal radiation it is in contact with.

Consideration also needs to be given to the effects resulting from the products of combustion. A fire has the capacity to transfer materials from the burning process into the air with subsequent potential for deposition at/on sensitive receptors. In the burning of hydrocarbons, the major components of combustion are NO_x and CO (rapidly evolving to form CO_2).

As the pollutants of interest which may be associated with an explosion or fire are by nature short-term events, the starting point for identification of potential impacts is to consider the sensitivity of receptors to short term, but potentially high dose events resulting from direct exposure to pollutants, and through deposition to ground and their subsequent uptake. It should be noted that impacts at sensitive ecological receptors are primarily focused upon long term changes in vegetation. Where the feature of interest is fauna, then these are largely dependent upon the maintenance of the health of the underlying floral habitat and general ecosystem.

The radiative heat flux required to generate a fire (without direct contact with flames) is estimated to be around 10kW/m^2; however, conservatively a thermal radiation extent of 6 kW/m^2 is used to assess the potential impacts of fire scenarios. There are various models available to analyse in more detail the potential for ignition via radiant heat flux based on separation distance, type of receptor, and moisture content for vegetation. This is considered a conservative approach, as research has found that vegetation and wood typically require heat fluxes of at least 20 kW/m^2 over a defined time period [14].

Figure 4-13 shows the simulated distance to the worst-case lower flammability limit (LFL) for a flash fire, and the worst-case 6.3 kW/m^2 thermal radiation extent for a pool fire and jet fire scenario on-site. The worst-case extents consider the asset which has the greatest impact extent (e.g. YP1366 North Jetty Crude Import), the associated MAS with the greatest impact extent (e.g. rupture release scenario), under the worst-case weather conditions (e.g. 1.5F weather conditions[42]). The worst-case impact extents for a

[42] *Very stable, 1.5 m/s wind speed, representative of low wind speed conditions found during nighttime.*

flash fire, jet fire, pool fire, and boilover are described below as sourced from the QRA, and are illustrated in Figure 4-13:

- Flash fire: A rupture of YP1336 pipeline, resulting in a release of crude oil with subsequent ignition resulting in a flash fire, under 1.5F weather conditions, which is simulated to have a lower flammability limit extent of 615 m.
- Jet fire: A rupture of YP1336 pipeline, North Jetty arms or North Jetty Manifold resulting in a release of crude oil with subsequent ignition resulting in a jet fire, under 1.5F weather conditions, which is simulated to have a 6.3 kW/m^2 thermal radiation extent of 350 m.
- Pool fire: A rupture of South Jetty crude manifold, resulting in a release of crude oil with subsequent ignition resulting in a pool fire, under 1.5F weather conditions, which is simulated to have a 6 kW/m^2 thermal radiation extent of 380 m.
- Boilover: A full surface tank fire may lead to a boilover scenario, with a hazard range or thermal impact extending up to 10 times the diameter of the tank. T6019 is the largest diameter crude tank at 72.17m, giving a boilover radius of 722 m. However, consideration has also been given to T6018 given its proximity to the southern boundary. The tank diameter from T6018 is 60 m, giving a boilover radius of 600 m. The boilover scenario extents have the potential to

Figure 4-13 presents the thermal radiation and boilover extents of the different ignition scenarios along with the receptors in the vicinity of the Site. Parts of the deciduous woodland located to the south of the Site falls within the thermal radiation and boilover extents, however, as less than the 2 ha of woodland (the Priority Habitats threshold) is present, it is not considered to have MATTE potential.

The thermal radiation extents are otherwise shown to intersect residential and commercial areas onshore which are not CDOIF receptors, and the intertidal areas and surface water offshore which are not considered to be at significant risk of harm from a short-lived thermal radiation event. Therefore, it is not considered to pose a MATTE risk.

4.4.3 COMBUSTION PRODUCTS

Fires and explosions have the potential to release to air several substances that are potentially polluting both due to direct toxic effects and due to deposition and subsequent uptake. The Air Pollution Information System (APIS) website sets out an extensive body of evidence relating to the potential impacts of atmospheric pollutants on protected habitats, both flora and fauna. This evidence, gathered from a wide range of sources, has been used as the primary source of information to define those pollutants that are of interest and assess potential for significant impacts on habitats.

Based on the evidence set out in APIS, emissions of oxides of nitrogen and associated deposition of nutrient nitrogen and acid nitrogen are considered to be the only potentially significant pollutants from a fire or explosion at the Site which might have MATTE potential.

Whilst there is a short-term guideline for Nitrogen Oxides (NOx) for protection of vegetation, the key impacts are long term and rather than being associated with

exposure to NOx directly are more associated with acidification, nitrification (discussed below) and the regional formation of ozone.

APIS states:

'Nitrogen oxides are not directly harmful to plants at concentrations below 14 ppb.'

In this case the European Union air quality standard of 30µg/m^3 (approximately equivalent to 14ppb), is set for the annual mean. The increases in annual mean NOx that may potentially arise because of a one-off fire or explosion event is not considered likely to be sufficient to contribute significantly to the annual mean levels of NOx in this area.

With regards to nitrogen nitrification, the key consideration is that detrimental impacts are associated with long term increases in nutrient nitrogen deposition. APIS discusses short term increases in nutrient nitrogen:

'Because the availability of nitrogen is often the main growth limitation in many semi-natural ecosystems the response of most plants is positive initially, i.e. they grow better. However, such communities exist in balance because their growth rates are contained by the level of available N. When the availability of N increases this balance is upset and some, especially the lower plants, lose out from too little light or other resources.'

On this basis, a one-off dose of nutrient associated with a short-term nitrogen deposition event is considered to be of negligible significance as no significant potential for long term changes in flora composition at sensitive receptors is expected.

Similarly, a one-off dose of acidic by-products of combustion is of negligible significance as no significant potential for long term changes in soil chemistry and flora is expected.

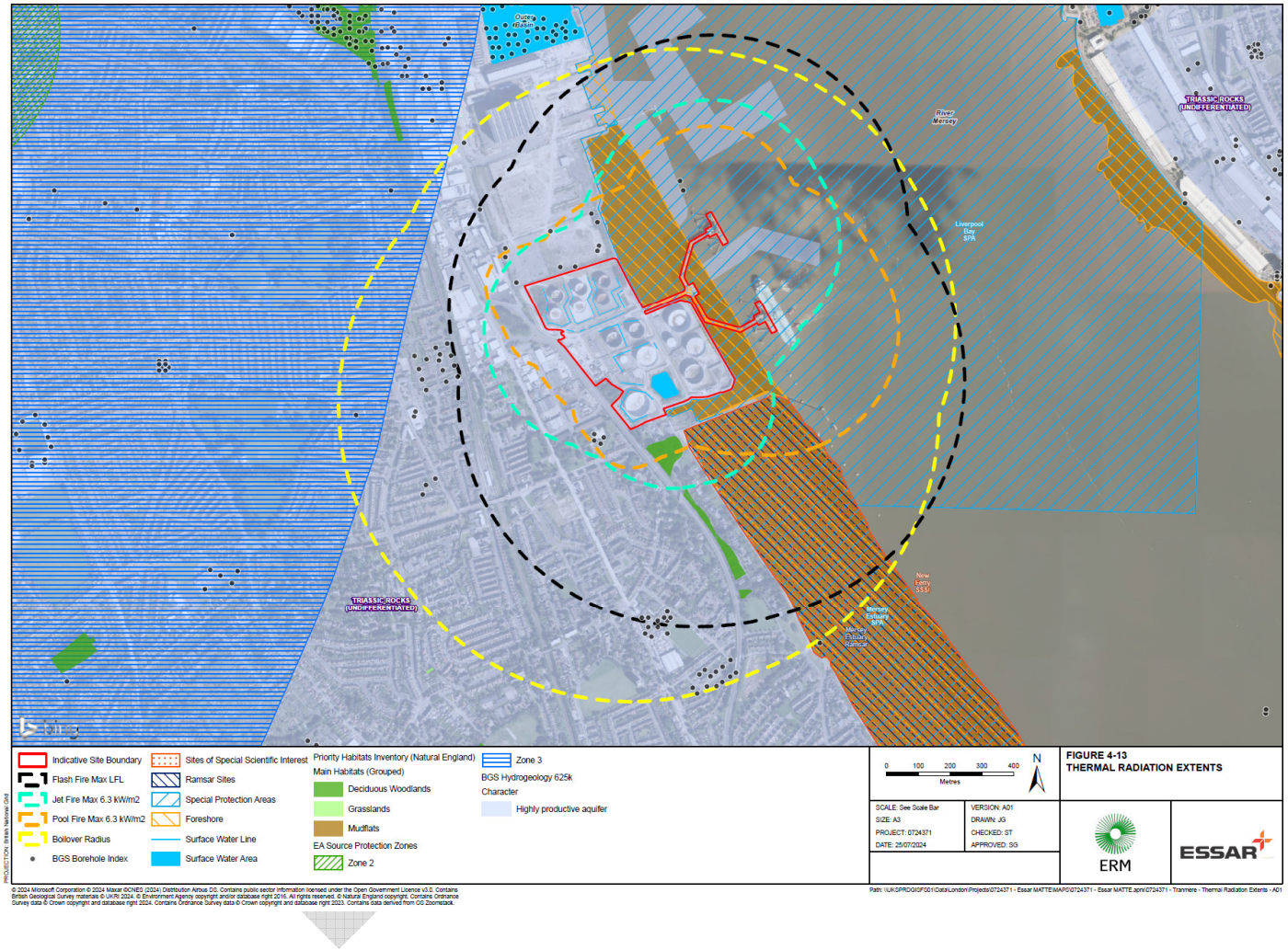
Regarding the smoke plumes themselves, there is a potential for an asphyxiant risk to fauna. This risk is, however, considered to be negligible for several reasons:

1. The smoke plumes from a fire are buoyant and therefore unlikely to drift across the foreshore to affect fauna at low elevations, instead rising high into the atmosphere and dispersing laterally based on the prevailing wind direction.
2. Most of the protected species relating to the SSSI and SPA are birds. These species are expected either to not be significantly exposed or are mobile and likely to move away from areas where smoke plumes could occur.
3. Studies from the Buncefield disaster suggest that environmental impacts from the smoke were limited. While there was likely to have been some degree of 'toxic' fallout as rain drove particulate matter from the smoke back to earth, it will have been dispersed over a wide area and despite the scale of the fire it was not predicted to cause any lasting problems.
4. Predictive modelling completed after the Buncefield disaster assessed potential air pollution impacts which might have occurred under different prevailing meteorological conditions. Although the particle pollution-related health impacts of the Buncefield fire could have been higher under different meteorological conditions, the study concluded that it was unlikely that the impacts would be substantially greater than those attributable to regular anthropogenic particle pollution over a

similar period – even if weather conditions had been less favourable and the smoke plume had been diverted over larger population areas.

Based on the evidence identified in the review, an emission to air as a result of a fire or explosion at the Site are considered likely to have negligible effects on the identified sensitive ecological receptors, and as such is considered unlikely to give rise to a MATTE event. On this basis, the potential risks via the air pathway for the products of combustion are not considered to present a plausible MATTE risk following a fire or explosion and are thus considered Sub-MATTE.

FIGURE 4-13 THERMAL RADIATION EXTENTS



4.4.4 TOXIC RELEASE

No acutely toxic material is handled within the Site. Whilst some toxic hazards could be associated with crude oil, the H_2S concentrations in the crude oil received is generally low.

4.4.5 OVERPRESSURE

One of the potential risks from an explosion, regarding the environment (and for risk to life), is the generation of overpressure which has the potential to result in structural damage.

The amount of overpressure to cause damage will vary based on the type of receptor. For a building where glass windows are part of the reason for listing the tolerable level of overpressure may be much lower than that which would cause structural damage.

Given the nature of the immediate surroundings the risks to the natural environment are low via this 'pathway'.

The range of overpressures which may cause damage are summarised by the US National Oceanic and Atmospheric Administration (NOAA)[43] is provided in Table 4-9.

TABLE 4-9 OVERPRESSURES AND RELATED DAMAGE EXTENT

Level of damage expected at specific overpressure values		
Overpressure*		Potential Damage
(psig)	bar	
0.04	0.0028	Loud noise (143 db); sonic boom glass failure.
0.15	0.0105	Typical pressure for glass failure.
0.4	0.028	Limited minor structural damage.
0.50-1.0	0.035-0.07	Windows usually shattered; some window frame damage.
0.7	0.049	Minor damage to house structures.
1	0.07	Partial demolition of houses; made uninhabitable.
1.0-2.0	0.07-0.14	Corrugated metal panels fail and buckle. Housing wood panels blown in.
1.0-8.0	0.14-0.56	Range for slight to serious laceration injuries from flying glass and other missiles.
2	0.14	Partial collapse of walls and roofs of houses.
2.0-3.0	0.14-0.21	Non-reinforced concrete or cinder block walls shattered.
2.4-12.2	0.17-0.854	Range for 1-90% eardrum rupture among exposed populations.
2.5	0.175	50% destruction of home brickwork.
3	0.21	Steel frame buildings distorted and pulled away from foundation.
5	0.35	Wooden utility poles snapped.
5.0-7.0	0.35-0.49	Nearly complete destruction of houses.
7	0.49	Loaded train cars overturned.

[43] https://response.restoration.noaa.gov/oil-and-chemical-spills/chemical-spills/resources/overpressure-levels-concern.html (accessed 21/03/2024)

Level of damage expected at specific overpressure values		
9	0.63	Loaded train box cars demolished.
10	0.7	Probable total building destruction.
14.5-29.0	1.015-2.03	Range for 1-99% fatalities among exposed populations due to direct blast effects.
* These are peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.		
Lees, Frank P. 1980. *Loss Prevention in the Process Industries*, Vol. 1. London and Boston: Butterworths.		

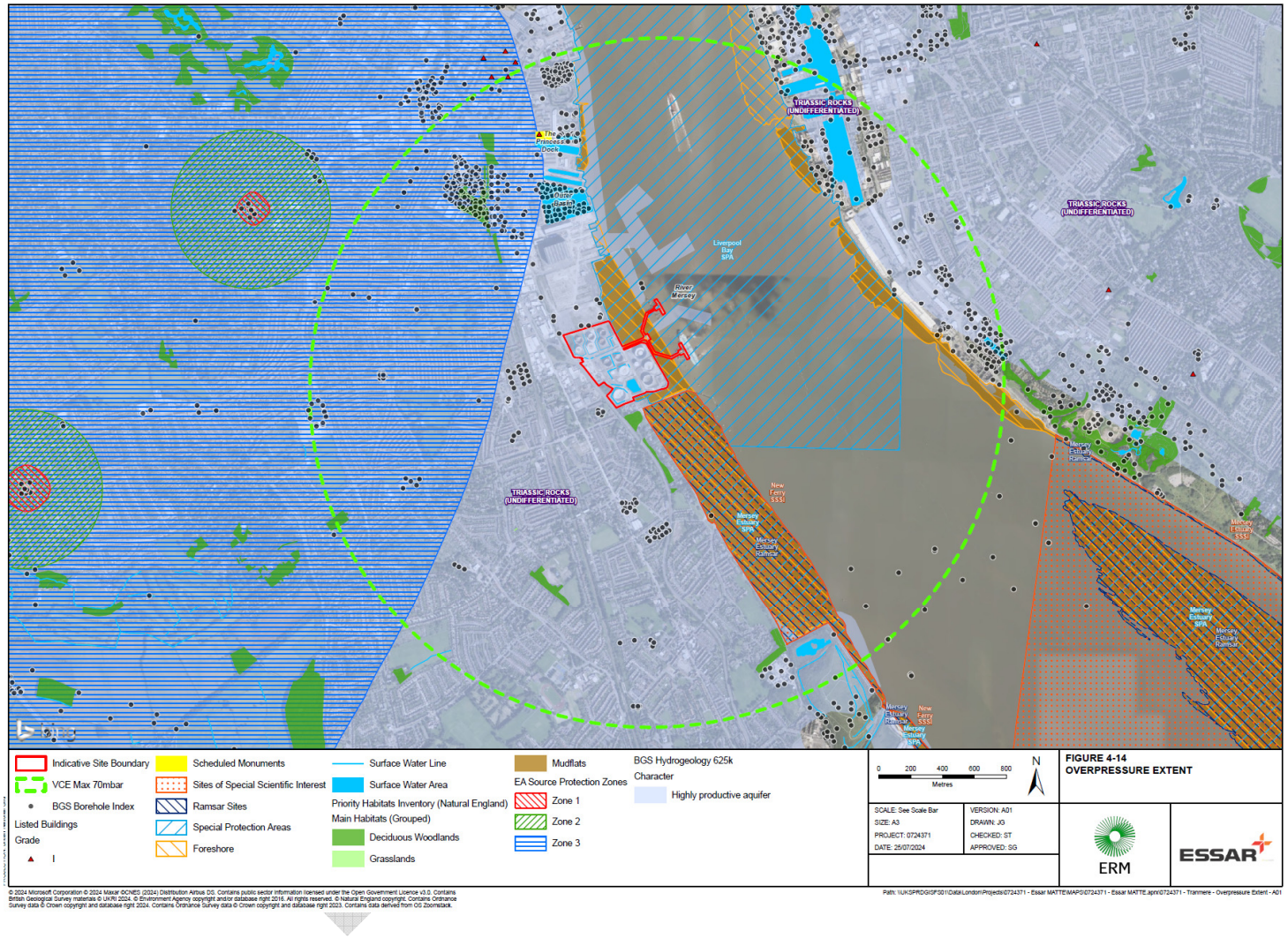
Evidence from the Buncefield disaster showed a rapid decline in overpressure with distance away from the vapour cloud, with overpressure values of 0.10 - 0.12 bar being indicated up to 200m from the vapour cloud source [15].

The closest Grade I Listed Building or Scheduled Monument to the Site is the Remains of Birkenhead Priory, located approximately 1.2 km to the north, in the town of Birkenhead. These receptors are shown to be intersected by the worst-case 70 mbar overpressure extents (where partial demolition of houses is expected rendering them uninhabitable as indicated in Table 4-12). Figure 4-14 shows the worst-case 70 mbar overpressure extent with respect to MAS, downwind distance, and weather conditions sourced from the QRA, and shows Birkenhead Priory is the only Grade I Listed Building or Scheduled Monument intersected by the overpressure extent. This 70 mbar overpressure extent is for a VCE of the Mogas Export pipeline (TRAN-04C-MO) which extends approximately 2,100 m. The next largest 70mbar overpressure extent extends approximately 890 m from a VCE of the Mogas Loading Arm (TRAN-05-MO), which falls short of the Birkenhead Priory.

For the estuary-based receptors intersected by the VCE extent, these are focussed around the intertidal mudflats and as such are not considered to be at risk of a MATTE from overpressure.

Therefore, the risk from a VCE MAS from the mogas export pipeline is considered to have MATTE potential, while all other VCE scenario are considered to be sub-MATTE and excluded from the assessment.

FIGURE 4-14 OVERPRESSURE EXTENT



4.4.6 OVERLAND FLOW

Overland flow at the Site could result from the release of material from primary or secondary containment following an incident or because of the addition of firewater. Runoff could result in:

- localised pooling of released liquid or firewater on the ground surface, and subsequent infiltration into the underlying groundwater
- released liquid or firewater encountering a barrier high enough to contain the released volume, and preventing further release into the environment
- liquid release due to the catastrophic failure of a tank and the subsequent formation of a wave of liquid overtopping the bund wall and/or
- released liquids entering the site drainage system, where they have potential to discharge via the North Interceptor out to the Mersey Estuary.

The potential for the release of liquid substances onto the land surface exists for the storage tanks, pipelines and pumps. The storage tanks are located within bunds which provide secondary containment. Any releases into a bund would have to escape the secondary containment before moving off-site and engaging tertiary containment / site drainage. It is noted that the effect of bunding is ignored in the unmitigated assessment of risk.

All pumps are located within bunded areas. The Pumphouse contains crude and gas oil transfer pumps, and is situated within a common bunded area with a reported capacity of 8,000 m³. The Eastham export and boost pumps are located within the bund of T6015 / T6012 / T6009.

The pipeline sections YP1336-W, YP1239-W, and YP1439-W, representing crude and gas oil export lines from the north and south jetties to the jetty tie-in point, are located over the water and as such do not have containment. Therefore, any release has the potential to directly enter the Mersey Estuary.

The pipelines sections YP2140-W, YP1251-W, and YP3460 are provided with partial containment for the extents located within the pumphouse / pipetrack bund, T6015/T6012/T6009 bund, T6016 bund, and the overflow compound. For the extents located over the water, releases would directly enter the Mersey Estuary.

The pipeline sections YP2140-L, YP1251-L,YP1366-L, YP1239-L, YP1439-L, YP1245 are located within bunds.

The main receptor which may be impacted by a release is the Mersey Estuary, which is home to a range of receptors that are considered to potentially be at risk of a MATTE. These include the Intertidal Substrate which includes the Littoral / Sub-Littoral Zones, Shellfish Water Protected Areas, seabirds, sea mammals and the estuary itself as a surface water receptor.

4.4.7 DIRECT ENTRY TO SURFACE WATER

The ship loading/unloading activities at the north and south jetty, and the associated crude / gas oil pipelines and manifolds have the potential to result in a release of oil directly into the Mersey Estuary.

Additionally, as discussed in Section 4.4.6 YP3460 is divided into two sub-compartments to account for the possibility of direct release into the tidal flats from the section of the pipeline located outside the seawall. YP1336-W, YP1239-W, and YP1439-W, TRAN-04C-MO, and TRAN-

07A-VG are situated beyond the seawall on the jetty and could lead to a direct release of hydrocarbons into the estuary.

4.4.8 GROUND INFILTRATION REACHING GROUNDWATER

A release of liquids is likely to result in pooling on the ground, except in areas where there are impervious linings such as concrete. This liquid will then begin to permeate into the ground. The rate of ground infiltration will be dependent on a number of parameter: properties of product leading to volatilisation and evaporation; the hydraulic conductivity of the ground, the depth of liquid which has pooled and the amount of time the pool persists for.

Potential ground infiltraiton can occur following a release inside or outside of secondary containment. The detection and residence time for the liquid will also be a factor in terms of how much liquid may be lost to the ground. Once it reaches the subsurface, given the fuel types are LNAPLs the liquid hydrocarbon will begin to spread out on, and dissolve into groundwater within the underlying principal aquifer.

As discussed in Section 4.3.2.7, the bedrock aquifer beneath the Site is not within a Source Protection Zone and no drinking water abstraction wells have been identified within the vicinity of the Site. However, The Environment Agency (EA) have advised the bedrock aquifer beneath the Site should be treated as a drinking water source due to the potential for future utilisation.

A MATTE to groundwater as a drinking water source is defined as the interruption of drinking water supplied from a ground or surface source (where persons affected x duration in hours [at least 2] > 1,000 hours), or an impact to >1ha of a SPZ where drinking water standards are breached. However, as it is understood the aquifer beneath the Site is not currently supplying any people, the potential to exceed the areal threshold will be used to determine MATTE potential.

In 2020, a tank floor leak incident occurred at the Site due to corrosion from T6017, resulting in the release of approximately 340 m^3 crude oil. A subsequent investigation conducted by WSP [7] focused on examining the T6017 bund and the area north of the tank within the T6019 bund. Analysis of soil and groundwater quality data gathered during the investigation revealed the following estimated extents of contamination:

- The estimated area of soil contamination resulting from the loss of 340 m^3 of crude oil is approximately 1.2 ha.
- The estimated area of groundwater contamination within the underlying aquifer, resulting from a loss of 340 m^3 of crude oil, has been estimated at approximately 1.8 ha.

The report further indicates that the majority of the hydrocarbon mass is concentrated within the shallow part of the groundwater system with no clear evidence of significant vertical migration into the deeper parts of the sandstone aquifer.

It is considered plausible for releases on-site to impact >1ha of the underlying bedrock aquifer resulting in drinking water standards being breached, triggering the MATTE threshold. As such for releases to groundwater a MATTE is considered plausible.

4.4.9 SUBSURFACE FLOW INTO SURFACE WATER COURSES

Based on the location of the Site adjacent to the Mersey Estuary, the only surface water receptor for subsurface transmission of a release would be the estuary itself. It is understood the potential pathway for transmission of subsurface releases to the Mersey Estuary are limited

by the sea wall and cofferdam installed around the T6017 bund, which are expected to extend 3-5m below the ground surface. This is discussed further in Section 4.5.1.2.

Furthermore, the same initiating events pose an overland risk to the same receptor, and the potential for a slower subsurface pathway for the same release would result in double-counting of the risk (since there eis no partitioning of likelihood between the pathways). When also considering the size of the Mersey Estuary, even if a subsurface pathway existed, it is considered that the chronic nature of any subsurface transmission from a release would be sub-MATTE.

4.4.10 MULTI-ASSET ESCALATION

Based on the asset sizes and locations, as well as the surrounding environmental receptors, it is not considered a secondary escalation event resulting in the release of additional unignited liquid, or additional thermal radiation or overpressure, would result in an increase in MATTE Severity at any of the identified receptors. Therefore, the failure frequency of the original initiating MAS is considered appropriate in representing the risk from on-site MAS even when including potential multi-asset escalation.

4.4.11 SOURCE-PATHWAY-RECEPTOR SUMMARY

In conclusion, following the assessment of S-P-R linkages, the following are considered plausible for the identified MAS, pathways and receptors discussed above.

- Overland flow of liquid releases from the Site, including firewater addition in the event of a fire scenario, which follow the topography of the Site and surrounding land, before either entering the drainage system, and/or moving off-site into the Mersey Estuary and impacting the associated receptors.
- Direct entry of a release from the north and south jetty and associated pipelines and crude and gas oil manifolds. Additionally, a release from Eastham and Stanlow export lines into the Mersey Estuary potentially impacting the associated environmental receptors.
- A liquid release onto the ground surface, or via a below tank floor leak, has the potential to infiltrate into the subsurface and impacting the underlying bedrock aquifer which is considered to have potential future drinking water utility.
- A VCE from the mogas export pipeline has the potential to generate a 70mbar overpressure extent that reaches the Birkenhead Priory, which is classified as both a Grade I Listed Building and Scheduled Monument.

4.5 ASSESSMENT OF ENVIRONMENTAL CONSEQUENCES

4.5.1 ASSESSMENT OF MATTE SEVERITY

A MATTE severity assessment for the identified MAS and receptors has been undertaken and is based on ERM's professional judgement and published guidelines.

4.5.1.1 RECEPTOR MATTE SEVERITY SUMMARY

Table 4-10 summarises the MATTE potential and severity considered for each of the receptors identified within 10 km of the Site. Receptors which are not considered to have MATTE potential are not considered further in this assessment, meaning only the receptors considered to have MATTE potential are included in subsequent sections of the assessment.

The MATTE Severity is assessed based not only on the pathway and receptor MATTE thresholds, but also based on the released substance and associated volume (the source). The hazardous substances are categorised under 'Liquid Hydrocarbons', due to possessing similar physical and chemical properties.

4.5.1.2 LIQUID HYDROCARBON RELEASES

This includes crude oil, gas oil of various grades, gasoline and flushing oil stored and utilised on-site. An unignited release of these substances is expected to form sheens across surface waters and receptors, as well as producing dissolved phase constituents. In groundwater, hydrocarbons will form both a sheen on top of the water table as well as dissolved phase constituents that are dispersed and transported through groundwater.

A release of hydrocarbons into the Mersey Estuary will have adverse effects on water quality in the vicinity of the release and is expected to form a slick on the surface. The significance of this is likely to become reduced as the oil is dispersed through the estuary due to tidal action, wind action, and currents. Degradation of the oil will also occur, with evaporation to air, and deposition to the sediment reducing the quantity of oil present in the water. It is expected that volatilisation from the slick to the air is likely to be significant. This will reduce the quantity of liquid hydrocarbon present in the slick.

Where an oil release reaches shoreline areas in the estuary, the hydrocarbons will 'coat' the land surface. The oil thickness on the shoreline will be a function of the amount spilled, the spill trajectory, the characteristics of the oil (viscosity and adhesiveness), steepness of the shoreline slope, tidal conditions at the time of shoreline impact, and the porosity of the surface [16]. On-shore winds can result in oil being blown onto the coast above the high tide mark.

The effectiveness of wave energy in removing or re-floating oil is dependent on the permeability of the shoreline substrate, the oil type and weathering condition with respect to adhesiveness. Wave energy can effectively remove oil from a bedrock shoreline where there is little to no penetration [16].

When oil is spilled at sea it normally spreads out and moves on the sea surface with wind and current while undergoing several chemical and physical changes. These processes are collectively termed weathering and determine the fate of the oil. There are eight main weathering processes; spreading, evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation.

Some of these processes, like natural dispersion of the oil into the water, lead to the removal of the oil from the sea surface and facilitate its natural breakdown in the marine environment. Others, particularly the formation of water-in-oil emulsions, cause the oil to become more persistent, and remain at sea or on the shoreline for prolonged periods of time.

The speed and relative importance of the processes depend on factors such as the quantity spilled, the oil's initial physical and chemical characteristics, weather and sea conditions and whether the oil remains at sea or is washed ashore.

Ultimately, the marine environment usually eliminates spilled oil through the long-term process of biodegradation [44].

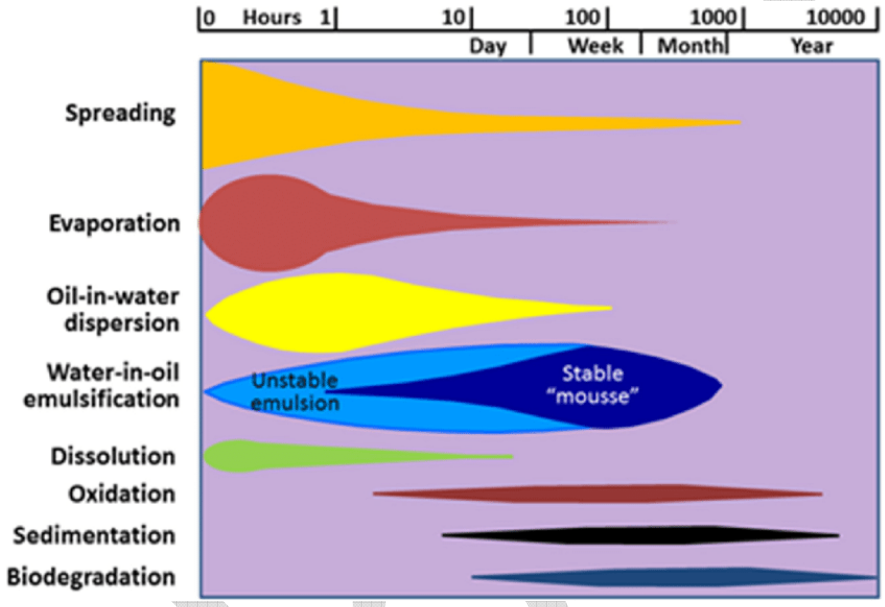
[44] *https://www.itopf.org/knowledge-resources/documents-guides/fate-of-oil-spills/weathering/ (Accessed 24/04/2024)*

As a rule, each process can be put into one of two chronological categories in terms of when their effect is most significant:

- Early stage of a spill: spreading, evaporation, dispersion, emulsification and dissolution
- Later stage of a spill: oxidation, sedimentation and biodegradation. These are longer term processes that will determine the fate of the oil spilled.

The diagram below represents the fate of a typical crude oil spill, showing changes in the relative importance of weathering process with time (from hours to years). The width of the band indicates the importance of the process.

FIGURE 4.15 WEATHERING PROCESS OF A TYPICAL CRUDE OIL



Therefore, liquid hydrocarbons are considered to pose a MATTE risk to environmental media and habitats such as the mudflats and estuarine waters themselves, as well as posing a risk to the species that are present.

For this assessment, the minimum thickness of oil required to result in a MATTE level impact are presented below;

- For surface waters thicknesses of 0.1 mm and greater are categorised as a 'coat' by the Convention in Shoreline Cleanup Assessment Team (SCAT) Data [16]
- For mudflats an oil thickness of 14mm is considered as the threshold for environmental impact [17]

Regulatory authorities within the UK have previously advised that a slick thickness of 0.1 mm is considered capable of resulting in a MATTE level impact on open water should sufficient volume be released to exceed the areal extents outlined in the CDOIF guidance. On this basis, 1 m^3 could potentially result in a MATTE level of impact with an areal extent of 10,000 m^2 (1 ha).

This is considered highly conservative as an even spreading of oil over very significant areas of open water is highly improbable. Wind and tidal action are likely to significantly constrain the area over which the oil would be able to spread and is likely to be directed to near-shore

environments because of the location of the discharge point into the Mersey Estuary. In lieu of modelling we have adopted this conservative pancake spreading approach.

Following a release of oil into the Mersey Estuary, it is expected the volume of the release would decrease significantly over the first few hours or days of the release incident occurring. Notwithstanding these effects on the oil the MATTE assessment assumes that at the unmitigated stage all of the oil could ultimately reach a sensitive downgradient environmental receptor.

Anecdotal Evidence

Pipeline Release to Mersey Estuary

In August 1989, a pipeline fracture resulted in the release of approximately 150 m^3 of crude oil into the Mersey Estuary [18]. The oil spread widely due to tidal currents within a single cycle. The estuary hosts salt marshes and intertidal mudflats used by wildfowl and wading birds. Shoreline cleanup was organised on a local district basis and was carried out at key sites. Approximately 20 tonnes of the spilled oil came ashore at Grassendale along 200 m of shoreline, in places up to 45 cm deep. The main environmental impact of the spill is discussed below:

- Most of the spilled oil was deposited high on the shore and its heavy, viscous nature determined that little remobilisation occurred after stranding.
- The area from the Widnes-Runcorn bridge to Warrington suffered continuous oiling of the upper shore along the northern bank and sporadic oiling along the southern bank.
- Inner estuary damage was concentrated on the north shore, with oiled salt marshes sustaining localised vegetation impact, primarily at high water marks and creek edges.
- Intertidal sediments were minimally affected.
- Species such as shelduck, widgeon, teal, pintail, dunlin, and redshank, both internationally and nationally significant, remained unaffected by the oil spill.
- The major resources affected in the outer estuary were the sandy beaches of New Brighton, Crosby, Formby, and Southport. New Brighton was heavily contaminated in the early stages of the spill and dispersant was used in the beach cleanup.
- Bird population surveys showed no significant impact, however 350 bird deaths were directly attributed to oiling.
- Invertebrate studies detected no spill-related effects within salt marshes, mudflats, and sandy shores.

Milford Haven Sea Empress Incident

The grounding of the Sea Empress tanker in February 1996 resulted in a large spill of Forties Blend crude oil. It is estimated that approximately 71,800 tonnes of oil (approximately 91,445 m^3 based on a density of 800 kg/m^3) was lost from the ship before being salvaged. It is reported that approximately 2,000 seabirds (plus 3,500 scoters) were killed following the Sea Empress spill; however these numbers may understate the impacts. Following the Sea Empress spill, there were no reports of impacts to otters. Similarly, no impacts to seals were reported, apart from some tar spots present on the fur of pups. The Sea Empress spill occurred at the end of the moulting season, and well after the 1995 pupping season, hence is likely that seal numbers in the area were relatively low.

Designated Bird Species

The CDOIF guidance states the following MATTE thresholds for impacts on bird populations associated with internationally designated areas (i.e. they form part of the basis for the designation).

- Sub-MATTE: <5% of site population
- Severe: >5-25% of site population
- Major: >25-50% of site population
- Catastrophic: >50% of site population

Bird population data from the Wetland Bird Survey Data (WeBS), provided by the British Trust for Ornithology (BTO), for the intertidal subsections ('Birkenhead Waterfront' and 'New Ferry') adjacent to the Site were not available for the last five years. It is considered a release could impact bird populations in the two intertidal subsections adjacent to the Site. These intertidal subsections occupy a combined area of approximately 570 ha.

Due to the lack of current bird population data for the adjacent intertidal subsections, this assessment adopts an approach where it is assumed that an MAS from the Site could impact 100% of the bird population in the New Ferry and Birkenhead Waterfront intertidal areas. The assessment also assumes uniform bird population distribution throughout the Mersey Estuary SPA. These intertidal subsections collectively represent approximately 11% of the aerial extent of the SPA, assuming an even distribution of bird population, this equates to approximately 11% of the SPA bird populations being present within the intertidal subsections at any time. Using this logic the 5% threshold for a Level 2 Severity MATTE equates to 260 ha of the adjacent intertidal subsections being impacted by an oil thickness of 0.1mm, which equates to 260 m^3.

Therefore, according to the MATTE threshold, a **Level 2 'Severe'** MATTE Severity (>5-25% of Site Population) is considered plausible for release volumes >260 m^3.

Seabirds

A MATTE to seabirds can be realised under the marine receptor classification.

- Sub-MATTE: <100 dead seabirds
- Severe: >100 - 1,000 dead seabirds
- Major: >1,000 - 10,000 dead seabirds
- Catastrophic: >10,000 dead seabirds

The WeBS dataset provides a monthly bird population core count for the Mersey Estuary as a whole. Using the same logic as above, the two intertidal areas adjacent to the Site represent 11% of the total SPA area, and are as such considered to have the potential to impact 11% of the total observed bird population for a given month. The data spans 60 months, and as such the MATTE Severity was proportioned on the number of months where 11% of the total SPA observed bird population exceeded 100, 1000, and 10000 birds. It was found that;

- A MATTE Severity 2 (>100 sea birds) was exceeded 100% of the time
- A MATTE Severity 3 (>1,000 sea birds present) was exceeded approximately 80% of the time
- A MATTE Severity 4 (>10,000 sea birds present) was not exceeded at any month

Protected Species

Dissolved phase concentrations are considered to have the potential to cause a MATTE by impacting protected species potentially located within the Mersey Estuary. These species discussed in Section 4.3.2.10 include the European Eel (*Anguilla anguilla*), Bullhead (*Cottus gobio*), and Crucian carp (*Carassius carassius*). To trigger a MATTE under the internationally designated site/species receptor type >5% of the designated population must be impacted by a MAS. Population data for these species within the Mersey Estuary has not been identified.

It is reported the European eel and migratory lamprey species have failed to capitalise on the improvements in water quality and remain absent from the upper catchment of the Manchester Ship Canal [19]. The presence of high densities of eels in the Rivers Weaver and Gowy confirm that the Mersey Estuary does, however, receive a healthy influx of elvers.

The eel has been regarded as one of the most pollution tolerant fish which was evident as it was one of the first species to take advantage of improving water quality in the Thames [20]. Wheeler [21] notes that even during the height of the pollution in the Thames, eels could be found in the river's upper reaches. It is unclear whether these stocks originated naturally from the successful ascent of the river by elvers or from the substantial numbers of elvers that are now known to have been imported via the Thames for food consumption.

The reasons for the total extinction of eels from the upper Mersey catchment is not known, but the extended freshwater phase of the European eel can typically range between 7-19 years [22], making them particularly susceptible to bioaccumulation of various pollutants as well as more immediate sensitivity to poor oxygen levels during migration. Despite their avoidance of low oxygen concentrations, eels commonly occur in deep stratified waterbodies, but favour the shallower littoral zone, only venturing into deeper water for limited periods to feed [23].

Whilst toxicity studies haven't been undertaken for the eels themselves there are studies on diesel toxicity to fish which are considered conservatively representative of eels which have tolerance to poor water quality. The lethal loading rate resulting in 50% mortality in fish (LC50) for diesel (gas oil) was reported to be 21 mg/l in the MSDS for diesel. This is considered a reasonable timeframe as the diesel release is expected to be diluted, weathered and dispersed upon entering the estuary. It is considered local to the Site releases of oil could result in short-term exceedances of this LC50 value.

The European eel is reported to be distributed in the Mersey Estuary and its various tributaries [24], as such the total population is considered to be spread across a relatively large area of surface waters. Based on the LL50 concentration, it is considered that releases of oil into the Mersey Estuary would have MATTE potential through impacting >5% of the local European eel population, meaning a MATTE Severity Level 2 is considered plausible. However, based on the international distribution of the European eels based on their migratory patterns, their geographic distribution in and around the Mersey Estuary, and the short-term nature of the oil persistence in the water column, it is not considered a release from Site could impact >25% of the population, meaning a MATTE Severity Level 3 is not considered plausible.

The habitat favoured by the bullhead is not considered to be represented by the Mersey Estuary around the Site, as it is not considered to comprise hard substrate and clear / shallow waters, due to the presence of the mudflats and intertidal substrate found throughout the estuary. It is not considered that >5% of the local population would be present within the vicinity of the Site, and as such the risk posed to the bullhead is considered to be sub-MATTE.

The Crucian carp prefers shallow slow-flowing watercourses, and is considered tolerant to polluted, low oxygen watercourses. Although the species could be present in the Mersey Estuary, it is not considered >5% of the local species population would be located within the vicinity of the Site. The risk posed to the carp is considered to be sub-MATTE.

Groundwater

T6017 Tank Floor Release

The MATTE Severity to groundwater can be informed in part by the incident in 2020 where approximately 340 m^3 of crude oil was lost via the floor of T6017 due to corrosion, and this is described by the WSP ground investigation completed in 2020 [7]. The tank leak is reported to have occurred over a period of two weeks before the tank contents were transferred out. The estimated leak rate was 3.5 m^3/hour from an estimated hole size of up to 18mm.

Whilst a proportion of the released hydrocarbon product is considered to have penetrated the ground, observations following the incident highlighted that a significant proportion of the product was contained within the bund and was able to be recovered. Following the incident, no reports of visible impact in the Mersey Estuary or its foreshore have been recorded. The majority of the release was reported to have moved laterally within the sand-bitumen layer beneath the tank floor and discharged into the bund. The bund drainage which was pumped to the North Interceptor (now a permanent process) was not found to exceed any emission limits at outfall W1 following the incident.

It is understood the tank base comprised approximately 0.6m hardcore, overlaying 1.0m – 1.5m of limestone gravel laid directly onto sandstone. An approximate 50mm layer of sand separates the base of the tank from the hardcore. The tank floor did not have tell-tale leak detection installed, but did benefit from a protective coating.

The current sea wall protecting the T6017 bund is a cellular caissons (cofferdam) construction of fifty-five alternating larger and smaller diameter circular steel sheet pile cells along approximately 400m of estuary frontage. The depth of the driven piles and the specific pile design are not known; however, both the original sea wall and current cofferdam structure could reasonably be expected to extend to 3-5m below ground level.

In summary;

- The estimated area of soil contamination resulting from the loss of 340 m^3 of crude oil is approximately 1.2 ha.
- The estimated area of groundwater contamination within the underlying aquifer, resulting from a loss of 340 m^3 of crude oil is approximately 1.8 ha.

The report further indicates that the majority of the hydrocarbon mass is concentrated within the shallower parts of the groundwater system and indicates no clear evidence of significant vertical migration into the deeper parts of the principal bedrock sandstone aquifer [7].

Tank Floor Release Modelling

IKM completed a series of tank floor hole release simulations using the Hydrocarbon Spill Screening Model (HSSM) model. A series of models were completed for a release of light and medium crude oil from tanks T6013, T6015, T6017 and T6019, for hole sizes of 0.05m (small), 0.3m (medium) and 1.0m (large) diameter.

The results indicate the oil is simulated to move between 400m - 700m from the bund over a period of 1,000 assuming no degradation, with a maximum areal extent of approximately 60 ha (for small hole) and 200 ha (for medium hole) at steady state and on the basis that the leak continues to occur over a period of more than 12 years. The release is simulated to reach the water table within a few days, and the 1 ha MATTE threshold is simulated to be exceeded within 14 days for all hole sizes.

The model does not account for the presence of the coffer dam wall / sea wall boundary which is located at a distance of 25m (T6017 / T6019) - 170m (T6013) from the tanks. It also doesn't consider degradation of the hydrocarbon or the potential (especially for the medium size hole) that it would be detected either through loss analysis, routine monitoring or as a result of discharge being observed in the Mersey Estuary. Therefore, the areal extent of product from the simulations will be significantly overestimated. The practical limit for groundwater contamination given the modelling work, observations from the 2020 incident and the presence of the estuary which will introduce limitations on groundwater utility due to salinity, is considered to be <100 ha.

4.5.1.3 FIREWATER APPLICATION

As discussed in Section 4.2.4.2 the firefighting foam is not considered to pose a MATTE risk to the environmental receptors in its own right. It is the potential for the foam as part of firewater addition to mobilise hydrocarbons and potentially transport them to these receptors that is considered to have MATTE potential. The MATTE Severity assigned to firewater addition scenarios is consistent with the severity assigned to the associated unignited hydrocarbon release scenarios.

4.5.1.4 RECEPTOR MATTE SEVERITY SUMMARYTABLE 4-10 RECEPTOR MATTE SEVERITY

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
Designated Land/Water Sites (Internationally important)	Mersey Estuary SPA / Ramsar (Areal Threshold)	Directly south	5,023	<0.5ha or <5% of site area	>0.5ha or >5-25% of site area	>25-50% of site area	>50% of site area	A majority of the Mersey Estuary SPA / Ramsar comprises of mudflats. As such the oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2; • The release volume required to coat 0.5 ha with 14mm of oil and trigger a MATTE Severity 2 is 70 m^3 The release volume required to coat >25% of the receptor (approximately 1,250 ha) with 14mm of oil and trigger a MATTE Severity 3 is >175,000 m^3 The largest release volume from the Site is approximately 171,960 m^3, as such a **MATTE Severity 2** is considered appropriate for MAS with volumes >70 m^3.
	Mersey Estuary SPA Designated Bird Populations	Directly south	5,023	<0.5ha or <5% of site population	>0.5ha or >5-25% of site population	>25-50% of site population	>50% of site population	**MATTE Severity 2** is considered appropriate as explained in Section 4.5.1.2.
	Mersey Narrows & North Wirral Foreshore	7km north	2,079	<0.5ha or <5% of site area	>0.5ha or >5-25% of site area	>25-50% of site area	>50% of site area	A majority of the SPA / Ramsar comprises of mudflats. As such the oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2;

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
	SPA / Ramsar							• The release volume required to coat 0.5 ha with 14mm of oil and trigger a MATTE Severity 2 is 70 m^3 • The release volume required to coat >25% of the receptor (approximately 520 ha) with 14mm of oil and trigger a MATTE Severity 3 is >72,800 m^3 • The release volume required to coat >50% of the receptor (approximately 1,140 ha) with 14mm of oil and trigger a MATTE Severity 4 is >145,600 m^3 The largest unmitigated release volume from the Site is approximately 171,960 m^3. However, a majority of the receptor is located around the headland from New Brighton to Hoylake which is considered to be located sufficiently far to experience widespread impact from an oil release from Site. Therefore, a **MATTE Severity 2** is considered appropriate for MAS with volumes >70 m^3.
	IUCN Protected Species	Mersey Estuary	-	<5% of population	>5-25% of population	>25-50% of population	>50% of population	Based on the geographic distribution, migratory patterns and short-term persistence of hydrocarbons in the water column, it is not considered plausible for >25% of European eels to be impacted, but >5% is considered

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
								plausible resulting in a **MATTE Severity 2**. Bullheads and Crucian carp are not considered to be present within the vicinity of the Site based on their preferred habitats. The species are not unique to the Mersey Estuary and are reported to be widespread across several tributaries. As such it is considered highly unlikely that a release could result in >5% of the local populations being impacted, and the risk is considered **sub-MATTE**.
Designated Land/Water Sites (Nationally important)	New Ferry SSSI	Directly south	74	<0.5ha or <10% of site area or <10% of associated linear feature or population	>0.5ha or > 10%-50% of site area, associated linear feature or population	>50% of site area, associated linear feature or population	N/A	New Ferry SSSI comprises mudflats located directly south of the Site. As such the oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2; • The release volume required to coat 0.5 ha with 14mm of oil and trigger a MATTE Severity 2 is 70 m^3 • The release volume required to coat >50% of the receptor (approximately 38 ha) with 14mm of oil and trigger a MATTE Severity 3 is >5,320 m^3 MAS with release volumes of >5,320 m^3 are plausible at the Site meaning a **MATTE Severity 3** is considered plausible.

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
	Mersey Estuary SSSI	2.5km south	6,715	<0.5ha or <10% of site area or <10% of associated linear feature or population	>0.5ha or > 10%-50% of site area, associated linear feature or population	>50% of site area, associated linear feature or population	N/A	A majority of the Mersey Estuary SSSI comprises of mudflats. As such the oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2; • The release volume required to coat 0.5 ha with 14mm of oil and trigger a MATTE Severity 2 is 70 m^3 • The release volume required to coat >50% of the receptor (approximately 3,360 ha) with 14mm of oil and trigger a MATTE Severity 3 is >470,000 m^3 The largest release volume from the Site is approximately 171,960 m^3, as such a **MATTE Severity 2** is considered appropriate for MAS with volumes >70 m^3
	Mersey Narrows SSSI	3km north	116	<0.5ha or <10% of site area or <10% of associated linear feature or population	>0.5ha or > 10%-50% of site area, associated linear feature or population	>50% of site area, associated linear feature or population	N/A	A majority of the Mersey Narrows SSSI comprises of mudflats. As such the oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2; • The release volume required to coat 0.5 ha with 14mm of oil and trigger a MATTE Severity 2 is 70 m^3 • The release volume required to coat >50% of the receptor (approximately 30 ha) with 14mm of oil and trigger a MATTE Severity 3 is >8,120 m^3

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
								The largest release volume from the Site is approximately 171,960 m^3, as such a **MATTE Severity 3** is considered plausible.
Other Designated Land	Mersey Estuary RSPB Reserve	Directly south	1,500	<10ha or <10%	10-100ha or 10-50% of land	>100ha or >50% of land	N/A	A majority of the RSPB Reserve comprises of mudflats. As such the oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2; • The release volume required to coat 10 ha with 14mm of oil and trigger a MATTE Severity 2 is 1,400 m^3 • The release volume required to coat >100 ha with 14mm of oil and trigger a MATTE Severity 3 is >14,000 m^3 The largest release volume from the Site is approximately 171,960 m^3, as such a **MATTE Severity 3** is considered plausible.
	Priority Habitat Mudflats / Intertidal Substrate Foreshore	Directly south	~6,700	<2ha or <10-of habitat	>2ha or >10-of habitat	>20ha or >50% of habitat	N/A	The mudflats / foreshore represents the same approximate area as the Mersey Estuary SPA / Ramsar. The oil thickness threshold of 14mm is used to assess MATTE Severity as referenced in Section 4.5.1.2; • The release volume required to coat 2 ha with 14mm of oil and trigger a MATTE Severity 2 is 280 m^3 • The release volume required to coat 20 ha with 14mm of oil and trigger a MATTE Severity 3 is 2,800 m^3

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
								The largest release volume from the Site is approximately 171,960 m^3, as such a **MATTE Severity 3** is considered plausible.
	Priority Habitat Deciduous Woodland	70m south	-					Approximately 2 ha of deciduous woodland, elongated along Rock Ferry By-Pass is located to the south of the Site. The thermal radiation contours in Figure 4.13 indicate it is not considered plausible for a pool fire or jet fire scenario from Site to impact the entire woodland area (~2 ha), and the individual patches are not considered to be individual receptors where the >10% threshold can be used to trigger a MATTE. The flash fire scenario is considered short-lived, and unlikely to impact the full 2 ha of woodland. The elongated shape of the woodland area means it is considered unlikely a boilover scenario would result in an impact on the full 2 ha. Therefore, the risk posed to the deciduous woodland is considered to be **sub-MATTE**.
Widespread Habitat - Non Designated Water	Aquaculture / Fisheries Beaches	Mersey Estuary	-	-	Contamination of aquatic habitat which prevents fishing or aquaculture	N/A	N/A	Based on the presence of fishing and shellfish activities within the Mersey Estuary, a **MATTE Severity 2** is considered plausible due to a release causing a stop to these activities.

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
					or renders is inaccessible to the public.			Additionally, it is considered a release could result in closure of Rock Ferry Beach to public access, also triggering a **MATTE Severity 2**.
Groundwater – Drinking Source	Principal Aquifer (Bedrock) Source Protection Zones	-	-	Interruption of drinking water supply <1000 person-hours or <1ha SPZ	Interruption of drinking water supplied from a ground or surface source (where persons affected x duration in hours [at least 2] > 1,000) or 1-10ha of SPZ where drinking water standards are breached	>1 x 10^7 person-hours interruption of drinking water (a town of ~100,000 people losing supply for month) or 10-100ha SPZ drinking water standards breached	1 x 10^9 person-hours interruption of drinking (~1 million people losing supply for 1 month) or >100ha SPZ drinking water standards breached	As discussed in Section 4.4.8, the EA have requested the bedrock aquifer beneath the Site to be classified as a drinking water source based on potential for future utilisation. Groundwater beneath the Site is not currently used to supply drinking water, and as such the number of people that would be impacted by contamination of the aquifer is not quantified. Therefore, the areal thresholds are used to assign MATTE Severity. The Site area is approximately 20 ha. It is considered release volumes of >1,000 m^3 could impact of >10 ha of the bedrock aquifer, but not >100 ha. Releases of <1,000 m^3 are considered to be able to impact >1 ha, but not >10 ha of the sandstone aquifer. Therefore, a **MATTE Severity 3** is assigned to the bedrock aquifer.
Built Environment	Listed Buildings (Grade I) / Scheduled Monument	1.2 km north	-	Damage below a level at which designation of	Damage sufficient for designation of importance to be withdrawn.	Feature of built environment subject to designation of	N/A	As discussed in Section 4.4.5, the 70 mbar overpressure extent from a VCE of the Mogas Export Line has the potential to reach approximately 2100 m from the Site. A 70 mbar overpressure wave

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
				importance would be withdrawn.		importance entirely destroyed.		is considered to have the potential to cause partial demolition of buildings. Consequently, it is considered that this could damage the Birkenhead Priory sufficiently for its designation to be withdrawn, resulting in a **MATTE Severity Level 2**.
Marine	Seabirds	Mersey Estuary	-	<100 dead sea birds	100-1,000 dead sea birds	1,000-10,000 dead sea birds	>10,000 dead sea birds	Section 4.5.1.2 describes a **MATTE Severity 3** is plausible for a release scenario from Site.
	Sea Mammals	Mersey Estuary	-	<5 dead / significantly impaired sea mammals	>5 dead / significantly impaired sea mammals	> 50 dead / significantly impaired sea mammals	>500 dead / significantly impaired sea mammals	Although the information provided regarding the Sea Empress disaster did not identify significant impacts or deaths of seals and otters, it is noted this may have been influenced by the seasons. Therefore, the risk to sea mammals is considered to be **MATTE Severity 2**. However, it is not considered that >50 sea mammals would be significantly impaired or killed.
Fresh and Estuarine Water Habitats	Estuarine Waters	Directly east and south	-	WFD Chemical or ecological status lowered by one class for <2ha or 10% area of estuaries	WFD Chemical or ecological status lowered by one class for >2ha or 10% area of estuaries	WFD Chemical or ecological status lowered by one class for >20ha or 50% area of estuaries	WFD Chemical or ecological status lowered by one class for >200ha or 90% area of estuaries	Section 4.5.1.2 identifies that a slick thickness of 0.1mm on the water surface can be constituted as a 'coat', and as such is considered the thickness for a MATTE level impact. • The release volume required to coat 2 ha with 0.1mm of oil and trigger a MATTE Severity 2 is 2 m^3

CDOIF Receptor Type	CDOIF Receptor Name	Distance from Site (km) & Orientation	Area (ha)	MATTE Severity Threshold				Plausible Worst-Case Severity
				1	2	3	4	
								• The release volume required to coat 20 ha with 0.1mm of oil and trigger a MATTE Severity 3 is 20 m^3 • The release volume required to coat 200 ha with 0.1mm of oil and trigger a MATTE Severity 4 is 200 m^3 Therefore, based on the MAS release volumes a **MATTE Severity 4** is considered plausible. However, it is worth noting the WFD status is assigned to the Mersey Estuary as a whole, and not to subsections or parts of the estuary. The impact from directly to the estuarine waters also needs to take into account the potential duration of harm from the event noting that thresholds for bird mortality and species for the mudflats associated with the estuary are already considered separately.

4.5.2 ASSESSMENT OF DURATION AND RECOVERY PERIODS

The Energy Institute (EI) guide [5] provides assessors with a process for selecting a recovery category, which when combined with a 'Duration of Harm' category, will allow assessors to select an appropriate risk tolerability group for a given receptor. The assessment uses a flowchart to assess applicable duration criteria based on the type of material released and the sensitivity of the receptor, and these are provided for water and land based habitats in Figure 4-16 and Figure 4-17 respectively.

4.5.2.1 LIQUID HYDROCARBONS

Hydrocarbons in Figure 4-16 are classed as chemicals which may breakdown and transform in the environment, but which could have an effect which lasts for more than 1 year but less than 10 years. Hydrocarbon breakdown in the environment encompasses evaporation, dissolution, and biodegradation. Evaporation releases lighter hydrocarbons into the atmosphere, dissolution allows some to dissolve in water, and biodegradation involves microbial breakdown. These processes help mitigate the environmental impact of hydrocarbons, but the extent varies based on factors like hydrocarbon type and environmental conditions. While some hydrocarbons fully degrade, others may persist, posing potential risks to ecosystems. Weathering of hydrocarbons released to the marine environment is explained in section 4.5.1.2.

The primary sensitive receptor under assessment is the Mersey Estuary, designated at both international and national levels due to the significance of various bird populations and intertidal habitats. The intertidal habitats, mainly the mudflats, play a crucial role in these designations (SPA / RAMSAR / SSSI). This water habitat falls under Water Habitats Group 1 in the EI guidance in Figure 4-16. The most conservative duration criteria deemed relevant for the MATTE scenarios, considering the site's characteristics, materials involved, and receptor vulnerability, is classified as medium-term (i.e. > 1 year and < 10 years).

Anecdotal Evidence

Milford Haven Sea Empress Incident

A summary of the impacts of the release with a focus on the duration of impact is provided in Table 4-11:

TABLE 4-11 SEA EMPRESS SPILL IMPACTS AND DURATIONS

Receptor	Impact	Duration of Harm and Recovery
Seabirds	More than 2,000 dead or oiled seabirds were collected. Almost 80% were guillemots, and most of the rest were razorbills. Surveys of guillemots, razorbills and shags indicated that the populations of these species were affected in 1996 but were recovering in 1997.	By 2006, populations of guillemots, razorbills, and shags in Pembrokeshire showed rapid recovery post-spill, with overall guillemot numbers notably higher than pre-spill levels. However, certain marginal colonies seemed abandoned. Individual bird fate studies revealed significant impacts, attributed to population

Receptor	Impact	Duration of Harm and Recovery
		redistribution and breeding among previously non-breeding pairs, driving species recovery.
Scoter	Approximately 3,500 common scoters were killed, affecting a large proportion of the European population.	By 2006, the population had returned to pre-spill levels. It was also suggested that that the population was impacted by a reduction in the food supply (e.g. benthic bivalves), hence a recovery in scoter numbers implies a recovery of benthic species.
Wetland birds	Direct mortality of wetland birds, including waterfowl and waders, was limited, with fewer than 20 oystercatchers confirmed dead from observed corpses. The 1996 Wetland Bird survey revealed a stark decline in bird numbers on the two most contaminated mudflats, Angle Bay, and Pembroke River, shortly after the spill, while numbers increased at other sites. Approximately 100 badly oiled oystercatchers were discovered at Wiseman's Bridge, near Saundersfoot.	In the winter of 1997-98, bird numbers at all sites were not significantly different to previous years. however, there was evidence to suggest that wigeon and oystercatchers were avoiding Angle Bay.
Otters	No evidence of any effects	n/a
Seals	No evidence of notable impacts	n/a
Seabed Benthos Seabed Infaunal communities	Surveys of seabed sediment communities in Milford Haven carried out in 1996 and 1997 showed marked reductions in the numbers of small crustacean (amphipods and cumaceans). No other notable effects on macro fauna were noted.	Following the oil spill, a significant decline in amphipods, particularly Ampelisca spp., known for their sensitivity to oil pollution, prompted monitoring efforts in Milford Haven. However, within five years, the population of this genus displayed a clear recovery trend, returning to pre-spill levels. Surveys conducted in Carmarthen Bay between 1998 and 2000 showed no detectable effects on seabed communities, with shallow water bivalves appearing healthy and present in high densities.
Sub-Tidal Seagrass	The subtidal seagrass (Zostera marina) bed between Gelliwick Bay and Little Wick on the northern shoe of Milford Haven is of conservation interest. Surveys of the seagrass bed following the spill found no signs of impact and hydrocarbon concentrations in sediments were reported to be low.	n/a

Receptor	Impact	Duration of Harm and Recovery
Sediment shorelines Fauna	Observations post-spill at Dale beach revealed uncommon burrowing echinoderms (Echinocardium cordatum), the extinction of spiny cockles (Acanthocardia echninata) by 2006, and a possible decline in razor shell (Ensis spp.) numbers.	The report notes that other factors may have affected populations of these fauna including bait digging, an abundance of the burrowing brittle star and burrowing crab.
Saltmarsh	Monitoring in 1997 and 1998 at the worst affected sites (West Angle Bay, Sandy Haven, Angle Bay, and Pembroke River) indicated ongoing recovery of infaunal communities. However, small crustacean numbers remained low compared to pre-spill levels. By early 1997, most species populations had returned to typical pre-spill levels, though fluctuations persisted.	A comprehensive resurvey of all saltmarsh in the waterway was conducted in 2002. Surveyors revisited monitoring sites established in 1996 and added new ones. They found no discernible differences between sites affected by the spill and those untouched.
Macrofauna	Following the spill, a macrofauna sampling program commenced on eight sandy beaches and muddy shores, running until August 1998. Early findings revealed decreases in amphipod numbers, notably Ampelisca brevicornis, as well as certain molluscs like cockles (Cerastoderma edule), alongside increases in opportunistic bristle worms.	Monitoring conducted in 1997 and 1998 at the four most heavily impacted sites (West Angle Bay, Sandy Haven, Angle Bay, and Pembroke River) indicated ongoing positive recovery trends in infaunal communities. However, small crustacean populations remained below pre-spill levels. By early 1997, most species had returned to typical pre-spill levels, although significant fluctuations persisted.

Following the Sea Empress spill, the fin-fish fisheries were re-opened within approximately 3 months of the spill. Cockle, whelk and crustacean fisheries were reopened within 8 months of the spill. A literature review [25] of data relating to ecosystem recovery following the Sea Empress spill suggests that recovery occurred within a period of 10 years. The harvesting of edible seaweed and mussels (a non-commercial activity in Milford Haven) were banned until four and seven months later respectively [26]. The impacts to intertidal seagrass areas, sandy beaches, muddy shores, saltmarsh, and rocky shores was found to be predominantly <1 year following the incident. This information shows Milford Haven receptors largely recovered within a year of the incident, which would place the duration of harm as sub-MATTE (<1 year).

Some data indicates that certain sites and / or species took longer to recover from the spill, for instance, the spiny cockle and small crustaceans were reported to have been slow to recover. However, based on the reports reviewed, the evidence indicates that the Milford Haven environment almost fully recovered within 10 years of the spill.

Excluding releases from the jetty manifolds, the potential largest unmitigated hydrocarbon release volume from the Site is approximately 90,890 m^3 of crude oil (T6016 catastrophic rupture). As this is similar to the release volume from the Sea Empress incident, it is considered appropriate to select a 'medium-term' duration of harm for hydrocarbon releases

into the Mersey Estuary. Also, as the material involved is similar, a 'medium-term' duration is also applied to the larger jetty manifold release scenarios.

Figure 4-16 classifies a release of liquid hydrocarbons to an estuary habitat to have a 'medium-term' duration of harm (1 – 10 years). However, this is considered to relate to the estuary habitat, rather than the estuarine waters. Following a hydrocarbon release to the Mersey Estuary, it is expected the tides, currents and wind would act to dilute and disperse the spill over time. It is considered that the waters themselves would not be impacted for a period of >1 year and would naturally recover within the timeframe. Therefore, the duration of harm for estuarine waters is considered to be short term.

Sea mammals

Table 4-11 shows the seals and otters were not reported to have suffered notable impacts following the Sea Empress incident. Additionally, the areas in the vicinity of the Site are not identified to be key habitats for any sea mammal populations, and as such it is considered any impacted species populations would recover within 1 year, due to replenishment from populations present throughout the estuary. Therefore, the duration of harm is set to 'short-term'.

Seabirds

Table 4-11 shows the bird populations were reported to have recovered within 10 years of the Sea Empress incident. As such, a 'medium-term' duration of harm (1 – 10 years) is assigned to both designated bird populations and marine seabirds as a whole.

Aquaculture

An example of a release incident impacting an estuarine receptor was a train derailment that occurred involving approximately 330 m^3 of diesel which entered the Loughor Estuary in Carmarthenshire[45]. The shellfish beds were closed as a safety precaution for seven weeks. Following the incident sampling and monitoring took place and initial rounds of analysis of cockles and mussels in the area for residual oil contamination indicated they were within statutory limits set to protect the health of consumers and the quality of the product[46].

Additional anecdotal evidence is provided by the Sea Empress spill which occurred at Milford Haven in February 1996. Following the Sea empress spill, the fin-fish fisheries were re-opened within about 3 months of the spill. Cockle, whelk, and crustacean fisheries were reopened after 8 months of the spill. The harvesting of edible seaweed and mussels (a non-commercial activity in Milford Haven) were banned until June 1997 and September 1997 respectively. Considering this data, the harm duration for this receptor is conservatively set to be 'medium-term'. It is also considered that recreational boating would be able to recommence within a period of 1 year [26].

[45] https://www.bbc.co.uk/news/uk-wales-64644798 (Accessed 01/02/2024)
[46] https://naturalresources.wales/about-us/news-and-blogs/blogs/llangennech-freight-train-derailment/?lang=en (Accessed 01/02/2024)

FIGURE 4-16 ENERGY INSTITUTE RECOVERY PERIOD SELECTION PROCESS (WATER ENVIRONMENT)

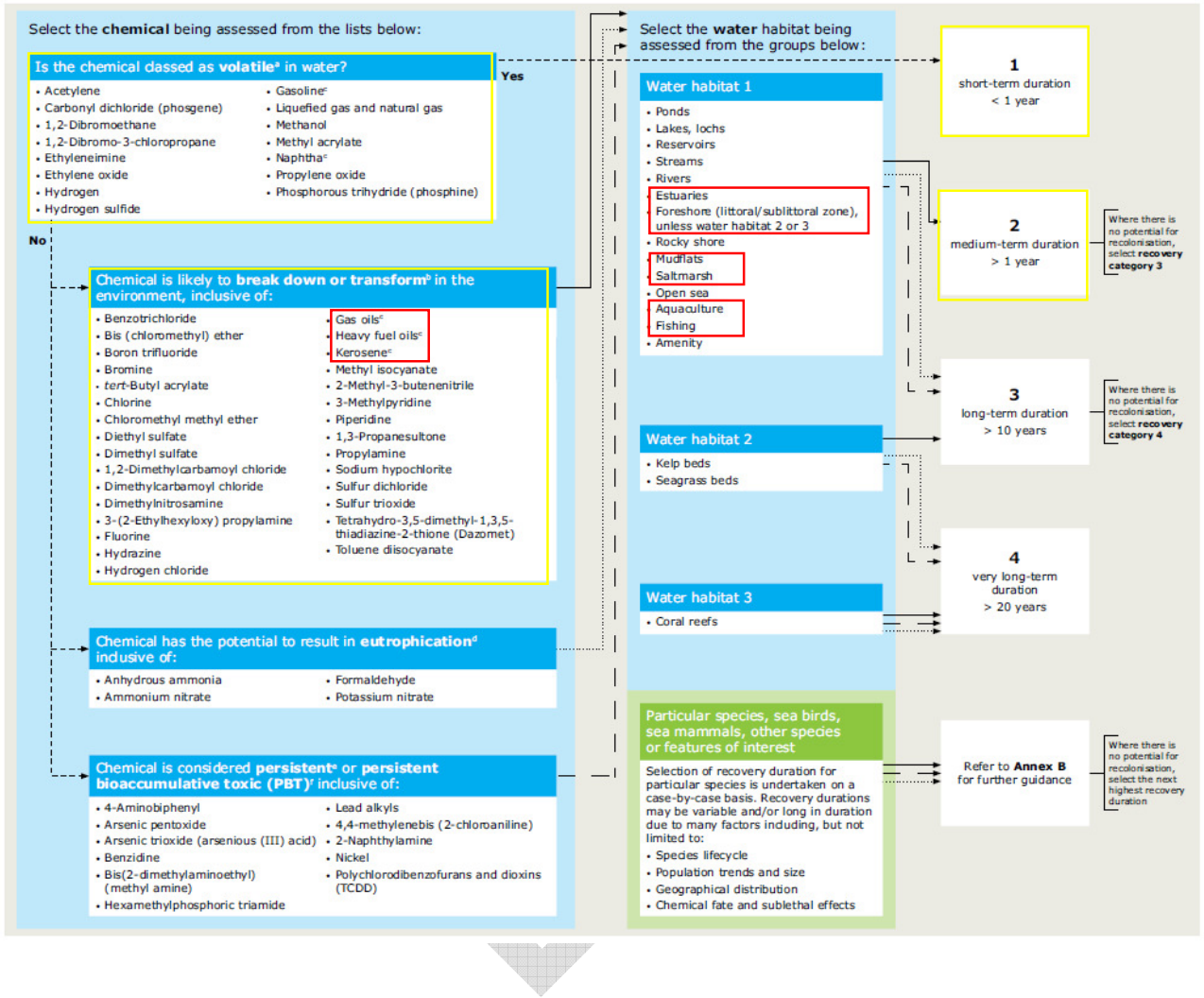
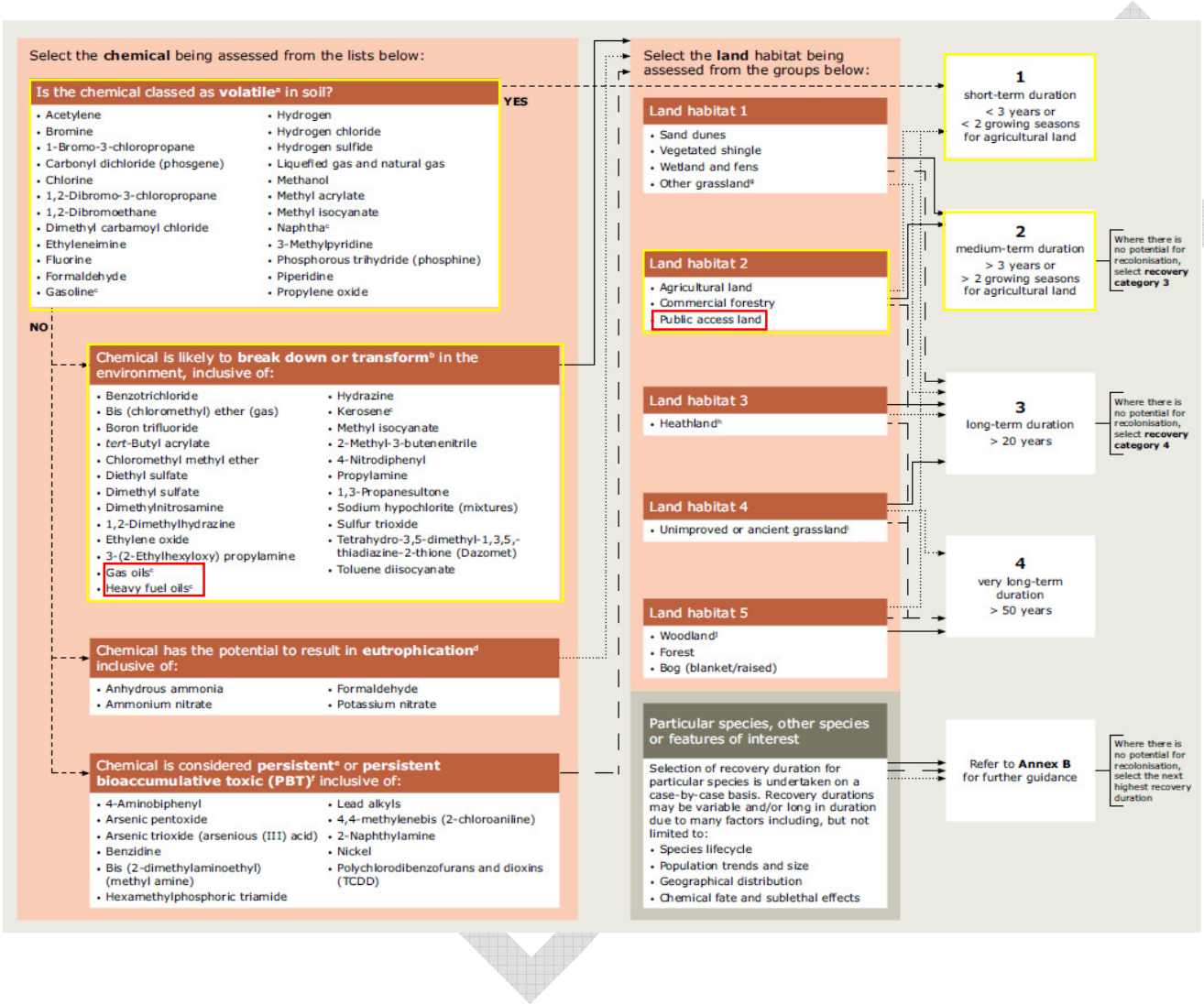


FIGURE 4-17 ENERGY INSTITUTE RECOVERY PERIOD SELECTION PROCESS (LAND ENVIRONMENT)



Groundwater

The duration of harm categories for groundwater as a drinking and non-drinking source are presented in Figure 4-18.

The bedrock sandstone aquifer may be considered as a potential future drinking source, which has two duration of harm options of 'Long Term' (<6 years harm) and 'Very Long Term' (>6 years harm) available. However, on the basis that this is an operating oil terminal, given the likely influence of the saline waters of the Mersey Estuary, and the fact it cannot currently impact on a drinking water supply (public or private) it is considered more appropriate, at this point in time, to consider the duration of harm in-line with the current status of the groundwater which is as a non-drinking water source (i.e. if a release happened today with the potential to generate a MATTE level impact to groundwater, it would be characterised on the basis of the current utility of groundwater which is not as a drinking water supply. The long-term criteria and very long-term criteria explicitly relate to the resulting impact being to a drinking water source or SPZ and neither criteria are currently relevant at the site).

Should there ever be a coincidence of a groundwater abstraction from the Site or downgradient within the estuary itself or laterally from the Site which could plausibly draw water (and contamination) from the Tranmere site then it may be appropriate to consider an alternative duration of harm. Contamination which may occur because of a release from the Site is primarily comprised of petroleum hydrocarbons which would be readily degradable (non-persistent contaminants) and on that basis a duration of harm of >6 years but <20 years is considered appropriate which would place releases to groundwater beneath the site in the 'Long Term' category (on the basis of the aquifers current status as being groundwater without a drinking water source but which may be contaminated by WFD hazardous substances).

4.5.2.2 FIREWATER APPLICATION

As discussed in Section 4.5.1.3, the duration of harm assigned to firefighting foam as part of firewater application MAS is consistent with the associated hydrocarbon being mobilised into the environment and is therefore considered 'Medium Term'.

4.5.2.3 OVERPRESSURE

The 70mbar overpressure extent from a VCE of the Mogas Export Line is considered to have the potential to cause partial destruction of the Birkenhead Priory as per Table 4-9. It is considered the damage caused to the priory could be repaired in to reinstate its designation status, as such a duration of harm of 'medium term' is considered appropriate. This is considered as a conservative approach, as modern restoration techniques and historical preservation efforts, it likely to rebuild and restore the priory within three years

FIGURE 4-18 CDOIF HARM DURATION CATEGORIES

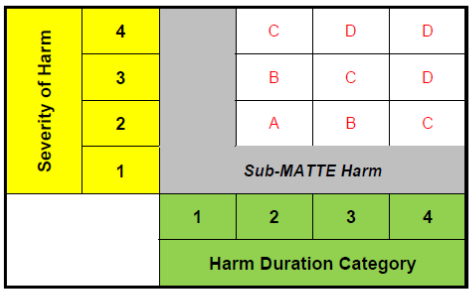
Description	Short term	Medium term	Long term	Very long term
	Harm with such short recovery is not considered a MATTE.			
Harm Duration Category →	**1**	**2**	**3**	**4**
Groundwater or surface water drinking water source (public or private)			Harm affecting drinking water source or SPZ < 6 years	Harm affecting drinking water source or SPZ >6 years
Groundwater (except drinking water sources): WFD Hazardous/Non Hazardous Substances	WFD hazardous substances < 3 months	WFD hazardous subs > 3 months	WFD hazardous subs > 6yrs	WFD hazardous subs >20 years
	WFD non-hazardous substances < 1yr	WFD non-hazardous substances > 1yr	WFD non-hazardous substances >10 years	WFD non-hazardous substances >20 Years
Surface water (except drinking water sources – see above)	< 1year	>1 year	>10 years	>20 years
Land	< 3 years or < 2 growing seasons for agricultural land	> 3 years or > 2 growing seasons for agricultural land	>20 years	>50 years
BUILT ENVIRONMENT	Can be repaired in < 3 years, such that its designation can be reinstated	Can be repaired in > 3 years, such that its designation can be reinstated	Feature destroyed, cannot be rebuilt, all features except world heritage site	Feature destroyed, cannot be rebuilt, world heritage site

4.5.3 MATTE CONSEQUENCE LEVEL

Using the CDOIF guidance the severity and duration results for the S-P-Rs are assigned a consequence level as shown in Figure 4-19. The consequence level determines the Tolerability Region that is considered for a given receptor.

As a result of the MATTE severity defined in Section 4.5.1, and the MATTE duration of harm defined in Section 4.5.2, the MATTE consequence level can be derived for each receptor type which is considered to have MATTE potential, and these are shown in Table 4-12.

FIGURE 4-19 ASSIGNMENT OF MATTE TOLERABILITY



Frequency at which the CDOIF consequence level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

TABLE 4-12 RECEPTOR SEVERITY, HARM & MATTE CATEGORIES

Receptor	Maximum Severity	Maximum Harm Duration	Maximum MATTE Tolerability Level
Mersey Estuary SPA/Ramsar/SSSI	Severe (2)	Medium (2)	A
Mersey Estuary Designated Bird Species	Severe (2)	Medium (2)	A
Mersey Narrows & North Wirral Foreshore SPA / Ramsar	Severe (2)	Medium (2)	A
IUCN Protected Species (European eel)	Severe (2)	Medium (2)	A
New Ferry SSSI	Major (3)	Medium (2)	B
Mersey Narrows SSSI	Major (3)	Medium (2)	B
Mersey Estuary RSPB Reserve	Major (3)	Medium (2)	B
Scarce (Priority) Habitat Mudflats / Intertidal Substrate Foreshore	Major (3)	Medium (2)	B
Scarce (Priority) Habitat Deciduous Woodland	Sub-MATTE (1)	Medium (2)	Sub-MATTE
Widespread Non-Designated Water – Aquaculture / Fisheries / Beaches	Severe (2)	Short (1)	Sub-MATTE
Widespread Non-Designated Water – Beaches	Severe (2)	Short (1)	Sub-MATTE
Bedrock Aquifer – Drinking Water Source	Major (3)	Long (3)	C
Built Environment Receptors: Birkenhead Priory	Severe (2)	Medium (2)	A
Marine: Seabirds	Severe (2)	Medium (2)	A
Marine: Sea Mammals	Severe (2)	Short (1)	Sub-MATTE
Estuarine Waters of Swansea Bay	Catastrophic (4)	Short (1)	Sub-MATTE

4.5.4 ASSESSMENT OF TOLERABILITY BOUNDARIES

Table 4-12 shows that the maximum (worst-case) MATTE tolerability levels for the receptors considered to be potentially at risk of a MATTE event to be 'A' or 'B', with some receptors being considered sub-MATTE.

The CDOIF table of receptors along with the guide for assessing severity, duration and tolerability levels is provided in Appendix A for reference.

'A Tolerability' region. The Site would present an 'Intolerable' risk if the additive MAS risks were greater than 1×10^{-2} per year for a given receptor. The site risk would be considered 'Broadly Acceptable' if lower than 1×10^{-4} per year for a given receptor. A risk of in between 1×10^{-2} and 1×10^{-4} per year would be TifALARP.

'B Tolerability' region. The Site would present an 'Intolerable' risk if the MAS risks were greater than 1×10^{-3} per year for a given receptor. The site risk would be considered 'Broadly Acceptable' if lower than 1×10^{-5} per year for a given receptor. A risk of in between 1×10^{-3} and 1×10^{-5} per year would be TifALARP.

'C Tolerability' region. The Site would present an 'Intolerable' risk if the MAS risks were greater than 1×10^{-4} per year for a given receptor. The site risk would be considered 'Broadly

Acceptable' if lower than 1 x 10^{-6} per year for a given receptor. A risk of in between 1 x 10^{-4} and 1 x 10^{-6} per year would be TifALARP.

5. PHASE 1B ASSESSMENT

Stage 1B involves the estimation of the unmitigated risk posed by the different assets and MAS to the individual receptors as defined through the S-P-R linkage presented in Stage 1A.

The unmitigated results of the assessment are presented in Appendix B3. This appendix pulls information from Appendix B1a (Site Materials) and B1b (Compartments) which define the range of assets, their capacities, and the substances they contain. Failure frequency data is drawn from Appendix B2 which defines the likelihood of each MAS occurring. The assigned MATTE Severity, Duration of Harm, and thus Tolerability is also presented in Appendix B3 for each given receptor with MATTE potential.

MAS are considered to have the potential to affect more than one receptor, and this has been considered in the analysis, and is summarised in Appendix B3.

5.1 UNMITIGATED RISK ASSESSMENT

A summary of all MAS, failure frequencies and the source of information used are provided in Appendix B2.

Results are presented as a worst-case at the unmitigated stage for each of the receptors considered.

The following tables show the results of the unmitigated risks by receptor and are split out by MAS with the total risk to the given receptor presented at the bottom of each table.

The contribution from the MAS always adds up to 100% and helps to highlight the risk driving scenarios.

'Proportion of Level A / Level B, etc' presents the contribution from each MAS to the overall risk at a given MATTE Tolerability Level posed to a given receptor grouping.

- A result below 1% equates to a Broadly Acceptable level of risk
- A result between 1-10% places the Site in the lower half of the TifALARP range for this receptor
- A result between 10-100% places the Site in the upper half of the TifALARP range for this receptor
- A result above 100% places the Site in the Intolerable range for this receptor.

5.2 UNMITIGATED RECEPTOR RISKS

The unmitigated risk is presented for each individual receptor in Table 5-1 and illustrated in **Error! Reference source not found.**. For a detailed breakdown of the contributing MAH to each individual receptor type, these can be accessed in the Master Spreadsheet Assessment Tool.

TABLE 5-1 UNMITIGATED RISK SUMMARY

Receptor	MATTE Tolerability	Pathway	Unmitigated Risk Frequency	Outcome
Mersey Estuary SPA/Ramsar	A	Overland Flow	5.6×10^{-2}	Intolerable

Receptor	MATTE Tolerability	Pathway	Unmitigated Risk Frequency	Outcome
Mersey Estuary SPA Designated Bird Species	A	Overland Flow	3.7×10^{-2}	Intolerable
Mersey Narrows & North Wirral Foreshore SPA / Ramsar	A	Overland Flow	5.6×10^{-2}	Intolerable
IUCN Protected Species (European Eel)	A	Overland Flow	8.1×10^{-2}	Intolerable
Mersey Estuary SSSI	A	Overland Flow	5.6×10^{-2}	Intolerable
New Ferry SSSI	A	Overland Flow	5.6×10^{-2}	Intolerable
	B	Overland Flow	6.1×10^{-3}	Intolerable
Mersey Narrows SSSI	A	Overland Flow	5.6×10^{-2}	Intolerable
	B	Overland Flow	5.4×10^{-3}	Intolerable
Mersey Estuary RSPB Reserve	A	Overland Flow	9.2×10^{-3}	Intolerable
	B	Overland Flow	5.0×10^{-5}	Intolerable
Mudflats / Intertidal Substrate Foreshore	A	Overland Flow	3.7×10^{-2}	Intolerable
	B	Overland Flow	7.2×10^{-3}	Intolerable
GW Bedrock Aquifer	A	Overland Flow	5.6×10^{-2}	Intolerable
	B	Overland Flow	5.6×10^{-2}	Intolerable
	C	Overland Flow	4.3×10^{-2}	Intolerable
Birkenhead Priory Grade 1 LB/SM	A	Overpressure	1.4×10^{-7}	Broadly Acceptable
Seabirds	A	Overland Pathway	8.0×10^{-2}	Intolerable

The table shows that the risk posed by overpressure are considered to be 'Broadly Acceptable' to the Birkenhead Priory located approximately 1.2 km to the north, in the town of Birkenhead. It is worth noting overpressure is also considered to pose the same level of MATTE risk to other surrounding receptors within 2km of the Site, as presented in Figure 4-14, and the risk to these is also considered Broadly Acceptable. However, these receptors are also at risk of unignited liquid release scenarios as indicated by the 'Pathway' defined in the table above.

The risk of an aircraft crash of 4×10^{-7} per year is added to the unmitigated risks posed to each receptor.

5.2.1 UNMITIGATED RISK MATRIX

Figure 5-1 presents the unmitigated risk matrix for the Site.

FIGURE 5-1 UNMITIGATED RISK MATRIX

	Frequency per establishment per pathway per year (Unmitigated)								
Frequency at which CDOIF Consequence Level is equalled or exceeded	$< 10^{-9}$	$10^{-9} - 10^{-8}$	$10^{-8} - 10^{-7}$	$10^{-7} - 10^{-6}$	$10^{-6} - 10^{-5}$	$10^{-5} - 10^{-4}$	$10^{-4} - 10^{-3}$	$10^{-3} - 10^{-2}$	$>10^{-2}$
D - MATTE									
C - MATTE									7
B + C - MATTE								1b,1c,3a	7
A + B + C - MATTE				A,11					1a,1b,1c,2a,2b,2c,2d, 4,7,14
Sub MATTE	Tolerability not considered by CDOIF								

CDOIF RECEPTORS

2a-Mersey Estuary SPA/SSSI/Ramsar
2b-Mersey Estuary SPA Designated Bird Species
2c-IUCN Protected Species (European Eel)
2d-Mersey Narrows & North Wirral Foreshore SPA /

3a-Mersey Estuary RSPB Reserve

4-Priority Habitat Mudflats and Intertidal Substrate Foreshore

7-Groundwater (Drinking Source)

11-Birkenhead Priory Grade 1 LB / SM

14-Seabirds

A-Aircraft Crash

1a-Mersey Estuary SSSI
b-New Ferry SSSI
c-Mersey Narrows SSSI

6. PHASE 2 ASSESSMENT

6.1 INTRODUCTION

Having estimated the unmitigated MATTE risk levels at the Site, the next step is to evaluate the level of mitigation which could be applied based on the presence of preventative and/or containment measures present. The following sections provide an overview of the mitigations identified and factors applied, along with the Phase 2 results.

Appendix B4 and Section 6.2 provide details on the mitigations applied to the unmitigated risk, so that an estimated mitigated risk posed to the various receptors can be estimated.

6.2 MATTE SEVERITY REDUCTION FACTORS

This section reviews the unmitigated release volumes for the MAS which are estimated based on conservative assumptions.

6.2.1 MITIGATED RELEASE VOLUMES

Expected Duration for Detection and Isolation

Section 4.2.7 explains the difference between the unmitigated and mitigated release volumes with respect to the time taken for detection and isolation of a release. As such this applies to MAS which involve a release rate over time that can be stopped through responsive action (e.g. closure of a valve, turning off a pump etc).

At the unmitigated stage a conservative stand-point is taken wherein the maximum possible inventory associated with an asset is released to a receptor and this it is not considered reasonable to assume this would occur 100% of the time. For example, for several assets the unmitigated release volume is a result of the release occurring undetected for a period of six hours which is equivalent to the routine site inspection round. However, in reality, it is considered a release would likely be detected sooner by instrumentation and site operators, and this duration for detection and isolation is based on that defined by the QRA, and is termed the mitigated release volume.

The unmitigated and mitigated durations for detection and isolation and associated release volumes per asset are provided in Appendix B2c.

Tank Overfill Alarms

Section 1, Volume 2 of the COMAH Report describes three level alarms of increasing priority, which protect the tanks from overfill. Each alarm has an associated operator action that is designed to stop the flow of crude oil into the receiving tank.

The system triggers a Priority 3 alarm five minutes before the tank reaches its maximum working level, signalling the need to end the transfer. If the transfer continues, a Priority 2 alarm sounds five minutes after maximum working level is reached, followed by a Priority 1 alarm ten minutes later if the transfer persists. The Priority 1 alarm allows a minimum 20 minute response time to prevent the tank's floating roof from being pushed above the tank wall.

Therefore, the alarms provide operators with three separate opportunities to stop the tank overfilling over a period of 20 minutes before a release from the tank would begin.

~~As the tank overfilling procedure always has an operator present, with three separate alarms in place prior to an overfill release being realised, it is considered reasonable to assume the mitigated release volume is 0, and no liquid release occurs. The likelihood of successful alarms and operator response to shut down the overfilling operation prior to a release occurring is considered to be 90%.~~

Tank Rupture Bund Overtopping Calculations

A series of bund overtopping calculations following catastrophic failure of a storage vessel have been undertaken by IKM (sourced from the document 'TranSR-WD090 TRA - Overtopping Calcs') to understand the potential portion of a release volume that would be contained within the bund. It is not considered reasonable to assume 100% of the maximum tank contents would escape secondary containment in every instance of a catastrophic failure.

The overtopping calculations were completed using Equations 4.1 and 4.3 from an experimental investigation prepared by Liverpool John Moores University for the Health and Safety Executive 2005. Research Report 333. There are four calculations per storage tank to cover the four principal potential failure directions.

The MATTE assessment uses the largest calculated potential overtopping volume for each storage tank to represent the mitigated release volume for catastrophic tank ruptures and to account for the portion of the released liquid which would remain contained within secondary containment.

It is subsequently assumed the bund could fail completely 10% of the time, meaning for that 10% of the time it is assumed 100% of the tank contents escapes secondary containment. Therefore, 90% of the time the bund does not fail, and the largest overtopping volume calculated for the specific tank is assumed to escape secondary containment.

6.3 APPLIED MITIGATION FACTORS

The assessment has considered mitigations that may be applied through consideration of engineering controls that are in place at the Site.

The rationale for each mitigation is summarised in Table 6-1 below. The mitigation factors are summarised in Appendix B4.

TABLE 6-1 APPLIED MITIGATION FACTORS

Mitigation Measure	Mitigation Factor	Applicable MAS	Details
Tank Underfloor Liners	0.1	Tank Floor Failure	T6013, T6014, T6016 and T6017 benefit from having either a Rawell or HDPE membrane installed. These liners are considered to form a barrier to a tank floor release moving into the subsurface and eventually groundwater. These tanks benefit from a mitigation factor of 0.1.
Tank Floor Tell-Tale Leak Detection and Emergency Response	0.1	Tank Floor Failure	T6014 and T6017 have tell-tale leak detection installed. Therefore, in the event of a tank floor release the liquid is routed to the bund where it can be identified rather than down into the subsurface unseen.

Mitigation Measure	Mitigation Factor	Applicable MAS	Details
			This mitigation accounts for the leak detection limiting downward migration and allowing for the detection and recovery of the release prior to a MATTE being realised.
Secondary Containment	0.05 - 0.10	Overland MAS	All tanks on site are located in bunds which can be drained to interceptor pits via gullies. The bund drain valves are kept closed and only opened for draining excess rainwater. In the case of a major spill, the two bunded areas which cannot contain >110% of the tank contents have overflow pipes to an overflow compound, where the excess can be contained. This overflow compound has an approximate capacity of 40,000 m^3, and is considered to contain the majority of a release escaping the bund. The tanks connected to this overflow compound include T6009, T6012, T6013, T6014, T6015, T6016, and T6019. As such, all bunds are considered to have >110% capacity of the largest tank (including T6015 and T6016 with the overflow compound). The mitigations assigned are based on unignited vs ignited releases, as the additional firewater volume applied reduces the containment volume available for the release. For unignited releases into bunds a factor of 0.05 is applied, and for ignited releases a factor of 0.1.
Bund Floor and Emergency Response	0.1	Releases into the Bund	This mitigation applies to releases into bunds which would be contained and provide an opportunity for recovery by emergency response prior to infiltration of the release into the subsurface triggering a MATTE. It is also worth noting that the groundwater table is relatively high (sitting in the made ground rather than the bedrock) which would help reduce the degree of contamination entering the bedrock directly – particularly for smaller release volumes.
Tertiary Containment and Emergency Response	1 - 0.1	Small Pipeline, Pump, and Manifold Leaks	A mitigation factor of 0.1 is assigned to account for the risk posed by small leaks to both Mersey Estuary and groundwater receptors. This is due to the low release rate meaning that only a few m^3 of release is calculated to escape the pipework over the 6 hour period for detection and isolation, and the isolatable volume will is considered to escape at the same rate or lower. Therefore, it is considered the release could be recovered by vacuum tankers and deployment of sandbags / spill kits, prior to the release moving offsite or into the subsurface in sufficient quantity as to result in a MATTE. No mitigation is provided to other MAS.

Mitigation Measure	Mitigation Factor	Applicable MAS	Details
Emergency Response	1	All MAS	At present responses are credited as part of recovery from containment systems.
Bird Count % of Year Present	0.5	All MAS	In the summer months, many of the Mersey Estuary's bird species migrate to the Arctic or Scandinavia to breed, typically returning in September and October. As such, they are present approximately 50% of the year. Consequently, these SPA designated birds are only present in the estuary for approximately 50% of the year. A mitigation factor of 0.5 is credited for the designated bird species based on their presence for approximately half of the year.
Boilover Mitigation	1	Tank Boilover MAS	A tank full surface fire can develop into a boilover when the heat from the fire causes the oil in the tank to reach its boiling point, creating a layer of vapor underneath. If water is present at the bottom of the tank, the intense heat can rapidly vaporise the water into steam, resulting in a violent expulsion of burning oil. However, according to Essar's tank full surface fire firefighting methodology (Boilover Guidance), firewater is not applied, making water levels in crude tanks negligible. Consequently, a mitigation factor of 0.1 is credited for all crude tank boilover scenarios, based on the assumption that only 10% of the time, a tank full surface fire develops into a boilover.

6.4 MITIGATED RISK ASSESSMENT

The failure frequencies defined in Appendix B2b, and the mitigation factors described above and presented in Appendix B4, have been used to define the estimated mitigated risk.

6.5 MITIGATED RECEPTOR RISKS

The mitigated risk presented by to each of the receptor groupings is described below, and presented in the tables below, and summarised in

Receptor	MATTE Tolerability	Pathway	Mitigated Risk Frequency	Outcome
Mersey Estuary SPA/Ramsar	A	Overland Flow	2.4×10^{-2}	Intolerable
Mersey Estuary SPA Designated Bird Species	A	Overland Flow	1.0×10^{-2}	TifALARP
Mersey Narrows & North Wirral Foreshore SPA / Ramsar	A	Overland Flow	1.0×10^{-3}	TifALARP

Receptor	MATTE Tolerability	Pathway	Mitigated Risk Frequency	Outcome
IUCN Protected Species (European Eel)	A	Overland Flow	3.4×10^{-2}	Intolerable
Mersey Estuary SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
New Ferry SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
	B	Overland Flow	1.0×10^{-3}	Intolerable
Mersey Narrows SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
	B	Overland Flow	9.3×10^{-4}	TifALARP
Mersey Estuary RSPB Reserve	A	Overland Flow	2.7×10^{-3}	TifALARP
	B	Overland Flow	8.6×10^{-4}	TifALARP
Mudflats / Intertidal Substrate Foreshore	A	Overland Flow	2.0×10^{-2}	Intolerable
	B	Overland Flow	1.2×10^{-3}	Intolerable
GW Bedrock Aquifer	A	Overland Flow	7.6×10^{-3}	TifALARP
	B	Overland Flow	7.6×10^{-3}	Intolerable
	C	Overland Flow	1.8×10^{-3}	Intolerable
Birkenhead Priory Grade 1 LB/SM	A	Overpressure	1.5×10^{-7}	Broadly Acceptable
Seabirds	A	Overland Pathway	3.4×10^{-2}	Intolerable

Figure 6-1**.**

The risk of an aircraft crash of 4 x 10^{-7} per year is added to the unmitigated risks posed to each receptor.

6.5.1 OVERLAND LIQUID RELEASES TO ENVIRONMENTAL MEDIA

The receptors containing mudflats as part of their designation are assessed against a 14 mm oil thickness criteria, meaning a MATTE Level A is triggered by a release volume of 70 m^3. The assessed level of MATTE risk are as follows:

Mersey Estuary SPA/Ramsar/SSSI, Mersey Narrows & North Wirral Foreshore SPA / Ramsar, New Ferry SSSI, Mersey Narrows SSSI

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Loading Arm			
Large Leak Firewater Addition	1.9E-03	8.1%	19.2%
Medium Leak Firewater Addition	2.0E-05	0.1%	0.2%
Rupture Firewater Addition	3.4E-04	1.4%	3.4%
Large Leak	1.3E-02	54.0%	128.6%
Medium Leak	6.4E-04	2.7%	6.4%
Rupture	2.3E-03	9.6%	22.9%
Manifold			
Large Leak Firewater Addition	2.5E-05	0.1%	0.3%
Medium Leak Firewater Addition	8.1E-06	0.0%	0.1%
Small Leak Firewater Addition	1.0E-06	0.0%	0.0%
Rupture Firewater Addition	1.8E-06	0.0%	0.0%
Large Leak	1.6E-04	0.7%	1.6%
Medium Leak	3.5E-04	1.5%	3.5%
Small Leak	5.9E-06	0.0%	0.1%
Rupture	2.7E-05	0.1%	0.3%
Pigging			
Large Leak Firewater Addition	1.5E-07	0.0%	0.0%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	9.0E-06	0.0%	0.1%
Rupture	6.0E-06	0.0%	0.1%
Pipeline			
Large Leak Firewater Addition	5.7E-05	0.2%	0.6%
Medium Leak Firewater Addition	2.8E-05	0.1%	0.3%
Small Leak Firewater Addition	1.1E-05	0.0%	0.1%
Rupture Firewater Addition	5.1E-06	0.0%	0.1%
Large Leak	8.4E-04	3.5%	8.4%
Medium Leak	1.6E-03	6.6%	15.6%
Small Leak	5.4E-05	0.2%	0.5%
Rupture	6.3E-05	0.3%	0.6%
Pump			
Large Leak Firewater Addition	2.1E-05	0.1%	0.2%
Medium Leak Firewater Addition	1.1E-05	0.0%	0.1%
Rupture Firewater Addition	8.2E-06	0.0%	0.1%
Large Leak	1.8E-04	0.8%	1.8%
Medium Leak	1.8E-04	0.8%	1.8%
Rupture	1.1E-03	4.5%	10.6%
Tank			
Large Leak Firewater Addition	7.3E-06	0.0%	0.1%
Large Leak	8.4E-05	0.4%	0.8%
Small Leak	2.6E-04	1.1%	2.6%
Overfill	3.5E-05	0.1%	0.4%
Overfill Firewater Addition	1.5E-05	0.1%	0.1%
Catastrophic Rupture Firewater Addition	1.3E-07	0.0%	0.0%
Catastrophic Rupture	5.9E-05	0.2%	0.6%
Vessel			
Large Leak Firewater Addition	3.2E-06	0.0%	0.0%
Medium Leak Firewater Addition	2.4E-07	0.0%	0.0%
Rupture Firewater Addition	1.6E-06	0.0%	0.0%
Large Leak	4.4E-04	1.9%	4.4%
Medium Leak	1.2E-04	0.5%	1.2%
Rupture	3.0E-05	0.1%	0.3%
Grand Total	**2.4E-02**	**100%**	**238%**
		Intolerable	

The main mitigated risk drivers are identified as follows;

- Loading arm large leak – 54%
- Loading arm rupture – 10%

- Loading arm large leak firewater addition – 8%

For New Ferry SSSI, a release volume of at least 5,320 m^3 of liquid hydrocarbon is required to potentially trigger a MATTE Level B. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

New Ferry SSSI

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level B MATTE
Manifold			
Large Leak Firewater Addition	2.2E-05	2.2%	2.2%
Medium Leak Firewater Addition	8.1E-06	0.8%	0.8%
Small Leak Firewater Addition	1.0E-06	0.1%	0.1%
Rupture Firewater Addition	1.6E-06	0.2%	0.2%
Large Leak	1.5E-04	14.9%	15.0%
Medium Leak	3.5E-04	35.0%	35.1%
Small Leak	5.9E-06	0.6%	0.6%
Rupture	1.2E-05	1.2%	1.2%
Pigging			
Rupture Firewater Addition	3.2E-08	0.0%	0.0%
Rupture	6.0E-07	0.1%	0.1%
Pipeline			
Large Leak Firewater Addition	3.2E-06	0.3%	0.3%
Rupture Firewater Addition	1.4E-06	0.1%	0.1%
Large Leak	3.2E-05	3.2%	3.2%
Rupture	1.5E-05	1.5%	1.5%
Tank			
Large Leak Firewater Addition	7.3E-06	0.7%	0.7%
Large Leak	7.9E-05	7.9%	7.9%
Small Leak	2.4E-04	24.0%	24.0%
Overfill Firewater Addition	1.4E-05	1.4%	1.4%
Catastrophic Rupture Firewater Addition	1.2E-07	0.0%	0.0%
Catastrophic Rupture	5.4E-05	5.4%	5.4%
Vessel			
Rupture Firewater Addition	1.4E-07	0.0%	0.0%
Rupture	2.6E-06	0.3%	0.3%
Grand Total	**1.0E-03**	**100%**	**100%**
		Intolerable	

The main mitigated risk drivers are identified as follows;

- Manifold medium leak – 35%
- Tank small leak – 24%
- Manifold large leak – 15%

For Mersey Narrows SSSI, a release volume of at least 8,120 m^3 of liquid hydrocarbon is required to potentially trigger a MATTE Level B. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

Mersey Narrows SSSI

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level B MATTE
Manifold			
Large Leak Firewater Addition	2.2E-05	2.4%	2.2%
Medium Leak Firewater Addition	8.1E-06	0.9%	0.8%
Small Leak Firewater Addition	1.0E-06	0.1%	0.1%
Rupture Firewater Addition	1.6E-06	0.2%	0.2%
Large Leak	1.5E-04	16.0%	15.0%
Medium Leak	3.5E-04	37.6%	35.1%
Small Leak	5.9E-06	0.6%	0.6%
Rupture	1.2E-05	1.3%	1.2%
Pigging			
Rupture Firewater Addition	1.6E-08	0.0%	0.0%
Rupture	3.0E-07	0.0%	0.0%
Pipeline			
Large Leak Firewater Addition	6.8E-07	0.1%	0.1%
Rupture Firewater Addition	3.4E-07	0.0%	0.0%
Large Leak	6.1E-06	0.7%	0.6%
Rupture	3.8E-06	0.4%	0.4%
Tank			
Large Leak Firewater Addition	7.2E-06	0.8%	0.7%
Large Leak	7.5E-05	8.0%	7.5%
Small Leak	2.3E-04	24.1%	22.5%
Overfill Firewater Addition	1.2E-05	1.3%	1.2%
Catastrophic Rupture Firewater Addition	1.2E-07	0.0%	0.0%
Catastrophic Rupture	4.9E-05	5.3%	4.9%
Vessel			
Rupture Firewater Addition	1.4E-07	0.0%	0.0%
Rupture	2.6E-06	0.3%	0.3%
Grand Total	**9.3E-04**	**100%**	**93%**
		TifALARP	

The main mitigated risk drivers are identified as follows;

- Manifold medium leak – 39%
- Tank small leak – 24%
- Manifold large leak – 16%

For Mersey Estuary RSPB Reserve, a release volume of at least 1,400 m^3 of liquid hydrocarbon is required to potentially trigger a MATTE Level A (coat 10 ha of the receptor with 14mm of oil). The assessed level of risk to this receptor at this MATTE severity level is summarised below:

Mersey Estuary RSBP Reserve

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Loading Arm			
Rupture	1.3E-03	48.9%	13.4%
Manifold			
Large Leak Firewater Addition	2.3E-05	0.8%	0.2%
Medium Leak Firewater Addition	8.1E-06	0.3%	0.1%
Small Leak Firewater Addition	1.0E-06	0.0%	0.0%
Rupture Firewater Addition	1.8E-06	0.1%	0.0%
Large Leak	1.5E-04	5.5%	1.5%
Medium Leak	3.5E-04	12.8%	3.5%
Small Leak	5.9E-06	0.2%	0.1%
Rupture	2.7E-05	1.0%	0.3%
Pigging			
Rupture Firewater Addition	3.2E-08	0.0%	0.0%
Rupture	6.0E-07	0.0%	0.0%
Pipeline			
Large Leak Firewater Addition	1.1E-05	0.4%	0.1%
Medium Leak Firewater Addition	4.4E-06	0.2%	0.0%
Small Leak Firewater Addition	1.5E-06	0.1%	0.0%
Rupture Firewater Addition	3.6E-06	0.1%	0.0%
Large Leak	1.0E-04	3.7%	1.0%
Medium Leak	1.2E-04	4.5%	1.2%
Small Leak	7.6E-06	0.3%	0.1%
Rupture	3.6E-05	1.3%	0.4%
Pump			
Rupture Firewater Addition	2.0E-06	0.1%	0.0%
Rupture	1.3E-04	4.8%	1.3%
Tank			
Large Leak Firewater Addition	7.3E-06	0.3%	0.1%
Large Leak	7.9E-05	2.9%	0.8%
Small Leak	2.4E-04	8.7%	2.4%
Overfill	1.4E-05	0.5%	0.1%
Overfill Firewater Addition	1.4E-05	0.5%	0.1%
Catastrophic Rupture Firewater Addition	1.2E-07	0.0%	0.0%
Catastrophic Rupture	5.4E-05	2.0%	0.5%
Vessel			
Rupture Firewater Addition	1.4E-07	0.0%	0.0%
Rupture	2.6E-06	0.1%	0.0%
Grand Total	**2.7E-03**	**100%**	**27%**
		TifALARP	

The main mitigated risk drivers are identified as follows;

- Loading arm rupture – 49%
- Manifold medium leak – 13%
- Tank small leak – 9%

A release volume of 14,000 m3 of hydrocarbon is required to potentially trigger a MATTE Level B (coat >100 ha of the receptor with 14mm of oil). The assessed level of risk to this receptor at this MATTE severity level is summarised below:

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level B MATTE
Manifold			
Large Leak Firewater Addition	2.2E-05	2.6%	2.2%
Medium Leak Firewater Addition	8.1E-06	0.9%	0.8%
Small Leak Firewater Addition	1.0E-06	0.1%	0.1%
Rupture Firewater Addition	1.6E-06	0.2%	0.2%
Large Leak	1.5E-04	17.5%	15.0%
Medium Leak	3.5E-04	41.0%	35.1%
Small Leak	5.9E-06	0.7%	0.6%
Rupture	1.2E-05	1.4%	1.2%
Pipeline			
Rupture Firewater Addition	3.1E-07	0.0%	0.0%
Rupture	3.1E-06	0.4%	0.3%
Tank			
Large Leak Firewater Addition	7.2E-06	0.8%	0.7%
Large Leak	6.1E-05	7.1%	6.1%
Small Leak	1.8E-04	21.5%	18.5%
Overfill Firewater Addition	1.2E-05	1.4%	1.2%
Catastrophic Rupture Firewater Addition	1.2E-07	0.0%	0.0%
Catastrophic Rupture	3.6E-05	4.2%	3.6%
Grand Total	**8.6E-04**	**100%**	**86%**
		TifALARP	

The main mitigated risk drivers are identified as follows;

- Manifold medium leak – 41%
- Tank small leak – 22%
- Manifold large leak – 18%

The intertidal mudflats require a release volume of at least 280 m^3 to potentially trigger a MATTE Level A. The assessed level of MATTE risk to this receptor is summarised below:

Priority Habitat Mudflats

s	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Loading Arm			
Large Leak Firewater Addition	1.9E-03	9.6%	19.2%
Rupture Firewater Addition	3.0E-04	1.5%	3.0%
Large Leak	1.3E-02	64.4%	128.6%
Rupture	2.0E-03	9.8%	19.7%
Manifold			
Large Leak Firewater Addition	2.3E-05	0.1%	0.2%
Medium Leak Firewater Addition	8.1E-06	0.0%	0.1%
Small Leak Firewater Addition	1.0E-06	0.0%	0.0%
Rupture Firewater Addition	1.8E-06	0.0%	0.0%
Large Leak	1.5E-04	0.8%	1.5%
Medium Leak	3.5E-04	1.8%	3.5%
Small Leak	5.9E-06	0.0%	0.1%
Rupture	2.7E-05	0.1%	0.3%
Pigging			
Large Leak Firewater Addition	9.3E-08	0.0%	0.0%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	4.5E-06	0.0%	0.0%
Rupture	6.0E-06	0.0%	0.1%
Pipeline			
Large Leak Firewater Addition	5.2E-05	0.3%	0.5%
Medium Leak Firewater Addition	1.7E-05	0.1%	0.2%
Small Leak Firewater Addition	7.4E-06	0.0%	0.1%
Rupture Firewater Addition	5.1E-06	0.0%	0.1%
Large Leak	5.3E-04	2.7%	5.3%
Medium Leak	6.7E-04	3.4%	6.7%
Small Leak	3.8E-05	0.2%	0.4%
Rupture	6.3E-05	0.3%	0.6%
Pump			
Large Leak Firewater Addition	1.1E-05	0.1%	0.1%
Medium Leak Firewater Addition	1.4E-06	0.0%	0.0%
Rupture Firewater Addition	5.9E-06	0.0%	0.1%
Large Leak	3.7E-05	0.2%	0.4%
Medium Leak	3.1E-05	0.2%	0.3%
Rupture	3.9E-04	2.0%	3.9%
Tank			
Large Leak Firewater Addition	7.3E-06	0.0%	0.1%
Large Leak	8.4E-05	0.4%	0.8%
Small Leak	2.6E-04	1.3%	2.6%
Overfill	3.5E-05	0.2%	0.4%
Overfill Firewater Addition	1.5E-05	0.1%	0.1%
Catastrophic Rupture Firewater Addition	1.3E-07	0.0%	0.0%
Catastrophic Rupture	5.9E-05	0.3%	0.6%
Vessel			
Rupture Firewater Addition	1.4E-06	0.0%	0.0%
Rupture	2.7E-05	0.1%	0.3%
Grand Total	**2.0E-02**	**100%**	**200%**
		Intolerable	

The main mitigated risk drivers are identified as follows;

- Loading arm large leak – 64%
- Loading arm rupture – 10%
- Loading arm large leak firewater addition – 10%

A release volume of 2,800 m^3 of hydrocarbon is required to potentially trigger a MATTE Level B. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

	Mitigated Risk	% Contribution from MAS	Proportion of Level B MATTE
Manifold			
Large Leak Firewater Addition	2.2E-05	1.8%	2.2%
Medium Leak Firewater Addition	8.1E-06	0.6%	0.8%
Small Leak Firewater Addition	1.0E-06	0.1%	0.1%
Rupture Firewater Addition	1.8E-06	0.1%	0.2%
Large Leak	1.5E-04	12.1%	15.0%
Medium Leak	3.5E-04	28.3%	35.1%
Small Leak	5.9E-06	0.5%	0.6%
Rupture	2.7E-05	2.2%	2.7%
Pigging			
Rupture Firewater Addition	3.2E-08	0.0%	0.0%
Rupture	6.0E-07	0.0%	0.1%
Pipeline			
Large Leak Firewater Addition	1.1E-05	0.9%	1.1%
Medium Leak Firewater Addition	4.4E-06	0.4%	0.4%
Small Leak Firewater Addition	1.5E-06	0.1%	0.2%
Rupture Firewater Addition	2.2E-06	0.2%	0.2%
Large Leak	1.0E-04	8.3%	10.3%
Medium Leak	1.2E-04	10.0%	12.4%
Small Leak	7.6E-06	0.6%	0.8%
Rupture	2.4E-05	1.9%	2.4%
Tank			
Large Leak Firewater Addition	7.3E-06	0.6%	0.7%
Large Leak	7.9E-05	6.4%	7.9%
Small Leak	2.4E-04	19.3%	24.0%
Overfill Firewater Addition	1.4E-05	1.1%	1.4%
Catastrophic Rupture Firewater Addition	1.2E-07	0.0%	0.0%
Catastrophic Rupture	5.4E-05	4.4%	5.4%
Vessel			
Rupture Firewater Addition	1.4E-07	0.0%	0.0%
Rupture	2.6E-06	0.2%	0.3%
Grand Total	**1.2E-03**	**100%**	**124%**
		Intolerable	

The main mitigated risk drivers are identified as follows;

- Manifold small leak – 28%
- Tank small leak – 19%
- Manifold large leak – 12%

6.5.2 OVERLAND LIQUID RELEASES TO SPECIES

For the SPA designated bird species, a release volume of 2,80 m^3 of hydrocarbon (based in the oil thickness threshold of mudflats) is required to potentially trigger a MATTE Level A. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

SPA Designated Bird Species

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Loading Arm			
Large Leak Firewater Addition	9.6E-04	9.6%	9.6%
Rupture Firewater Addition	1.5E-04	1.5%	1.5%
Large Leak	6.4E-03	64.4%	64.3%
Rupture	9.8E-04	9.8%	9.8%
Manifold			
Large Leak Firewater Addition	1.1E-05	0.1%	0.1%
Medium Leak Firewater Addition	4.0E-06	0.0%	0.0%
Small Leak Firewater Addition	5.1E-07	0.0%	0.0%
Rupture Firewater Addition	9.1E-07	0.0%	0.0%
Large Leak	7.5E-05	0.8%	0.8%
Medium Leak	1.8E-04	1.8%	1.8%
Small Leak	2.9E-06	0.0%	0.0%
Rupture	1.3E-05	0.1%	0.1%
Pigging			
Large Leak Firewater Addition	4.7E-08	0.0%	0.0%
Rupture Firewater Addition	1.6E-07	0.0%	0.0%
Large Leak	2.2E-06	0.0%	0.0%
Rupture	3.0E-06	0.0%	0.0%
Pipeline			
Large Leak Firewater Addition	2.6E-05	0.3%	0.3%
Medium Leak Firewater Addition	8.5E-06	0.1%	0.1%
Small Leak Firewater Addition	3.7E-06	0.0%	0.0%
Rupture Firewater Addition	2.5E-06	0.0%	0.0%
Large Leak	2.6E-04	2.7%	2.6%
Medium Leak	3.4E-04	3.4%	3.4%
Small Leak	1.9E-05	0.2%	0.2%
Rupture	3.2E-05	0.3%	0.3%
Pump			
Large Leak Firewater Addition	5.5E-06	0.1%	0.1%
Medium Leak Firewater Addition	7.2E-07	0.0%	0.0%
Rupture Firewater Addition	2.9E-06	0.0%	0.0%
Large Leak	1.8E-05	0.2%	0.2%
Medium Leak	1.5E-05	0.2%	0.2%
Rupture	2.0E-04	2.0%	2.0%
Tank			
Large Leak Firewater Addition	3.7E-06	0.0%	0.0%
Large Leak	4.2E-05	0.4%	0.4%
Small Leak	1.3E-04	1.3%	1.3%
Overfill	1.8E-05	0.2%	0.2%
Overfill Firewater Addition	7.3E-06	0.1%	0.1%
Catastrophic Rupture Firewater Addition	6.6E-08	0.0%	0.0%
Catastrophic Rupture	3.0E-05	0.3%	0.3%
Tank Boilover	0.0E+00	0.0%	0.0%
Vessel			
Rupture Firewater Addition	7.0E-07	0.0%	0.0%
Rupture	1.3E-05	0.1%	0.1%
Grand Total	**1.0E-02**	**100%**	**100%**
		TifALARP	

The main mitigated risk drivers are identified as follows;

- Loading arm large leak – 64%
- Loading arm rupture – 10%
- Loading arm large leak firewater addition – 10%

For ICUN Protected Species (European Eel), a release of hydrocarbons from the Site has the potential to trigger a MATTE Level A. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

IUCN Protected Species (European Eel)

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Loading Arm			
Large Leak Firewater Addition	1.9E-03	5.6%	19.2%
Medium Leak Firewater Addition	2.0E-04	0.6%	2.0%
Rupture Firewater Addition	3.4E-04	1.0%	3.4%
Large Leak	1.3E-02	38.2%	130.8%
Medium Leak	6.6E-03	19.1%	65.5%
Rupture	2.3E-03	6.7%	22.9%
Manifold			
Large Leak Firewater Addition	2.5E-05	0.1%	0.3%
Medium Leak Firewater Addition	8.6E-06	0.0%	0.1%
Small Leak Firewater Addition	1.1E-06	0.0%	0.0%
Rupture Firewater Addition	1.8E-06	0.0%	0.0%
Large Leak	1.6E-04	0.5%	1.6%
Medium Leak	3.8E-04	1.1%	3.8%
Small Leak	6.4E-06	0.0%	0.1%
Rupture	2.7E-05	0.1%	0.3%
Pigging			
Large Leak Firewater Addition	1.5E-06	0.0%	0.0%
Medium Leak Firewater Addition	8.9E-07	0.0%	0.0%
Small Leak Firewater Addition	7.6E-07	0.0%	0.0%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	9.0E-05	0.3%	0.9%
Medium Leak	2.4E-04	0.7%	2.4%
Small Leak	4.3E-06	0.0%	0.0%
Rupture	6.0E-06	0.0%	0.1%
Pipeline			
Large Leak Firewater Addition	5.8E-05	0.2%	0.6%
Medium Leak Firewater Addition	2.9E-05	0.1%	0.3%
Small Leak Firewater Addition	1.7E-05	0.0%	0.2%
Rupture Firewater Addition	5.1E-06	0.0%	0.1%
Large Leak	9.2E-04	2.7%	9.2%
Medium Leak	2.0E-03	5.8%	19.9%
Small Leak	9.2E-05	0.3%	0.9%
Rupture	6.3E-05	0.2%	0.6%
Pump			
Large Leak Firewater Addition	2.1E-05	0.1%	0.2%
Medium Leak Firewater Addition	1.8E-05	0.1%	0.2%
Small Leak Firewater Addition	2.3E-06	0.0%	0.0%
Rupture Firewater Addition	8.2E-06	0.0%	0.1%
Large Leak	1.8E-04	0.5%	1.8%
Medium Leak	3.9E-04	1.1%	3.9%
Small Leak	6.8E-06	0.0%	0.1%
Rupture	1.1E-03	3.1%	10.6%
Tank			
Large Leak Firewater Addition	7.4E-06	0.0%	0.1%
Large Leak	8.9E-05	0.3%	0.9%
Small Leak	2.7E-04	0.8%	2.7%
Small Tank Flammable Firewater Addition	1.1E-04	0.3%	1.1%
Small Tank Flammable Large Leak	1.0E-04	0.3%	1.0%
Small Tank Flammable Small Leak	1.0E-03	2.9%	10.0%
Small Tank Flammable Catastrophic Failure	1.6E-05	0.0%	0.2%
Overfill	3.5E-05	0.1%	0.4%
Overfill Firewater Addition	1.5E-05	0.0%	0.1%
Catastrophic Rupture Firewater Addition	1.3E-07	0.0%	0.0%
Catastrophic Rupture	6.4E-05	0.2%	0.6%
Vessel			
Large Leak Firewater Addition	4.2E-06	0.0%	0.0%
Medium Leak Firewater Addition	3.8E-06	0.0%	0.0%
Small Leak Firewater Addition	5.0E-06	0.0%	0.1%
Rupture Firewater Addition	1.6E-06	0.0%	0.0%
Large Leak	5.4E-04	1.6%	5.4%
Medium Leak	1.7E-03	5.1%	17.4%
Small Leak	3.7E-05	0.1%	0.4%
Rupture	3.0E-05	0.1%	0.3%
Grand Total	**3.4E-02**	**100%**	**343%**
		Intolerable	

The main mitigated risk drivers are identified as follows;

- Loading arm large leak – 38%
- Loading arm medium leak – 19%
- Loading arm rupture – 7%

For seabirds a hydrocarbon release from the Site has the potential to result in a MATTE level A. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

Seabirds

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Loading Arm			
Large Leak Firewater Addition	1.9E-03	5.6%	19.2%
Medium Leak Firewater Addition	2.0E-04	0.6%	2.0%
Rupture Firewater Addition	3.4E-04	1.0%	3.4%
Large Leak	1.3E-02	38.2%	130.8%
Medium Leak	6.6E-03	19.1%	65.5%
Rupture	2.3E-03	6.7%	22.9%
Manifold			
Large Leak Firewater Addition	2.5E-05	0.1%	0.3%
Medium Leak Firewater Addition	8.6E-06	0.0%	0.1%
Small Leak Firewater Addition	1.1E-06	0.0%	0.0%
Rupture Firewater Addition	1.8E-06	0.0%	0.0%
Large Leak	1.6E-04	0.5%	1.6%
Medium Leak	3.8E-04	1.1%	3.8%
Small Leak	6.4E-06	0.0%	0.1%
Rupture	2.7E-05	0.1%	0.3%
Pigging			
Large Leak Firewater Addition	1.5E-06	0.0%	0.0%
Medium Leak Firewater Addition	8.9E-07	0.0%	0.0%
Small Leak Firewater Addition	7.6E-07	0.0%	0.0%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	9.0E-05	0.3%	0.9%
Medium Leak	2.4E-04	0.7%	2.4%
Small Leak	4.3E-06	0.0%	0.0%
Rupture	6.0E-06	0.0%	0.1%
Pipeline			
Large Leak Firewater Addition	5.8E-05	0.2%	0.6%
Medium Leak Firewater Addition	2.9E-05	0.1%	0.3%
Small Leak Firewater Addition	1.7E-05	0.0%	0.2%
Rupture Firewater Addition	5.1E-06	0.0%	0.1%
Large Leak	9.2E-04	2.7%	9.2%
Medium Leak	2.0E-03	5.8%	19.9%
Small Leak	9.2E-05	0.3%	0.9%
Rupture	6.3E-05	0.2%	0.6%
Pump			
Large Leak Firewater Addition	2.1E-05	0.1%	0.2%
Medium Leak Firewater Addition	1.8E-05	0.1%	0.2%
Small Leak Firewater Addition	2.3E-06	0.0%	0.0%
Rupture Firewater Addition	8.2E-06	0.0%	0.1%
Large Leak	1.8E-04	0.5%	1.8%
Medium Leak	3.9E-04	1.1%	3.9%
Small Leak	6.8E-06	0.0%	0.1%
Rupture	1.1E-03	3.1%	10.6%
Tank			
Large Leak Firewater Addition	7.4E-06	0.0%	0.1%
Large Leak	8.9E-05	0.3%	0.9%
Small Leak	2.7E-04	0.8%	2.7%
Small Tank Flammable Firewater Addition	1.1E-04	0.3%	1.1%
Small Tank Flammable Large Leak	1.0E-04	0.3%	1.0%
Small Tank Flammable Small Leak	1.0E-03	2.9%	10.0%
Small Tank Flammable Catastrophic Failure	1.6E-05	0.0%	0.2%
Overfill	3.5E-05	0.1%	0.4%
Overfill Firewater Addition	1.5E-05	0.0%	0.1%
Catastrophic Rupture Firewater Addition	1.3E-07	0.0%	0.0%
Catastrophic Rupture	6.4E-05	0.2%	0.6%
Vessel			
Large Leak Firewater Addition	4.2E-06	0.0%	0.0%
Medium Leak Firewater Addition	3.8E-06	0.0%	0.0%
Small Leak Firewater Addition	5.0E-06	0.0%	0.1%
Rupture Firewater Addition	1.6E-06	0.0%	0.0%
Large Leak	5.4E-04	1.6%	5.4%
Medium Leak	1.7E-03	5.1%	17.4%
Small Leak	3.7E-05	0.1%	0.4%
Rupture	3.0E-05	0.1%	0.3%
Grand Total	**3.4E-02**	**100%**	**343%**
		Intolerable	

The main mitigated risk drivers are identified as follows;

- Loading arm large leak – 35%
- Loading arm medium leak – 19%
- Loading arm rupture – 7%

6.5.3 OVERPRESSURE

The tables below present the mitigated risk to the Birkenhead Priory built environmental receptor from overpressure at MATTE Tolerability Level A.

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Pipeline			
Rupture VCE	1.5E-07	100.0%	0.0%
Grand Total	**1.5E-07**	**100%**	**0.0%**
		Broadly Acceptable	

6.5.4 GROUNDWATER (DRINKING SOURCE)

The risk to the bed rock aquifer, classified as a 'Principal Aquifer', could occur at a MATTE Tolerability Level A, B and C. The assessed level of risk to this receptor at this MATTE severity level is summarised below:

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Manifold			
Large Leak Firewater Addition	2.7E-05	0.4%	0.3%
Medium Leak Firewater Addition	5.5E-06	0.1%	0.1%
Small Leak Firewater Addition	9.8E-07	0.0%	0.0%
Rupture Firewater Addition	2.4E-06	0.0%	0.0%
Large Leak	2.4E-05	0.3%	0.2%
Medium Leak	5.7E-05	0.8%	0.6%
Small Leak	9.8E-06	0.1%	0.1%
Rupture	1.6E-06	0.0%	0.0%
Pigging			
Large Leak Firewater Addition	1.5E-06	0.0%	0.0%
Medium Leak Firewater Addition	8.9E-07	0.0%	0.0%
Small Leak Firewater Addition	7.6E-07	0.0%	0.0%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	9.0E-05	1.2%	0.9%
Medium Leak	2.4E-04	3.1%	2.4%
Small Leak	4.3E-05	0.6%	0.4%
Rupture	6.0E-06	0.1%	0.1%
Pipeline			
Large Leak Firewater Addition	6.0E-06	0.1%	0.1%
Medium Leak Firewater Addition	3.1E-06	0.0%	0.0%
Small Leak Firewater Addition	4.2E-06	0.1%	0.0%
Rupture Firewater Addition	1.2E-06	0.0%	0.0%
Large Leak	3.4E-04	4.4%	3.4%
Medium Leak	7.7E-04	10.1%	7.7%
Small Leak	2.3E-04	3.0%	2.3%
Rupture	2.3E-05	0.3%	0.2%
Pump			
Large Leak Firewater Addition	2.1E-04	2.7%	2.1%
Medium Leak Firewater Addition	1.8E-04	2.3%	1.8%
Small Leak Firewater Addition	2.3E-05	0.3%	0.2%
Rupture Firewater Addition	8.2E-05	1.1%	0.8%
Large Leak	3.6E-04	4.7%	3.6%
Medium Leak	7.8E-04	10.3%	7.8%
Small Leak	1.4E-04	1.8%	1.4%
Rupture	1.1E-04	1.4%	1.1%
Tank			
Large Leak Firewater Addition	2.1E-05	0.3%	0.2%
Large Leak	1.3E-04	1.7%	1.3%
Small Leak	3.9E-04	5.1%	3.9%
Floor Failure	4.6E-04	6.0%	4.6%
Overfill	5.0E-05	0.7%	0.5%
Overfill Firewater Addition	1.3E-04	1.7%	1.3%
Catastrophic Rupture Firewater Addition	9.1E-07	0.0%	0.0%
Catastrophic Rupture	6.4E-06	0.1%	0.1%
Tank Boilover	3.7E-06	0.0%	0.0%
Vessel			
Large Leak Firewater Addition	4.2E-06	0.1%	0.0%
Medium Leak Firewater Addition	3.8E-06	0.0%	0.0%
Small Leak Firewater Addition	5.0E-06	0.1%	0.1%
Rupture Firewater Addition	1.6E-06	0.0%	0.0%
Large Leak	5.4E-04	7.0%	5.4%
Medium Leak	1.7E-03	22.8%	17.4%
Small Leak	3.7E-04	4.9%	3.7%
Rupture	3.0E-05	0.4%	0.3%
Grand Total	**7.6E-03**	**100%**	**76%**
		TifALARP	

The main mitigated risk drivers are identified as follows;

- Vessel medium leak – 23%
- Pipeline medium leak – 10%
- Pump medium leak – 10%

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Manifold			
Large Leak Firewater Addition	2.7E-05	0.4%	0.3%
Medium Leak Firewater Addition	5.5E-06	0.1%	0.1%
Small Leak Firewater Addition	9.8E-07	0.0%	0.0%
Rupture Firewater Addition	2.4E-06	0.0%	0.0%
Large Leak	2.4E-05	0.3%	0.2%
Medium Leak	5.7E-05	0.8%	0.6%
Small Leak	9.8E-06	0.1%	0.1%
Rupture	1.6E-06	0.0%	0.0%
Pigging			
Large Leak Firewater Addition	1.5E-06	0.0%	0.0%
Medium Leak Firewater Addition	8.9E-07	0.0%	0.0%
Small Leak Firewater Addition	7.6E-07	0.0%	0.0%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	9.0E-05	1.2%	0.9%
Medium Leak	2.4E-04	3.1%	2.4%
Small Leak	4.3E-05	0.6%	0.4%
Rupture	6.0E-06	0.1%	0.1%
Pipeline			
Large Leak Firewater Addition	6.0E-06	0.1%	0.1%
Medium Leak Firewater Addition	3.1E-06	0.0%	0.0%
Small Leak Firewater Addition	4.2E-06	0.1%	0.0%
Rupture Firewater Addition	1.2E-06	0.0%	0.0%
Large Leak	3.4E-04	4.4%	3.4%
Medium Leak	7.7E-04	10.1%	7.7%
Small Leak	2.3E-04	3.0%	2.3%
Rupture	2.3E-05	0.3%	0.2%
Pump			
Large Leak Firewater Addition	2.1E-04	2.7%	2.1%
Medium Leak Firewater Addition	1.8E-04	2.3%	1.8%
Small Leak Firewater Addition	2.3E-05	0.3%	0.2%
Rupture Firewater Addition	8.2E-05	1.1%	0.8%
Large Leak	3.6E-04	4.7%	3.6%
Medium Leak	7.8E-04	10.3%	7.8%
Small Leak	1.4E-04	1.8%	1.4%
Rupture	1.1E-04	1.4%	1.1%
Tank			
Large Leak Firewater Addition	2.1E-05	0.3%	0.2%
Large Leak	1.3E-04	1.7%	1.3%
Small Leak	3.9E-04	5.1%	3.9%
Floor Failure	4.6E-04	6.0%	4.6%
Overfill	5.0E-05	0.7%	0.5%
Overfill Firewater Addition	1.3E-04	1.7%	1.3%
Catastrophic Rupture Firewater Addition	9.1E-07	0.0%	0.0%
Catastrophic Rupture	6.4E-06	0.1%	0.1%
Tank Boilover	3.7E-06	0.0%	0.0%
Vessel			
Large Leak Firewater Addition	4.2E-06	0.1%	0.0%
Medium Leak Firewater Addition	3.8E-06	0.0%	0.0%
Small Leak Firewater Addition	5.0E-06	0.1%	0.1%
Rupture Firewater Addition	1.6E-06	0.0%	0.0%
Large Leak	5.4E-04	7.0%	5.4%
Medium Leak	1.7E-03	22.8%	17.4%
Small Leak	3.7E-04	4.9%	3.7%
Rupture	3.0E-05	0.4%	0.3%
Grand Total	**7.6E-03**	**100%**	**76%**
		TifALARP	

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level A MATTE
Manifold			
Large Leak Firewater Addition	2.7E-05	0.4%	2.7%
Medium Leak Firewater Addition	5.5E-06	0.1%	0.6%
Small Leak Firewater Addition	9.8E-07	0.0%	0.1%
Rupture Firewater Addition	2.4E-06	0.0%	0.2%
Large Leak	2.4E-05	0.3%	2.4%
Medium Leak	5.7E-05	0.8%	5.7%
Small Leak	9.8E-06	0.1%	1.0%
Rupture	1.6E-06	0.0%	0.2%
Pigging			
Large Leak Firewater Addition	1.5E-06	0.0%	0.1%
Medium Leak Firewater Addition	8.9E-07	0.0%	0.1%
Small Leak Firewater Addition	7.6E-07	0.0%	0.1%
Rupture Firewater Addition	3.2E-07	0.0%	0.0%
Large Leak	9.0E-05	1.2%	9.0%
Medium Leak	2.4E-04	3.1%	23.9%
Small Leak	4.3E-05	0.6%	4.3%
Rupture	6.0E-06	0.1%	0.6%
Pipeline			
Large Leak Firewater Addition	6.0E-06	0.1%	0.6%
Medium Leak Firewater Addition	3.1E-06	0.0%	0.3%
Small Leak Firewater Addition	4.2E-06	0.1%	0.4%
Rupture Firewater Addition	1.2E-06	0.0%	0.1%
Large Leak	3.4E-04	4.4%	33.8%
Medium Leak	7.7E-04	10.1%	77.5%
Small Leak	2.3E-04	3.0%	23.1%
Rupture	2.3E-05	0.3%	2.3%
Pump			
Large Leak Firewater Addition	2.1E-04	2.7%	20.9%
Medium Leak Firewater Addition	1.8E-04	2.3%	17.5%
Small Leak Firewater Addition	2.3E-05	0.3%	2.3%
Rupture Firewater Addition	8.2E-05	1.1%	8.2%
Large Leak	3.6E-04	4.7%	35.8%
Medium Leak	7.8E-04	10.3%	78.5%
Small Leak	1.4E-04	1.8%	13.6%
Rupture	1.1E-04	1.4%	10.6%
Tank			
Large Leak Firewater Addition	2.1E-05	0.3%	2.1%
Large Leak	1.3E-04	1.7%	12.9%
Small Leak	3.9E-04	5.1%	39.0%
Floor Failure	4.6E-04	6.0%	46.1%
Overfill	5.0E-05	0.7%	5.0%
Overfill Firewater Addition	1.3E-04	1.7%	12.8%
Catastrophic Rupture Firewater Addition	9.1E-07	0.0%	0.1%
Catastrophic Rupture	6.4E-06	0.1%	0.6%
Tank Boilover	3.7E-06	0.0%	0.4%
Vessel			
Large Leak Firewater Addition	4.2E-06	0.1%	0.4%
Medium Leak Firewater Addition	3.8E-06	0.0%	0.4%
Small Leak Firewater Addition	5.0E-06	0.1%	0.5%
Rupture Firewater Addition	1.6E-06	0.0%	0.2%
Large Leak	5.4E-04	7.0%	53.6%
Medium Leak	1.7E-03	22.8%	174.1%
Small Leak	3.7E-04	4.9%	37.3%
Rupture	3.0E-05	0.4%	3.0%
Grand Total	**7.6E-03**	**100%**	**765%**
		Intolerable	

MAS	Mitigated Risk	% Contribution from MAS	Proportion of Level C MATTE
Manifold			
Large Leak Firewater Addition	2.7E-05	1.5%	26.9%
Rupture Firewater Addition	2.4E-06	0.1%	2.4%
Large Leak	2.4E-05	1.4%	24.3%
Rupture	1.6E-06	0.1%	1.6%
Pigging			
Rupture Firewater Addition	3.2E-07	0.0%	0.3%
Rupture	6.0E-06	0.3%	6.0%
Pipeline			
Large Leak Firewater Addition	2.9E-05	1.6%	28.9%
Medium Leak Firewater Addition	4.4E-06	0.2%	4.4%
Small Leak Firewater Addition	1.5E-06	0.1%	1.5%
Rupture Firewater Addition	3.2E-06	0.2%	3.2%
Large Leak	3.6E-04	20.1%	357.3%
Medium Leak	1.2E-04	7.0%	124.0%
Small Leak	7.6E-06	0.4%	7.6%
Rupture	4.8E-05	2.7%	48.0%
Pump			
Rupture Firewater Addition	2.0E-05	1.1%	19.6%
Rupture	1.3E-05	0.7%	13.1%
Tank			
Large Leak Firewater Addition	2.0E-05	1.1%	20.0%
Large Leak	1.1E-04	6.1%	109.2%
Small Leak	3.3E-04	18.6%	330.0%
Floor Failure	4.6E-04	25.9%	461.0%
Overfill	2.9E-05	1.6%	29.0%
Overfill Firewater Addition	1.2E-04	6.6%	116.8%
Catastrophic Rupture Firewater Addition	8.3E-07	0.0%	0.8%
Catastrophic Rupture	5.4E-06	0.3%	5.4%
Tank Boilover	3.7E-06	0.2%	3.7%
Vessel			
Rupture Firewater Addition	1.6E-06	0.1%	1.6%
Rupture	3.0E-05	1.7%	30.4%
Grand Total	**1.8E-03**	**100%**	**1777%**
		Intolerable	

6.5.5 MITIGATED RISK MATRIX

Table 6-2 presents the overall mitigated risk to each individual receptors, and the mitigated risk is illustrated in

Receptor	MATTE Tolerability	Pathway	Mitigated Risk Frequency	Outcome
Mersey Estuary SPA/Ramsar	A	Overland Flow	2.4×10^{-2}	Intolerable
Mersey Estuary SPA Designated Bird Species	A	Overland Flow	1.0×10^{-2}	TifALARP
Mersey Narrows & North Wirral Foreshore SPA / Ramsar	A	Overland Flow	1.0×10^{-3}	TifALARP
IUCN Protected Species (European Eel)	A	Overland Flow	3.4×10^{-2}	Intolerable
Mersey Estuary SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
New Ferry SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
	B	Overland Flow	1.0×10^{-3}	Intolerable
Mersey Narrows SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
	B	Overland Flow	9.3×10^{-4}	TifALARP
Mersey Estuary RSPB Reserve	A	Overland Flow	2.7×10^{-3}	TifALARP
	B	Overland Flow	8.6×10^{-4}	TifALARP
Mudflats / Intertidal Substrate Foreshore	A	Overland Flow	2.0×10^{-2}	Intolerable
	B	Overland Flow	1.2×10^{-3}	Intolerable
GW Bedrock Aquifer	A	Overland Flow	7.6×10^{-3}	TifALARP
	B	Overland Flow	7.6×10^{-3}	Intolerable
	C	Overland Flow	1.8×10^{-3}	Intolerable
Birkenhead Priory Grade 1 LB/SM	A	Overpressure	1.5×10^{-7}	Broadly Acceptable
Seabirds	A	Overland Pathway	3.4×10^{-2}	Intolerable

Figure 6-1.

TABLE 6-2 MITIGATED RISK SUMMARY

Receptor	MATTE Tolerability	Pathway	Mitigated Risk Frequency	Outcome
Mersey Estuary SPA/Ramsar	A	Overland Flow	2.4×10^{-2}	Intolerable
Mersey Estuary SPA Designated Bird Species	A	Overland Flow	1.0×10^{-2}	TifALARP
Mersey Narrows & North Wirral Foreshore SPA / Ramsar	A	Overland Flow	1.0×10^{-3}	TifALARP
IUCN Protected Species (European Eel)	A	Overland Flow	3.4×10^{-2}	Intolerable
Mersey Estuary SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
New Ferry SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
	B	Overland Flow	1.0×10^{-3}	Intolerable
Mersey Narrows SSSI	A	Overland Flow	2.4×10^{-2}	Intolerable
	B	Overland Flow	9.3×10^{-4}	TifALARP
Mersey Estuary RSPB Reserve	A	Overland Flow	2.7×10^{-3}	TifALARP
	B	Overland Flow	8.6×10^{-4}	TifALARP
Mudflats / Intertidal Substrate Foreshore	A	Overland Flow	2.0×10^{-2}	Intolerable
	B	Overland Flow	1.2×10^{-3}	Intolerable
GW Bedrock Aquifer	A	Overland Flow	7.6×10^{-3}	TifALARP
	B	Overland Flow	7.6×10^{-3}	Intolerable
	C	Overland Flow	1.8×10^{-3}	Intolerable
Birkenhead Priory Grade 1 LB/SM	A	Overpressure	1.5×10^{-7}	Broadly Acceptable
Seabirds	A	Overland Pathway	3.4×10^{-2}	Intolerable

FIGURE 6-1 MITIGATED RISK MATRIX

	Frequency per establishment per pathway per year (Mitigated)								
Frequency at which CDOIF Consequence Level is equalled or exceeded	$< 10^{-9}$	10^{-9} - 10^{-8}	10^{-8} - 10^{-7}	10^{-7} - 10^{-6}	10^{-6} - 10^{-5}	10^{-5} - 10^{-4}	10^{-4} - 10^{-3}	10^{-3} - 10^{-2}	$>10^{-2}$
D - MATTE									
C - MATTE								7	
B + C - MATTE							1c,3a	1b,7	4, 6
A + B + C - MATTE				A,11				2b,2d,3a,7	2a,2c,1a,1b,1c,4,14
Sub MATTE	Tolerability not considered by CDOIF								

CDOIF RECEPTORS

2a-Mersey Estuary SPA/SSSI/Ramsar
2b-Mersey Estuary SPA Designated Bird Species
2c-IUCN Protected Species (European Eel)
2d-Mersey Narrows & North Wirral Foreshore SPA

1a-Mersey Estuary SSSI
1b-New Ferry SSSI
1c-Mersey Narrows SSSI

3a-Mersey Estuary RSPB Reserve

4-Priority Habitat Mudflats and Intertidal Substrate Foreshore

7-Groundwater (Drinking Source)

11-Birkenhead Priory Grade 1 LB / SM

14-Seabirds

A-Aircraft Crash

7. RECCOMMENDATIONS

This section presents the recommendations for actions which may address the main risk-driving S-P-Rs contributing to the 'Intolerable' level of mitigated risk currently estimated in the assessment.

7.1 DIRECT ENTRY (JETTY) MAS

The risk posed by the jetty MAS to Mersey Estuary based receptors is driven by the currently applied large leak frequecy from the loading arm and the absence of containment available in the event of a liquid release. Recommendations to address this S-P-R risk include;

- Consideration of instrumentation and emergency shutdown options which would allow for a reduced duration for detection and isolation in the event of a release incident. At present the detection and isolation time is 10 minutes. It is considered that automated systems may allow for a significantly reduced isolation time, and as such a significantly reduced release volume. Additionally, consideration of additional valve installation may allow for reduced isolatable volumes, thus reducing the volume (draindown) available for to be released following successful detection and isolation of a release. Lastly it may be appropriate for an enhanced inspection regime which could contribute to a lowering of the failure frequency for the loading arm.

7.2 OVERLAND FLOW MAS VIA DRAINAGE SYSTEM TO NORTH INTERCEPTOR

The risk posed by on-site MAS to Mersey Estuary based receptors is primarily driven by assets located outside of secondary containment bunds, such as pipework and pumps. These assets do not benefit from secondary containment, and as such rely upon tertiary containment for mitigation. Releases outside of secondary containment are assumed to enter the drainage system, which is ultimately routed to the North Interceptor where it is discharged by an automated pump which activates upon being submerged.

The current operation of the North Interceptor does not allow for detection of a release, or for subsequent isolation following detection of a release. It is considered automated hydrocarbon detectors would allow for early detection, and when combined with ability to remotely shutdown the pumping to the Mersey Estuary would provide sufficient control to contain the majority of releases. Recommendations to address this S-P-R risk through implementation of a robust teriry containment strategy include;

- Installation of automated hydrocarbon detectors at the North Interceptor, or within the drainage system approaching the North Interceptor.
- Ability to remotely operate the North Interceptor pump, allowing for shutdown of the pump in the event of a release being detected.
- Procedure and equipment to allow for the recovery and storage (with associated transfer) of released liquids outside of secondary containment. This would likely require mobile pumps with sufficient capacity to recover a release at a rate that limits the potential for significant accumulation of the released liquid. The recovered liquid would also require available storage capacity in the form of empty or partially filled storage tanks or potentially the Overflow Compound. The recovery and storage of a release

would mean less is available to accumulate on the ground surface and penetrate into groundwater.

7.3 RELEASES ON-SITE WITH SUBSEQUENT ENTRY INTO GROUNDWATER

The risk posed to groundwater at MATTE Tolerability Levels A and B is driven predominantly by assets located outside of secondary containment, which includes pipelines, pumps, and vessels. Recommendations to address this S-P-R risk include;

- Procedure to recover and store released liquid as defined above.
- Enhanced detection and isolation times through inspections and maintenance activities to limit the volume which may be lost upon asset failure.

The risk posed to groundwater at MATTE Tolerability Level C is driven predominantly by tank floor failures, tank small leaks, and large leaks from pipelines. The recommendations for addressing the risk from the pipeline large leak is covered in the points above. Recommendations to address the tank floor failure and tank small leak include;

- A systematic inspection of tank floors by qualified personnel. Any tank floors falling below the required standard should have tank floors replaced with the installation of impermeable tank floor liners and tell-tale leak detection.
- For tank small leaks the risk lies in penetration of a release through the bund floor. As such the demonstratable ability to recover and transfer product from the bund to alternative spare capacity, along with the application of a 'water heel' to float the release and prevent ground penetration, would allow for the release volume entering groundwater to be reduced.

A general recommendation across all assets, and as such S-P-R linkages, would be to review and enhance the inspection and maintenance regime in order to demonstrate it is above and beyond industry standard. The inspection and maintenance regime serves two purposes, firstly it is preventative, and could help demonstrate the assets are inspected frequently enough with the aim of identifying potential defects and issues prior to a MAS being realized. Secondly, it may help justify a reduced detection and isolation time for on-site assets such as pipework and pumps, which will consequently result in reduced release volumes.

These recommendations are only initial options to attempt to bring the assessment of risk out of the intolerable range. They are not in lieu of a more detailed ALARP analysis or cost benefit analysis. There may be a need to consider more extensive measures to reduce the risk (e.g. upgrading of jetty loading arm, tank floor lining, bund lining etc).

8. BIBLIOGRAPHY

[1] CDOIF, "Guideline Environmental Risk Tolerability for COMAH Establishments V2.0," 2016.

[2] E. O. UK, "Volume 1: Core Information Stanlow Manufacturing Complex COMAH Safety Report 2020," 2020.

[3] ESSAR Oil UK, "Volume 2: Detailed Operational Area Descriptions COMAH Safety Report 2020," 2020.

[4] ESSAR Oil UK, "Volume 1: Technical Aspects," 2020.

[5] Energy Institute, "Guide to Predicting Environmental Recovery Durations from Major Accidents. Supporting Guide to the Environmental Risk Tolerability for COMAH Establishments Guideline. 1st Edition," 2017.

[6] Brown & May Marine Limited , "LIVERPOOL CRUISE TERMINAL: Fishing Activity Technical Note," 2019.

[7] WSP, "Interpretative Ground Investigation Report. Tranmere Oil Terminal," 2022.

[8] D Righton et al, "Empirical observations of the spawning migration of European eels: The long and dangerous road to the Sargasso Sea. Science Advances Vol 2, Issue 10," 2016.

[9] C. R. J. R. S. C. J Graham, "European smelt (Osmerus eperlanus (L.)) Recovery Management Plan for the Solway Firth Marine Conservation Zone (MCZ)," 2021.

[10] T. H. a. S. L. (HSL), "Module 14. Operational Efficiency: Ground Risk Analysis," 2015.

[11] T. D. t. t. E. "'Earthquake Hazard and Risk in the UK', HMSO, ISBN 0 11 752773 4," 1993.

[12] D. Lewis, "Unconfined vapour-cloud explosions - Historical Perspective and Predictive Method Based on Incident Records," 1980.

[13] Jacobs, "Stanlow and Tranmere FRM Stanlow and Tranmere Flood Risk Assessment. ENVIMNW000998-JAC-00-00-RP-C0001," 2021.

[14] Durda and Kring, "Ignition threshold for impact-generated fires," 2004.

[15] HSE, "Buncefield Explosion Mechanism - Phase 1," 2009.

[16] D. Etkin, D. McCay and J. Michel, ""Review of the State-Of-The-Art on Modeling Interactions Between Spilled Oil and Shorelines for the Development of Algorithms for Oil Spill Risk Analysis Modeling,".," 2007.

[17] D. P. French-McCay, "Oil spill impact modeling: Development and validation. Environmental Toxicology and Chemistry," 2009.

[18] P. M. Taylor, "A pipeline spill into the Mersey Estuary, England. Oil Spill Conference 1991.," 1989.

[19] United Utilities, "Manchester Ship Canal Strategic Review of Fish Populations. Final Report. APEM REF: 410039," 2007.

[20] P.D. Jones, "Water quality and fisheries in the Mersey estuary, England: a historical perspective. Marine Pollution Bulletin 53, 144-154.," 2006.

[21] J.H. Wheeler, "The Tidal Thames: The History of a River and its Fishes ,Routledge & Kegan Paul, London.," 1979.

[22] Maitland & Campbell, "Freshwater Fishes of the British Isles. Harper Collins, London.," 1992.

[23] F. W. Tesch, "Anguillidae In: The Freshwater Fishes of Europe, Clupeidae and Angullidae (Hoestlandt, H. ed.), pp. 388-437. Aula-Verlag Wiesbaden.," 1991.

[24] Mersey Rivers Trust, "Mersey Rivers Trust Fisheries Strategy 2021-2050," 2021.

[25] CCW, "State of the Marine Environment in SW Wales, 10 years after the Sea Empress oil spill. Marine Monitoring Report No 21 Coastal Assessment, Liaison and Monitoring.," 2006.

[26] R. Edwards and I. White, "The Sea Empress Spill: Environmental Impact and Recovery. International Tanker Owners Pollution Federation. Paper presented at The International Oil Spill Conference.," 1999.

[27] Lanzatech, Fire Protection Philosophy. 202947C., 2023.

[28] Genesis, Dragon Integrated FEED Preliminary QRA Study Report. 202947C-000-RT-1990-00002. Rev 3., October 2023.

[29] Genesis, Dragon Integrated FEED. Fire And Explosion Risk Analysis. 202947C-000-RT-1990-00001., October 2023.

[30] HSE, "Failure Rate and Event Data for use within Risk Assessments (28/06/2012)," 2012.

[31] ERM, "LanzaTech – Project Dragon, Port Talbot H5 Site Condition Report," 2023.

[32] T. E. C. ltd, "Ground Investigation Report - Phoenix Wharf, Port Talbot," 2022.

[33] HSL, "Health and Safety Laboratory, Module 14. Operational Efficiency: Ground Risk Analysis," 2015.

[34] P. R. Steiner, "homelandguards.org," 15 June 2018. [Online]. Available: https://homelandguards.org/wp-content/uploads/2018/08/2018-07-15-prof-richard-steiner-leviathan-project-environmental-risks.pdf. [Accessed 2023].

[35] E. M. e. al., "https://www.hnsconvention.org," 2009. [Online]. Available: https://www.hnsconvention.org/wp-content/uploads/2019/02/review-of-chemical-spills-at-sea.pdf. [Accessed 21 11 2023].

[36] Technip Energies, "Specification for Atmospheric and Low Pressure API Storage Tanks. Project 202947C," 2023.

[37] Stopford, COMAH Emergency Response Guideline Document. R6716-PR-0002. P2., 2023.

[38] LanzaTech, "Shipping and Road Movements," 2023.

[39] S. Powers and D. Rice, "LUSTLine Bulletin 36. The Subsurface Fate of Ethanol. A Look at the Emerging Oxygenate Alternative to MTBE.," 2000.

[40] Technip Energies, Overpressure Protection and Emergency Shutdown (ESD) Philosophy. 202947C. Rev 2., 2023.

[41] B. &. G. W.J. Langston, "Site Characterisation of European Marine Sites - The Mersey Estuary SPA," 2006.

[42] W. Ritchie and M. O'Sullivan, "The Environmental Impact of the Wreck of the Braer, Scottish Office, Edinburgh," 1994.

[43] R. &. C. D. &. D. T. &. O. T. &. W. R. &. W. T. Helm, "Overview of Effects of Oil Spills on Marine Mammals," 2015.

[44] B. E. B. C. M. D. C. R. K. J. B. D. M. G. E. K. K. Daniel Esler, "Timelines and mechanisms of wildlife population recovery following the Exxon Valdez oil spill," 2018.

[45] J. M. A. D. O. D. Á. P. M. L. A. V. Ignacio Munilla, "Mass mortality of seabirds in the aftermath of the Prestige oil spill," *Ecosphere,* vol. 27, pp. 1-14, 2011.

[46] P. Roscigno and C. Proffit, "Proceedings: Gulf of Mexico and Caribbean Oil Spills in Coastal Ecosystems: Assessing Effects, Natural Recovery, and Prograss Remediation Research," 1996.

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