Environmental Impact Assessment Report

Volume 4

Appendix 10.9 Investigation of disturbance tolerance of terns breeding near to the onshore substation site

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Investigation of disturbance tolerance of terns breeding near proposed onshore substation site

Report to Codling Wind Park Ltd.

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Version control

Version	Date	Changes	Confidentiality	Prep	Rev	Auth
V1	11/01/2024		Not confidential	AL/NK		AL
Final	26/03/2024	AL	Not confidential	AL	Client	AL

Contents

Summary

1. Study aim was to investigate disturbance tolerance of breeding terns at CDL and ESB Dolphin breeding colonies
2. Findings are presented and potential mitigation considered and recommended
3. Field survey consisted of tern disturbance/behavioural monitoring during background disturbance levels (151.5 h and 148.5 h at the two colonies).
4. Experimental testing of disturbance tolerance was carried out over five days, under license, to examine response to construction type disturbance stimuli on the proposed onshore substation site.
5. There were 516 potential disturbance events recorded at ESB Dolphin and 580 at CDL Dolphin. The majority came from boat traffic movements and predators. Around 40% of traffic related potential disturbance events resulted in observed disturbance while response to predators was >90% at both sites.
6. Predators accounted for a similar contribution of calculated daily disturbance time than traffic.
7. Total daily background disturbance time for the colonies was similar at c.25-30 minutes per day.
8. Experimental treatments included a range of simulated construction operations. In most cases operations had a lower disturbance response than anticipated.
9. The presence of people close to the colony caused a higher proportion of disturbance response than vehicle activity alone but response rates were generally low and thus, less significant than were anticipated
10. There is a strong indication of habituation to several forms of disturbance in the area
11. Extreme noise was the only significant stimulus to cause an apparent severe reaction from the terns on CDL Dolphin.
12. None of the experimental treatments caused any disturbance at ESB Dolphin.
13. The onshore substation site sits well outside the Flight Initiation Distance for terns at ESB Dolphin and, in relation to most activities, is also outside the FID for CDL Dolphin . As such, disturbance effects of the type regularly seen are unlikely to cause significant adverse effects.
14. The potential for large scale construction effort at the site is likely to cause significant visual and audible disturbance and as such several mitigations are recommended:
    - Recommendation 1: Consider physical screening to reduce risk of disturbance effects during the breeding season
    - Recommendation 2: Ensure colony response is monitored to enable minor adaptations of works
    - Recommendation 3: Avoidance of highest disturbance risk works during key periods
    - Recommendation 4: Consider reduction of background disturbance levels by reducing other forms of disturbance during construction works and by managing predator risk from built structures (post-construction)
15. The design of the proposed substation avoids any issues with shadow effects and is unlikely to increase predator risk at the site and may result in a net decrease in real predator risk due to changes in the shoreline adjacent to the colony and design features which discourage predator perching.

1. Introduction

1.1 Background

An area of reclaimed land to the north of the Uisce Éireann stormwater tanks, on the Poolbeg Peninsula forms the proposed location for an onshore substation for the Codling Wind Park Project. As such, several aspects of ecological interest have been surveyed close to and within the area of interest (Figure 1).

There are two tern breeding colonies on the "Dolphins" (ESB Dolphin and CDL Dolphin). These colonies have been present for several decades[1,2], and are designated accordingly, as an SPA (ESB dolphin only[3]) and a pNHA (both sites[4]), for their breeding tern interest, primarily Common Tern *Sterna hirundo* on the ESB Dolphin and mainly Arctic Tern *Sterna paradisaea* on the CDL. In 2022 CDL had 13 pairs of Arctic Tern and 11 pairs of Common Tern, while ESB Dolphin held 138 Common Tern nests (census on 10th June) (per Dublin Bay Birds Project). Tern breeding numbers for 2023 are unknown but broadly comparable to 2022 (based on observations) though with more Common tern at CDL than the previous year. Breeding success was apparently significantly affected by HPAI[5] (Highly Pathogenic Avian Influenza).

Figure 1 Site location & survey layout

[1] Merne, O.J. 2004. Common Sterna hirundo and Arctic Terns S. paradisaea breeding in Dublin Port, County Dublin, 1995-2003. *Irish Birds*. 7: 369-374.
[2] Whilde, A. 1985. The 1984 All Ireland Tern Survey. *Irish Birds* 3: 1-32
[3] South Dublin Bay and River Tolka Estuary SPA SITECODE 004024
[4] Dolphins, Dublin Docks pNHA (000201)
[5] https://birdwatchireland.ie/bird-flu-devastates-key-irish-seabird-colonies/

The potential of the site to form a location for the proposed onshore substation gives some potential for effects on the breeding tern interest of the SPA and pNHA. While there are no planned developments of the Dolphins themselves, there are two potential phases of the development which are of relevance to breeding terns on the sites:

- Construction phase – when construction activities on the perimeter, and within, the site may cause some level of disturbance effect on the breeding terns
- Operational phase – when the presence of buildings or other infrastructure on the site may have effects on the suitability of the site for breeding terns

This report primarily deals with potential for disturbance effects which may arise during the construction phase and also reviews the potential for impacts during the operational phase, on the basis of the proposals for substation design.

1.2 Study aims

The aim of this study was to investigate the level of tolerance of breeding terns at the site, to various forms of disturbance, and to ascertain whether disturbance was likely to be significant and adverse in itself, or whether new forms of disturbance may be additive to existing background levels of disturbance.

Findings are presented and consideration of potential forms of mitigation are considered and recommended.

In addition. the study examined the existing proposals for building design and considered the potential for the presence of a new building to have effects on the suitability of the site for breeding terns.

2. Methods

Field survey was carried out on 22 dates between 31st May and 27th July 2022, and on nine dates in April and May 2023, by experienced/trained personnel with good familiarity of the species and the colonies.

The surveys in 2022 (between 31st May and 13th July 2022) investigated existing levels of disturbance at the sites (background disturbance). The second period (25th, 26th and 27th July 2022) focused on the assessing the level of response of breeding terns to the application of simulated construction disturbance on the site (experimental disturbance). The survey visits in April and May 2023 including checks for occupancy and activity, and the investigation of background and experimental disturbance response early in the breeding season,

2.1 Background disturbance approach

Totals of 151.5 h and 148.5 h of vantage point survey time were completed at the CDL Dolphin and ESB Dolphin respectively, during background disturbance monitoring across the two seasons. This included 3 hours of nocturnal surveys at each site (between 2200h and 0100h on 16th June at CDL and 20th June at ESB Dolphin). All were simultaneous watches at each site except for one additional 3-hour watch at CDL.

Survey periods were spread through the survey days, with all hours of the day surveyed except for the period 0100h-0400h. Hours of darkness were included within the survey. Figure 2 illustrates the effort distribution across the 24h period during the two survey seasons.

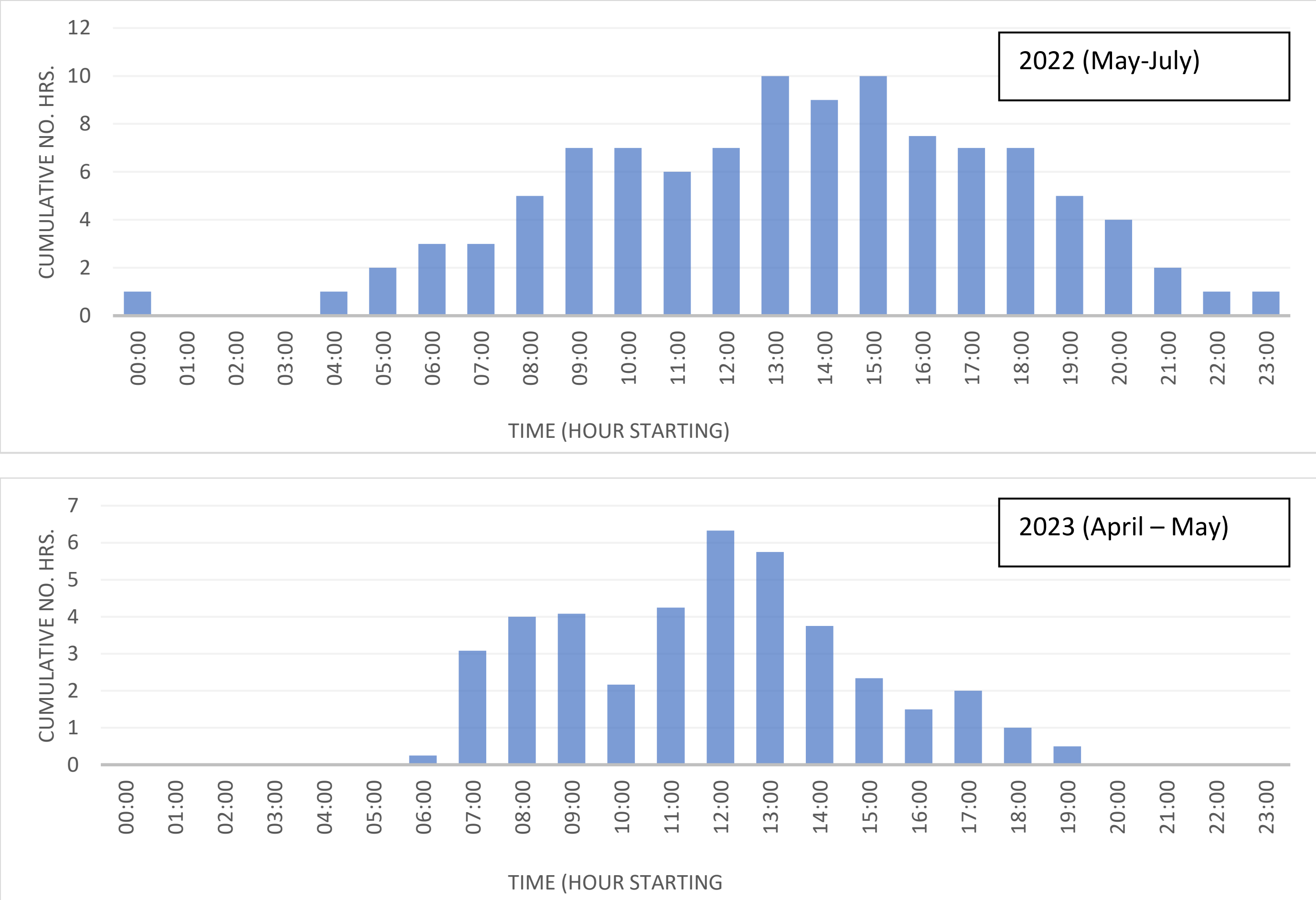

Figure 2 Distribution of vantage point watch effort

Vantage point watches involved observers remaining still, observing the colonies from a suitable vantage point (Figure 1) at a distance whereby no disturbance was caused, and recording all disturbance related activity of terns at each respective colony platform in two ways:

- On a defined schedule (every 10 minutes)
- During all perceived potential disturbance events

Typical potential disturbance events include (but were not limited to):

- Watercraft & ship movements
- Predator presence or activity
- Human presence
- Sudden or prolonged loud noises
- Changes in lighting (such as beacons or flashes)
- Close pass of aircraft (drones, helicopters etc)

Disturbance stimuli and behaviour were coded accordingly, to enable subsequent analysis – examining the duration and severity of reaction to events in each case. The recording form and coding schema is included at Appendix 1.

The range of disturbance sources were able to be broken down into four main stressor types:

- Traffic movement (water/aircraft) – no road traffic movements were obvious from the sites and thus traffic related only to waterborne vessels.

- Predator/perceived predator – avian, mammal and human "predators" either presence or attack. Included non-predators perceived as predators including, occasionally, lone pigeons which can often briefly be perceived by birds as small raptors.
- Light – significant lighting presence or change, particularly at night.
- Noise – loud or sudden, short or continuous noises from a range of sources which are over and above the background volume of noise at the site form road traffic. Generally, this included sirens, loud percussive banging, alarms and "Tannoy" announcements.

2.2 Experimental disturbance approach

A planned series of disturbance events to simulate construction works were carried out in the study area across five dates; in July (25th, 26th and 27th July 2022) and in May (19 & 22 May 2023). These were designed to simulate typical construction activities but necessarily were in full view and relatively close proximity of the CDL Dolphin (Figure 3). The ESB Dolphin sits out of line of sight of the onshore substation site.

A licence[6] was obtained, from National Parks and Wildlife Service of the Department of Housing, Local Government and Heritage, to carry out the works. This was on the basis of providing close monitoring, periodic breaks and review throughout in order that signs of severe disturbance could be managed, and the tests ceased or reduced accordingly.

The summary scope of experimental disturbance testing on each day is outlined in Table 1.

Table 1 Summary of range of experimental disturbance applied during the study

Date	Total duration	Outline of experimental works
25 July 2022	2h 5m	Presence of personnel (1- 4) to closest colony approach Personnel movement (slow – rapid approach) Personnel intensive movement (arm waving, associated shouting, flag waving)
26 July 2022	5h 30m	Machinery presence Machinery & personnel combined Machinery activity (low – high) Simulated vehicle operations (excavation, spreading, piling) All above combined with beacon lights and horn sounds
27 July 2022	4h 45m	Machinery presence Machinery & Personnel combined Machinery activity (low – high/close to moderate distance) Simulated vehicle operations (excavation, spreading, piling) All above combined with beacon lights and horn sounds Air horn use, extreme/unbearable sound
19 May 2023	2h 40m	Machinery presence Machinery & personnel combined Machinery activity (low – high) Simulated vehicle operations (excavation, spreading, piling) All above combined with beacon lights and horn sounds
22 May 2023	2h 28m	Machinery presence Machinery & personnel combined Machinery activity (low – high) Simulated vehicle operations (excavation, spreading, piling) All above combined with beacon lights and horn sounds

The experimental disturbance treatments are further described in Table 4 in the results section. Reference to machinery or vehicles refers to those illustrated in Figure 2. A combination of an excavator and dumper truck were

[6] Licence No. C118/2022 under Wildlife Acts 1976 to 2018 – Sections 23 and 34

used. Both vehicles able to generate significant noise, movement and light stimuli and able to access ground to within 40m of the CDL.

Data recording was carried out by taking detailed behavioural notes during each treatment and subsequently applying the codes used for background disturbance monitoring (Appendix 1) to observed response behaviour.

2.3 Survey limitations and assumptions

This survey aims to assess the frequency and severity of individual disturbance events occurring at the study site, comparing this to the observed response to disturbance stimuli from simulated works.

Most bird disturbance studies have focussed on observed population change under variable environmental conditions to create correlates of change. In this case, the study is short term - a "snapshot" during the mid-late breeding season and does not capture data during nest initiation, egg laying or incubation periods or comparative year to year data.

Analytical approaches to the results are, necessarily, simple and summarised, observed and narrative. This can provide inferences with regard to expected vs observed responses under certain environmental or test conditions but is not intended for robust statistical modelling.

Behavioural studies focus predominantly on two main measures of disturbance response, Alert Distance[7][8] (AD) and Flight Initiation Distance[9][10] (FID). The former can be an effective measure when species can be observed clearly, and subtle behavioural changes noticed. The latter is more appropriate to species observed at distance or where line of site is obscured (as in this case). FID tends to underestimate physiological stresses which can be subtle even when birds remain on nests but can infer AD by applying some level of conversion.

In this study FID is the primary measure and, in all cases, disturbance events (DE) refer to flight initiation and thus relate to FID.

Relatively few disturbance studies use behavioural observations, as opposed to many which use population size, distribution, breeding parameters or physiological response data[11] (which generally require significantly longer study periods). Those behavioural studies that do exist generally take a form which ordinates observed behaviour into defined categories. These categories vary on a study-by-study basis, as appropriate to the species and context.[e.g.,12] In this case, coding the response severity was key to providing a relative measure of response, and was based on a scale of response behaviours identifiable in the field from authors' experience with the species, and from preliminary observations of the species at the site. The coding for severity of the response is not related to specific physiological measures or thresholds but relates to the level of vocal and physical agitation observed and the duration of the

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[7] AD: Alert Distance (AD) is defined as the distance at which a bird or group of birds starts to show alert behaviour (e.g., head up, alarm calling, staring at the source of disturbance, aggressive display, chicks startled, crouching or flattening on the nest etc) rather than sleeping, foraging or preening behaviour when approached by a disturbance agent (such as a person, or powerboat) (Livezey et al., 2016).

[8] Livezey, K. B., Fernández-Juricic, E. and Blumstein, D.T. 2016. Database and metadata of bird flight initiation distances worldwide to assist in estimating human disturbance effects and delineating buffer areas. *Journal of Fisheries and Wildlife Management* 082015–JFWM–078.4

[9] FID: Flight Initiation Distance (FID) is defined as the distance at which a bird or group of birds starts to escape (by walking away, running away, swimming away, taking flight, or diving) when approached by a disturbance agent (such as a person, or powerboat). This distance is assumed to reflect the trade-off between costs of escape (energetic costs of flight plus loss of food intake during the period of disturbance) and the risk associated with staying put (inferred predation risk) (Mikula et al., 2018).

[10] Mikula, P., Díaz, M., Møller, A.P., Albrecht, T., Tryjanowski, P. and Hromada, M. 2018. Migratory and resident waders differ in risk taking on the wintering grounds. *Behavioural Processes* 157: 309-314.

[11] Hockin, D., Ounsted, M., Gorman, M., Hill, D., Keller, V. & Barker, M. (1992) Examination of the effects of disturbance on birds with reference to the role of environmental impact assessments. *Journal of Environmental Management*, 36, 253-286

[12] : R. Riddington , M. Hassall , S.J. Lane , P.A. Turner & R. Walters (1996) The impact of disturbance on the behaviour and energy budgets of Brent Geese *Branta bernicla* , *Bird Study*, 43:3, 269-279, DOI: 10.1080/00063659609461019

response. This in turn can be assumed to broadly equate to greater energy expenditure and higher nest predator risk when the response is more severe.

Limited sample size and range – There were higher numbers of low severity events and rather few high severity events. Though this may well simply reflect the ambient environmental conditions and without significantly more watch effort more severe events would be unlikely to be recorded.

Analytical limitations – while the methods used follow typical approaches of coding/scoring of disturbance response types, the short available duration to initiate and bring the study to fruition necessarily meant further finessing of the coding was not possible. Resulting analytical approaches are necessarily simple and narrative.

Figure 3 Vehicles used for simulating construction activity to provide a range of disturbance stimuli – the nearby crane and ferry are typical sources of regular background traffic

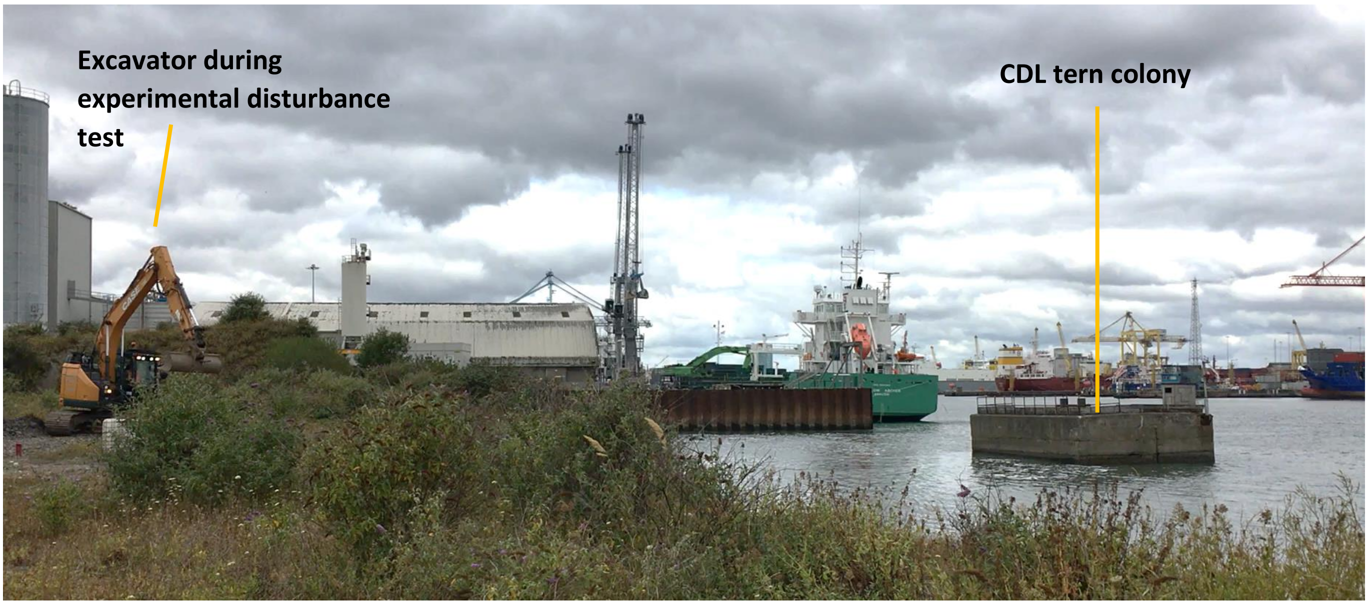

Figure 4 Image of experimental disturbance activity in progress

3. Results

3.1 Background disturbance levels

3.1.1 Sources of background disturbance

The study area sits within a heavy industrial zone in the Dublin Port/Poolbeg area. It has high levels of human activity.

During the survey period the following main sources of disturbance were observed:

- Waterborne craft: Cargo ships, passenger ships and small watercraft of a wide range of types.
- Industry and traffic: Close to the onshore substation site are roads and industrial facilities and there is a high level of background moise throughout the day and night.
- Predators: The tall buildings and other structures in the area give rise to suitable nest locations for a range of avian predators (Peregrine and Buzzard) and meso-predators (crows, gulls). Rats and Otter are regualrly seen on the shoreline and Grey and Common seals can be seen in the main port channel.
- Humans: The tern colonies were infrequently visited by research workers from another project and humans may be visible in pierside or shoreline areas adjacenet to the dolphins from time to time. In addition, on 4th May 2023, personnel carrying out colony site maintainence caused prolonged disturbance.
- Aircraft: helicopters (mainly) occasionally fly close to the area and there is occasional use of drones in the area.

These were categorised and recorded as four stressor types; traffic movement (water/aircraft), predator/perceived predator, light, noise for the application of analysis. In each case the range of potnetial responses varied considerably due to proximity, noise and movement level.

3.1.2 Background disturbance (all sources)

Table 2 details responses observed during background disturbance monitoring.

There were 516 potential disturbance events (PDE) recorded at ESB Dolphin and 580 at CDL Dolphin. Of these the majority came from traffic movements, predominantly ships and small boat traffic, and predators. Table 4 and Table 5 outlines the main contributions to both PDE from all stressors during the two survey periods in June/July 2022 and May 2023 and notes the proportions which elicited a disturbance response in each case. Notably no response was seen from light-borne disturbance sources, albeit there were relatively few events.

Boat traffic generated the highest proportion of PDE with only 42% and 31%, at ESB and CDL Dolphins respectively, soliciting a detectable disturbance response.

Table 2 Background disturbance monitoring results (mid-late breeding period 2022)

	Potential Dist. Events (PDE)		Actual Dist. Events (DE)							No. events with response score						
Stressor type	Total no. day	Total no. night	total no. day	Total no. night	Total disturbed duration day (m)	Total disturbed duration night	Av. DE per hour	Est. no. DE/day	Av. time disturbed per event (m)	Total no. of no response	1 L	2 M	3 H	4 VH	5 Sev.	Av. response score
ESB Dolphin																
traffic movement (water/aircraft)	304	3	129	1	253	1	1.1	26.3	0.5	177	70	24	26	10	0	1.82
predator/perceived predator	145	4	141	4	361	20	1.2	29.4	0.4	4	61	30	31	8	15	2.21
Light	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0	0	0.00
noise	35	0	13	0	31	0	0.1	2.6	0.4	22	4	2	2	5	0	2.62
CDL Dolphin																
traffic movement (water/aircraft)	323	6	101	0	217	0	0.8	20.0	0.5	228	34	16	42	9	0	2.26
predator/perceived predator	117	2	108	1	190	0	0.9	21.6	0.6	10	41	27	24	15	2	2.17
Light	4	1	0	0	0	0	0.0	0.0	0.0	5	0	0	0	0	0	0.00
noise	79	4	14	0	16	0	0.1	2.8	0.9	69	10	3	1	0	0	1.36

Table 3 Background disturbance monitoring results (early breeding period 2023)

	Potential Dist. Events (PDE)		**Actual Dist. Events (DE)**							**No. events with response score**						
Stressor type	Total no. day	Total no. night	total no. day	Total no. night	Total disturbed duration day (m)	Total disturbed duration night	Av. DE per hour	Est. no. DE/day	Av. time disturbed per event (m)	Total no. of no response	1 L	2 M	3 H	4 VH	5 Sev.	Av. response score
ESB Dolphin																
traffic movement (water/aircraft)	97	0	13	0	17	0	0.4	10.4	0.7	84	0	11	2	0	0	2.15
predator/perceived predator	29	0	27	0	37	0	0.9	21.6	0.7	2	1	14	9	1	2	2.59
Light	0	0	0	0	0	0	0.0	0.00	0.00	0.00	0	0	0	0	0	0.00
noise	4	0	0	0	0	0	0.0	0.00	0.00	4	0	0	0	0	0	0.00
CDL Dolphin																
traffic movement (water/aircraft)	94	0	17	0	23	0	0.6	13.6	0.7	77	2	13	1	1	0	2.05
predator/perceived predator	25	0	18	0	18	0	0.6	14.4	1.0	7	1	7	10	0	0	2.5
Light	0	0	0	0	0	0	0.0	0.00	0.0	0	0	0	0	0	0	0.00
noise	7	0	2	0	2	0	0.1	1.6	1.0	5	0	0	2	0	0	3.0

The different stressors also resulted in different perceived disturbance response scores. With highest response scores relating to predator events but with relatively high response to noise at ESB Dolphin, and traffic at ESB Dolphin, albeit none reach high response on average.

Table 4 Contribution of stressor types to background PDE and DE (mid-late breeding period 2022)

	ESB Dolphin			CDL Dolphin		
Stressor	% of all PDE	% with response	Av. response score	% of all PDE	% with response	Av. response score
Traffic	63%	42%	1.8	61%	31%	2.3
Predators	30%	97%	2.2	22%	92%	2.2
Light	0%	0%	0.0	1%	0%	0.0
Noise	7%	37%	2.6	15%	17%	1.4

Table 5 Contribution of stressor types to background PDE and DE (early breeding period 2023)

	ESB Dolphin			CDL Dolphin		
Stressor	% of all PDE	% with response	Av. response score	% of all PDE	% with response	Av. response score
Traffic	75%	13%	2.2	74%	18%	2.1
Predators	22%	93%	2.6	20%	72%	2.5
Light	0%	0%	0.0	0%	0%	0.0
Noise	3%	0%	0.0	6%	28%	3.0

The observed number of PDE per hour was 2.4 at ESB Dolphin and 1.8 at CDL Dolphin thus deriving estimated daily rates of 58.3 and 44.3 respectively. Suggesting lower frequency of disturbance events at CDL.

Table 6 indicates the estimated duration of disturbance at each site in each survey period, per day.

Table 6 Disturbance duration in two breeding period

	Mid-Late 2022		Early 2023	
	Estimated disturbance duration (min/day)		Estimated disturbance duration (min/day)	
Stressor type	**ESB**	**CDL**	**ESB**	**CDL**
Traffic	13.5	9.3	10.4	13.6
Predators	11.2	12.4	21.6	14.4
Light	0.0	0.0	0.0	0.0
Noise	1.1	2.4	0.0	1.6
Total	25.8	24.1	32.0	24.1

There appears strong consistency both in the total duration of disturbance recorded between the sites and the total daily disturbance estimated for each site between the two periods. Predators appear to contribute more overall disturbance at both sites, but with boat traffic also significant contributor in both cases. The close proximity of CDL Dolphin to shoreline areas, and of ESB Dolphin to the shipping lane, is a consideration here.

3.1.3 Predators as background disturbance

The role of predators as a disturbance source is readily observable in Tables 2-6. Predators (or perceived predators) take several forms (Figure 5, Figure 6). Raptors (Peregrine *Falco peregrinus*, Buzzard *Buteo buteo*, Sparrowhawk *Accipiter nisus* all recorded), gulls (Lesser Black-backed *Larus fuscus*, Great Black-backed *L. marinus*, Herring *L. argentatus* and Black-headed *Chroicocephalus ridibundus*), Herons (Grey Heron *Ardea cinerea* and Little Egret *Egretta garzetta*), Feral Pigeon *Columba livia ssp domestica* (a perceived "raptor") are all noted.

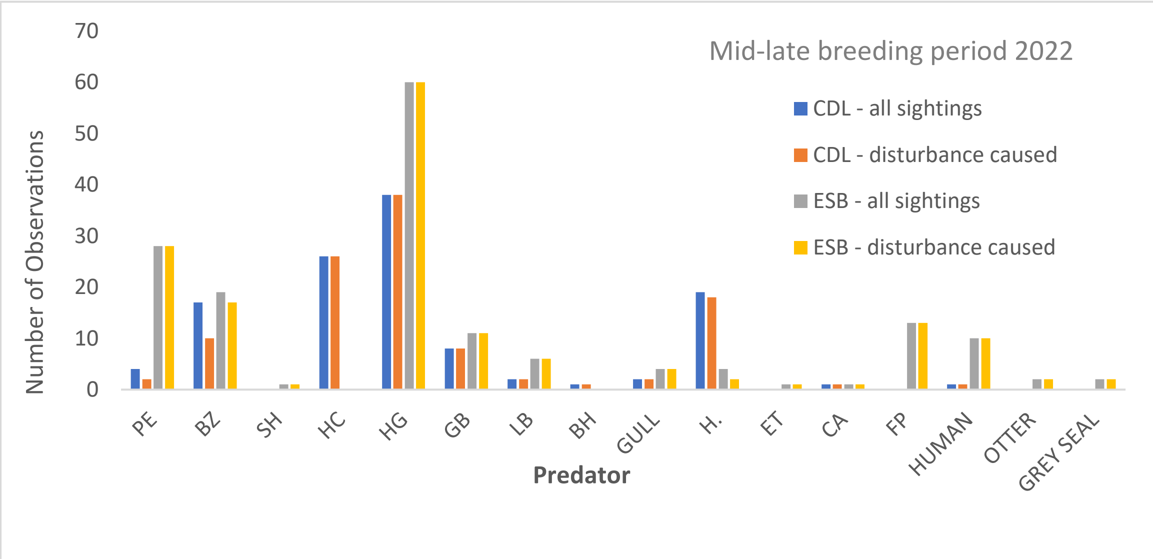

Figure 5 Predator/perceived predator interactions in mid-late breeding period 2022

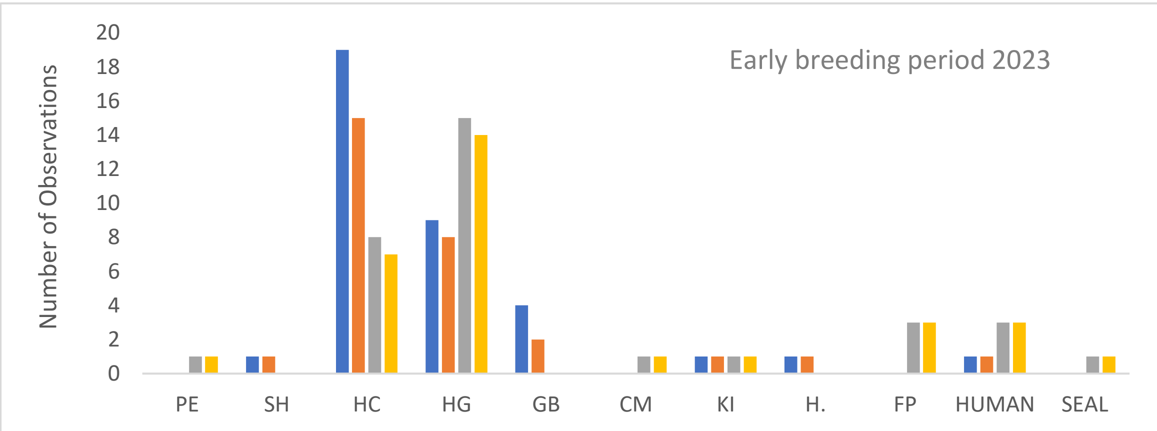

Figure 6 Predator/perceived predator interactions in early breeding period 2023

The proportion of disturbance events from each species at each site indicates that when predators are present, disturbance at some level nearly always results. There is some variation in the main sources of predator borne disurbance between the sites, with Hooded Crow quite prevalent across both, but notably so at the CDL Dolphin, and Peregrine and large gulls frequent at the ESB Dolphin.

Response severity observed from the range of disturbance stimuli is highest from predator events as opposed to other forms.

3.2 Experimental disturbance response

Table 7 and Table 8 outlines the comparison between the planned experimental disturbance treatments and the actual disturbance observed, for each broad stressor type (at CDL Dolphin only) in the mid-late breeding period 2022 (Table 7) and early breeding period 2023 (Table 8) .

Levels of disturbance at ESB Dolphin from testing was effectively zero, i.e. no disturbance effects were observed on ESB Dolphin terns from experimental disturbance treatments in either of the survey periods.

Table 7 Experimental disturbance – presumed vs actual disturbance derived from aggregated stressors/stimulus type (late breeding period 2022)

	Predicted/planned disturbance treatments				**Actual Disturbance Events (DE)**		**Disturbance response scores**						
Stimulus/ Stressor Type	**Presumed Response Level**	**Presumed Average Response Score**	**Number of treatments**	**Total dur'n (min)**	**No. Events**	**Total dur'n (min)**	**0 None**	**1 Low**	**2 Mod**	**3 High**	**4 Very High**	**5 Severe**	**Average observed response score**
V (standard movement + noise)	Mod	2	12	45	1	5	11	0	0	1	0	0	0.3 Low
P (Personnel)	Mod	2	23	40	13	18	9	1	10	1	2	0	1.4 Low-mod
VM (movement, noise + lights)	High	3	24	115	0	0	24	0	0	0	0	0	0.0 None
P + VM	V High	4	3	25	6	19	2	0	0	0	1	0	1.3 Low - mod
VN (extreme noise levels)	Severe	5	1	2	1	2	0	0	0	0	0	1	5.0

Table 8 Experimental disturbance – presumed vs actual disturbance derived from aggregated stressors/stimulus type (early breeding period 2023)

	Predicted/planned disturbance treatments				**Actual Disturbance Events (DE)**		**Disturbance response scores**						
Stimulus/ Stressor Type	**Presumed Response Level**	**Presumed Average Response Score**	**Number of treatments**	**Total dur'n (min)**	**No. Events**	**Total dur'n (min)**	**0 None**	**1 Low**	**2 Mod**	**3 High**	**4 Very High**	**5 Severe**	**Average observed response score**
V (all treatments)	High	3	28	265	3	26	25	0	0	3	0	0	0.3 Low
VM (movement, noise)	Mod	2	7	60	0	0	0	0	0	0	0	0	0.00 None
VM (move, noise, lights)	Very high	3	21	205	3	0	0	0	0	3	0	0	0.4 Low
P (Personnel)	Mod	2	7	40	1	12	6	0	0	0	1	0	0.6 Low
P + VM	High	3	17	160	3	26	14	0	0	3	0	0	0.5 Low

The predicted levels of disturbance from each treatment is shown (all of which were presumed to be moderate or higher by design). The range of scores arising from treatments categorised under each broad stressor type is given and an average provided. Comparing the average observed score against the presumed/planned response indicates whether the perceived level of disturbance arising from an given stressor is reflected in the real world response.

Personnel presence was presumed to be moderate (score 2) and the range of observed scored was zero to four in both periods. The average scores (1.4 and 0.6 in late and early periods respectively) vary substantially and this is likely due to the relatively low frequency of higher scores. Most of the personnel-based treatments, created no, low or only moderate, disturbance response and these generally followed a reaction to first approach in a series of treatments followed by subsequent approaches eliciting a lower or no repsonse.

The presence and operation of vehicles in close proximity to the CDL colony was tested in several treatment types – this included presence at a range of distances and presence and various levels of activity at closest proximity possible. Figure 6 shows a general layout of the site in relation to vehicle and personnel disturbance treatments.

The combination of vehicle operations with a range of lights, alarms and horn noise associated with personnel nearby, appeared to elicit a high or very high response in only four cases from 20, and the [pattern generally followed a higher response followed subsequently by little or no response in repeat treatments. In the early period the response, on average, was lower when vehicles were present than when people alone were present and near equal in the late period.

The similar, vehicle-based stressor types without associated personnel on the ground, showed a lower overall response, with only four high responses from a total of 63 treatments across the two periods, with the remainder regarded as no response.

The only stressor predicted to elicit a severe response (sudden and then prolonged noise via air horn blasting) showed a response broadly as predicted. This stressor was highly artificial, and not the norm in a construction setting, but was, in effect, testing the uppermost noise-based stressor available to the field team.

Figure 7 Approximate layout of experimental disturbance treatment areas – the main area outline in red dashed line contained the main vehicle treatments. Personnel treatments were carried out at closest proximity as shown

Table 9 provides a narrative account of tern response at each of the dolphin sites in response to the experimental disturbance treatments applied during both breeding periods. This clearly indicates no apparent effect of disturbance, at the proposed substation site, upon the ESB dolphon colony.

At the CDL, in summary, almost all experimental disturbance during this period was found to have “zero”, “low” or “low to moderate” level of disturbance effect, except for three scenarios;

- where fledged young (present for 1 day) occasionally landed on shore close to the experimental works taking place, personnel in the area were subjected to mobbing attack behaviour by one to four adult Arctic terns.
- Where extreme noise (air horn) was directed at the colony (one treatment) the tern response was an expected, fast, dramatic and high flush/dread and a slow return after cessation. Taking some 5+ minutes to settle.

In other cases, there were strong indications that vehicle presence and activity, even when loud and mobile, was tolerated at closest approach (c. 40m). There were also indications that personnel proximity was a combining factor for an initial disturbance response, both with and without vehicle presence. This however, showed clear signs of reducing and thus tolerance by the CDL terns, after a period of habituation even at closest feasible proximity of c. 25-30m.

Table 9 Detailed accounts of experimental treatments and resulting disturbance behaviour

Test Description	Assumed Response Severity	Actual Response Description (initial)	Actual Response Description (subsequent)	Actual Response Severity	Further notes
Personnel in hi-viz present (standing) within 40m of CDL	2 (Moderate)	CDL: No response from terns ESB: None	CDL: Terns actively mobbed personnel when fledged chicks present on shoreline ESB: None	CDL: av. <2 (Low to mod), <1 (low – early breeding) ESB: 0 (None)	Personnel in hi-viz standing still while close to CDL initially elicited no response but after other treatments (vehicle, noise etc) and incident of mobbing began as apparent agitation levels increased and this was likely related to fledged juveniles mobile and present on the shoreline very close. No observed effect at the ESB Dolphin.
Personnel in hi-viz present (active) within 40m of CDL	2 (Moderate)	CDL: No response from terns ESB: None	CDL: Terns mobbing personnel ESB: None	CDL: <2 av (<1 early period) but 3 incidents of VH (4) ESB: 0 (None)	Personnel in hi-viz walking about, waving arms/flags, clapping and shouting close to CDL Dolphin. Initially elicited no response but after other treatments (vehicle, noise etc), mobbing began as apparent agitation levels increased. Noticeably more aggresion and mobbing when fledged juveniles were mobile and present on the shoreline. No observed effect at the ESB Dolphin.
All work vehicles stationary, 40-100m of CDL, with engines running	1 (Low)	CDL: No response from terns ESB: None	CDL: No response from terns ESB: None	CDL: 0 (None) ESB: 0 (None)	Simulating start of day activities at a construction site with engines of work vehicles (stationary) in central area turned on and allowed to run for several minutes. No reaction from the terns on the CDL Dolphin. No observed effect at the ESB Dolphin colony at that time.
Small work vehicle active within 40-100m of CDL	2 (Moderate)	CDL: No response from terns ESB: None	CDL: No response from terns ESB: None	CDL: 0 (None) ESB: 0 (None)	Dumper truck work vehicle simulating active works around the onshore substation site up to c. 50m proximity of CDL dolphin. Activies included driving around, banging the bucket and beeping the horn sporadically. Driver wearing hi-viz in the open while driving. Noise from engine and tires driving on rubble found to be relatively low. No reaction from the terns on the CDL Dolphin. No observed effect at the ESB Dolphin.
Large work vehicle active 100m or more away from CDL	1 (Low)	CDL: No response from terns ESB: None	CDL: No response from terns ESB: None	CDL: 0 (None) ESB: 0 (None)	Large work vehicle (excavator) simulating active works in central area of site (c. 100m distance) of CDL Dolphin. Activies included driving (noise from tracks), engine noise, movement alarms, beeping horn sporadically, flashing lights, bright LED lights, banging the bucket and scraping rubble. No reaction at CDL Dolphin. No observed effect at the ESB Dolphin.

Test Description	Assumed Response Severity	Actual Response Description (initial)	Actual Response Description (subsequent)	Actual Response Severity	Further notes
Large work vehicle active within 40m of CDL (closest possible approach)	3 (High)	CDL: No response from terns ESB: None	CDL: No response from terns ESB: None	CDL: 0 (None) ESB: 0 (None)	Large work vehicle (digger) simulating active works within 40m of CDL. Activies included driving around (noise from tracks), engine noise, movement alarms, beeping horn sporadically, flashing lights, bright LED lights, banging the bucket and scraping rubble. No reaction on the CDL or ESB Dolphin colonies.
Large work vehicle simulating pile driving (high volume) within 40m of CDL	4 (Very High)	CDL: No response from terns ESB: None	CDL: No response from terns ESB: None	CDL: 0 (None) ESB: 0 (None)	Large work vehicle (digger) simulating pile driving activity c40m from CDL Dolphin by banging the bucket loudly on large concrete blocks. Repeated and continuous action for 4 minutes. Ground shaking was felt by personnel at 75m range. No reaction from terns on the CDL Dolphin. No reaction from the terns on the ESB Dolphin.
Combined personnel in hi-viz plus large work vehicle active 100m or more away from CDL	1 (Low)	CDL: No response from terns ESB: None	CDL: No response from terns ESB: None	CDL: 0 (None) ESB: 0 (None)	Personnel in hi-viz present near large work vehicle (digger) in operation, 100m or more away from CDL. Large vehicle works included driving, engine noise, scraping rubble, operating the arm, simulated pile driving banging and flashing lights. No reaction from the terns at the CDL Dolphin. No reaction CDL or ESB Dolphins.
Combined personnel in hi-viz plus large work vehicle active within 40m of CDL	3 (High)	CDL: Terns flush, dread and mob personnel ESB: None	CDL: Terns flush, dread and mob personnel ESB: None	CDL: one incident at 4 (Very High), one with no reaction (chick not present) ESB: 0 (None)	Two personnel in hi-viz present near large work vehicle (digger) in operation within 50m of the CDL Dolphin. Large vehicle works included driving, engine noise, scraping rubble, operating the arm, simulated pile driving banging and flashing lights. Terns flush, dread and then begin to mob the personnel. <u>Note that this was during the time when fledged juveniles were mobile in the area and often on shoreline of close to work site</u>. No observed effect at the ESB Dolphin colony at that time. No significant effect in the early breeding period, generally initial short, high repsonse was followed by no subssequent response.
Sporadic high volume noise levels within 50m of CDL	3 (High)	CDL: No reaction from terns initially when noise directed away from colony site	CDL: Terns dread and give agitated calls when noise was directed at the colony site	CDL: 3 (High)x1 ESB: 0 (None)	Excavator sounding horn in repeated short bursts (of singles and multiples) for up to 5 minutes while 40m away from the CDL Dolphin. Initially done so facing away from the colony site, with no reaction from the terns noted. Once the noise was directed at the colony site, the terns flushed and began to

Test Description	Assumed Response Severity	Actual Response Description (initial)	Actual Response Description (subsequent)	Actual Response Severity	Further notes
		ESB: None	ESB: None		dread, giving agitation calls. Terns returning to the colony site within 3 minutes or so. No observed effect at the ESB Dolphin colony at that time.
Continuous high volume noise levels within 40m of CDL	5 (Severe)	CDL: Instant reaction from terns – all adults and fledglings flushed and left the colony site ESB: None	CDL: Terns began to dread/flock, flying high above the colony site – agitation/distress calls heard ESB: None	CDL: 5 (Severe) ESB: 0 (None)	Digger vehicle stationary, facing the CDL Dolphin nest platform and sound air horn continuously at full volume for two minutes. Response from the terns was instant and dramatic. Unlike any other disturbance event noted throughout the full survey period. Full colony flush (birds silent) followed by flocking high over the site with lots of agitation calls and general signs of stress. Terns did not return to the colony to settle for >5 minutes. Not tested in early period.- No observed effect at the ESB Dolphin.

3.3 Tern arrival and departure

The arrival and departure dates of of terns at the ESB and CDL dolphin colonies is of relevance in considering the period during which terns may be subject to disturbance from ativities in the area. Arrival dates were gauged by recording presence of terns on several survey visits in spring 2022 and 2023. Departure dates are determined by local knowledge of the authors and observations of, and extrapolation from, the stage of breeding of terns observed in late July 2022. Table 10 illustrates the stage of breeding during early season season visits. This shows that over the two seasons arrivals occur in late April with courtship and display until c. end of first week in May and laying and incubation subsequently.

Table 10 Breeding activity at the study site in the tern arrival period

Date	No. of Terns present (all spp.)		Breeding Status	Notes
	CDL	ESB		
14/04/2023	0	0	n/a	No terns present. Observations during Black Guillemot survey.
28/04/2023	15	40	Courtship & Display	Maximum c45 birds in total. Lots of movement between both platforms. Observation during Black Guillemot survey.
03/05/2023	26	80	Courtship & Display	
04/05/2023	15	50	Courtship & Display	
10/05/2022	63	12	Courtship & Display	
17/05/2022	60	100	Nest With Eggs (AON)	Arctic Tern on eggs (AON) seen at CDL.
19/05/2022	60	n/a	Nest With Eggs (AON)	AE with eggs (AON) seen at CDL. ESB not surveyed on this date.
22/05/2022	80	70	Nest With Eggs (AON)	Approx 30-40 AE and 40-50 CN at CDL. Both species on nests with eggs (AON).
26/05/2023	60	120	Nest With Eggs (AON)	Approx 20 AE and 40 CN at CDL. Birds on nests with eggs (AON).

Observations in late season 2022 indicated that most terns at CDL had completed breeding with fledged chicks by first week of August, some late breeders (arguably with low likelihood of success) were still present on small chicks in early August.

A defined maximum breeding period of c. 01 May to c. 15 Aug appears to encompass most breeding activity.

4. Discussion and conclusions

Background disturbance levels

Terns nesting at ESB and CDL Dolphins are subject to a wide range of disturbance stimuli and this has certainly been the case for the duration of their use of the Dolphins. Dublin Port area is busy with shipping and industry. While activity levels vary over time and exact location, the two tern colonies lie in close proximity to major waterborne transport routes, as well as adjacent to industrial areas, with attendant noise, people and vehicles.

The general premise that the terns nesting at these sites are somewhat robust to disturbance, through their habituation to the normal patterns of disturbance to which they are exposed is, in the main, borne out by this study. There is an estimated c. 25-30 minutes of "Flight Initiation" behaviour during a typical day, in response to several disturbance stressors. The main stressors are identified as predators and small boat movements. The former eliciting the greatest response with the most frequency. This predator response being largely driven by Hooded Crows and large Gulls, the presence of which is frequent, with Hooded Crows nesting nearby and using multiple available perches in the area from which to observe and attack.

Habituation to disturbance stimuli is seen in several species, including seabirds. Studies on Common Terns have indicated that frequent disturbance including e.g., in-colony survey, nest visiting, handling of adults and chicks at the nest has a negligible effect on breeding performance.[13][14][15] Goodship & Furness (2022[16]) provide a range of FID across several different contexts and cite the role of habituation in facilitating a wide range of variation in effects of disturbance on breeding Terns.

This context can typically be seen in Arctic, Common and Roseate (*Sterna dougalli*) Terns at breeding colonies where disturbance can include research workers visiting nests, close proximity of visiting tourists and the general workings of fishing ports or industrial sites. At these sites nesting distribution is rarely affected by human proximity and at times the use of human structures such as fences and boats are actively used to facilitate successful defence against other predators. It is notable that Arctic Terns in remote tundra locations may drive off people when approaching even at several hundred metres[17][18], and this aggressive behaviour is likely to result in lower impacts than on many species which are less aggressive and capable at nest and chick defence[16]. This was easily recognised when surveyors at the proposed substation site were "buzzed" by attacking adult Arctic Terns when a recently fledged chick was present on the shoreline near to the survey area. While this may not constitute active disturbance, there may be some energetic costs which could be more significant if the activity was prolonged. Examples include reduced chick provisioning in Arctic Terns where disturbance is frequent, thereby disrupting normal activity levels to be replaced with vigilance and defence[19] and enhanced breeding success in Common Tern following control of the speed and use of personal watercraft (Jet Skis)[20]. Fast approach by small watercraft at ESB Dolphin was also noted as a disturbance stimulus in this study.

There are some observable differences in the disturbance response between the two colonies, ESB and CDL Dolphins. Primarily these derive from the main disturbance stressors. At ESB Dolphin a significant stressor is passing boats of various types but notably small motorboats (Figure 7) which are able to approach closely as they pass by to the south side of the main shipping channel, ESB Dolphin being closer to this route than CDL Dolphin. Predators are also a significant disturbance factor at this site and the large colony size and proximity to perches lend itself to be a good hunting opportunity. At CDL, predators form the main disturbance with boat traffic slightly less significant as a stressor. The predator types responsible for disturbance in this case are mainly Hood Crow and Herring Gull but

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[13] Nisbet, I.C.T. 2000. Disturbance, habituation, and management of waterbird colonies. *Waterbirds* 23: 312–332.
[14] Morris, R.D. and Burness, G.P. 1992. A new procedure for transmitter attachment: effects on brood attendance and chick feeding rates by male common terns. *Condor* 94: 239-243.
[15] Galbraith, H., Hatch, J. J., Nisbet, I. C. T. and Kunz, T. H. 1999. Age-related changes in efficiency among breeding common terns Sterna hirundo: measurement of energy expenditure using doubly-labelled water. *Journal of Avian Biology* 30: 85.
[16] Goodship, N.M. and Furness, R.W. (MacArthur Green. 2022. Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. NatureScot Research Report 1283.
[17] Mallory, M.L. 2016. Reactions of ground-nesting marine birds to human disturbance in the Canadian Arctic. *Arctic Science* 2: 67-77.
[18] Author's personal observations
[19] Bogdanova, M.I., Newell, N., Harris, M.P., Wanless, S. and Daunt, F. 2014. Impact of visitor disturbance on Atlantic Puffins and Arctic Terns breeding on the Isle of May. *Scottish Natural Heritage report*.
[20] Burger, J. (2002). Effects of Motorboats and Personal Watercraft on Nesting Terns: Conflict Resolution and the Need for Vigilance. J*ournal of Coastal Research*, 7–17. http://www.jstor.org/sTable/25736339

include Otter and heron spp. The latter species are regularly observed on the slopping shoreline close to the onshore substation site and thus in closer proximity to CDL. The site is a little further from main boat traffic but fairly close to a loading point for an industrial facility, which can cause irregular disturbances. The general presence of meso-predators such as Hooded Crows and large gulls in the port affects both sites. Overall disturbance from predators is somewhat natural and in general breeding success at the two sites is likely more affected by direct predation than by any disturbance effects.

Figure 8 Small boat traffic causing a disturbance event at ESB Dolphin – Common Terns briefly disturbed by the close proximity of boats settled again within 2-3 minutes

Overall, it would appear that background disturbance, from observations in this study is lower than might be expected, given knowledge of the nature of the disturbance sources in the area, and that following observations, the terns at both sites appear relatively unaffected by disturbance sources, in their current form. The likelihood is that habituation to the types of disturbance which they are regularly exposed to has created a greater tolerance than may be seen in terns nesting in more natural environments.

Testing tolerances using experimental disturbance

This study applied a series of disturbance stressors on the site adjacent to the CDL Dolphin. These ranged from apparently low-level stressors such as the presence of vehicles at >50m distance to the combined operation of vehicles alongside high volume noises, lights, and the active presence of personnel. The disturbance response matrix (Table 11) is derived from the study findings and applies to terns at CDL Dolphin for experimental disturbance and for terns at both sites in reference to background disturbance.

It was notable that the Common Tern colony on the ESB Dolphin was undisturbed by all of the experimental disturbance treatments. The range of the colony from the disturbance sources (c. 370m), then, is greater than the apparent FID. Published FIDs for Common Terns are highly variable and context dependent. They can be as close as a few metres[20] to as far as 400m[21]. Results from this study, therefore, are consistent with findings elsewhere.

On the CDL Dolphin colony, the general disturbance response to most of treatments was zero to low/mod (0 to <2) in the main with only initial or few incidents greater than that. This indicates habituation by the terns to a wide range

[21] Erwin, R. M. 1989. Responses to human intruders by birds nesting in colonies: experimental results and management guidelines. Colonial *Waterbirds* 12:104–108.

of typical stressor found in the area and which may be derived from construction works. The range of sounds, movement and presence of personnel as used for the treatments, is not unusual for the site or general area. It is likely that Arctic and Common Terns breeding on the CDL Dolphin are well used to experiencing similar disturbance stimuli in most breeding seasons at the site.

While Goodship and Furness (2022[16]) publish an FID of 37-92m (a surveyor in arctic tundra[17]) there are many examples on Arctic Tern colonies around the world where the FID is shorter and terns show far more tolerance. Authors' own observations record Artic Terns during incubation on islands with tourist visitors rarely reacting until approach to within 15m of nests is made (Figure 8).

Figure 9 Incubating and brooding Arctic Terns allowing approach to within 15m before flight initiation (A. Lauder pers. obs.)

An FID of as low as 37 metres is somewhat consistent with the results of this study, indicating that the closest point of the proximity of the study area at CDL Dolphin is still beyond the approximate FID for most activities and circumstances. That changes when fledged tern checks are present closer to the site. Mobile chicks using the shoreline effectively reduce the FID, by extending the area defended by adults closer to, and even including the shore of, the onshore substation site.

Table 11 provides a summary matrix of expected/planned disturbance stimulus with observed disturbance response. This illustrates that the response to several stimuli is context driven and this can relate to the level of previous exposure and habituation, the stage of breeding and the combination of attributes of the disturbance source (e.g., speed).

This then has implications for how, in light of construction activity any disturbance risk could be effectively mitigated.

Table 11 Disturbance response summary matrix

Planned or predicted disturbance stimulus

Low → High

Observed disturbance response: None/Low → Severe

Background noise Typical ferry traffic **Vehicle presence at closest point**	**People presence at closest point (subsequent)** **Vehicle activity + noise + people (subsequent)**		**Simulated piling (subsequent)**	
People presence at closest point (initial)	**Small boats at range or slow** **Vehicle presence**	**Vehicle activity + noise + people (initial)**	**Simulated piling (initial)**	**Multiple construction stimuli**
		small boat close proximity	**Meso-predator presence**	**Predator presence**
People presence at closest point (fledged chick nearby)			**small boat close proximity fast**	**Predator attack**
				Air horn at high volume and prolonged

Tern arrival and breeding season phenology

A defined maximum breeding period of c. 01 May to c. 15 Aug appears to encompass most breeding activity, with c. 7th May to c. 31 July as a core period when nest activity is highest. This is based on observations in the early breeding period of two seasons and the late breeding period of one season.

It is notable that the resilience (and aggression response) of breeding terns to disturbance at or around the nest increases with stage of breeding. Generally, once chicks are hatched, and more so when close to fledging, the risk of nest desertion decreases with disturbance events and the aggression response increases[22][23], presumably as a result

[22] Palestis, B. G. (2005). Nesting Stage and Nest Defense by Common Terns. *Waterbirds: The International Journal of Waterbird Biology*, 28(1), 87–94. http://www.jstor.org/stable/1522319

[23] Kania, W. (1992) The safety of catching adults of European birds at the nest – ringers opinions. *The Ring* 14 (1-2)

of the relative "investment" in the breeding attempt[24]. Thus, sensitivity to disturbance is likely to be highest during incubation and lowest in the period after hatching, albeit with likely higher aggression (as seen in this study).

As a result, considering measures to minimise disturbance, and thus desertion risk, during the incubation period are of highest priority.

Potential considerations of substation design

While much of this study has focussed on activities associated with construction works, a significant consideration is the presence of the final onshore substation at its operational phase. The design statement and shadow assessment available (extracts at Appendix 3) indicates a new building on the site at c. 30 metres of the CDL Dolphin and attendant changes to the shoreline adjacent – notably changing it from a broken slope to vertical sheet piling and sections with piling and revetment combined.

The key considerations in regard to building design/presence and shoreline structure are: predator risk and perceived risk (perches for aerial predators and shoreline accessibility for mammalian predators), shadow/overshadowing (changes to the micro-climate and aspect deriving from building proximity), operational activity (noise, lighting and movement). These are considered further here.

Predator risk and perceived risk – the design statement indicates that predator risk is already considered and measures to reduce the attractiveness of edges and surfaces as perches is built into the design. Further the potential for active management of this through adaptive and reactive measures taken during the operation stage are highly feasible – such as exclusion/scaring etc. Predator risk in the area is already significant with a diverse range of perches and concealment available to predators. Replacing low lying open ground with a vertical building (with measures to discourage predators) is unlikely to increase real predator risk, and rather significantly lower it.

The construction of a vertical revetment wall is likely to result in lower accessibility for mammalian predators to the proximity of the CDL Dolphin colony, and as such is likely to be a net benefit to the resilience of the site to predation.

shadow/overshadowing – a shadow assessment (extract at appendix 3) indicates no significant shadow effects on the site during the period of occupancy by terns (May-July). The line of sight for the terns from the colony is already significant restricted by baffles on colony edge.

Operational activity – The building and its environs already take account through its design of minimising lighting cast on the CDL Dolphin. Noise is unlikely to contribute significantly to background levels, given the wide range of loud noise sources in the area. This study has already shown the terns at the CDL Dolphin to be highly resilient to noise in the area.

5. Implications for mitigation of potential construction/development

On the assumption that all significant risk to the tern colonies should be avoided and to inform the need to produce a work schedule for construction planning, the following recommendations are made and include spatial and temporal mitigation measures which would be likely to reduce risk of disturbance effects on breeding terns. A memo outlining mitigation proposals was submitted to NPWS in June 2023 but no comments were received.

Recommendation 1: Deploy physical screening to reduce risk of disturbance effects during the breeding season

An estimate of existing levels of background disturbance have been calculated. While these are based on a limited period of observation in the late breeding season, many of the forms of disturbance are likely to be fairly consistent

[24] Verboven, A. and Tinbergen, J.M. (2002) Nest desertion: a trade-off between current and future reproduction. *Animal Behaviour* 63 (5) 951-958 https://doi.org/10.1006/anbe.2001.1971.

throughout much of the year. This includes scheduled boat movements, the frequency of use of pleasure craft (which may heighten in fine weather), the frequency of predator pursuit tied to breeding season etc.

The testing of disturbance stimuli relating to construction activity indicates that there is **unlikely to be any disturbance effect on the colony at the ESB Dolphin** (SPA). While recognising that effects of construction activity in the experimental trial are not truly akin to full scale construction works, it is clear that typical noises from construction, while causing some reaction, are likely to be fairly well tolerated after a period of habituation.

Full scale construction at the onshore substation site is likely to be visually as well as audibly disturbing if in full view and fairly close proximity to the CDL Dolphin and while some activity may be tolerated, the prolonged, daily presence of high numbers of people and machinery, particularly during the early breeding period is, intuitively, likely to discourage breeding terns from the colony if in full view. While this could be short term, it would be best avoided, in order to ensure colony stability and given the propensity for terns to readily abandon colonies in response to predators and other threats[25][26][27].

A likely effective option for mitigating the effects of proximity of works to the CDL Dolphin colony would be the erection of hoarding on the edge of the site, prior to the arrival of terns at the colony in spring. This would aim to visually (and partially audibly) screen the bulk of construction ground-based activity from the terns. Standard height (c. 2.5m) hoarding would result in the screening of most regular activity from the line of sight of the terns, albeit occasional (an unknown frequency) of monitored visual disturbance above the height of the hoarding may be tolerable by the colony.

Recommendation 2: Ensure colony response is monitored to enable minor adaptations of works

Alongside screening, ensuring that the colony is monitored during construction will be important in enabling early warning of issues arising. While screening of the works is likely to be effective in reducing most of the visual disturbance effects throughout the season, the risk of unexpected changes in tern response to innocuous site changes may carry risk. **Regular monitoring of tern activity and reaction to works, through the season** would be of value.

Recommendation 3: Avoidance of highest disturbance risk works during key periods

In general birds are particularly sensitive to disturbance at the nest (and at risk of abandonment) during nest initiation and in early incubation. Later in incubation onwards most species become more robust to disturbance. Kania (1992[28]) reports data on catching adult Arctic and Common Terns at the nest for ringing. Common tern nest failure during first half of incubation is reported as c.40% (no results for Arctic Tern) but this reduces to c3% for Common and 0% for Arctic in the second half of incubation. This is indicative of the sensitivity to disturbance in the early breeding period.

Given this, combined with robust screening, works during the typical laying and early incubation period (a c. 1-month period c. 7th May to 7th June) should be planned to be **low noise or restricted** to areas at the southern portion of the site at distances of (say) >75m from the colony. This should be accompanied by consistent and regular monitoring to enable a suitable response in light of any observed behavioural changes which may pose a significant risk.

Recommendation 4: Consider reduction of background disturbance levels by reducing other forms of disturbance during construction works and by managing predator risk from built structures (post-construction)

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[25] Shealer, D. A., & Kress, S. W. 1991. Nocturnal Abandonment Response to Black-Crowned Night-Heron Disturbance in a Common Tern Colony. Colonial Waterbirds, 14(1), 51–56. https://doi.org/10.2307/1521279

[26] Arnold, J. M., S. A. Oswald, S. Wilson, and P. Szczys. 2022. Understanding widespread declines for Common Terns across inland North America: productivity estimates, causes of reproductive failure, and movement of Common Terns breeding in the large lakes of Manitoba. *Avian Conservation and Ecology* 17(1):14. https://doi.org/10.5751/ACE-02067-170114

[27] https://www.washingtonpost.com/science/2021/06/07/drone-crash-abandoned-eggs/

[28] Kania, K. 1992. Safety of catching adult European birds at the nest. Ringers' opinions. *The Ring* 14, 1-2:5-50

There is some potential to reduce the potentially additive nature of disturbance from new activities in the area (construction) by reducing existing forms of disturbance risk. This could include predation risk and disturbance form small boats. Consideration could be given to creating a policed or zoned area to reduce small boat traffic approaching either tern colony.

The shoreline area is currently accessible to rats, Otter and seals and these are all know predation risks (albeit no mammalian predation occurred in 2022[29]). Any changes to the shoreline to reduce its accessibility for mammalian predators Is likely to benefit the tern colony – as indicated by the design statement.

The presence of Hooded Crow in addition to protected raptor species is a continuing challenge for terns on CDL Dolphin, with a nest on structures overlooking the site[29]. The prevention or discouragement of nesting by Hooded Crow could be used to reduce impacts on terns.

Consideration as to the final design or management of the built structures to ensure that they do not add to the predator perch opportunities in the area is already accounted for by the design statement and further this may benefit from adaptive measures identified through management after construction should the need arise.

[29]Boland, H., Adcock, T., and Burke, B. Dublin Port Tern Conservation Project report (2022) Dublin Bay Birds Project (Dublin Port Company and BirdWatch Ireland)

Appendices

Appendix 1 Coding schema for disturbance monitoring:

Response Score Matrix				
Score	**Severity**	**Descriptor**		
0	**None**			
1	**Low**	W+S		
2	**Moderate**		M+S	
3	**High**		M+M	H+S
4	**Very High**		M+L	H+M
5	**Severe**			H+L

A response score and severity are assigned based on a score described by a combination of *response type* and *response duration* (see below)

Response Type	**Descriptor**
None	No response. Activity normal.
Weak	Birds move or fly slightly. Return to nest site quickly.
Moderate	Birds dread/flush/move away from nest site. Return reasonably quickly. Some light alarm calls and mobbing included.
High	Birds actively dread/flush, moving well away from the nest site. Return time to nest site is longer. Very agitated alarm calls and mobbing. Distressed.

Response Type	**Descriptor**
None	No response. Activity normal.
Weak	Birds move or fly slightly. Return to nest site quickly.
Moderate	Birds dread/flush/move away from nest site. Return reasonably quickly. Some light alarm calls and mobbing included.
High	Birds actively dread/flush, moving well away from the nest site. Return time to nest site is longer. Very agitated alarm calls and mobbing. Distressed.

Response Duration	**Descriptor**
Short	Most birds instantaneous return or return to nest site within c. 1 minute of disturbance event
Medium	Most birds returning to nest site more than 1 min and <3 minutes after disturbance
Long	Most birds returning to nest site > 3 minutes after disturbance event

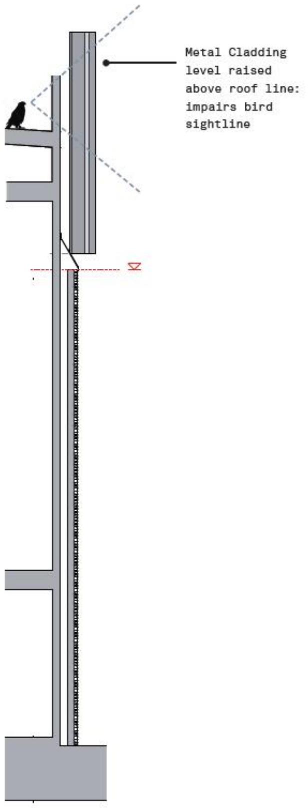
Appendix 2 Field recording sheet – Background disturbance

Tern Activity and Disturbance Monitoring

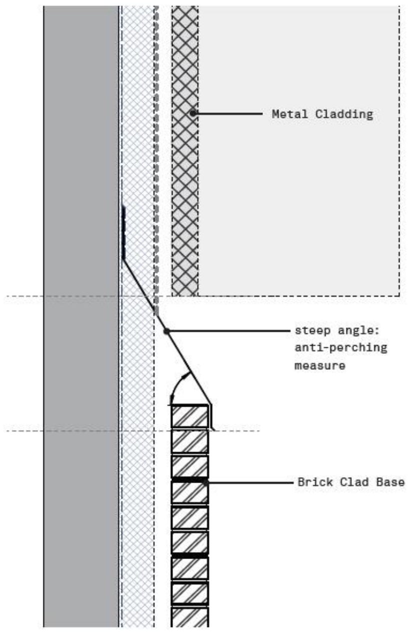
Date:	**Surveyor(s):**	**Hour:**	**Start Time:**	**End Time:**
Vantage Point: CDL / ESB	**Primary Focal Species:** CN / AE	**Tide:**	**Sunrise/Sunset:**	**Temperature:**
Wind Direction:	**Wind Force:**	**Precipitation:**	**Visibility:**	**Cloud:**
Notes: (include description of on-site activity / background noise at start and any notable changes thereafter)				

Time	Point/Event	Count	Activity	Stressor	Distance	Response	Duration	Notes (description of events, assessment of noise levels etc)

Appendix 3 Extracts from Design statement and shadow assessment



03 ESB GIS Building Section



04 Cladding Junction Section

3.9 DETAIL: BIRD OF PREY DETERRENT

Arctic Terns, a protected species of bird, nest in the region of the harbour in close proximity to the site. A series of platforms are located around Dublin Bay to facilitate their breeding, one of which - CDL Dolphin - is located to the north of the substation site. It was therefore important that the building design did not facilitate birds of prey to use the substations as perch/ surveillance points to prey on the nearby terns.

Two potential perch points were identified and mitigations were put in place:

1) Creating a steep angle (+60°) to the band at the material junction

2)Metal cladding raised above roof parapet impairing hunting birds' view of target platform.

Please refer to ornithological report for further information.

Tern Platform

Tern

Codling Wind Park Substation - Design Statement 43

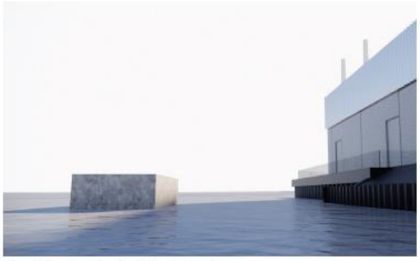
1.1 SHADOW STUDY

The CDL Dolphin is a tern breeding ground located to the north of the substation buildings site at Dublin Port. The tern breeding season is April to August. In order to determine any potential shading to the dolphin cast by the new substation buildings, a shadow study was carried out.

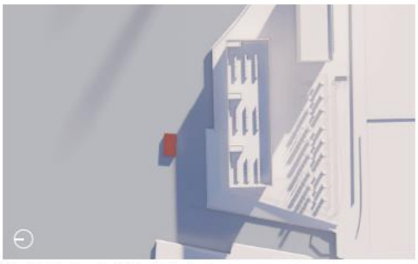
The study was carried out assessing the shadows cast by the substation buildings during three times of the day: 9am, 12pm and 3pm, at three months of the year: March Equinox (before breeding season begins), June (Midsummer) and September Equinox (after breeding season).

The study illustrates two perspectives, one at eye level close to the CDL Dolphin, and a second aerial view from above.

Substation Buildings Site Location, Dublin Port

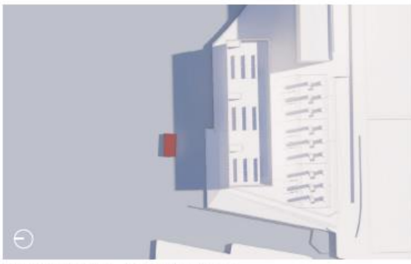


9am 21st March / 21st September



9am 21st March / 21st September

12pm 21st March / 21st September



12pm 21st March / 21st September

3pm 21st March / 21st September

3pm 21st March / 21st September