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[redacted]

Potential for unleashed dogs to damage seagrasses off Station Beach, Palm Beach NSW.

Dear [redacted]

In response to your recent request for information regarding the potential impact of unleased dog activity on Station Beach and the adjacent seagrass meadow, the previous report prepared by Dr John Runcie in relation to a similar request in 2008 is provided here with some amendments. This report compiled information that may be helpful in understanding the nature of the problem, and includes information describing seagrass meadows in general, their importance and vulnerability, and the likely effects of unleashed dog activity on the Station Beach meadow in particular. Additional material not in the 2008 report is provided in the last section "Additional Information" and as an additional figure.

The current Proposed Trial for a Dog Off Leash Area permits dog exercise and swimming between 16:00 and 10:30 AEST, Seven days, and between 17:30 and 10:30 Monday to Friday during AEDT. During these times there will be very low tides. This means the seagrass meadow in the Trial area will be subject to direct physical impact from dogs. This is discussed in more detail below

Summary

Potential impacts of unleashed dog activity on seagrass meadows adjacent to Station Beach, Palm Beach include increased nutrient input from uncollected faeces and physical disturbance. Elevated nutrients in seagrass meadows are known to increase epiphyte and plankton growth leading to reduced light reaching the seagrass and reduced growth. Tearing and puncturing of seagrass rhizomes and stems leads to seagrass death and may allow bare patches to develop. This damage is most likely to occur at low tides when the seagrass is in shallow water or is exposed to the air; the seagrass *Posidonia australis* is exposed during the

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lowest tides. The Station Beach meadow is already likely to be stressed from human pollution of the Pittwater embayment and is experiencing an invasion of *Caulerpa taxifolia*. As a consequence, the effects of additional stresses from dog activity may have a greater impact than would be expected if the meadow were in a pristine environment.

Seagrass meadows

Seagrass meadows are found on the shallow margins of many estuaries in NSW. They are found adjacent to deep channels as narrow strips between the lowest tide height and the depth limit for growth (at least 10 m depending on water clarity), or as much wider meadows in waters that are shallow a long distance from shore. These extensive meadows in shallow waters generally provide more refuge area for juvenile fish and invertebrates than narrow strips. The seagrass meadow off Station Beach, Palm Beach NSW extends some 500 m in a north-west direction from Station Beach, forming an extensive shallow meadow (Figure 1). It is dominated by *Posidonia australis*, with *Zostera spp*, and possibly *Halophila spp*. also present. This meadow is by far the largest in Pittwater and, coupled with its proximity to the Hawkesbury River and Broken Bay, is likely to support the largest number of juvenile commercial species of any meadow in the area. This seagrass meadow may also be an important source of baitfish for the (protected) fairy penguin colony living at nearby Lion Island.

Of the two dominant seagrass species in the meadow by Station Beach, *Posidonia australis* is the slower growing species and is most vulnerable. *P. australis* is present some tens of metres from the shore, with *Zostera spp*. forming a narrow strip in shallower water closer to the sandy beach as well as within the deeper *P. australis* meadow. Dog activity will extend into the *P. australis* dominated part of the meadow as this will be exposed or in shallow water accessible to dog traffic. Seagrasses are vulnerable to polluted water, elevated nutrient concentrations and physical disturbance. When *P. australis* is removed from an area it takes many years to recover even under ideal conditions (Larkum 1976). Many major estuaries in NSW have lost up to 85% of their seagrass meadows in the last 30 to 40 years (Poiner and Peterken 1995).

Light is vital for seagrass growth. Seagrass subjected to low light levels grow more slowly and are less able to resist erosion and effects of pollution. As seagrasses stabilise the sea bed and buffer against wave action, patches of exposed sediment where seagrass has died allow increased wave action and increased sediment resuspension (Larkum 1976). This in turn leads to a reduction in water clarity and light levels, resulting in reduced light for growth. Pittwater is close to the most northerly limit for *Posidonia australis* (Lake Macquarie; Aston 1977) and as a consequence the Station Beach meadow is likely to experience slower growth rates than more southerly meadows. Gradually elevating

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temperatures are likely to impose additional stresses on seagrasses, especially *P. australis* at Station Beach as it is close to its most northern/high-temperature limit.

Why should we protect seagrass?

Seagrass meadows are ecologically and commercially important habitats. Seagrass provides essential habitat for fish and invertebrates, including the juveniles of commercially fished species (see Smith and Pollard 1997 (Fish Habitat Protection Plan No 2: Seagrasses, NSW Fisheries 1995)). Seagrass bind soft sediments leading to high water clarity. Their blades dampen wave action, reducing the erosive potential of waves. Seagrasses and their epiphytes take out nutrients from the surrounding waters, acting like a water filter (see Larkum et al. 1989 for more details).

Seagrass meadows are protected by law. The (Fisheries Management Act 1994) states that "*A person must not cut, remove, damage or destroy marine vegetation on public water land or an aquaculture lease, or on the foreshore of any land or lease, except under the authority of a permit issued by the Minister under this Part (205) or of an aquaculture permit*." Seagrass is included in the definition of marine vegetation. In particular *Posidonia australis* must not be directly or indirectly impacted by any activity or development (Smith and Pollard 1997). The Station Beach meadow is a habitat associated with the endangered Green Sawfish "*Pristis zijsron"*, which is known to occur in marine waters by the Hawkesbury River (http://www.threatenedspecies.environment.nsw.gov.au).

Is the invasive alga *Caulerpa taxifolia* a potential threat?

This invasive alga grows rapidly. It almost exclusively propagates by fragmentation. Seagrass meadows tend to trap floating fragments of *Caulerpa taxifolia* due to their physical structure. A recent study found *C. taxifolia* fragments in *Zostera spp*. meadows, but no fragments in *Posidonia australis* meadows (Creese et al. 2004). These investigators found that *C. taxifolia* colonised the edges of *P. australis* meadows, and in some circumstances led to the loss of sparse *P. australis* plants. These findings suggest the potential for *C. taxifolia* to colonise erosion patches within the *P. australis* meadow at North Pittwater, and the edges of the meadow where the density of plants is low. To avoid colonisation of *C. taxifolia*, the northern Pittwater meadow should be subjected to as little stress as possible.

Potential impacts of unleashed dog activity on seagrasses at Station Beach

Nutrients from dog faeces.

While the magnitude of dog faeces-derived nutrient input into the seagrass meadows off Station Beach is not known, the impact of nutrients on seagrasses is well understood. While

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seagrasses including *Posidonia australia* and *Zostera capricorni* require nutrients for growth, an excess of nutrients in the surrounding water can lead to excessive growth of algae including epiphytic algae growing on the seagrass and phytoplankton (Larkum 1976). These algae can significantly reduce the quantity and quality of light reaching the seagrass, thereby reducing growth rates. As *P. australis* already experiences considerable overgrowth by epiphytic algae, a relatively small additional nutrient input could have disproportionately large consequences. The impact of elevated nutrients is consistently identified in the literature as one of the main causes of seagrass loss.

Increased sedimentation on the beach.

Increased dog activity on the beach is unlikely to significantly increase the flux of sand into the seagrass meadows. High wind and storm events during mid to high tides will lead to turbulent waters over the beach resuspending beach sand and have the potential to shift far more sand than that disturbed by dog activity on the exposed beach.

Increased sedimentation within the meadow.

Increased dog activity within the seagrass beds will lead to increased sedimentation, and if persistent will lead to reduced light levels and reduced growth. The intermittent nature of dog activity in the water reduces the likelihood of this impact significantly degrading the seagrass meadow.

Physical damage

Physical damage to the seagrasses would be caused by tearing of seagrass structures by dog claws as the animal seeks purchase when running, jumping, landing and turning. The cutting action would presumably sever a proportion of horizontal rhizomes (roots), and if sufficiently extensive, lead to dislodgement of a plant. An erosion patch may occur if sufficient damage is localised in one area. Partial severing would necessarily reduce the capacity of the plant to transport solutes, increasing stress and the vulnerability of the affected plant. Seagrasses are plants and must maintain internal salt concentrations far below that of the surrounding seawater. Penetration of a seagrass stem by a single dog claw is highly likely to lead to the death of that stem and its associated leaves.

Most significant is the potential effect of dog activity on seagrass meadows at low tide. Dog claws can tear and dislodge seagrass roots. Once a patch of bare sediment is exposed, the patch is vulnerable to further erosion and colonisation by *Caulerpa taxifolia*. Recovery of the plant mainly occurs by growth of the rhizomes into the uncolonised area. Maximum reported rates of regrowth of horizontal *Posidonia australis* rhizomes were up to 22 cm per year (Meehan and West 2004); similarly, the recovery rate of seismic survey-created holes in *P. australis* meadows at Jervis Bay was 21 cm per year (Meehan and West 2000).

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While recovery of *Posidonia australis* may be assumed to occur at ~20 cm or less per year in relatively undisturbed environments, this does not account for repeated disturbance by dogs coupled with erosive forces from strong wind driven waves, the harmful effects of pollution and reduction in growth rates caused by algal overgrowth-induced reduction in light availability. The combined effect of all these stressors has the potential to lead to a gradual decline in the proportion of *P. australis* (and possibly *Zostera spp.*) comprising the seagrass meadows off Station Beach.

Additional information since the 2008 report.

Field observations (Figure 6) were made on the 26th February 2019 along the length of Station Beach from the rocks south of Beach Road up to the rocks north of the track leading up to Barrenjoey Lighthouse. 10 stations were selected approximately equidistant up the length of the beach (Figure 8.). Measurements were made by walking perpendicular from the beach edge into the water; water depth was measured at the first encounter of *Zostera spp* and *Posidonia australis* using a graduated measuring pole, and the time noted. The approximate distance of the seagrass from the sand/water interface was also recorded.

Both species are present offshore Station Beach. *Zostera spp.* ranged between 8 to 18 m from shore at stations 1 to 7, and 30 m from shore at station 8. No *Zostera spp.* were observed at stations 9 and 10 (although it may be present, as *Zostera* wrack was observed on the shore by these stations). *P. australis* was observed at 18 to 37 m south of The Boatshed, and from 40 to 83 m from shore north of The Boatshed. The sediment up to 50 m from shore along Station Beach was noted as being generally quite soft and therefore vulnerable to physical disturbance.

Depths measured at each time of measurement at each station were compared against the tidal height at this time at Fort Denison, and the depth of the water over the seagrass calculated at the lowest tide experienced at this location. At the lowest tide, the depth of water above *Posidonia australis* is approximately zero (-0.01 m ± 0.06SD), that is the seagrass is 0.01 m above low tide level and is therefore fully exposed. Under these lowest tide conditions, unleashed dog activity on these seagrass meadows has the potential to cause considerable damage. *Zostera spp.* appeared to be consistently and positively exposed during very low tides (*Zostera spp.* are 0.19 m ± 0.13SD above the lowest tide level); *Zostera spp.* are also vulnerable to damage during low tides.

Since the 2008 study, the author notes considerably more *Calulerpa taxifolia* was present at all sites. In particular *C. taxifolia* was observed in abundance at the most northern location by the trail head leading to Barrenjoey Lighthouse. Note in Figure 1 this species had not colonised as far north at Station Beach by 2008. The presence of *C. taxifolia* in the Station Beach seagrass meadow can be interpreted as a threat to the integrity of this seagrass

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meadow. This species is known to form monospecific stands and outcompete native species, including *P. australis.*

The assertion that seagrasses at the northern end of Station Beach are less valuable and vulnerable than seagrasses at the southern end of the beach is not supported by any evidence. The relatively recent invasion of the northern part of the beach environment by *Caulerpa taxifolia* indicates these seagrasses are now experiencing an additional threat. To deliberately concentrate potentially damaging activity on the northern part of the Station Beach seagrass meadow would be ill advised for this reason.

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Figure 1. *Caulerpa taxifolia* affected areas surveyed between 2001 to 2007 showing *Posidonia australis* at Station Beach in green to the left of "Palm Beach", main panel. (NSW Fisheries)

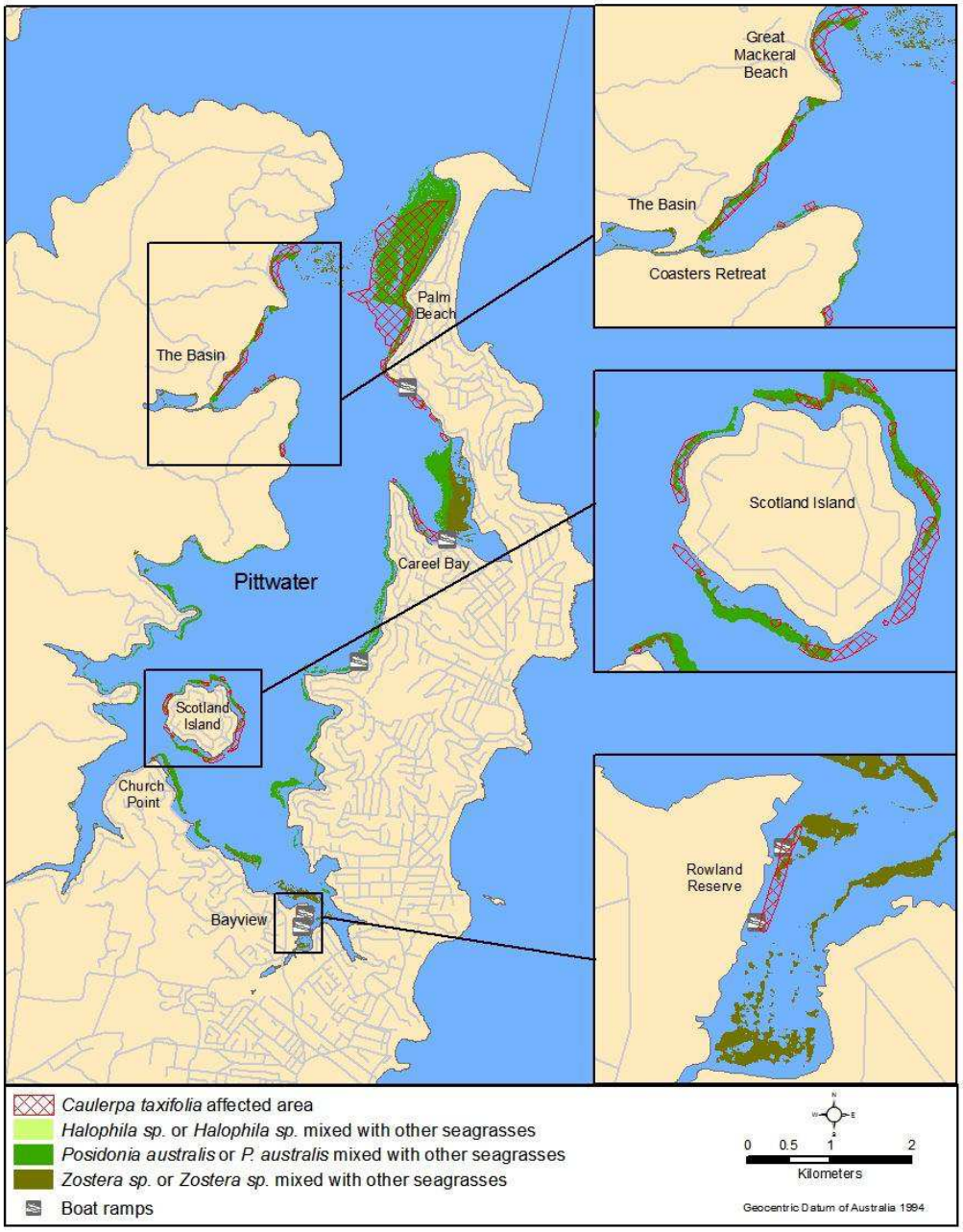

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Figure 2: Exposed *Zostera spp.*

Figure 3: Dog activity in shallows.

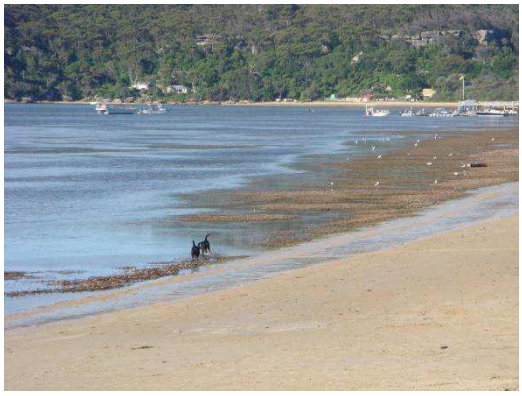

Figure 4: Dog activity.

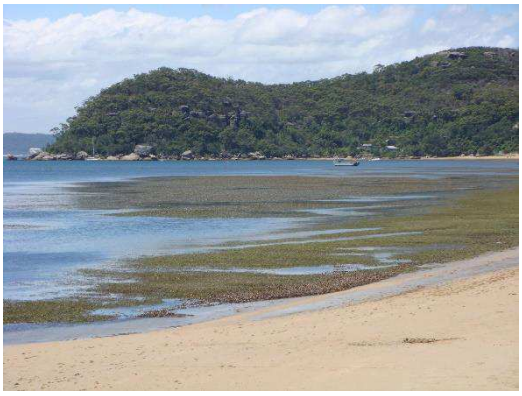

Figure 5: Exposed seagrasses.

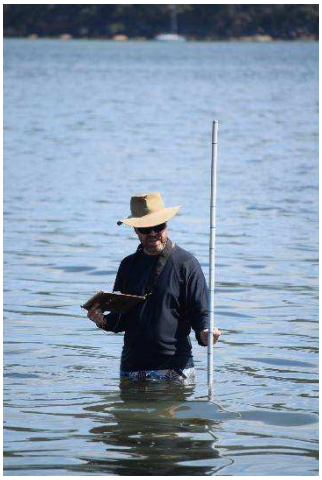

Figure 6. Determining water depth

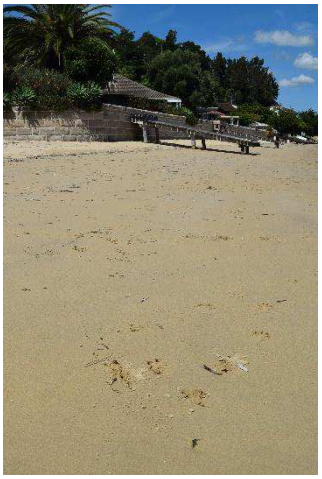

Figure 7. Dog activity (Feb 2019)

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Figure 8. Depth measurement stations at Station Beach, Pittwater, NSW (26/02/2019).