Chapter 8 PHYSICAL OCEANOGRAPHY

TIDES

The tides at Green Island are described by the Beach Protection Authority (1989) as mixed, semi-diurnal with a maximum range of 3.27m from Highest to Lowest Astronomical Tide.

Tidal planes for Green Island are given in Table 8.1. Heights relative to Local Low Water Datum (the mean of the Lower Low Waters, below which the tide seldom falls) are given by the Department of Harbours and Marine (1989); heights relative to the Australian Height Datum (Derived) are from the Beach Protection Authority (1989). The Australian Height Datum (Derived) was transferred by trigonometric heighting from Fitzroy Island and the mainland and was not determined by long term tidal measurements at Green Island (Beach Protection Authority, 1989).

Table 8.1: Tidal planes (in metres) for Green Island relative to Local Low Water Datum (L.L.W.D.) and Australian Height Datum (Derived) (A.H.D.(D)). Sources: Department of Harbours and Marine (1989), Beach Protection Authority (1989).

TIDAL PLANE	L.L.W.D.	A.H.D.(D)
Highest Astronomical Tide	3.18	1.46
Mean High Water Springs	2.20	0.48
Mean High Water Neaps	1.60	-0.12
A.H.D.(D)	1.72	0.00
Mean Sea Level	1.37	-0.35
Mean Low Water Neaps	1.10	-0.62
Mean Low Water Springs	0.50	-1.22
Lowest Astronomical Tide	-0.09	-1.81

Conversion of tidal predictions for Cairns (Green Island's standard port) is via the equation:
Height (Green Island) = [0.95 x Height (Cairns)] - 0.04m

(Department of Harbours and Marine, 1989)

On average, high and low waters occur 18 minutes earlier at Green Island than at Cairns (Department of Harbours and Marine, 1989).

WATER TEMPERATURE

Wolanski and Pickard (1985) measured water temperatures to the north-west of Green Island during their 1980/82 water current studies. Water temperature was generally 27 - 30°C during the summer months and 22 - 24°C during winter. However, they did note that water temperatures during the trade-wind season of 1982 were mostly 0.7 - 2.0°C lower than in 1980 or 1981, which they speculated may have been linked to the El Nino Southern Oscillation phenomenon apparent that year.

WATER CURRENTS

Wolanski and Pickard's study

From June 1980 to September 1982, Wolanski and Pickard (1985) measured water currents to the north-west of, and at an unspecified distance from, Green Island. Measurements were made at half-hourly intervals by a remote current meter situated 11m above the bottom in 35m water depth. They used this data to construct a simple model of the currents around Green Island to tentatively demonstrate that observed large seasonal and interannual fluctuations in current were due to a local on-shelf balance between winds and current in conjunction with fluctuations in Coral Sea circulation.

Beach Protection Authority study

Observations of wave and current conditions at four stations along the western end of the cay [Fig.1.3] were made by employees of the Green Island Reef Resort for the Beach Protection Authority from November 1982 until September 1987. The recording strategy was adapted from the Authority's Coastal Observation Program Engineering and parameters included average wave height, period and direction, and longshore current direction and velocity (from observation of a dye patch). Data from February 1983 to September 1987 are presented in Beach Protection Authority (1989).

Wave conditions around the western end of the cay were found to be quite complex. In general, waves came around the southern and northern sides of the cay and met at the north-western spit, indicating that the dominant wind and swell direction was from the south to south-east. Along with the measured current conditions, these observations were consistent with south-western erosion and north-western accretion at the cay (Beach Protection Authority, 1989).

Black and Gay's study

Black and Gay (1987) modelled the small scale hydrodynamics around and over Green Island reef using wind-current-tidal (WCT) simulations. The cay and large expanse of sub-tidal reef combined to produce complex patterns of flow on the reef in the lee of the cay. During flood tide, blockage due to the cay and high friction over the reef caused flow to travel around rather than over the reef, and the cay, leading to the formation of a strong eddy for some six hours during most of the ebb and the beginning of the flood tide.

Hillman's study

Mr. S. Hillman of the Great Barrier Reef Marine Park Authority utilised the data of Wolanski and Pickard (1985), with a computer model devised by Wolanski, to look at smaller-scale water movements around the cay itself. The model was run for several days during spring and neap tides occurring in November 1980, January 1982 and April 1982 - considered to be representative of conditions commonly experienced at Green Island. While Hillman acknowledged the limitations of the model, such as its depth-averaged nature, he drew some conclusions following discussion of the results with Wolanski. These include low flushing of the seagrass meadow area to the north-west of the cay during the summer months (when water flow is predominantly from the north-west) due to 'upstream blocking', but fairly good flushing of this area in the winter months (water flow from the south-east) (Hillman, pers. comm.).

Dight's study

Dight *et al.* (unpubl. ms.) modelled water movements within the Great Barrier Reef lagoon, including the Cairns region, to simulate the dispersal of larvae of the crown-of-thorns starfish, Acanthaster planci. Simulations under a variety of different hydrodynamic regimes showed strong connectivity between Green Island reef and the reefs off Innisfail - including Gibson, Howie, Feather and Peart reefs.

van Woesik's study

The small scale water flow around Green Island reef flat was studied by van Woesik (1990) as part of the Green Island Reef Multidisciplinary Study (Baxter, 1988). Measurements were made in April and September 1988 using tracer dye to determine current direction and current meters to determine current speeds at approximately 2m depth.

Survey site locations are shown in Fig.8.1. The preliminary data suggested that the predominant currents around Green Island were mainly wind driven, as currents did not reverse over various tidal cycles.

During south-east winds current flow was predominantly to the north-west during both flood and ebb tides. High retention areas were located in the lee of the cay [site 13: Fig.8.1], with double vortices recorded on the flooding tide. While these retention areas corresponded to the main seagrass meadow areas, van Woesik (1990) regarded these findings as 'speculative since no water quality information is available'.

During light north-east winds and a flooding tide, an anti-clockwise current flowed around the cay resulting in a poorly-flushed area over the southern reef flat. This area was considered to be continually exposed to the discharge plume from the sewer outfall.

SEWAGE DISPERSAL

Allan and Johns' study

One aspect of a study conducted by Allan and Johns (1989) in August 1987 and July 1988 was to determine the distribution in the water column and sediments of the biomarker coprostanol, which is unique to human sewage waste. Samples were collected from a number of sites [Fig.8.2] using horizontal particulate tows, benthic sediment sampling and sediment coring, with analysis utilising gas chromatography and gas chromatography-mass spectrometry.

Coprostanol was detected at one site only - adjacent to the sewer outfall [site A15: Fig.8.2]. Allan and Johns (1989) concluded that sewage was probably dispersed (by tides and currents) and/or consumed fairly rapidly through oxidising conditions in the sediments.

van Woesik's study

Advection and dispersal of the sewer outfall plume was investigated by van Woesik (1990) and co-workers in April 1988. Dye was injected simultaneously at toilets within the resort and within the public toilet block, with bags containing activated charcoal positioned at several locations around the reef [Fig.8.2] to detect dye both qualitatively and quantitatively.

A dye plume was first visible about three hours after injection, indicating minimal treatment-response-discharge time for the sewage. Dye plumes were observed at approximately half hour intervals throughout the following two days, consistently passing 50m from the end of the jetty at a bearing of 330^{o}. The dye plumes appeared to be unstratified down to 6m depth.

Further investigations in September 1988, when dye was released at the sewer outlet, revealed significant retention of dye/effluent in the lee of the cay for a period of up to 18 hours (van Woesik, 1990).

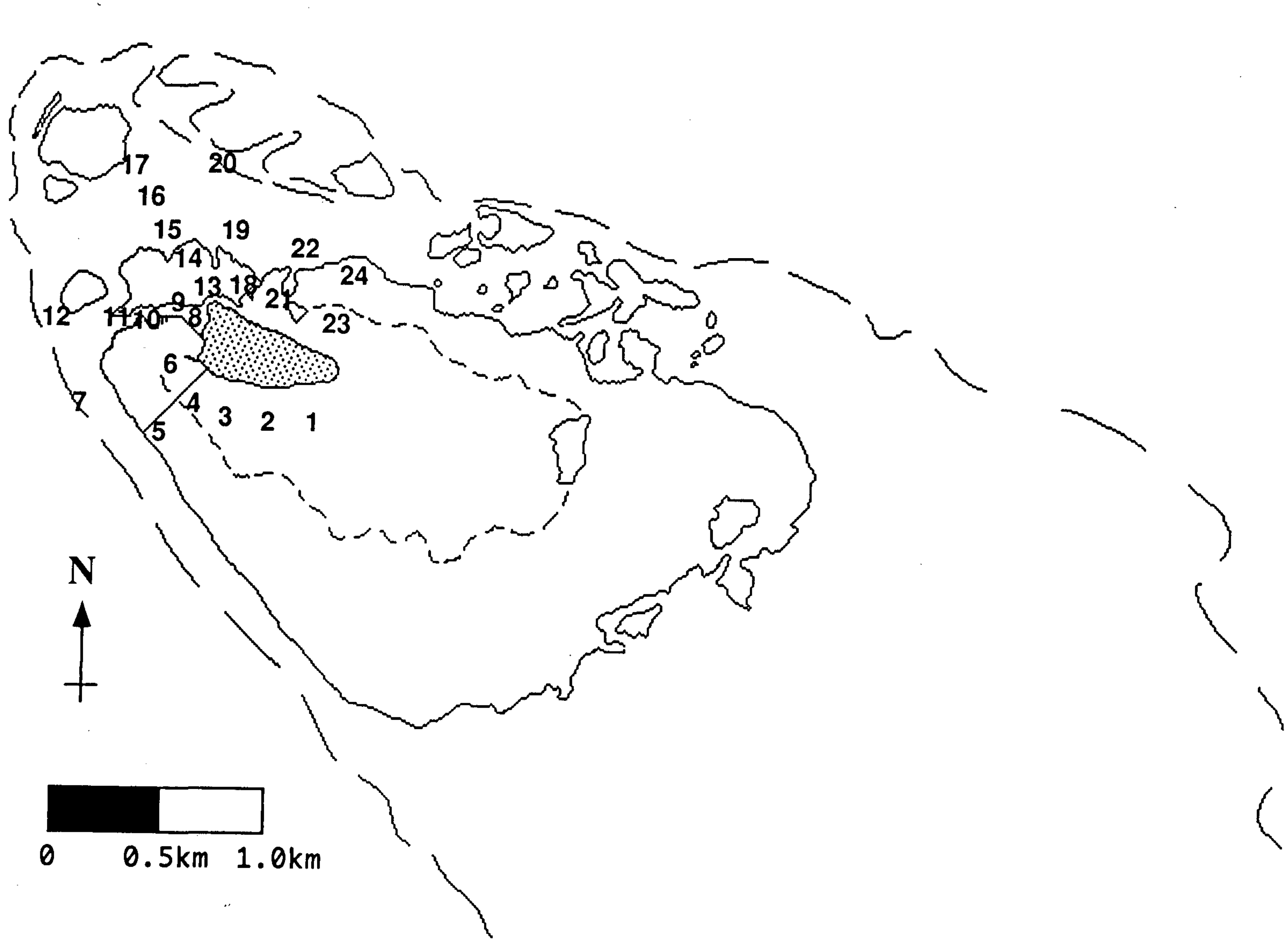

Figure 8.1 Location of van Woesik (1990) hydrodynamic survey sites

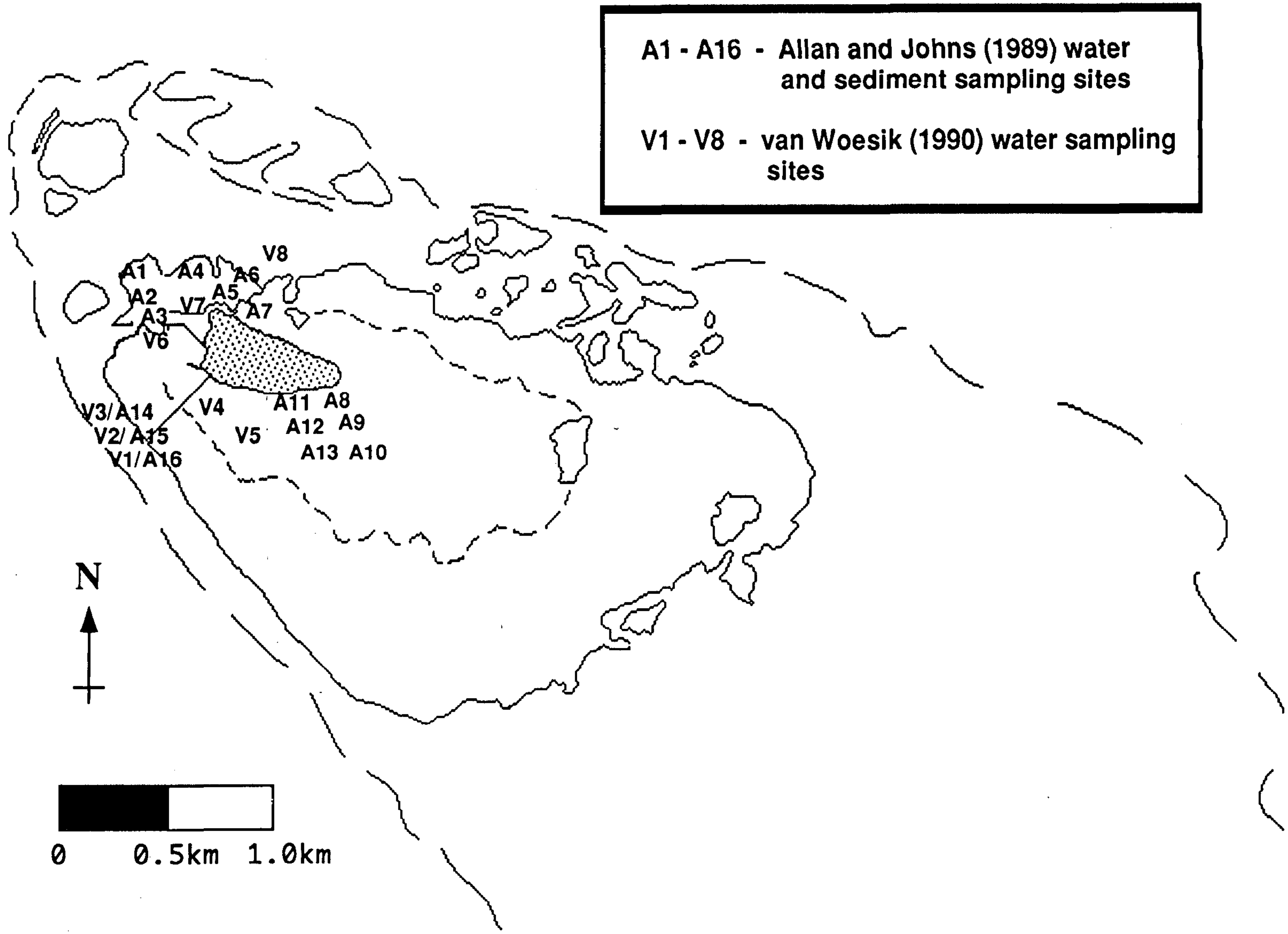

Figure 8.2 Location of sewage dispersal study sites