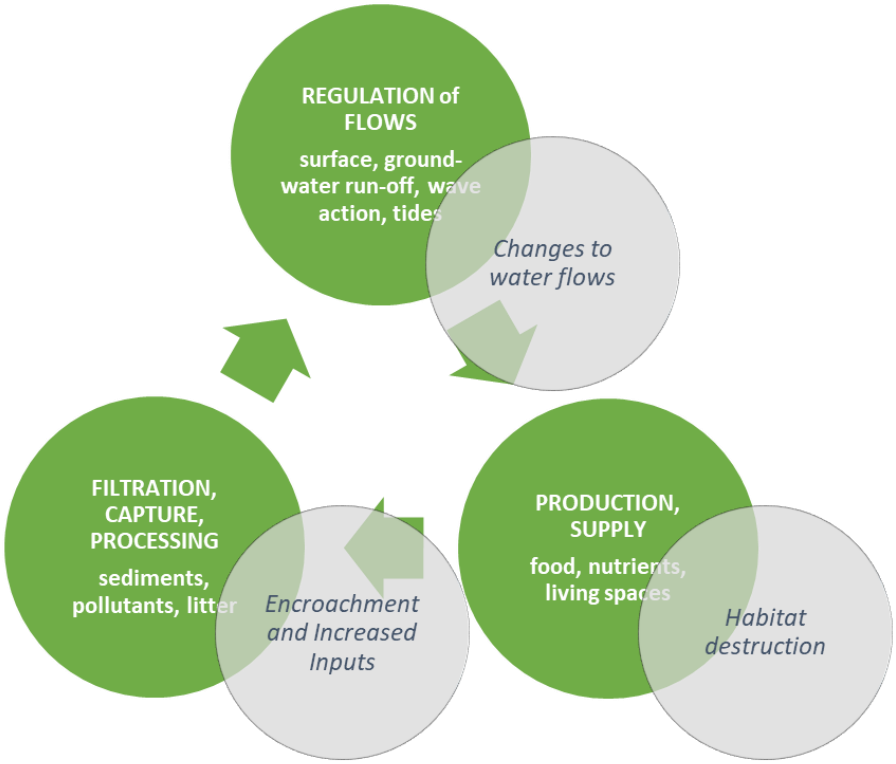
Wetlands in Noosa River Estuary

Assessment of Urban Land-Use Pressures
June 2022 Report



Ecological functions of Wetlands disrupted by intensive urban land-use

Report prepared by Peter Hunnam and Alex Western
as part of the Noosa *Get your Wetlands* Project
NICA, Noosa Integrated Catchment Association, and OzFish Noosa Chapter

supported by Queensland Department of Environment & Science
Community Sustainability Action grant program
Litter and Marine Debris Clean up and Prevention

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INTRODUCTION

This report presents an assessment of the pressures from intensive urban land-use on the ecology of the lower Noosa River, especially the habitats growing along the foreshore and riparian margins of the estuary.

The assessment is based on a desktop mapping survey of the whole central estuary and its catchment using existing spatial datasets and supplemented by on-ground observations. The survey and assessment were organized as the initial stage of a *Noosa Wetlands* project supported by local conservation groups NICA and Oz-Fish.

The purpose of the assessment report is **to increase awareness** among local government and community stakeholders of the ecology of the estuary and the pressures it is under from urban land-use development around its margins; and in the longer-term **to facilitate improved management** of the main types of urban land-use and effectively protect important shoreline and riparian wetland habitats.

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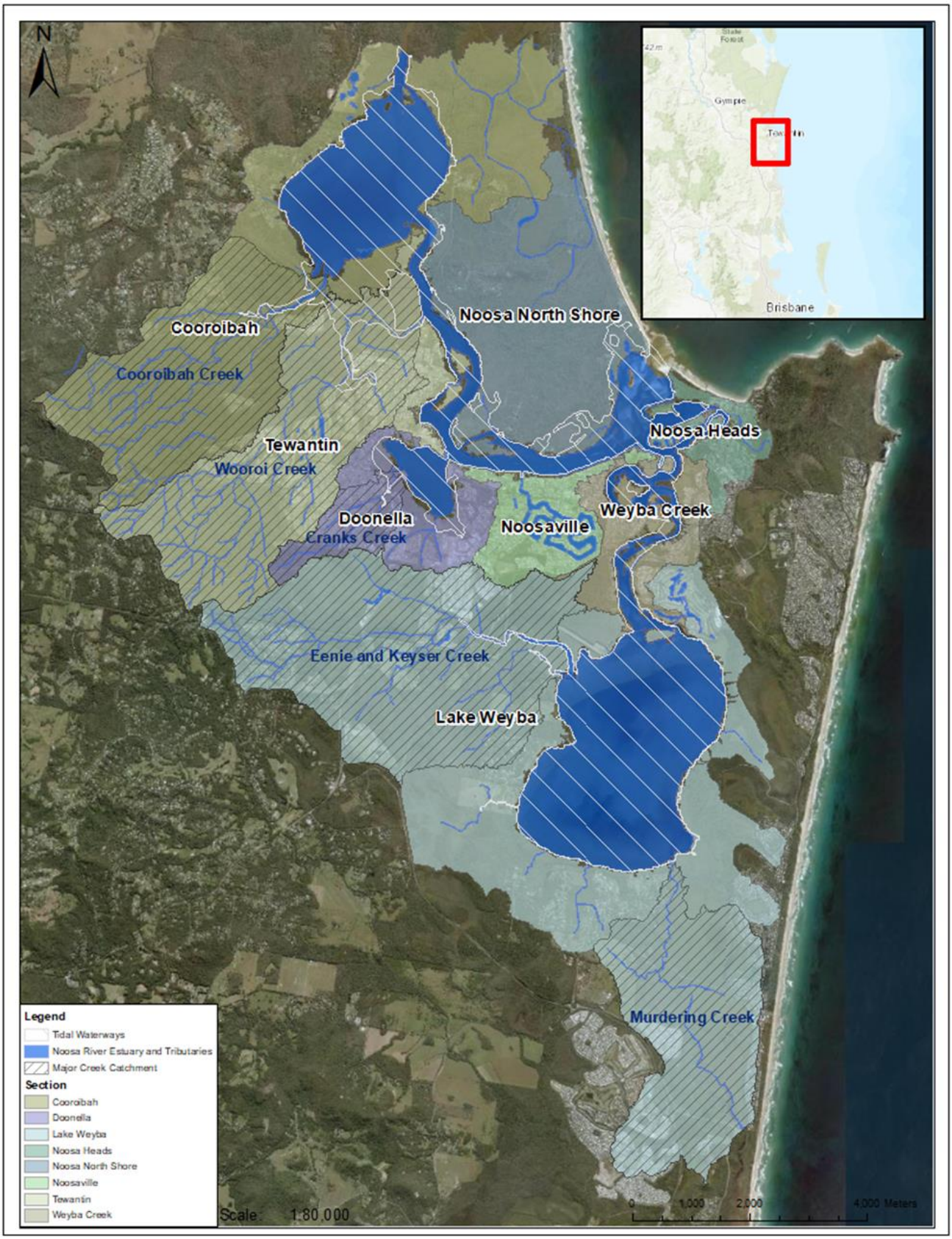
MAP 1 *Noosa River Estuary - Tidal Waterways, Catchment Basins and major Tributary Creeks*



PART 1 Noosa River Estuary – Geography & Ecology

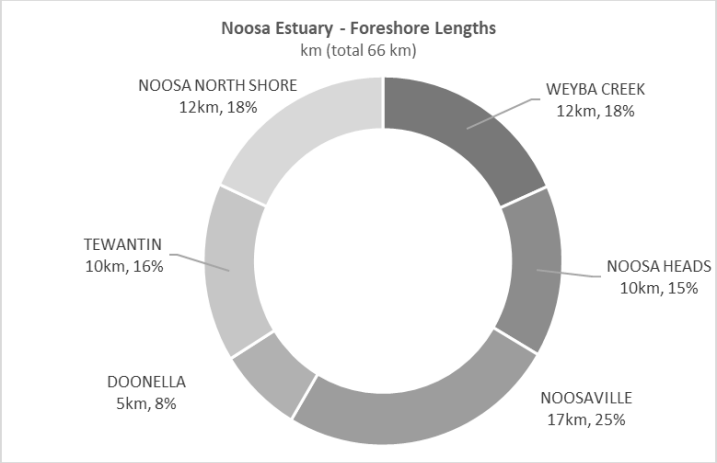
The lower Noosa River and its catchment form a complex estuarine ecosystem consisting of broad shallow lakes and tidal channels that flood with each tide and receive freshwater draining off the surrounding catchment basin, as well as the downstream flow from the upper river system.

The lower river basin extends over 9,000 hectares (90 sq.km.) divided into three sub-basins: Lake Cooroibah sub-basin to the north is 1,240 ha and Lake Weyba sub-basin at the southern end of the system is nearly 3,950 ha. Between the two major lakes, the central estuary has six main catchment areas – Noosa North Shore, Tewantin, Doonella, Noosaville, Noosa Heads and Weyba Creek – draining a total of nearly 4,000 ha.

The main features of the area are shown in **Map 1** and summary statistics are listed in **Table 1**.

Urbanised Estuary

The central estuary is the most urbanised part of the Noosa River system and the most intensively-used section of waterways and riverside land. The residential, commercial and tourism centres of Tewantin, Noosaville and Noosa Heads, with their associated networks of urban roads, utilities and other infrastructure, have been developed closely around the southern and western shores of the estuary and its riparian basin. Approximately 57,000 residents live in the area (Australian Bureau of Statistics 2021) with over two million tourist visitors each year, attracted primarily by the region's natural values. Many local recreation and tourism activities are centred on the river estuary and its extensive shoreline.

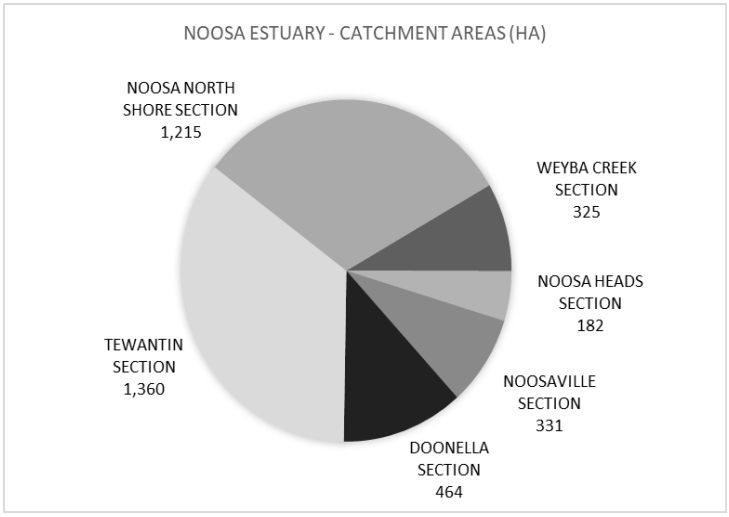


Tidal Waterways and Shores

The most significant feature of Noosa estuary is the mosaic of river and creek tidal channels and their littoral and riparian margins. These include Noosa River, Weyba Creek, Lake Doonella and the tidal reaches of Wooroi and Cranks Creeks, covering a total area of 920 hectares and extending along 66 kilometres of shoreline and foreshore land.

Catchment Tributary Creeks

Another key feature is the extent of the estuary catchment. Most of the lower river basin drains into the main river and lakes via just 5 large tributary creeks; their combined freshwater catchment area is over 5,000ha, 57% of the 9,000ha basin.



Just 2 of these major creek catchments – Wooroi (1,250 ha) and Cranks Creek (nearly 200 ha) – drain a large portion of the central estuary sub-basin and run into relatively large tidal channels to join the main river at Tewantin and Lake Doonella respectively; Wooroi Creek alone drains over 90% of the Tewantin section catchment.

The remaining 63% of the central estuary sub-basin drains via many small catchments along the foreshores of Tewantin, North Shore, Noosaville, Noosa Heads and Weyba Creek.

TABLE 1 ***Noosa River Estuary and Catchment – Summary Statistics***

	MAJOR SECTIONS - Features	Sub-Basin ha	Urban Land-use ha (%)	Major Creek Catchments ha	Tidal Waters ha	Tidal Foreshore km
	LAKE COOROIBAH SECTION - Lake Cooroibah, foreshore and catchment - Cooroibah Creek and catchment	1,240	202 (16%)	1,100	690	15
Central Estuary Sections	NOOSA NORTH SHORE SECTION - Noosa North Shore foreshore and catchment - Goat Island	1,220	123 (10%)		*a	12
	TEWANTIN SECTION - Tewantin main river channel and foreshore - Pig (Makepeace) Island and Sheep Island - Wooroi Creek and catchment	1,360	504 (37%)	1,250	280	13
	DOONELLA SECTION - Lake Doonella and foreshore - Cranks Creek and catchment	460	280 (60%)	190	120	6
	NOOSAVILLE SECTION - Noosaville main river channel and foreshore - Noosa Waters and catchment	330	254 (77%)		350	17
	NOOSA HEADS SECTION - Noosa Sound, Noosa Spit and Woods foreshore - Hayes Island foreshore	180	115 (63%)		*1	10
	WEYBA CREEK SECTION - Weyba Creek main channel and foreshores (west bank, east bank) - Keyser and other islands	320	180 (55%)		160	12
	LAKE WEYBA SECTION - Lake Weyba and foreshore - Eenie & Keyser Creeks and catchment - Murdering Creek and catchment	3,950	949 (24%)	2,630	1,030	17
TOTALS – Central Estuary Sections only		**3,880**	**1,456 (38%)**	**1,440**	**920**	**66**
TOTALS – incl. Lakes Cooroibah and Weyba		**9,100**	**2,607 (29%)**	**5,160**	**2,640**	**96**

Wetlands in Noosa River Estuary

The term “wetlands” is used here and commonly to refer to the variety of ecosystems that grow at the interface of land and water areas, where the land margins are inundated by water – salt or fresh – for periods of time (E.g., Department of Environment and Science Queensland 2013).

The plants and animals that grow in these watery land areas are specialists, each species finely attuned to the particular local conditions of salt and fresh surface waters, ground waters and sediments that flow through the ecological system, and to their neighbours in the wetland community.

In the Noosa River estuary, wetlands form the major physical habitats across the aquatic, littoral and riparian zones. They occur in two main categories – along all the tidal shoreline shallows and foreshore land (littoral zone), and in all the wet areas of riparian land across the freshwater catchment.

> **Noosa’s tidal foreshore wetlands** are salt-, brackish- and fresh-water wetland habitats, including seagrasses, mangroves, tidal marshes, reed beds, brackish and freshwater swamps and woodlands. They grow along 66 kilometres of tidal foreshore land throughout the estuary, varying in width from a few metres to several hundred metres, depending on the topography and hydrology of the land; and covering an estimated total area of over 3,000 ha.
>
> **Riparian catchment wetlands** are freshwater swamps, woodland and marshes growing in the land drainage catchments across the 4,000-ha basin of the central estuary – through Tewantin, Noosa North Shore, Noosaville, Noosa Heads and Weyba Creek.

Both categories of wetland habitats are integral parts of the Noosa River estuary, vital to its long-term ecological health, resilience, biodiversity and productivity. They are also a major contributor to the natural amenity and scenic attraction of the estuary’s waterways, foreshores and riparian lands.

Ecologically the significance of wetlands, when healthy and intact, is that they provide a range of essential ecosystem services.

> **Ecosystem services provided by wetlands in Noosa River estuary**
>
> - Wetlands **produce and provide** much of the food, nutrients and habitat for the estuary’s diverse plant and animal communities.
> - Wetlands naturally **filter, capture, stabilise and process** a high proportion of sediments and pollutants washed off the riparian catchment and in from the waterways.
> - Wetlands **regulate** all surface- and ground-water run-off from the land and govern the influence of tidal flows and ebbs throughout the estuary.

In addition, because of the natural buffering properties of wetlands, maintaining (and strengthening) their health and resilience are also important **adaptation** measures in the face of increasing impacts from climate change.

Urban Land Use Pressures on Noosa River estuary

A major source of damaging pressures on estuaries and wetlands in Queensland comes from intensive urban development, where land clearing and construction of buildings, roadways and other hard surfaces are carried out on or close to the natural ecosystem without adequate separation or buffering (Department of Science Information Technology Innovation and the Arts 2015).

Types and Extent of Urban Land-Use Pressures on Noosa Estuary

The mapping survey was used to make the following assessment of the pressures on the ecology of the lower Noosa River and the wetland habitats growing along the foreshore and riparian margins of the estuary.

The main types of urban land-use pressure on the ecology of Noosa estuary were identified and mapped from existing spatial data-sets supplemented by on ground observations. The extent of each type of land-use pressure and their effects were measured.

The main forms of urban land-use affecting the ecology and health of Noosa River estuary:

- **Buildings – residential, commercial**
- **Roads, paths and other hard surfacing**
- **Recreation parks**
- **Stormwater drainage**
- **Sewer pipelines**
- **Waterway infrastructure – boat ramps, jetties, etc.**

These land-use structures exert pressures on the ecosystem both directly and indirectly, by **direct habitat destruction, encroachment, increased inputs or changes to water flows**, depending on the proximity of the intensive land-use to the natural habitat, and also on the design and management of the urban development. (Newton et al. 2020). TABLE 2. summarises the extent of the main types of urban land-use pressure in central Noosa estuary, in particular on the foreshore riparian and littoral zone.

TABLE 2. Extent of Main Urban Land-Use Pressures in Noosa Estuary

Impacts	Urban Land-Use Pressures	Extent in Noosa Estuary
DIRECT HABITAT DESTRUCTION	• Buildings, roadways, other hard surfaces directly on foreshore land (<10m from shoreline and water's edge)	Along 32 km of foreshore (48% of 66 km total)
	• Riverside recreation areas (parks) and associated structures	Along 7 km of foreshore (5% of total)
	• Waterway infrastructure - jetties, ramps, pontoons, bridges	838 structures built on foreshore and across littoral zone
	• Buried sewer pipelines (<50m fromwater's edge)	Along 32 kilometres of foreshore (48% of total)
EDGE ENCROACHMENT INCREASED INPUTS (EEII)	• ULU (private and public properties, buildings, roadways, parks, golf courses etc.) near foreshore or riparian catchment wetlands (<100m from water's edge/ wetland)	EEII along 41 kilometres of the estuary shoreline (62% of total 66 km); and across 1456 ha of riparian catchment land (38% of total 3880 ha)
CHANGES TO WATER FLOWS	• Urban run-off and contaminants	All run-off and contaminants from 1456 ha of urban land are channelled onto the shore or into wetlands via 248 SW drain outfalls

Direct Habitat Destruction from Urban Land-Use

Where a building, roadway, recreation area or other urban land-use, structure or hard surface is built immediately on the foreshore or in a riparian area, the natural wetland habitat is destroyed or significantly degraded, including the physical land-form, hydrology and specialised plant and animal community. The ecological services provided, the natural amenity of the site, and the ecological integrity and resilience of the foreshore or riparian area are also extinguished, which increases the area's vulnerability to further damage, from flooding and erosion for example.

"Edge Effects" - Encroachment and Increased Inputs from Urban Land-Use

Where urban land-use is adjacent or close to a foreshore or riparian area, the natural habitat is impacted by encroachment and increased inputs of 'foreign' materials, spread or carried accidentally or deliberately into the area.

A broad range of types of encroachment and inputs are observed along the extensive edges of Noosa estuary wetland habitats, including weeds, plant debris, pest animals; domestic cats; litter and waste materials and pollutants - domestic, garden, golf courses, construction sites; sewage leakage. Each of these inputs has the potential to significantly disrupt and degrade the ecological functioning of the wetland habitat, especially by overloading its capacity to filter, capture and process contaminant materials spreading in from adjacent land or water areas.

The ecology and health of the estuary and wetlands are highly vulnerable to such edge effects: urban land-use pressures are not easily contained on the land-use site and will spread readily into nearby wetlands and waterways; and wetland areas are linear habitats with lengthy exposed edges, naturally "porous" and not readily protected from external inputs.

These are widespread and well-recognised risks to urban wetland areas (Department of Environment and Heritage Protection 2011). Guidelines for managers are to maintain an adequate buffer between intensive land-use and wetlands; a native vegetation buffer distance of at least 100 metres from HAT (highest astronomical tide) is recommended in tidal areas, to reduce damage to the wetland's ecology.

Changes to Water Flows

A related mechanism by which urban land-use degrades Noosa's wetlands is by changing the natural patterns of water flow – increasing or decreasing the volume and/or speed of water and water-borne materials into or out from the wetland from adjacent land and water areas. All forms of urban land-use built in or close to wetland habitats will impact natural water flows in this way.

The most significant form of this pressure and damage in Noosa estuary is the **stormwater drainage (SWD) system**. By design, the SWD system collects and channels the entire volume of water running off Noosa's urban areas[b] into the estuary's wetland areas and waterways.

The run-off water carries significant quantities of dissolved and particulate contaminant materials – **solid waste and litter, sediments, dissolved chemicals, plant and weed debris and seeds** – from the surfaces of every property, building, road and other hard structure and land area.

The SW drains concentrate and channel the urban run-off either into a wetland area, or, bypassing the wetland, directly onto the shore and into the waterway. Both practices drastically change the hydrology and ecology of the riparian and littoral zones: the former floods the wetlands with concentrated pulses of run-off water and contaminants; the latter, where the SW drain bypasses the wetland, pulses the contaminated freshwater run-off directly into the tidal (saltwater) waterway; and in the process starves the wetland of essential freshwater inflows from the land.[c]

Foreshore Habitat Protection in Noosa Estuary

The mapping survey measured the extent of foreshore and littoral wetland areas where there is a formal environmental protection mechanism in place, and where there is a native vegetation buffer of at least 100 metres between waterway and urban land-use.

The following formal protected areas were recorded[d]:

Terrestrial - State or Local **Environmental reserves** are designated along 35 km (54%) of tidal foreshore land;

Aquatic - **Noosa River Fish Habitat Area** is designated along 36 km (55%) of the central estuary tidal channels and littoral zone.

Both these types of reserve are compromised in some parts of the estuary by the close development of urban land-use: in total, along 6.2 km (18%) of the foreshore designated as environmental reserve, urban land-use is developed to within 50m of the water's edge; as well as along 6.4 km (18%) of the foreshore land directly adjacent to the FHA.

Along the total 66 km of tidal foreshores in Noosa estuary, just 25 km (38%) were mapped as reasonably buffered from urban land-use, i.e. by a fringe of natural vegetation 100 metres or more wide, between the nearest urban land-use (roadway, building, etc.) and the shoreline or water's edge.

These results are summarised in the following graph and, for each of the main Sections of the central estuary, in the table below.

TABLE 3. ***Foreshore and Littoral Habitat Protection***

Noosa Central Estuary – Main Sections		**Extent of Foreshore Buffering and Reserves**					
	Foreshore, km	Buffered (ULU >100m)	*%*	Env. Reserve	*%*	FHA	*%*
Noosa North Shore section	12	9	*78*	10	*87*	12	*98*
Tewantin section	10	6	*55*	8	*77*	8	*82*
Doonella section	5	3	*52*	4	*80*	4	*89*
Noosaville section	17	0	*0*	0	*0*	0	*0*
Noosa Heads section	10	3	*26*	4	*38*	0	*0*
Weyba Creek section	12	5	*41*	9	*76*	11	*93*
TOTALS	66	25	*38*	35	*54*	36	*55*

Extent of Urban Land-Use Pressures on Noosa Estuary

The extent and distribution of each type of urban land-use pressure and management issues were mapped and measured across all parts of the central estuary. The results are shown in **TABLE 4** and in six Section **MAPS 2.** to **7.** below.

Noosa North Shore
Tewantin
Doonella
Noosaville
Noosa Heads
Weyba Creek

TABLE 4. ***Extent of Land-Use Pressures on Foreshore Habitats across Noosa Estuary***

Noosa Estuary Sections		**DIRECT DESTRUCTION OF FORESHORE HABITAT**							**ENCROACHMENT, INCREASED INPUTS**				**CHANGES TO WATER FLOW**
Length of Foreshore		**ULU <10m**		**Rec.Area <10m**		**Sewer <50m**		**Jetties**	**ULU <100m**		**Roadway <100m**		**SWDs**
	km	*km*	*%*	*km*	*%*	*km*	*%*	*number*	*km*	*%*	*km*	*%*	*number*
Noosa North Shore foreshore	10	2	*22*	0	*0*	0		64	3	*27*	3	*34*	0
Goat Island foreshore	2	0			*0*	0	*0*	0	0	*0*	0	*0*	0
NOOSA Nth SHORE SECTION	12	2	*18*	0	*0*	0	*0*	64	3	*22*	3	*27*	0
Wooroi Creek - tidal reach	3	0.6	*18*	0	*0*	1	*19*	0	1	*26*	1	*25*	36
Tewantin foreshore	3	2	*48*	0.3	*9*	2	*70*	38	3	*98*	1	*33*	15
Pig (Makepeace) Island	2	0.2	*14*	0	*0*	0	*0*	2	0.5	*28*	0	*0*	0
Sheep Island	2	0	*0*	0	*0*	0	*0*	0	0	*0*	0	*0*	0
TEWANTIN SECTION	10	2	*24*	0.3	*3*	3	*29*	40	5	*45*	2	*19*	51
Lake Doonella foreshore	4	0.8	*20*	0	*0.8*	4	*89*	2	2	*51*	2	*44*	17
Cranks Creek - tidal reach	1	0.1	*13*	0.4	*38*	0.4	*40*	0	0.3	*4*	0	*2*	3
DOONELLA SECTION	5	0.9	*19*	0.4	*8*	4	*81*	2	2	*18*	2	*15*	20
Noosaville foreshore	4	4	*94*	3	*78*	1	*22*	47	4	*100*	3	*79*	42
Noosa Waters	13	13	*100*	1	*11*	12	*94*	454	13	*100*	12	*97*	23
NOOSAVILLE SECTION	17	16	*99*	4	*27*	13	*77*	501	17	*100*	15	*92*	65
Hayes Island foreshore	6	6	*100*	0.6	*10*	5	*83*	197	6	*100*	6	*100*	18
Noosa Spit and Woods	4	1	*22*	0.7	*18*	1	*20*	1	2	*40*	1	*28*	8
NOOSA HEADS SECTION	10	7	*67*	1	*13*	5	*56*	198	7	*74*	7	*69*	26
Weyba Creek - East shore	6	0	*1*	0	*0*	1	*22*	4	2	*34*	1	*10*	11
Weyba Creek - West shore	6	3	*56*	0.4	*6*	6	*94*	29	5	*83*	5	*80*	75
WEYBA CREEK SECTION	12	4	*29*	0.4	*3*	7	*59*	33	7	*59*	6	*46*	86
TOTALS	**66**	**32**	***48***	**7**	*5*	**32**	*49*	**838**	**41**	*62*	**35**	*53*	**248**

NOOSA NORTH SHORE SECTION

Features

Noosa North Shore is a sub-basin of 1,215 hectares with diffuse drainage (no major creek) through numerous wetland areas, small drains and groundwater seepage, into the main tidal river channel. Goat Island is an undeveloped low-lying tidal wetland with foreshore of 2.4 km.

The extensive (10 km) foreshore is largely undeveloped: 7 km (73%) is not impacted by intensive land-use pressures, buffered by at least 100m of foreshore wetland habitat.

8 km (83%) of foreshore land is in designated environmental reserve (ER).

11.7 km (98%) of the littoral zone is designated part of Noosa River Fish Habitat Area.

Main Pressures

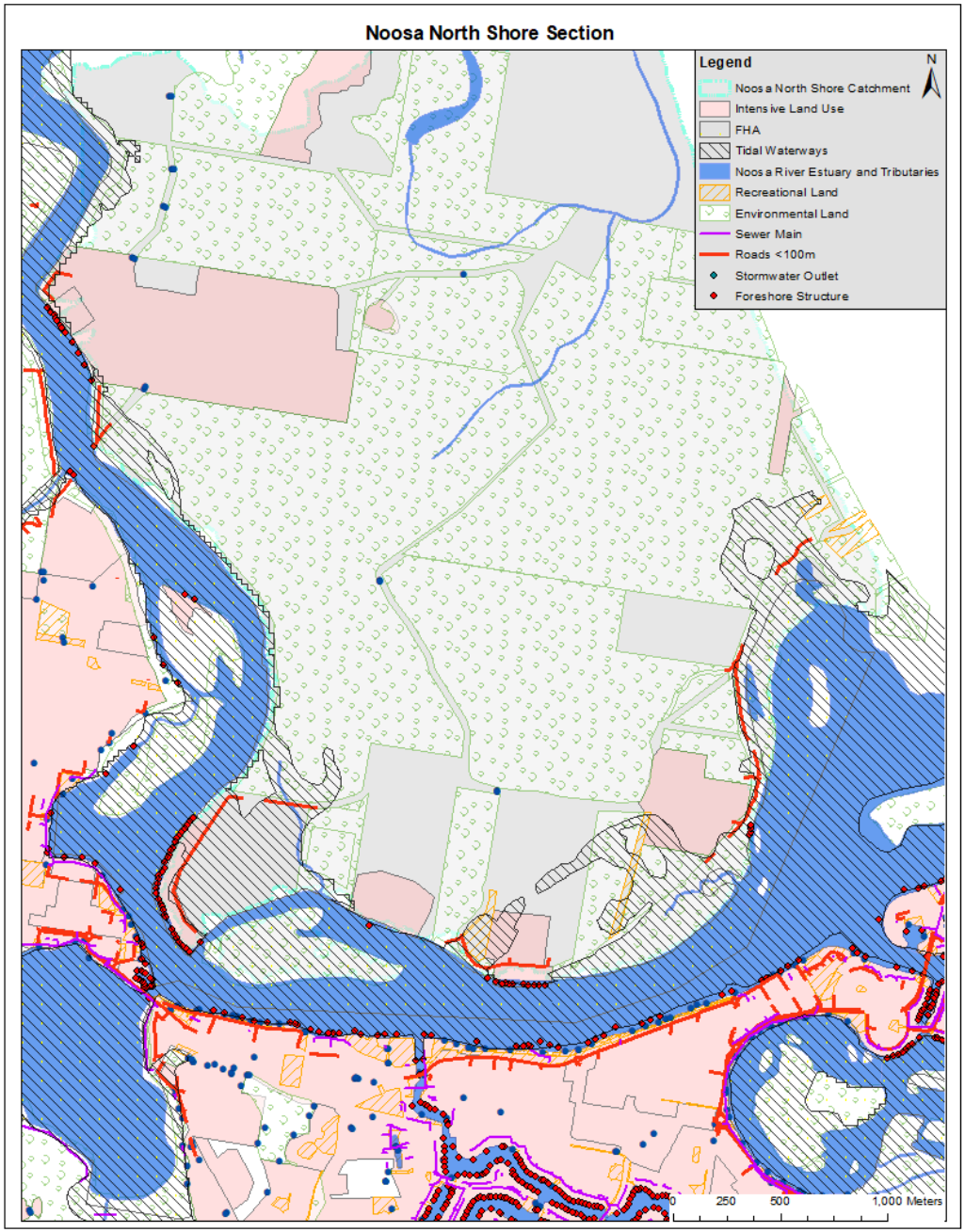
2.1 km (18%) of foreshore habitat has been replaced by intensive development (residential property, roadway) directly on the foreshore; with 64 adjacent jetty structures. A further 0.5 km of foreshore is impacted by ILU within 100 metres.

Roadway impinges directly on the shore at 7 sites.

0.6 km (6%) of the foreshore designated ER is affected by adjacent ILU (<50m buffer). 1.2 km (10%) of the FHA is immediately adjacent to ILU.

The mapping survey recorded no public stormwater drainage structures on the foreshore. A small number of stormwater drains collect and channel the run-off from public roadways into adjacent freshwater wetlands. It is understood that individual properties discharge their land run-off directly onto the shore or into the river (or into adjacent wetland if not on the foreshore).

There is no mains sewer network on Noosa North Shore



MAP 2 Distribution of main ULU pressures across Noosa North Shore section

TEWANTIN SECTION

Features

Tewantin has an extensive freshwater basin (1,360ha) dominated by Wooroi Creek catchment (1,248ha), which becomes a significant tidal channel joining the river at Ferry Park.

Wooroi Creek is one of just five major tributary creeks draining into the central estuary (the second is the smaller Cranks Creek).

Tewantin foreshore is 3.3 km between Ferry Park and Doonella Bridge, with a relatively narrow riparian zone with limited drainage from the land.

The central portion is dominated by Makepeace (foreshore 1.7 km) and Sheep Islands (foreshore 1.9 km) closely facing the foreshore across mangrove-lined channels

Main Pressures

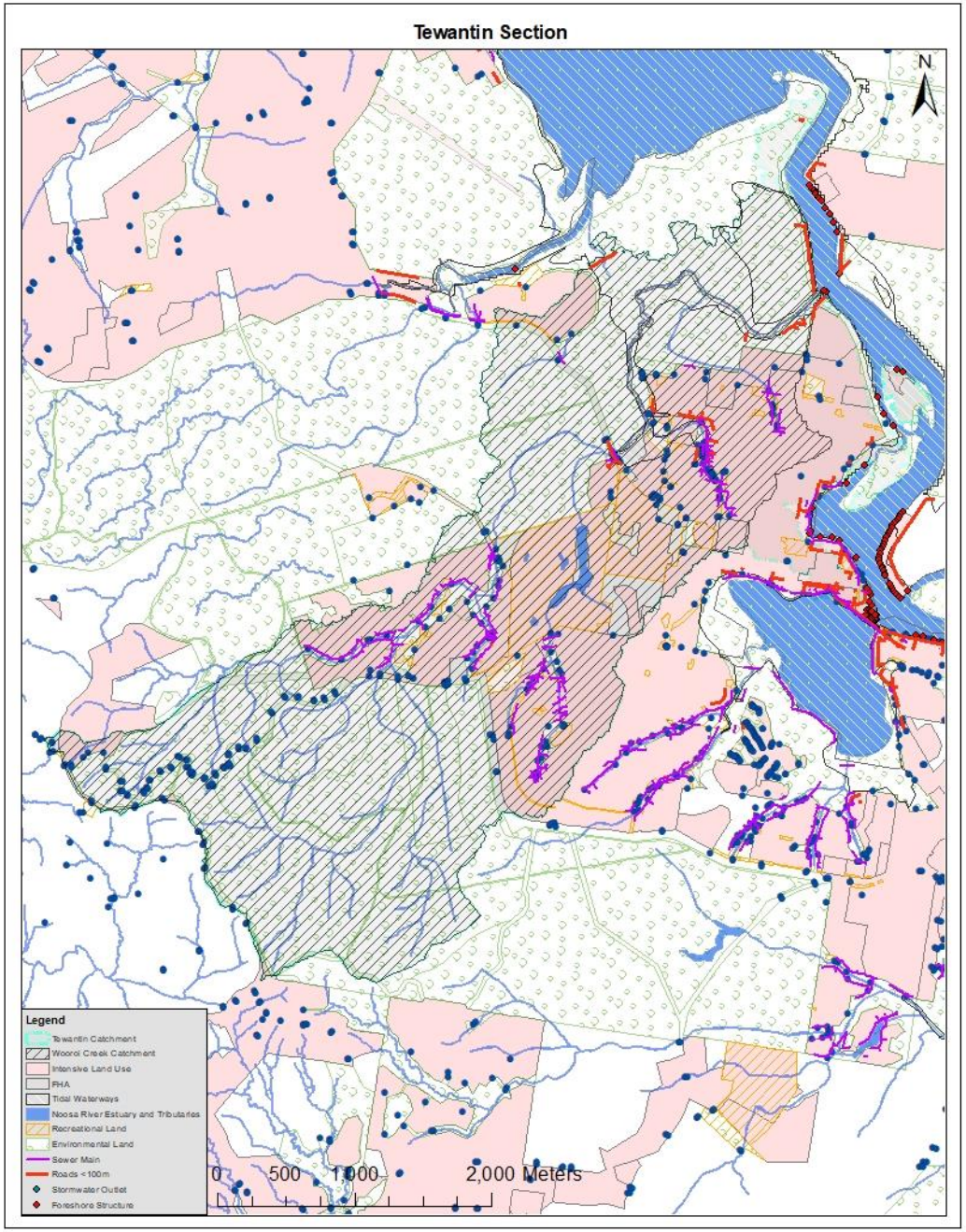
Virtually all Tewantin 'esplanade' foreshore (3.2 km, 98%) is impacted by urban land-use (buildings, roads, parks) developed either directly on the foreshore (along 1.6 km, 48%) or in close proximity (<100 m to the water's edge).

15 SW drain outfalls, 20 jetties/ ramps (and Marina) are built on foreshore or shoreline. Recreation areas cover 0.3 km (9%) of foreshore. Sewer lines (<50m from water edge) are along 2.3 km (70%) of foreshore. Roadways extend to shoreline at 10 sites.

1.8 km (55%) of foreshore land is Env. reserve; with ULU within 50m along 1 km (54%). FHA extends along 2 km (63%) of littoral zone; with ULU adjacent to 0.6 km (29%).

Urban land-use covers significant portion (34%, over 400 ha) of Wooroi Creek catchment area (inc. Tewantin GolfCourse). All urban run-off is channelled via SW outfalls (36) into freshwater wetlands and creek drainage.

Wooroi Creek tidal reach (3.4km length) is lightly impacted (sewer pipelines along just 0.7km (19%); no jetty structures). 2.6 km (74%) is buffered from ULU by >100m wetland habitat. 3.2km (92%) of tidal reach designated environmental reserve and 2.8 km (82%) is FHA. Wooroi Creek mouth into main river at Moorindil Street is significantly affected by NNS Ferry ramps, road reserve, recreation area, river access and structures.



MAP 3 Distribution of main ULU pressures across Tewantin section

DOONELLA SECTION

Features

Doonella section comprises the shallow tidal lake covering 124 hectares, connected to the main estuary via narrow channel under Doonella Bridge, with an extensive drainage basin (460 ha) surrounding the lake.

This includes 190 ha freshwater catchment draining into Cranks Creek and numerous small catchment areas around the east, south and west sides of the lake.

Lake Doonella foreshore is over 5 km in length, including the 0.9 km tidal reach of Cranks Creek.

The tidal foreshore varies in width from less than 50 m to over 300 m, extending over an estimated area of 80 hectares of dense salt- and freshwater wetland habitats.

Over 3 km (75%) of lake foreshore land is designated environmental reserve. 0.7 km, over 20% of reserve foreshore is affected by adjacent ULU (<50m buffer).

100% of the lake foreshore is declared fish habitat area (FHA). 0.8 km, 20% of the FHA is immediately adjacent to ILU.

Main Pressures

Intensive urban land-use is developed along 0.8 km (20%) of the Doonella foreshore close to the water's edge (<10 m) on the north and east sides.

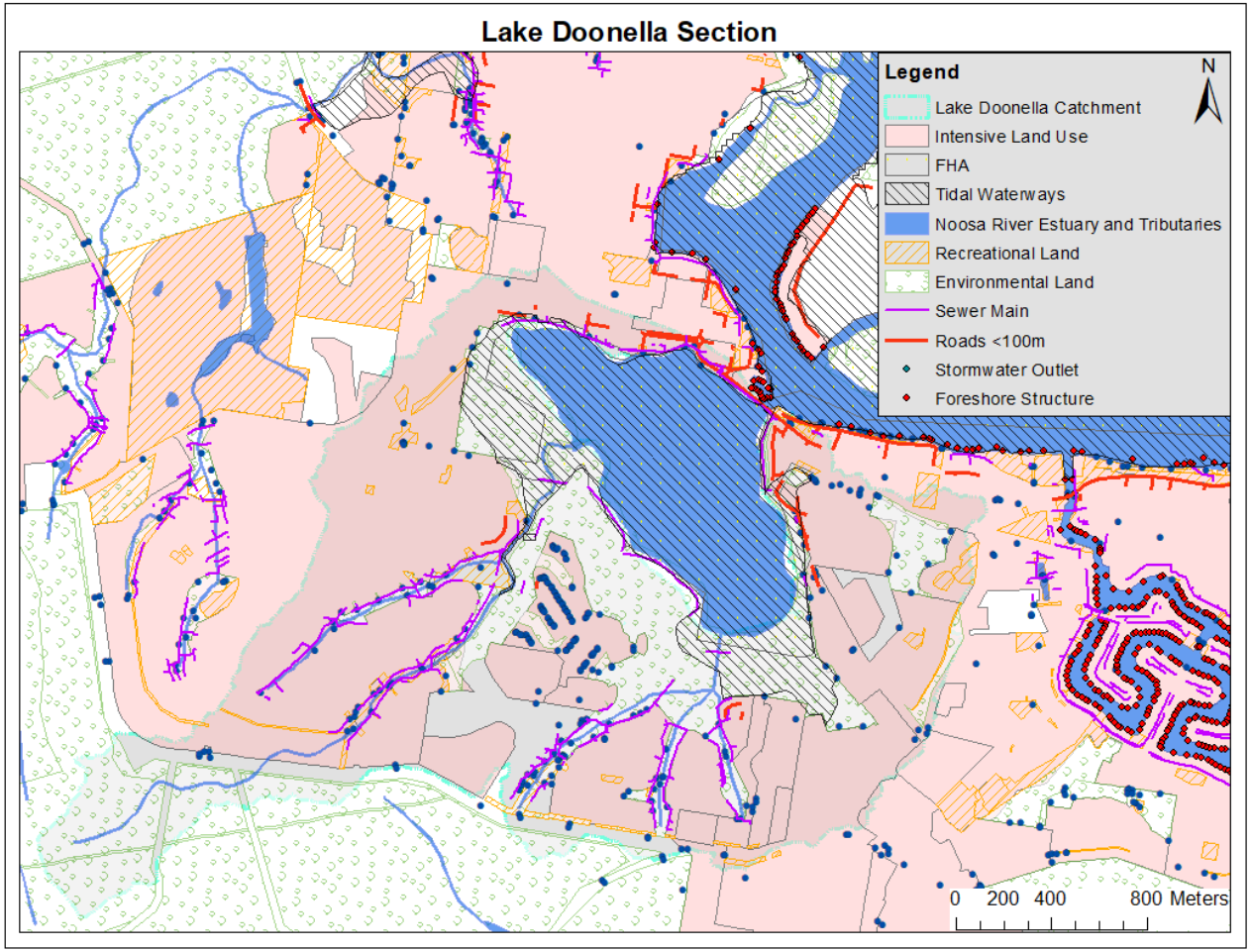
An additional 1.2 km (30%) of the lake foreshore is impacted by encroachment and increased inputs from residential development and roadways within 100 m of the water's edge.

SW drain outfalls are constructed at 17 foreshore sites.

Main sewer pipelines were mapped within less than 50 m of the water's edge along a total of 3.7 km (90%) of the lake shoreline.

2 jetty structures on the foreshore were recorded.

Cranks Creek catchment is impacted by 114 ha (60%) being converted to urban land-use, with all run-off channelled into the creek wetlands margins.



MAP 4 Distribution of main ULU pressures across Doonella Section

NOOSAVILLE SECTION

Features

Noosaville section extends along 4km of tidal foreshore, with a drainage basin of 330ha extending south to encompass the Noosa Waters canal estate and its catchment, including Shorehaven bushland park and recreation area.

The constructed foreshore of Noosa Waters is an additional 12.6km in length.

Main Pressures

Noosaville is the most intensely developed section of the central estuary: residential and commercial land-use occupies over 254ha (77%) of the drainage basin; and 3.7km (94%) of the immediate Noosaville foreshore (<10m of the water edge); as well as along 100% of the Noosa Waters foreshore.

Roadways run within 100m of the water edge along 3.1km (80%) of Noosaville foreshore; and 12.1km (97%) of Noosa Waters foreshores.

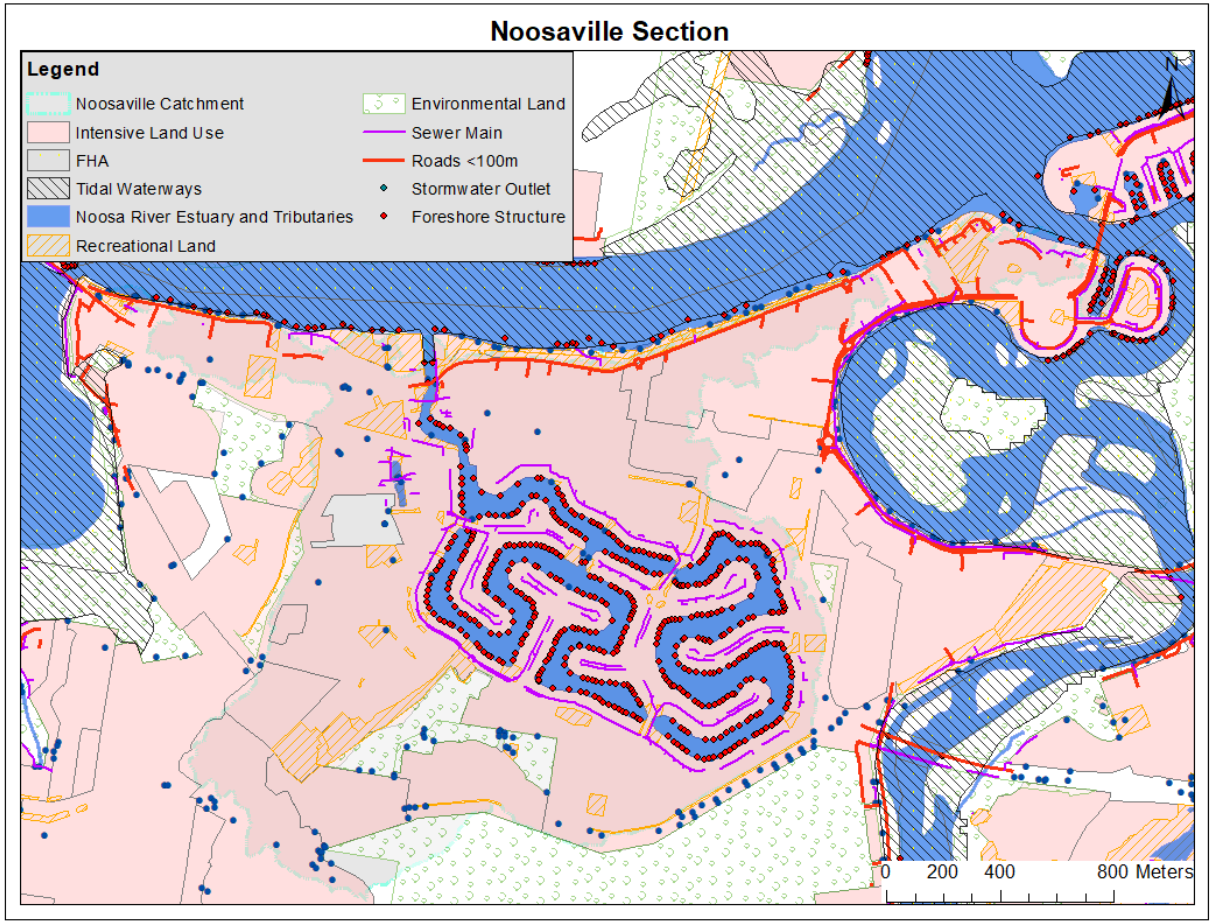
All run-off from Noosaville catchment is channelled and drained via the SW system onto the main river foreshore or via Noosa Waters: 42 SW drain structures were mapped along the Noosaville foreshore; and 23 on Noosa Waters foreshore.

Recreation areas are developed along 3.1km (78%) of Noosaville foreshore; and along 1.3km (11%) of Noosa Waters foreshore.

0.9km (22%) of Noosaville foreshore and 12km (94%) of Noosa Waters foreshore are impacted by sewer pipelines within 50m of the water edge.

47 waterway structures (jetties, ramps) were mapped along Noosaville foreshore and littoral zone; 454 were recorded in Noosa Waters.

None of the Noosaville foreshore or littoral zone is designated environmental reserve or protected by fish habitat area (FHA).



MAP 5 Distribution of main ULU pressures across Noosaville section

NOOSA HEADS SECTION

Features

Noosa Heads section comprises Noosa Spit and Woods, with foreshore length of 4.2km; and the artificially raised Hayes Island (foreshore 5.6km).

3.8km (90%) of the Spit and Woods foreshore land (zero on Hayes Island) is designated environmental reserve.

None of the littoral zone in this section is within FHA.

Main Pressures

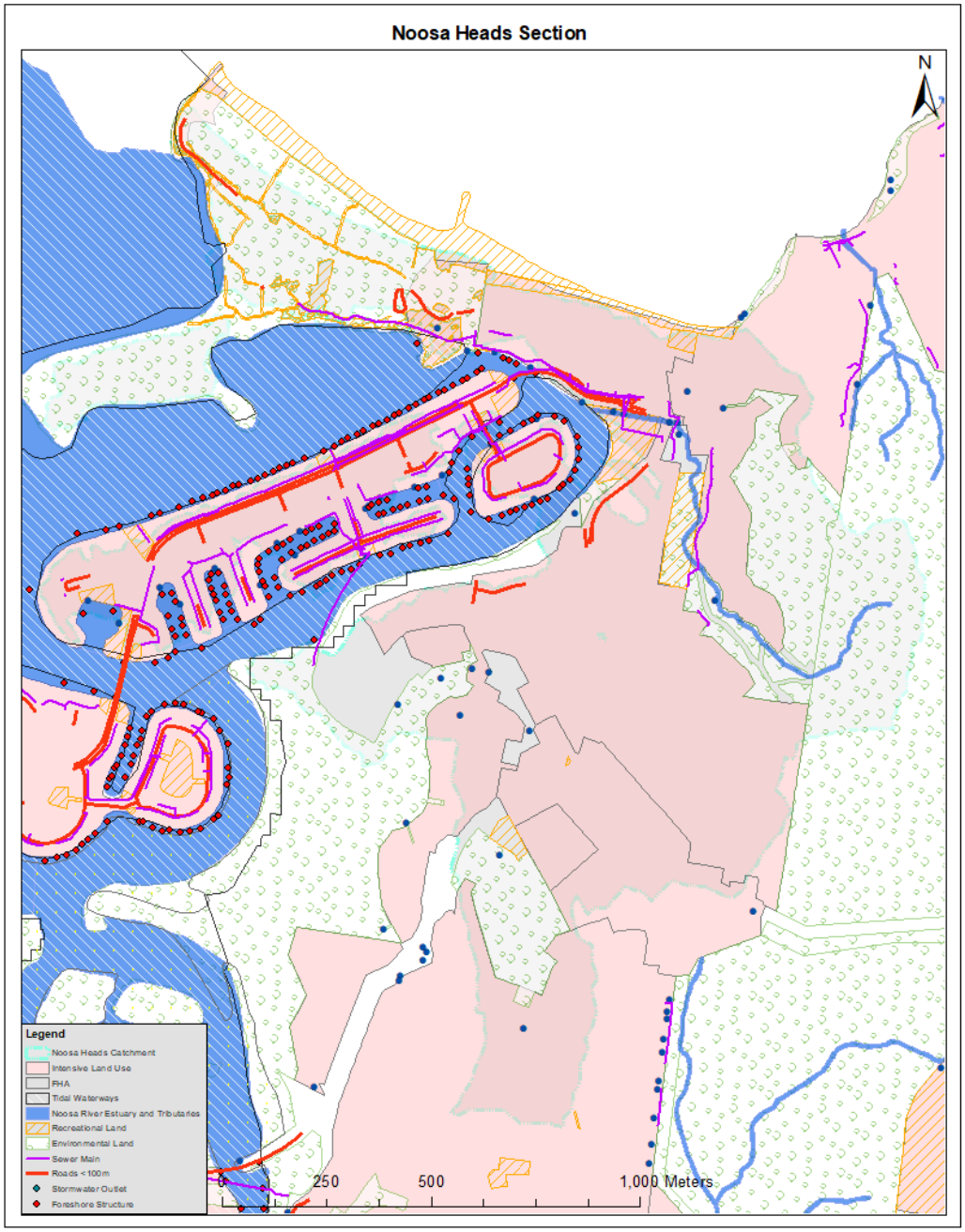
Hayes Island foreshore and littoral zone are "reclaimed" land with little ecological value: urban land-use covers 100% of the foreshore (within 10 m of the water's edge); 0.6 km (10%) of foreshore is recreation area; 197 jetties and 18 SW drain structures were mapped on the foreshore.

Roadways <100m of the water edge extend along 5.6km (100%) of the foreshore. Sewer pipelines <50m from the water are built along 4.6km (83%) of the foreshore.

The Spit foreshore has nearly 1km (22%) of urban land-use built on the foreshore (<10 m); and 1.7km (40%) built within 100m of the water's edge.

8 SW drainage outfalls were mapped along the foreshore. Sewer pipeline is mapped along 0.85km (20%).

Recreation parkland occupies a further 0.7km (18%).



MAP 6 Distribution of main ULU pressures across Noosa Heads section

WEYBA CREEK SECTION

Features

The shallow tidal waterway of Weyba Creek runs from Lake Weyba to join the main estuary at Noosa Sound; covering an area of 160ha, approximately 7km long and up to 250m wide with numerous sand-mud banks and islands. The local catchment basin extends over 325ha.

Weyba Creek eastern foreshore extends 6km; 3.9km (66%) is largely free from urban land-use (with >100 m buffer). 5.8km (98%) is designated environmental reserve; although 1.1km (20%) of the reserve is impacted by ULU within 50m of the water edge. 5.9km (100%) is designated FHA (below MHW), with less than 50m immediately adjacent to urban land-use.

The western foreshore is 6.2km; only 1km (17%) of the western foreshore is partially buffered from ULU (>100 m). 3.4km (54%) is designated environmental reserve; of which 0.8km (25%) is impacted by urban land-use within 50m. FHA extends along 5.5km (87%) of the littoral zone; with ULU immediately adjacent along 3.5km (64%).

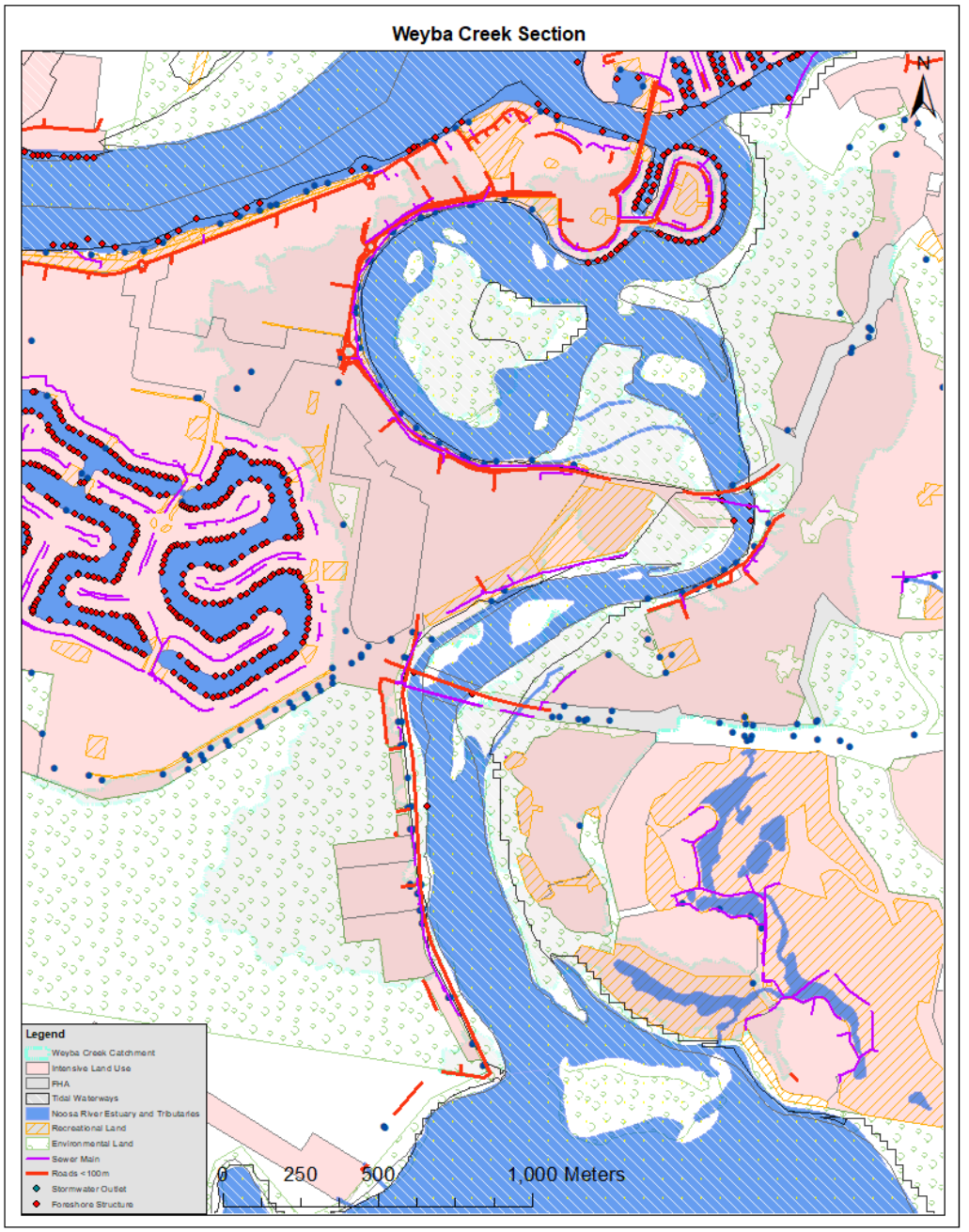
Main Pressures

180ha (55%) is developed ILU.

5.2km (83%) of the western foreshore has ULU developed within less than 100m of the water edge; this includes 3.5km (56%) with ILU immediately on the shore (within 10m). Recreation area is developed along 0.4km (6%) of the foreshore. Roadway (within 100m) is developed along 5km (80%) of foreshore; and sewer pipelines (within 50m) along 6km (94%). 75 SW drain outfalls and 29 jetty structures were mapped along the foreshore.

The eastern foreshore is comparatively undeveloped: ILU is developed within 100m of the water edge along 2km (34%) of foreshore; and within 10m along just 38m (1%). There is no recreation area mapped on the eastern foreshore. In the eastern catchment Noosa Springs development and golfcourse collect significant urban run-off and drain into southern end of Weyba Creek.

Roadway (within 100m) is built along 0.5km (10%) of the foreshore; and sewer pipelines (within 50m) along 1.3km (22%). 11 SW drain outfalls and 4 jetty structures were mapped along the foreshore.



MAP 7 Distribution of main ULU pressures across Weyba Creek section

PART 3 Conclusions & Initial Recommendations

CONCLUSIONS

1. The broad-scale mapping survey provides a useful perspective on the geography and ecology of Noosa River estuary and catchment, and the extent of the main types of urban land-use pressures exerted on the estuarine ecosystem. An overall conclusion is that with these significant and extensive pressures, the natural values of Noosa estuary are not sustainable without improved management and conservation measures.

2. There is no strategy or system in place for protecting the natural values of Noosa estuary, its foreshore and riparian wetlands or any other habitat; there are no effective estuarine or wetland 'reserve' areas. Current measures to conserve natural habitats in the estuary precinct are limited to a few designated 'reserve' areas that do not provide adequate protection from nearby urban land use or waterway use.

3. The underlying problem for conservation of Noosa River estuary is that urban land-use, public and private buildings and associated infrastructure have been developed closely and extensively around the central estuary 'precinct' with inadequate regard for the healthy functioning of the estuary ecosystem.

4. The survey highlights the following major concerns with the ways in which urban land-use is developed and managed in Noosa estuary precinct:

    a. There has been excessive clearing and destruction of foreshore habitats by development directly on foreshore land and the littoral zone – buildings, roads, other infrastructure and urban parks, as well as more than 1,000 hard structures of "waterway infrastructure" (jetties, boat ramps, stormwater outfalls, etc).

    b. Most other stretches of Noosa's foreshore wetlands have been significantly degraded by development of urban land-use in close proximity – resulting in extensive "edge effects" of encroachment and increased inputs of 'foreign' materials (litter, pollutants and waste dumping to weeds and domestic pests).

    c. The run-off and contaminants from every building, road and other hard surface in urban Noosa (over 1400 ha) is channelled through the stormwater drainage (SWD) system into the estuary (via over 200 unmodified SWD outfalls) – causing significant disruption to the ecological functions of foreshore and riparian wetlands and the estuary as a whole.

        Urban run-off is likely to be the most significant source of dissolved and particulate contaminant materials (solid waste and litter, sediments, dissolved chemicals, plant and weed debris and seeds) entering the Noosa River estuary.

INITIAL RECOMMENDATIONS - FOR DISCUSSION:

It is hoped that the assessment of urban development pressures on the lower Noosa River system will be useful to the current initiative by Noosa Council, State Government agencies and community representatives on the Noosa River Stakeholders Advisory Committee to strengthen collaborative management and conservation of the whole Noosa River and catchment system.

1. Noosa River & Catchment Management

An overarching recommendation is for an **ecosystem-based management approach** to be taken to ensure the long-term conservation and sustainability of the whole Noosa River and catchment system. The aim would be to bring together all agencies with responsibilities for managing different components and use activities across the whole river system, to collaborate on planning and putting in place a comprehensive, integrated and long-term management system and program.

2. Noosa Estuary

For the Noosa Estuary the most effective dual strategy for conservation and sustainability would be:

To address directly the main ecological problems caused by urban land-uses; plus

A complementary strategy **to systematically restore and enhance** the ecological functions and natural amenity of areas that are degraded.

Possible mechanisms to mitigate urban land-use pressures on the estuary:

- ULU structures and surfaces built directly on foreshore land: engage owners and managers in a systematic program to reduce their impacts on the ecology of those sites and surrounding areas.
- Renovation or new structure development directly on foreshore land: maximise application of ecological principles in design, materials, construction, operation and ultimate removal and site restoration.
- New and renovated roadways and road drainage throughout Noosa estuary and basin: modify design to minimise impacts of run-off and maximise wetland functionality. E.g., design and retro-fit road reserves for bio-retention and infiltration (Artificial Wetlands).
- SW Drain structures in the lower Noosa River and basin: systematically modify and retro-fit designs, including enhancement as AW, to minimise impacts (erosion, pollution, visual amenity, habitat damage) and maximise 'natural' surface and ground water flows and ecological functions through foreshore and riparian wetlands.
- Foreshore and riparian recreation parkland: re-design and modify to restore and enhance ecological processes, biodiversity and natural amenity.

3. Living Foreshore Strategy ~ Priority Sites for Management Attention

From the survey several degraded stretches of the estuary foreshore can be identified as priorities for restoration and enhancement, as pilot sites for a *Living Foreshores* strategy involving Noosa Council in partnership with local community conservation volunteers.

The criteria used for their selection include:

- Stretches of public foreshore and shoreline where a number of urban land-uses are developed (on or close to the foreshore) and exert combined pressures on the ecology of the site.
- Significant degradation of ecological health and natural amenity values
- General neglect of ecological values, lack of management attention

Noosa Estuary Priority Foreshore Sites for Management, Restoration, Enhancement

Noosa North Shore section – Map 2

1. Maximilian Drive Ferry Foreshore, Noosa North Shore
2. Noosa North Shore Esplanade – Frying Pan Foreshore

Tewantin section – Map 3

3. Moorindil Street Ferry Foreshore, Ferry Park, Wooroi Creek Bushland Reserve
4. Lakeside Park and Tewantin Esplanade – Sheep Island channel, Tewantin
5. RSL & Tewantin Parks, Tewantin

Doonella section – Map 4

6. North Lake Doonella Foreshore and Wetland Refuge, Tewantin
7. Lake Doonella Bushland Reserve - Goodchap St - Lakes Resort Foreshore, Tewantin
8. Cranks Creek Riparian/ Esplanade, Tewantin

Noosaville section – Map 5

9. Hilton Esplanade Foreshore
10. Chaplain Park Foreshore
11. Lion's Park (part) Foreshore

Weyba Creek section – Map 7

12. Weyba Creek Park – Lake Weyba Drive Riparian Tract – Esplanade Foreshore

4. Priority Catchment Sites for Improved Management

Central Estuary (study area)

1. Wooroi Creek and catchment - Map 3
2. Cranks Creek and catchment - Map 4
3. Noosa Springs catchment area - Map 7

Outside central estuary

4. Cooroibah Creek and catchment - Map1
5. Eenie and Keyser Creeks and catchment - Map 1
6. Murdering Creek and catchment - Map 1

Broad-scale mapping of Noosa Estuary wetland ecosystems: Methodology

Many direct and indirect pressures from human activities affect wetlands (Department of Environment and Heritage Protection, (2011). These pressures can negative impact wetland function through impacts to ecological communities, water quality, soils, and hydrology (Department of Environment and Science, Queensland (2013). Due to the complexity of wetland ecosystems, and the cumulative impact of pressures, it can be challenging to accurately identify and quantify these pressures.

Desktop mapping using existing spatial datasets provides a solution to identify and categorise individual pressure types, and measure the cumulative impact of these pressures, to provide a quantitative proxy for pressures that wetland ecosystems.

To systematically assess wetland pressures across the lower Noosa River estuary, the study area was separated into eight sections: Cooroibah, Tewantin, Doonella, Noosa North Shore, Noosaville, Noosa Heads, Weyba Creek and Lake Weyba. A range of wetland pressures, including intensive land use, roads, stormwater points, sewer infrastructure and foreshore infrastructure were identified and mapped, as well as factors providing environmental protection including fish habitat areas (FHAs) and foreshore areas with environmental land buffers.

The following quantitative section statistics and proxy measurements of pressures were used:

i. ***Section-sub catchments and Creek Basins***: Watersheds were delineated from the Digital Elevation Model (DEM) of Australia derived from a LiDAR 5 Metre Grid (Geoscience Australia 2022). Hydrology tools were applied in Esri ArcGIS to delineate the sub-section catchments and major creek basins.

ii. ***Tidal Waterways***: Tidal waterways were defined using the Queensland waterways for waterway barrier works spatial data layer (Department of Agriculture and Fisheries 2021). The tidal waterway areas and foreshore lengths for each foreshore section were calculated using Esri ArcGIS software.

iii. ***Proximity to intensive urban land use (ULU)*****:** Intensive land uses were identified and classified based on the primary classes under the Australian Land Use and Management Classification Version 8 (ABARES 2016). Under the classification, intensive land uses are defined as "land subject to substantial modification, generally in association with closer residential settlement, commercial or industrial uses". These intensive land uses are highly associated with increased pressure on wetlands, through direct destruction and replacement of wetlands, altered hydrology, nutrient, and contaminant inputs, as well as invasive weed, litter, and hard rubbish inputs (Newton et al. 2020).

iv. The most recent Queensland land use mapping dataset for the Maroochy and Noosa catchments (Department of Environment and Science 2013) was used to calculate intensive land uses for each section, including buffer distances between ULU and wetlands habitat. This is based on Queensland Fisheries Guidelines for Fish Habitat Buffer Zones (Bavins et al. 2000), which recommends 100m buffer between developments and tidal lands, especially adjacent to Fish Habitat Areas (FHAs).

v. ***Roads***: Roads were identified using the Baseline Roads and Tracks dataset and buffered to within 100m of tidal waterways (State of Queensland Department of Resources 2021).

vi. ***Shoreline structures***: The locations of jetties, pontoons, bridges and boat ramps were mapped in Esri ArcGIS ArcMap. The high-resolution Queensland imagery web map service (Queensland Department of Natural Resources and Mines 2017) was used as a base map to locate and count the number of shoreline structures in each section.

vii. ***Stormwater points***: The locations and number of stormwater points for each foreshore section were identified using the Noosa Shire Council (Noosa Shire Council 2022b) and Sunshine Coast Regional Council (Sunshine Coast Council 2021b) stormwater infrastructure datasets.

viii. ***Sewer infrastructure****:* The lengths of foreshores under pressure from sewer infrastructure were calculated for each foreshore section by clipping the UnityWater sewer infrastructure dataset (UnityWater 2019) to within 50m of foreshores, and then calculating the length of foreshore impacted by the sewer infrastructure.

ix. ***Recreation parks and recreational areas (including sports ground)*****:** Public recreation parks and sports grounds are a prominent feature on parts of the foreshore of the lower Noosa River estuary. These areas involve clearing natural habitat, land form and earthworks, nutrient loads from fertilisers, pollutants from pesticides, poor weed and vegetation management. For this assessment, the length of foreshore affected by recreational areas on the foreshore (<10m from water edge) was measured. Recreation areas were identified and classified using the Noosa Openspace (Noosa Shire Council 2022a) and Sunshine Coast Council Openspace datasets (Sunshine Coast Council 2021a).

x. ***Environmental and conservation areas****:* Designated environmental areas extend to the foreshore along parts of Noosa North Shore, Lake Weyba and Lake Cooroibah. In the more urbanised central estuary environmental areas are either absent or provide inadequate buffer (<50m) against intensive land use pressures. Environmental areas were identified and classified using the Noosa Openspace (Noosa Shire Council 2022a) and Sunshine Coast Council Openspace datasets (Sunshine Coast Council 2021a).

xi. ***Fish habitat areas***: A declared fish habitat area (FHA) is intended to protect against physical disturbance from intensive land or waterway use, while allowing legal fishing. The Queensland Fish Habitat Areas (FHA) shapefile (Department of Environment and Science 2018) was used in Esri ArcGIS ArcMap to calculate the length of shoreline/ littoral zone in each section designated as Noosa River Fish Habitat Area (FHA). The extent of urban land-use near the FHA was measured in each part of the estuary.

Dataset Name	**Overview**	**Sources**
Baseline roads and tracks - Queensland	Vector line dataset defining locations, names, classes of Queensland roads	(State of Queensland Department of Resources 2021)
Digital Elevation Model (DEM) of Australia derived from LiDAR 5 Metre Grid	LiDAR derived DEM raster dataset - used to delineate sub-catchment basins by applying watershed delineation tools in Esri ArcGIS ArcMap	(Geoscience Australia 2015)
Fish Habitat Areas - Queensland	Vector polygon dataset defining Qld Fish Habitat Areas (FHAs) - used to calculate length of shoreline declared FHA	(Department of Environment and Science 2018)
High-resolution Queensland imagery web map service	High resolution raster image used as base map for locating a range of on-ground features, including shoreline structures.	(Queensland Department of Natural Resources and Mines 2017)
Noosa Council Open Space	Open space vector dataset for Noosa Shire Council, capturing location of National Parks, State Forests, local environment reserves, recreation parks, sports grounds	(Noosa Shire Council 2022a)
Queensland land use mapping – Maroochy Noosa catchment	Land use vector dataset	(Department of Environment and Science 2013)
Queensland waterways for waterway barrier works - Tidal	Vector polygon dataset defining tidal waterway areas in Queensland - used to delineate tidal waterway extent.	(Department of Agriculture and Fisheries 2021).
Noosa Stormwater	Stormwater utilities across Noosa Shire Council region - used to identify locations of stormwater points along each foreshore section and catchment area	(Noosa Shire Council 2022b)
Stormwater Sunshine Coast Council	Stormwater utilities across Sunshine Coast Council region - used to identify locations of stormwater points along each foreshore section and catchment area	(Sunshine Coast Council 2021b)
Sunshine Coast Council Open Space	Open space vector dataset for Sunshine Coast Regional Council, capturing location of National Parks, State Forests, local environment reserves, recreation parks and sports grounds.	(Sunshine Coast Council 2021a)
UnityWater Sewer Infrastructure	Unitywater sewer infrastructure - used to calculate lengths of foreshores impacted by sewer infrastructure.	(UnityWater 2019)

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FOOTNOTES

[a] Areas of tidal waters are included in the figures for adjacent Sections

[b] **Urban stormwater run-off into Noosa River estuary**
The total area of intensive urban land-use in the central estuary sub-basin was mapped as 1,456 hectares. Based on average annual rainfall of 1,700mm at Tewantin (BOM), the average annual volume of urban run-off is estimated to be around 25,000 megalitres or 10,000 Olympic sized swimming pools- all channelled in the SWD system. (Total volume of Noosa's tidal waterways is estimated to be 46,000 megalitres (assuming an average depth of 5 metres over the area of 915 hectares).

[c] **SW drain performance**
The performance characteristics of individual SW drains (such as area of receiving catchment; rates, volumes and periodicity of discharge; levels of contamination of dissolved and solid materials; extent of encroachment and impacts around discharge points; state of repair) were observed to vary widely but were not measured in this initial survey.

[d] There is no area-based marine/ estuarine conservation mechanism in place other than the Noosa River FHA.