Inventory of Instream Structures Impacting on Ramsar Wetlands

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Executive summary

Fish depend on access to a wide range of habitats for their survival. Coastal wetlands are dynamic ecosystems that are vital habitats for fish. Wetland habitats provide fish with food, shelter that helps protect them from predation and are also important as breeding and nursery areas (Blaber, 1997). A number of fish species move between wetland habitats at various times of their lives in order to breed and complete their life cycles. Maintaining connectivity between wetland habitats and access to a diverse mosaic of healthy fish habitats is critical to sustaining those fish populations important to Queensland's commercial, recreational and traditional fisheries (Meynecke et al., 2008).

To meet the demands of expanding residential, industrial and agricultural development, a range of instream structures has been established throughout freshwater, estuarine and marine wetland fish habitats. Instream structures include floodgates, levee banks, jetties, pontoons, boat ramps, revetments, moorings and road crossings. These structures can impact fish habitats by modifying flow regimes and causing permanent physical disturbances that result in direct habitat loss or fragmentation (Burns, 2001; Adams, 2002). Other structures may form complete or partial barriers that prevent, disrupt or severely limit important migrations and movements of fish and other aquatic species within these areas (Fairfull & Witheridge, 2003). Negative impacts of instream structures can lead to population declines, reduced distributions of species and degraded fish habitats, which can have detrimental effects on Queensland's commercial, recreational and traditional fisheries.

The project Inventory of Instream Structures Impacting on Ramsar Wetlands (the project), completed in May 2010 and the focus of this report, was managed by Fisheries Queensland, a service of the Department of Employment, Economic Development and Innovation (DEEDI) and funded as part of the Queensland Wetlands Program (the Program). The project employed a framework and guidelines to identify priority structures impacting on wetland condition and fish habitats in the Bowling Green Bay (BGB) Ramsar site and the Bowling Green Bay declared Fish Habitat Area (FHA) near Townsville, and the Shoalwater and Corio bays Ramsar site and Corio Bay declared FHA near Yeppoon.

An output of the project is the development of a Response Action Plan (RAP) for every project area that includes a list of priority structures and identifies recommended management response actions for each. Actions include raising community awareness of ecological values, removal of problem structures, rehabilitation of disturbed sites and development of strategic approaches to specific identified management issues. The RAPs form the basis for informed management decisions to remediate the impacts of problem instream structures on protected wetlands and fish habitats. This report includes both the results from inventories and the RAPs for Corio Bay and Bowling Green Bay.

A local multi-agency working group has been established in Rockhampton to implement the Corio Bay RAP. Membership includes Fisheries Queensland (DEEDI), Department of Environment and Resource Management (DERM), Great Barrier Reef Marine Park Authority (GBRMPA), Department of Transport and Main Roads (DTMR), Rockhampton Regional Council (RRC) and Fitzroy Basin Association (FBA). A key issue to enable management actions to be implemented is the integration of the diverse policies, legislation and management regimes of the different local and state agencies with management and approval roles for problem structures in coastal wetlands. The working group is cooperating to achieve integrated outcomes with a common goal of protecting the region's important wetland values. Delivery of the RAP will depend on availability of funding, existing work programs and commitment from agencies on the working group.

A key responsibility of the working group is to develop and implement a regional communications plan for Corio Bay, to promote and create awareness of the area's natural values and prevent further structures that have unacceptable development impacts on those values. Delivery of the RAP and its communications plan will also promote an awareness of the benefits of the Program in Central Queensland. A similar working group is proposed to implement the Bowling Green Bay RAP.

The framework and guidelines were first developed by Fisheries Queensland in a 2009 pilot project, based on trials in the Great Barrier Reef lagoon, including two declared FHAs: Trinity Inlet declared FHA near Cairns and the Hinchinbrook declared FHA near Ingham. The results of these inventories are outlined in the report, Targeted collection of inventory data for wetlands fish barriers in the Great Barrier Reef (GBR) catchment. Fisheries guidelines for conducting an inventory of instream structures in coastal Queensland (revised version) encapsulate the protocols for conducting inventories and prioritising structures.

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1 Introduction

This report outlines the findings from instream structure inventories conducted in the Bowling Green Bay and Shoalwater and Corio bays Ramsar sites and the Bowling Green Bay and Corio Bay declared Fish Habitat Areas (FHA) for the project Inventory of Instream Structures Impacting on Ramsar Wetlands. The project was managed and conducted by Fisheries Queensland, a service of DEEDI.

The project was funded by SEWPaC as part of the Queensland Wetlands Program. The program supports projects and activities that result in long-term benefits to the sustainable management, wise use and protection of wetlands in Queensland. The tools developed by the program help wetlands land holders, managers, and decision makers in government and industry. The Program is a joint initiative of the Australian and Queensland governments.

Project objectives

The purpose of the project was to employ a framework and Fisheries Guidelines for Conducting an Inventory of Instream Structures in Coastal Queensland (Fish Habitat Guideline (FHG) 007) (Lawrence et al., 2009a), developed in the pilot project Targeted Collection of Inventory Data for Wetlands Fish Barriers in the Great Barrier Reef Catchment, funded by SEWPaC (2008/09), to conduct a physical inventory and data storage for identifying and plotting structures that impact on fish habitats and movement of fish and other aquatic species in two of Queensland's Ramsar wetlands. The project was developed and managed to meet the following main objectives:

1. to conduct inventories of instream structures within the Bowling Green Bay and Shoalwater and Corio bays Ramsar sites
2. to conduct inventory training workshops to transfer skills and knowledge to North Queensland Dry Tropics (NQDT) and FBA and Local Government staff at Townsville and Rockhampton/Yeppoon
3. to determine management actions appropriate to agreed problem structures with key stakeholders, within Natural Resource Management (NRM) investment plans and Council work programs
4. update and enhance the FishBarriers Version Queensland (VQ) digital menu system used to collect data and enhances the inventory guidelines and Decision Support System protocol.

The program has mapped the distribution of wetlands in Queensland and compiled related information to allow classification of wetlands and to document the extent of disturbance within those wetlands. This key step is an essential prerequisite to effective wetlands management for Ramsar sites, high conservation value aquatic ecosystems (HCVAE) and Marine Protected Areas (MPAs), including declared FHAs.

The mapping base identified a number of larger structures, e.g. bridges and impoundments, through interpretation of aerial photography. Many smaller but often more numerous structures which collectively have equal or greater impacts on wetland condition relative to the larger structures are not detected by this process.

The project fulfils a critical step in improving the quality and coverage of the program's database in corroborating and extending the current wetlands mapping and inventory data through conducting detailed on-ground surveys in a consistent manner, ensuring data accuracy and currency. Specifically, project data contributes to both the mapping and classification project and the Wetlands Information Capture (WIC) project of the program.

Prioritising remedial actions in partnerships with regional NRM agencies and other key stakeholders, e.g. local government, NRM groups, traditional owners, will follow the application of the management considerations for structures identified in this project at Bowling Green Bay and Corio Bay. Potential remedial actions for strategic priorities include modification or removal of structures options in alignment with NRM investment strategies and council work programs.

Background

The above mentioned pilot project was funded by SEWPaC from the Natural Heritage Trust II. Fisheries Guidelines for Conducting an Inventory of Instream Structures in Coastal Queensland (Lawrence et al., 2009a) (herein 'the guidelines') were developed based on trials in the Great Barrier Reef lagoon, including two declared FHAs: Trinity Inlet declared FHA near Cairns and Hinchinbrook declared FHA near Ingham.

The current project, also funded by SEWPaC as part of the program, employs the framework and guidelines (Lawrence et al., 2009a) developed in the pilot project to yield specific inventories and identify priority structures impacting on wetland condition and fish habitats in the Bowling Green Bay FHA and Bowling Green Bay Ramsar site near Townsville, and the Shoalwater and Corio bays Ramsar site and Corio Bay declared FHA near Yeppoon.

The guidelines (Lawrence et al., 2009a) consist of an inventory protocol that describes how to identify structure locations and assess structure impacts, as well as a response protocol including a decision support system for the prioritisation of structures for management response actions. The inventory protocol is based on the use of the fish barriers menu system, an Arcpad application originally developed by New South Wales Department of Primary Industries (NSW DPI), to collect field data.

The guidelines (Lawrence et al., 2009a) build on previous NSW DPI and Fisheries Queensland work aimed at prioritising fish passage barriers in a number of New South Wales and Queensland catchments (Stockwell et al., 2008; NSW DPI, 2006; Stewart & Marsden, 2006). They were developed to encompass the range of other 'non-barrier' structures that exist in estuarine areas of coastal Queensland in addition to establishing a specific protocol for use in targeted protected areas. The guidelines provide both government (e.g. state agencies, councils) and non-government (e.g. NRM bodies) organisations with the capacity to undertake similar inventory work.

Ramsar wetlands

Ramsar wetlands are designated as internationally important under The Convention on Wetlands of International Importance signed in Ramsar, Iran in 1971 (commonly known as the Ramsar Convention). The aim of the Ramsar Convention is to prevent further world wide loss of wetlands and conserve existing wetlands through wise use and management based on the principles of ecologically sustainable development.

In accordance with the Ramsar Convention, appropriate management of Ramsar wetlands includes describing and maintaining the ecological character of the wetland and implementing planning processes that promote conservation and wise use. Australia has embedded this requirement into the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

An Ecological Character Description (ECD) is prepared for each Ramsar site and provides the baseline description of the wetland at a given point in time. The ECD can be used to assess changes in the ecological character of these sites. A key part of the ECD process is to document the threats to Ramsar wetlands, including the threat of urban development.

Urban development and the modification of natural wetlands systems present a potential threat to the ecological character of Ramsar wetlands, through marine plant/terrestrial vegetation removal and subsequent introduction of weed species. In addition linear infrastructure interrupts natural surface water and groundwater flow paths. As population rises and associated development activities in the coastal zone continue to increase, the impacts that urban encroachment and changing surrounding land uses pose to the values of Ramsar wetlands is likely to intensify.

Baseline information on existing infrastructure within and adjacent to Ramsar sites is critical to the assessment of future development impacts on Ramsar values. Collection of this information is not only important within the boundaries of the Ramsar site, but changes in uses of adjacent lands will have impacts on the values within the site and should be monitored. In identifying and assessing the impacts of instream structures on Ramsar wetlands and recording wetlands inventory information, structure inventory project data supplements the ECD and forms a baseline by which to measure future impacts against.

There are 64 Ramsar sites in Australia. Of the five sites in Queensland (Figure 1) three incorporate declared FHAs – Bowling Green Bay near Townsville, Shoalwater and Corio bays north of Yeppoon and the Great Sandy Strait on the Cooloola Coast.

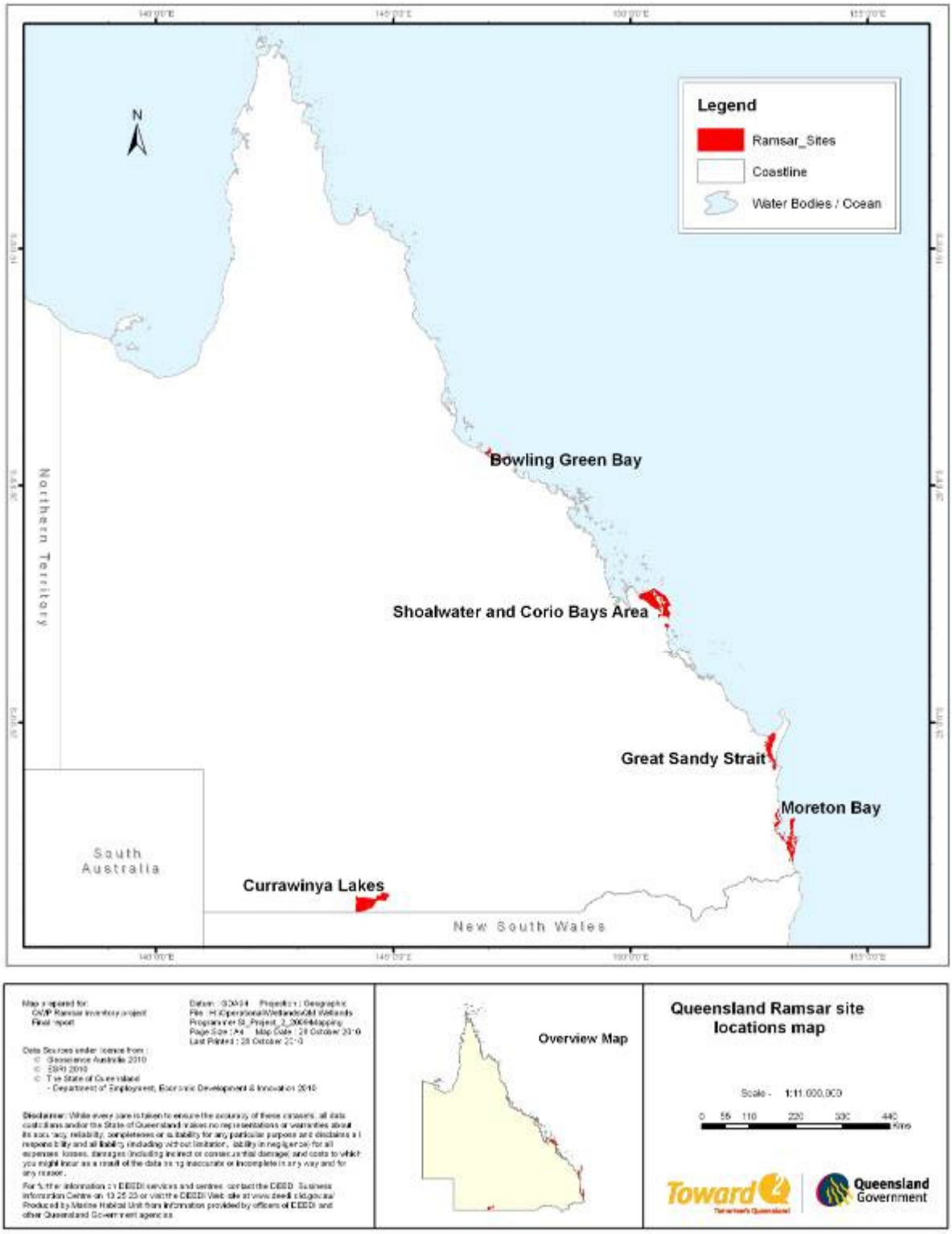

Figure 1. Map of Queensland showing the locations of Ramsar sites

Source: DEEDI

The declared Fish Habitat Area network

The declared FHA network was established by Fisheries Queensland in the late 1960s in response to development pressures in the coastal zone (McKinnon et al., 2002). These areas protect key fish habitats and fish stocks that sustain the commercial, recreational and traditional fisheries, from development. While protecting natural fish habitats (e.g. vegetation, sand bars, rocky headlands) from alteration and degradation from development impacts, declared FHAs allow for natural processes and community use, including: community access, boating and commercial, recreational and traditional fishing. The amount and nature of development activities that occur within the declared FHA network are regulated under the *Fisheries Act 1994*, supported by Fisheries Queensland policies and guidelines.

Despite the statutory framework that underpins the management of declared FHAs, development impacts exist in these protected areas. The legality of some structures within declared FHA boundaries is uncertain and the impacts of these structures can be detrimental to the health and value of key fish habitats within the declared FHA network.

Unauthorised structures include: those constructed or installed before FHA declaration and therefore not subject to the development assessment process; structures constructed in such a way that breaches the conditions of a fisheries development approval; or structures installed since FHA declaration without an approval.

A number of management responses may address the impacts of individual structures, including raising community awareness of ecological values, removal of structures and rehabilitation of disturbed sites, or development of a strategic approach to managing unauthorised structures. Comprehensive baseline information on the location and impacts of structures throughout the FHA network is essential to inform the determination of appropriate management responses to 'problem' structures.

The declared Fish Habitat Area network strategy

The pilot and current project satisfy completion of years one and two of a five-year Fisheries Queensland program to inventory instream structures in selected declared FHAs in coastal Queensland. This program is part of the declared Fish Habitat Area (FHA) Network Strategy (2009-14) that consists of three broad initiatives to achieve Fisheries Queensland's vision for the declared FHA Network and direct planning for the future. These initiatives include consolidating the declared FHA Network, reinforcing declared FHA management and strengthening declared FHA policy. The inventory program aligns with the second strategy initiative to reinforce declared FHA management. The program specifically meets the initiative to 'actively manage and respond to unlawful activities to prevent the degradation of individual declared FHAs and the declared FHA Network'.

Project working groups

A working group was established for each project area to provide local input and knowledge for project delivery and to ensure linkages with related projects. The working groups met on several occasions during the term of the project with representation from the following agencies and organisations: DERM, NQDT, GBRMPA, WetlandCare Australia, FBA and RRC. Members are listed in Appendix A.

Project areas

Project areas include the Bowling Green Bay Ramsar site and declared FHA and the Shoalwater and Corio bays Ramsar site including the Corio Bay declared FHA (Figure 2).

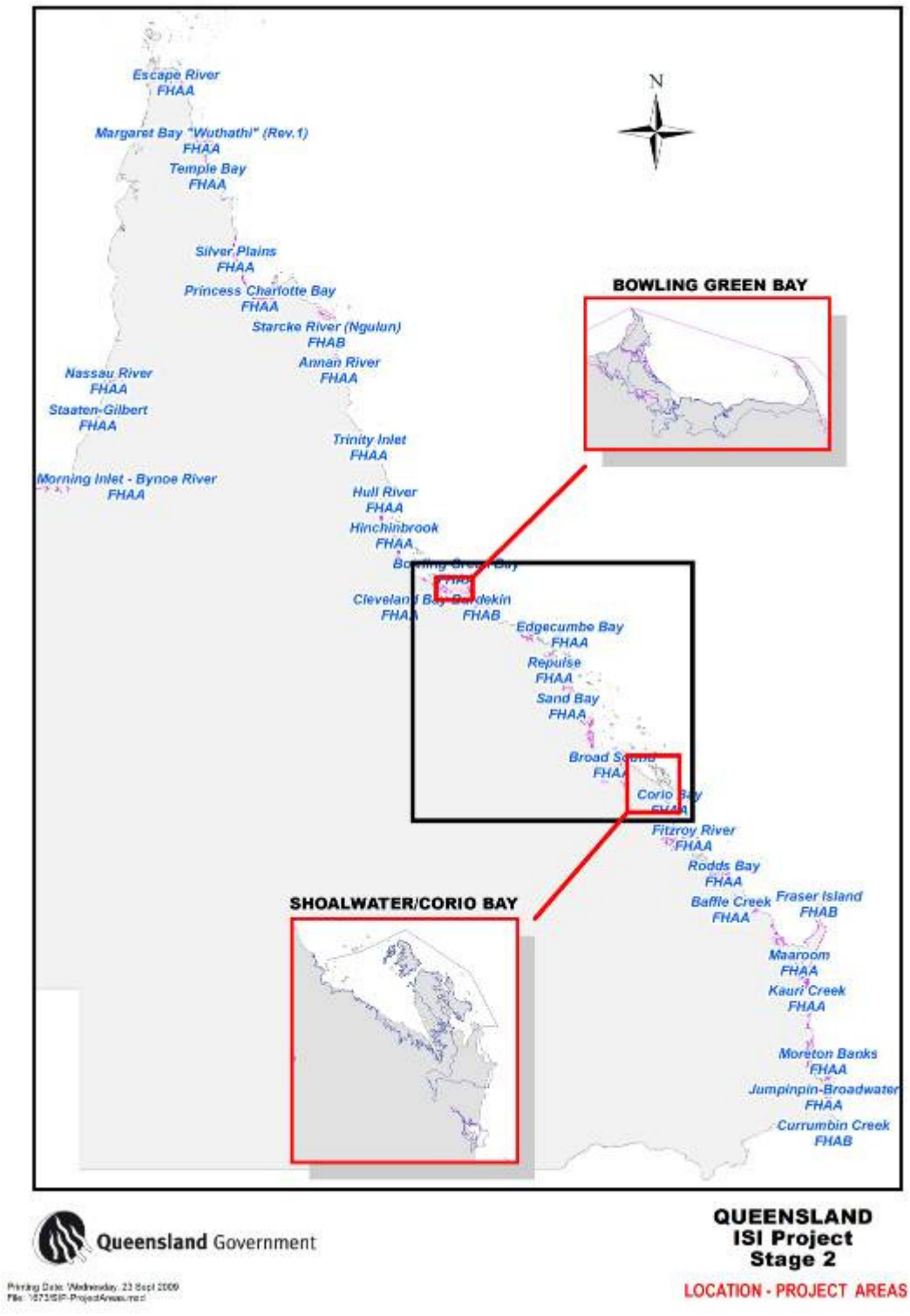

Figure 2. Location of Ramsar project areas within the declared FHA Network

Source: DEEDI

Bowling Green Bay

Bowling Green Bay, located on the North Queensland coast, was listed as a wetland of international importance under the Ramsar Convention in 1993. The draft ECD, recently completed describing the ecological character for the site listing since 1999, concluded that the site continues to meet the original criteria for which it was listed (Kelly et al., 2009).

The Bowling Green Bay declared FHA, declared in 1989 (and redeclared in 1998), is located adjacent to the Ramsar site and covers an area of 68 573 hectares (Figure 3). The FHA is under management level 'A' and is recognised for its valuable commercial and recreational fisheries resources, is important to the food chain of the offshore billfish fishery, incorporates major barramundi nursery habitat and is important dugong and loggerhead turtle habitat.

The bay and adjacent wetlands incorporate closed rhizophora and ceriops dominated mangrove stands with extensive areas of saltmarsh, sparse seagrass beds and exposed banks and freshwater lagoons. Important species include barramundi, blue salmon, bream, estuary cod, flathead, grey mackerel, grunter, mangrove jack, queenfish, school mackerel, whiting, tiger prawns and banana prawns. The Cleveland Bay declared FHA exists to the west of Bowling Green Bay and the Burdekin declared FHA is located to the south-east (Refer to Appendix B). Part of the Cleveland Bay FHA falls within the Bowling Green Bay project area and has been partly inventoried by this project.

The fish habitats of the declared FHA also lie within the Great Barrier Reef Marine Park under the Commonwealth *Great Barrier Reef Marine Park Act 1975* and are adjacent to the Bowling Green Bay Ramsar site.

Photo 1. Bowling Green Bay Ramsar site and declared FHA - looking south along Cape Bowling Green

Source: DEEDI

Shoalwater and Corio bays

The Shoalwater and Corio bays Ramsar site, located on the Central Queensland coast, was originally listed in 1996. The site is divided into two discontinuous sections including the Corio Bay portion to the south and the Shoalwater portion in the north (Appendix C). The majority of the Shoalwater component of the Ramsar site falls within the boundaries of the Shoalwater Bay Military Training Area (SWBTA). An ECD was completed by consultants BMT WBM for SEWPaC in 2009. This concluded that the site currently meets the Ramsar nomination criteria under which the site was originally listed in 1996 and confirmed there has been no significant deterioration in wetland condition or ecological character (Fisk et al., 2009). A key threat identified for consideration in future management of the site includes future infrastructure development within or adjacent to the site (Fisk et al., 2009).

The Corio Bay component of the site incorporates the Corio Bay declared FHA, located approximately 20 kilometres north of Yeppoon and covering an area of approximately 4652 hectares. The FHA was declared in 1974 (redeclared in 1995; 2009) as management level 'A'.

The declared FHA incorporates extensive sandy shallows with enclaves of mangrove shrubland dominated by rhizophora and ceriops, rocky outcrops, extensive saltmarshes around Fishing Creek and intertidal seagrass beds (Figure 4). The habitats of Corio Bay support the recreationally important banana prawn fishery in addition to a range of other fish including barramundi, blue salmon, bream, estuary cod, flathead, mackerel, whiting, mangrove jack and anguillid eels. The fish habitats of the Corio Bay declared FHA also lie within the Great Barrier Reef Marine Park and the Byfield National Park.

Photo 2. The Corio Bay portion incorporates sandy shallows and mangrove shrublands

Source: DEEDI

The Shoalwater Bay component of the Ramsar site contains a diverse range of marine habitat types, including extensive mangrove and saltmarsh areas and vast seagrass meadows (Figure 4). Due to the presence of the SWBTA, the fish habitats of Shoalwater Bay are not subject to the typical development pressures faced by urban areas and as such remain in a relatively pristine condition. While most of Shoalwater Bay is closed to fishing under the Great Barrier Reef Marine Park Zoning Plan 2003, parts of the bay provide important commercial and recreational fishing grounds. Habitats of the bay support species such as barramundi, mangrove jack, bream, snapper and mud crabs and provide an important nursery area for juvenile fish.

Photo 3. Pristine mangrove wetlands in the Shoalwater portion

Source: DEEDI

2 Project methods

This section provides a summary of the project methods employed to identify and prioritise structures in the Bowling Green Bay, Corio Bay and Shoalwater Bay project areas. Methods include an inventory protocol for structure identification and data collection and a response protocol for scoring and prioritisation of structures. Detailed information on project methodology can be found in Fish Habitat Guidelines FHG 007 (Lawrence et al., 2009).

Note that the current project (2009-20) implemented the original version of the guidelines published in 2009. However, through implementation of the guidelines and consultation with stakeholders, the current project has resulted in a number of changes to the original version, most notably changes to the prioritisation criteria. These changes are encapsulated in the 2010 revised version of the guidelines (available on the DEEDI website, <www.deedi.qld.gov.au>).

Part 1: Inventory protocol

Structure identification: desktop assessment

All available geographic information system (GIS) data layers (watercourses, vegetation, infrastructure, waterholes and bores, land tenure) and existing approvals information (fisheries development approvals, DTMR boat ramps, prescribed tidal works, section 86 approvals) were compiled for each project area. This information was laid over base layers consisting of the Digital Cadastral Data Base (DCDB), topographic maps, declared FHA mapping, the program's wetlands mapping and imagery to identify the locations of known structures.

ArcGIS was used to compile data layers and create project maps. First an overview map of each project area (Bowling Green Bay, Corio Bay and Shoalwater Bay) was created. The overview map, consisting of the project area and a buffer area, was used to determine the project area boundaries. A 1:5000 grid was then overlaid on the project area map to form a key map for individual maps (Figure 3).

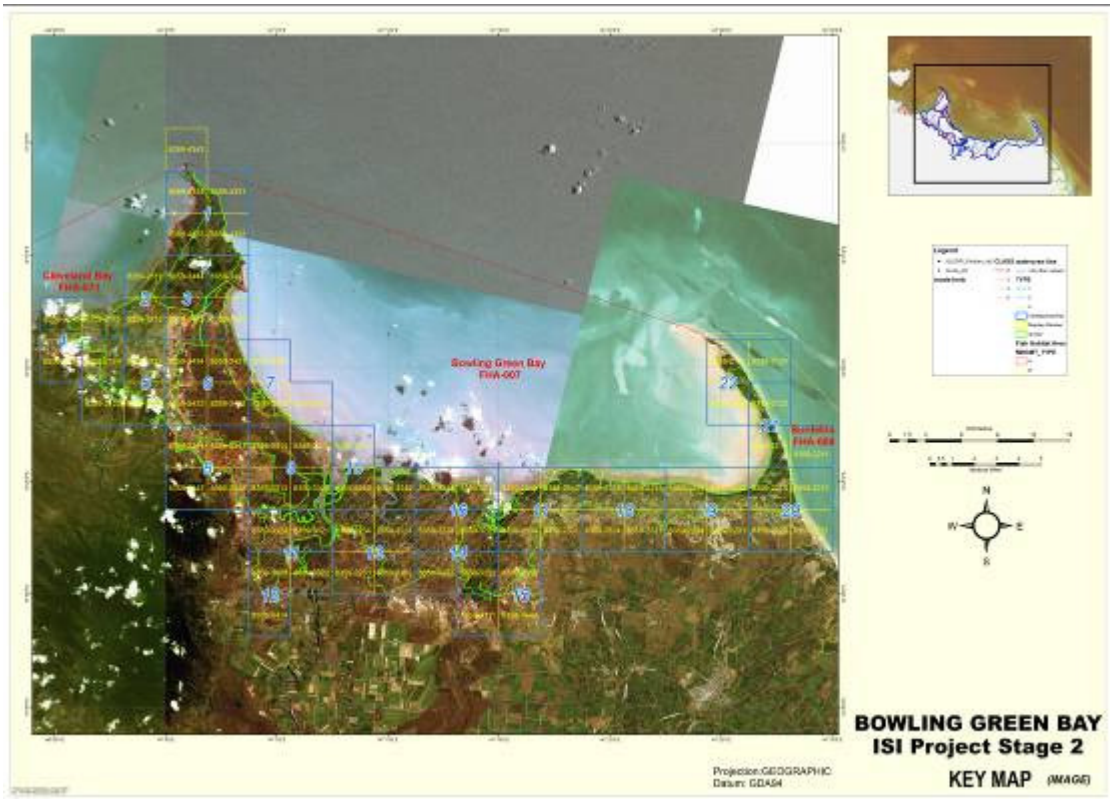

Figure 3. Key map - Bowling Green Bay project area

Source: DEEDI

This enabled fieldwork progress to be monitored. Each grid square was numbered consecutively for ease of reference. Individual maps were subsequently created for each numbered grid square and used for field navigation. An example of an individual map for the Bowling Green Bay project area is shown in Figure 4. Key maps for the Bowling Green Bay and Shoalwater and Corio bays project areas are included in appendices D and E respectively.

Figure 4. Individual Map 8395-3311 - Bowling Green Bay project area

Source: DEEDI

Structure identification: field assessment

Inventory data was collected in September 2009 (Bowling Green Bay), October 2009 (Shoalwater and Corio bays) and December 2009 and February 2010 (Corio Bay), using a TDS Nomad personal digital assistant (PDA) with an in-built GPS.

The PDA was uploaded with Arcpad (V.8), GIS data layers, project area maps and the FishBarriers VQ menu system, a modified version of the original menu system (FishBarriers V.4) developed by NSW DPI (2006).

The methods of data collection used in each project area are outlined in Table 1. Aerial surveys of each project area (Bowling Green Bay, Shoalwater Bay and Corio Bay) were conducted to enable identification of structures that were difficult to detect using aerial photographs or satellite imagery. The surveys also allowed the location of known structures to be confirmed and assisted with identifying access points for on-ground navigation and field assessments.

Data collection in Bowling Green Bay and Corio Bay included a combination of aerial, boat based and on-ground surveys, while structures in Shoalwater Bay were mapped via aerial survey, analysis of aerial and satellite imagery and consultation with local stakeholders. Wherever possible, field assessments were conducted at low tide to allow the greatest visibility of structures.

Using the FishBarriers VQ menu system data was collected on the following broad categories: general; spatial location; site details; non-barrier type; barrier type; barrier details; fish passage details; habitat; vegetation; threats (or impacts); location; and ownership.

A full list of data attributes and information regarding the application of the FishBarriers VQ menu system are contained in FHG 007 Fisheries guidelines for conducting an inventory of instream structures in coastal Queensland (Lawrence et al., 2009).

Table 1. Methods of data collection for each project area

Project area	Method of data collection
Bowling Green Bay	• Aerial survey – fixed wing aeroplane at approx. 1000 feet • Boat-based and on-ground surveys • Aerial photography – Bowling Green Bay & Townsville (2004) • Satellite Spot5 Imagery – Far North Queensland (2005) • Stakeholder working group consultation
Shoalwater Bay	• Aerial survey – fixed wing at approx. 1500 feet • Satellite Spot5 Imagery – Fitzroy Zone56 (2005) • Stakeholder working group consultation
Corio Bay	• Aerial survey – helicopter (Robinson R44) at approx. 300 feet • Boat-based and on-ground surveys • Stakeholder working group consultation

Part 2: Response protocol

Scoring of structures

To identify management priorities, structures were scored based on a number of 'habitat value' and 'fish-friendly' criteria, as per the original version of the guidelines (Lawrence et al., 2009). Individual structures were given a score for each criterion and these were added together to derive a total habitat value score and a total fish-friendly score for each structure. A high habitat value score indicates a structure located in an area of high habitat value, while a low score refers to a structure located in relatively poor quality habitat. The habitat value criteria for both non-barriers and barriers are listed in Table 2.

Table 2. Habitat value criteria and scoring system

Habitat value criterion	Description	Score
1. Habitat class	Inshore coastal waters/tidal inlet/main stream/lowland lagoon	10
	Major tributary of main stream direct to sea/small lowland lagoon	8
	Minor tributary of main stream/large low-order tributary direct to sea	4
	Minor, low order tributary	0
2. Extra fisheries value	Known special fisheries features	4
	No special fisheries features known to date	0
3. Habitat condition	Pristine, 100% natural forest	10
	Low disturbance, <25% of stream degraded	8
	Moderate disturbance, 25-50% of stream degraded	6
	High disturbance, 51-75% of stream degraded	4
	Very high disturbance, >75% of stream degraded	0
4. Relation to FHA*	If in declared FHA A	10
	If in declared FHA B	7
	Adjacent to or within tributary of an FHA	4
	None of the above	0

*Based on stakeholder discussions through the course of the project criterion 4 was removed.

Similarly, a high fish-friendly score refers to a structure that is fish-friendly and has a relatively low impact on fish habitat/fish passage, while a structure that is not fish-friendly with a relatively high level of impact on habitats/fish passage would result in a low fish-friendly score. The fish-friendly criteria for non-barriers are listed in Table 3 and those for barriers are listed in Table 4.

Table 3. Fish-friendly criteria and scoring system to prioritise non-barriers

Fish-friendly criterion	Description	Score
1. Structure type	Moorings—environmentally friendly	18
	Discharge/pipe—with scour protection/drain with no scouring of substrate	18
	Discharge/pipe—no/inadequate scour protection/drain with some scouring/erosion	16
	Bridge crossing (with instream pylons)	14
	Pile supported—adequate light penetration	14
	Pile supported—inadequate light; shading; inhibiting marine plant growth	12
	Moorings—traditional block system	10
	Stabilisation structures—rubble/rock; providing some fish habitat	8
	Rubbish/wreckage—fish/epibiota observed/likely habitat	6
	Rubbish/wreckage—no fish/epibiota observed/unlikely habitat	4
	Stabilisation structures—vertical/concrete face; unlikely habitat	3
	Fill, slab—no changes to sand and wave patterns observed	2
	Fill, slab—clear & observable changes to wave and sand patterns	0
2. Disturbance area	0-10 m^2	10
	11-50 m^2	8
	50-100 m^2	4
	>100 m^2	0

Table 4. Fish-friendly criteria and scoring system to prioritise barriers

Fish-friendly criterion	Description	Score
1. Barrier type	Not a barrier (e.g. bridge spanning waterway/few pylons/access road maintains flow)	20
	Bridge that may cause a barrier (e.g. by trapping debris; excessive # pylons)	18
	Culverts >60% waterway width or causeway/ford/levee <1.5 m high	10
	Culverts <60% waterway width or causeway/ford/levee 1.5-3 m high	5
	Tidal floodgate actively managed	5
	Causeway/ford/levee >3 m	2
	Tidal floodgate passively managed	2
	Tidal barrage	0

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Table 4. Continued

Fish-friendly criterion	Description	Score
2. Barrier impact	Barrier type a) Culvert crossings (score each criterion to get total of 0-6)	
(type a, b, c or d)	Culvert length <6 m	2
	Culverts length >6 m	0
	Individual culvert width >600 mm	2
	Individual culvert width <600 mm	0
	Culverts at bed level	2
	Culverts raised from bed	0
	Barrier type b) Causeways/fords	
	Headloss/invert <100 mm	6
	Headloss/invert >100 mm	0
	Barrier type c) Levee banks/bunds	
	Some tidal flow through	6
	No/minimal tidal flow through	0
	Barrier type d) Floodgates	
	Leaky; some fish passage likely	6
	Not leaky; fish passage unlikely	0

Individual habitat value criterion scores were added to obtain a habitat value score and similarly individual fish-friendly criterion scores were added to obtain an overall fish-friendly score. The ranges of habitat value and fish-friendly scores for barriers and non-barriers are shown in Table 5.

Table 5. The range of habitat value and fish-friendly scores for non-barriers and barriers

	Non-barriers	Barriers
Habitat value score (Criterion 1 + 2 + 3)	0-24	0-24
Fish-friendly score (Criterion 1 + 2)	0-28	0-26

Prioritisation matrix

Each structure was assigned a position in a prioritisation matrix based on the habitat value and fish-friendly scores (matrix concept presented in Figure 5). The matrix separated structures into four main quarters: less fish-friendly structures in high value habitat (quarter 1); less fish-friendly structures in low value habitat (quarter 2); more fish-friendly structures in low value habitat (quarter 3); and more fish-friendly structures in high value habitat (quarter 4).

Identification of structures in terms of their position within a specific matrix quarter allowed priorities to be developed for each project area.

Structures identified in quarter 1 were considered as being of highest priority for management response. These structures had relatively high impacts on fish habitats and were located in relatively high value habitat. Separate matrices were developed for each project area and for barriers and non-barriers.

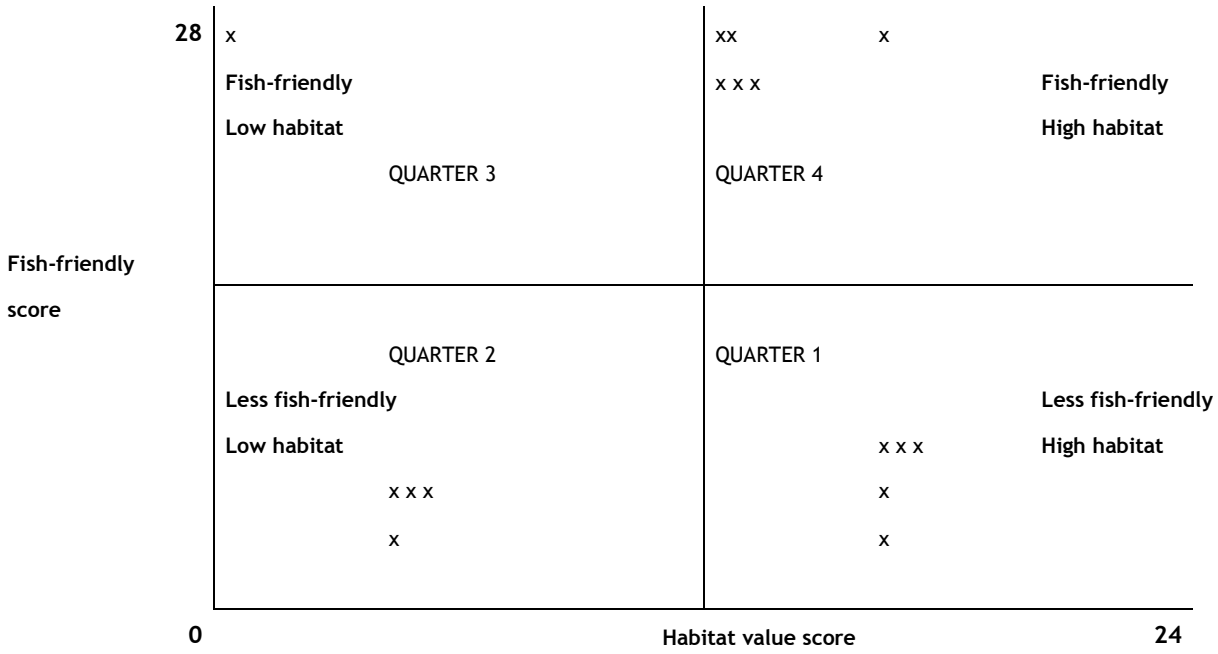

Figure 5. Prioritisation matrix concept diagram ('x' indicates an individual structure)

Response Action Plans (RAPs)

A Response Action Plan (RAP) that identifies priority structures and recommended management response actions was developed for each project area. The priority structures include all those non-barriers and barriers that were assessed to have relatively high impacts (less fish-friendly) to fish habitats and were also in ecologically high value areas (near pristine habitats) as described in the prioritisation matrix.

There are two types of management recommendations specific in the RAP:

- general recommendations that apply to structure categories
- specific recommendations that apply to individual structures.

The selected management responses vary depending on the type of structure and nature of impacts. Management responses are not restricted to but may include:

- further investigation or assessment of impacts
- developing strategic approaches to identified management issues
- decommissioning informal or unauthorised structures
- restricting access to informal or unauthorised structures
- raising awareness of ecological values
- removal of structures and rehabilitation of the site.

Local stakeholder consultation

Local stakeholder consultation and inventory training to transfer skills and knowledge took place via workshops with relevant stakeholders in each project area. A total of three workshops were held, in Townsville, Ayr and Rockhampton respectively. Workshop participants for the Bowling Green Bay project area (Townsville and Ayr) included representatives from NQDT, Townsville City Council (TCC), Burdekin Shire Council (BSC), DERM, Oceanwatch and Traditional Owners. The workshop for the Shoalwater and Corio bays project area (Rockhampton) included representatives from FBA, RRC, DERM, GBRMPA and the Department of Defence. The workshops included training in the inventory and response protocols, discussion of inventory results and development of draft RAPs including recommended response actions for priority 'problem' structures.

3 Project results & discussion

Results summaries for inventories in Bowling Green Bay and Corio Bay are outlined below. Given the location of Shoalwater Bay within the SWBTA, the results (and RAP) for the Shoalwater Bay project area is included within a supplement to this report. The supplement will have restricted circulation within state and federal Government agencies only to meet project reporting requirements and for wetlands management purposes.

The project identified a number of non-barrier and barrier structure types and these are displayed in Table 6. The name of each different structure type was abbreviated to a two-letter code, also included in Table 6.

Table 6. List of identified structure types (and abbreviated codes)

Non-barriers	Barriers
MO Moorings PI Pipe Pile supported structures: BW Boardwalks JE Jetties PX Pontoon fixed PF Pontoon floating WW Walkways VD Viewing decks Rubbish/wreckage: DM Dumped material DV Derelict vessels Stabilisation structures: RE Revetments GR Groynes Fill and slab: BR Boat ramps HO Houses/huts ON Other non-barriers WH Wharves	SX Stream crossings: Bridges Culverts Causeways LB Levee banks/bunds WD Weir/dam

Bowling Green Bay

Project area coverage

The map in Figure 6 shows the coverage of the Bowling Green Bay project area. The entire Ramsar site and declared FHA was inventoried, in addition to some adjacent areas.

Summary of structures identified

A total of 84 structures, including 41 barriers and 43 non-barriers, were identified in the Bowling Green Bay project area. A summary of the number of barrier and non-barrier structures located in the Bowling Green Bay project area is listed in Table 7. Of these, 18 structures were located within Ramsar boundaries, four structures within the Bowling Green Bay declared FHA and 14 structures were located within the Cleveland Bay declared FHA. Maps 1 and 2 of structure locations are in appendices F and G.

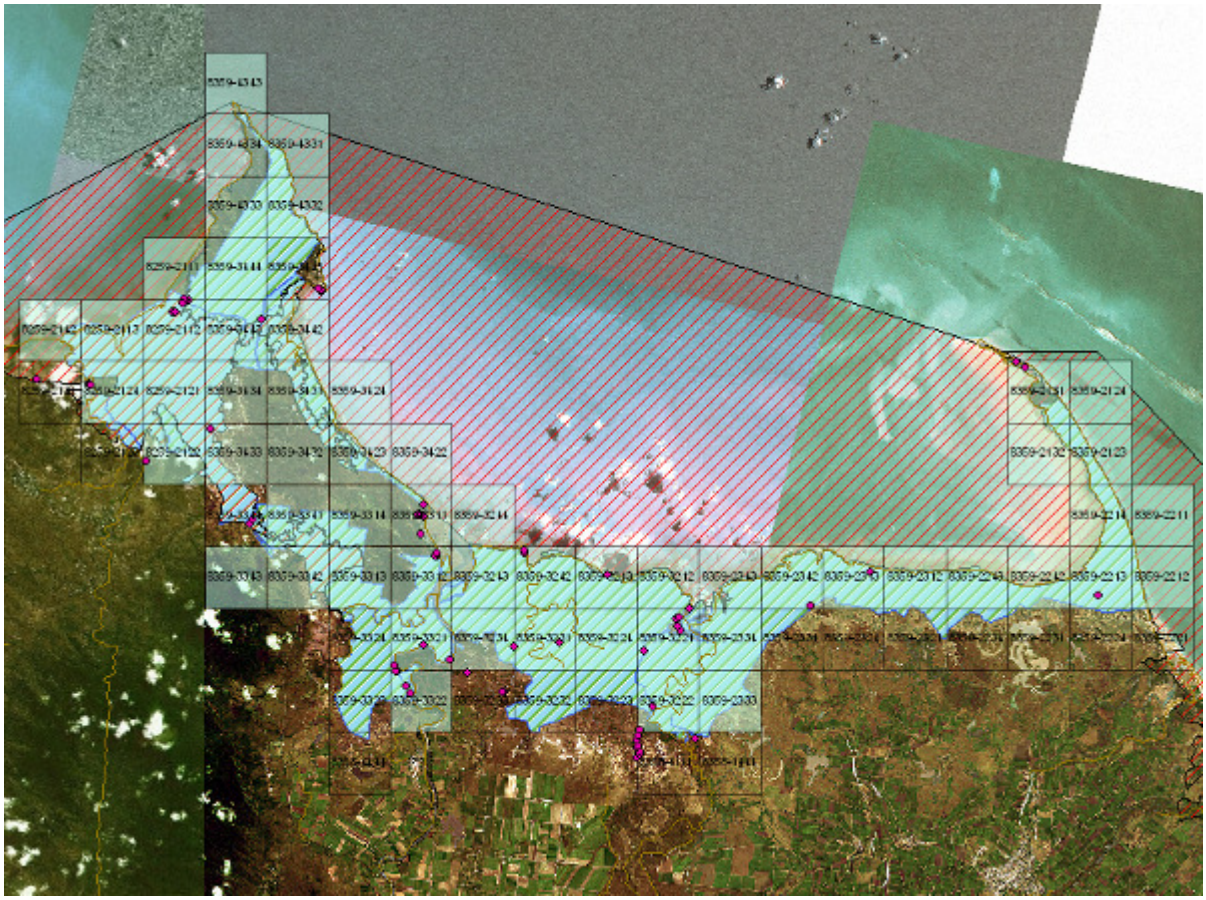

Figure 6. Inventory coverage of the Bowling Green Bay project area. Entire Ramsar site (in light blue hatching) inventoried, in addition to project area grid squares (in light blue). Locations of all structures, non-barriers and barriers, are shown in pink and declared FHA in red hatching. Entire or part grid squares not shaded were not inventoried.

Source: DEEDI

Prioritisation of structures

Out of the 84 total structures, 22 of these were not included within the prioritisation. These 22 structures consist mostly of earth bunds in addition to several culvert crossings that were assessed as part of the NQDT fish passage project (Carter et al., 2007).

The structures are located outside of Ramsar and FHA boundaries but lie within the project area grid. The remediation of these structures is being addressed by NQDT as part of the project Restoring Native Fish Passage funded by the Queensland Government.

Scoring of the remaining 62 structures against habitat value and fish-friendly criteria and application of the prioritisation matrix resulted in identification of 22 priority non-barriers and 13 priority barriers for the Bowling Green Bay project area. Appendices H and I contain the non-barrier and barrier prioritisation matrices respectively. Maps of the locations of priority structures are contained in appendices J and K. The RAP for Bowling Green Bay (Appendix L) includes prioritisation matrices and recommended response actions for priority structures.

Table 7. Total number of identified structures by type in the BGB project area. The total project area includes all structures surveyed; the numbers in the BGB Ramsar, declared FHA and the Cleveland Bay FHA are subsets. Those structures highlighted in bold font were identified as part of the NQDT fish passage assessment project for the Burdekin region (Carter at al., 2007).

	Structure type	Total project area	In BGB Ramsar	In BGB FHA	In CB FHA
BARRIERS	Weir/dam	**1**			1
	Bunds/Levees	**13**			
	Culvert crossings	21 (**4**)	3		3
	Causeways	4	2		2
	Weed chokes	**2**			
	Total barriers	**41**	**5**		**6**
NON-BARRIERS	Boat ramps	15	6	1	5
	Wharves	1		1	
	Revetments	5			
	Groyne	1			
	Pontoons	2	1		
	Walkways	4	2		1
	Jetties	1		1	
	Viewing decks	1			
	Pipe outlets	2	1		1
	Drain outlets	2			
	Dumped material	6	1		
	Houses / huts	2	1	1	
	Instream posts	1	1		1
	Total non-barriers	**43**	**13**	**4**	**8**
TOTAL STRUCTURES		**84**	**18**	**4**	**14**

Corio Bay

Project area coverage

Figure 7 shows the project area covered in relation to the mapping and prioritisation of structures in Corio Bay. The entire Ramsar site and declared FHA was inventoried, in addition to some adjacent areas.

Summary of structures identified

The project identified 57 instream structures including 19 barriers and 38 non-barriers in the Corio Bay project area. Of these, 14 of the non-barrier structures were within the Corio Bay Ramsar site however no barriers were identified within Ramsar boundaries. The Corio Bay declared FHA contained 24 non-barrier structures. A summary of the number of identified barrier and non-barriers, is listed in Table 8. Maps of Corio Bay structure locations are contained in appendices M and N.

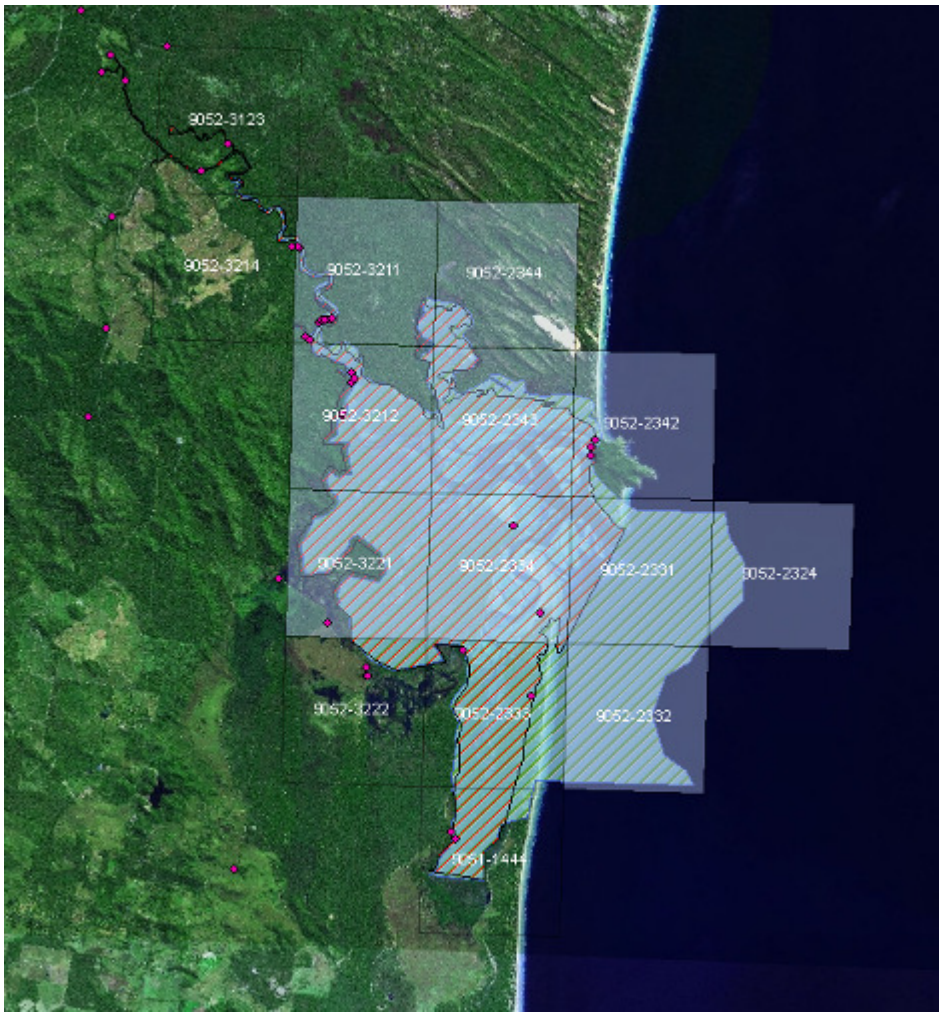

Figure 7. Inventory coverage of the Corio Bay project area. Entire Ramsar site (in light blue hatching) inventoried, in addition to project area grid squares (in light blue). Locations of all structures, non-barriers and barriers, are shown in pink and the declared FHA shown in red hatching. Entire or part grid squares not shaded were not inventoried.

Source: DEEDI

Table 8. Total number of identified structures by type in the Corio Bay project area. The total project area includes all structures surveyed; the numbers in the Corio Bay Ramsar portion and Corio Bay declared FHA are subsets.

	Structure type	Corio Bay project area	In Corio Bay FHA	Corio Bay Ramsar site
BARRIERS	Weirs	2		
	Bridges	1		
	Culvert crossings	10		
	Causeways	5	1	1
	Bund walls	1		
	Total barriers	**19**	**0**	**0**
NON-BARRIERS	Boat ramps	15	7	4
	Revetments	7	5	3
	Jetties	2	1	1
	Pontoons	2		
	Walkways	2	1	
	Dumped material	3	3	3
	Derelict vessel	1	1	1
	Moorings	4	4	
	Anchored houseboats	2	2	2
	Total non-barriers	**38**	**24**	**14**
TOTAL STRUCTURES		**57**	**24**	**14**

Prioritisation of structures

All structures in Corio Bay were scored against habitat value and fish-friendly criteria and the prioritisation matrix was applied. This resulted in identification of 18 priority non-barriers and one priority barriers in Corio Bay. Prioritisation matrices for non-barrier and barrier structures are contained in appendices O and P respectively. Maps in appendices Q and R indicate the locations of priority structures. The RAP for Corio Bay (Appendix S) includes prioritisation matrices and recommended response actions for priority structures.

Shoalwater Bay

Project area coverage

Figure 8 shows the project area grid for the Shoalwater Bay project area in relation to the mapping and prioritisation of non-barrier and barrier structures. The Ramsar site was inventoried via aerial surveys and consultation of satellite imagery and mapping.

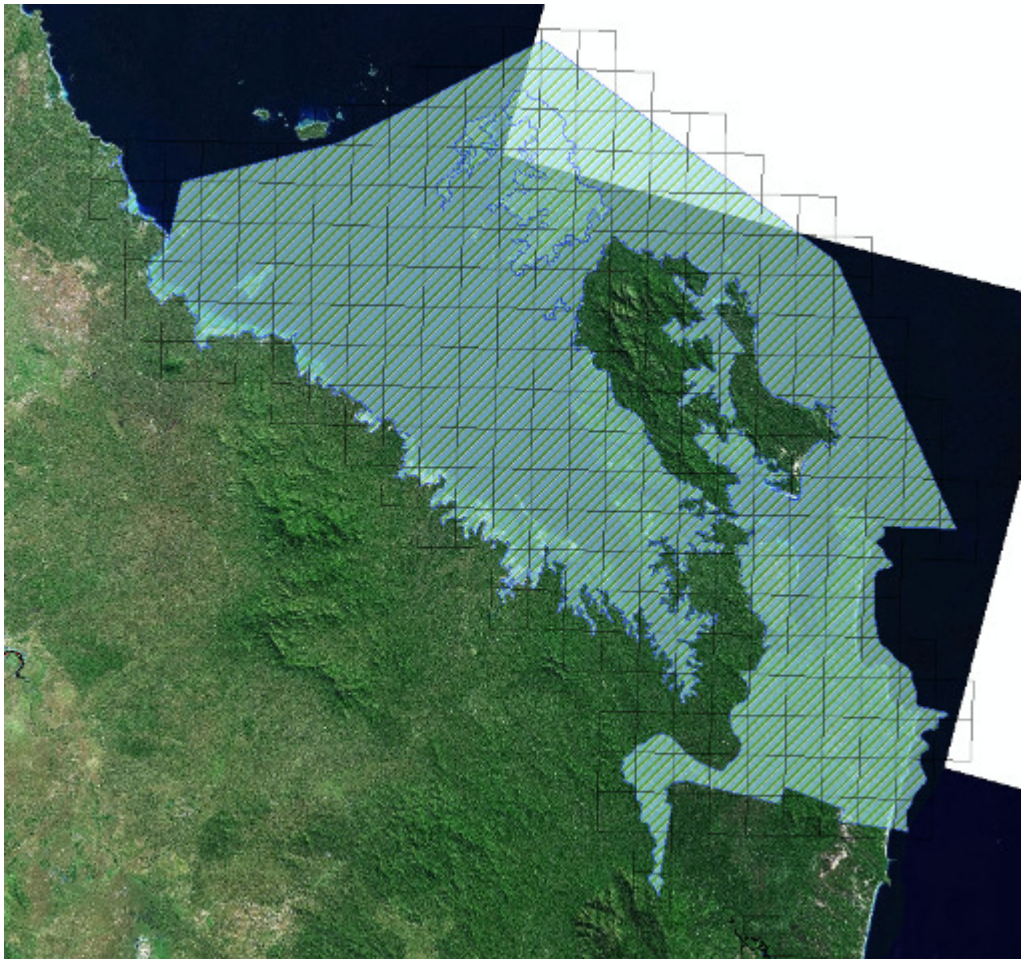

Figure 8. Inventory coverage of the Shoalwater portion of the Shoalwater and Corio bays project area. The Ramsar site inventoried is shown in light blue hatching.

Source: DEEDI

Summary of structures identified

The majority of structures in the Shoalwater Bay portion of the Ramsar site are related to boat launch and retrieval. A number of road networks that incorporate causeway crossings were identified within the southern section and adjacent to the eastern boundary of the Ramsar site. Crossing locations were not individually mapped as part of the project. Most infrastructure in the SWBTA is long standing (30 years plus) or of relatively minor impact with the exception of the underwater demolition area around Triangular Island (not surveyed as part of the project). Details of structures identified and the outcome of the prioritisation process are included in a supplement to this report.

4 Conclusions & future directions

A key output of the project was the development of the RAPs, that identify priority structures and management response actions with the aim of remediating the impacts of instream structures in the Shoalwater and Corio bays and Bowling Green Bay Ramsar sites and declared FHAs. The next step in this process is implementation of the RAPs. This requires an integrated and strategic approach. Fisheries Queensland recommends that working groups for each project area be established, with appropriate representation from local stakeholders. The role of the working groups will be to implement the response actions identified in the RAPs and facilitate a strategic approach to the management of unauthorised structures in the project areas.

The pilot and current project satisfy completion of years one and two of a five-year Fisheries Queensland program to inventory instream structures in selected declared FHAs areas in coastal Queensland. The inventory program is closely aligned with the initiative of the Fisheries Queensland declared Fish Habitat Area (FHA) Network Strategy (2009–14) to 'actively manage and respond to unlawful activities to prevent the degradation of individual declared FHAs and the declared FHA network'. Further inventory work is required to complete years three, four and five of this program.

Documenting the number and location of instream structures in the declared FHA network provides a measure of current development pressures in the area and temporal changes in these pressures since FHA declaration. This information can be used to assess the effectiveness of current FHA management arrangements and identify issues relating to the future declaration and management of FHAs, with a view to maintaining and enhancing the habitat values currently protected by the declared FHA network in supporting and sustaining Queensland's fisheries.

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Appendix A Project working group members

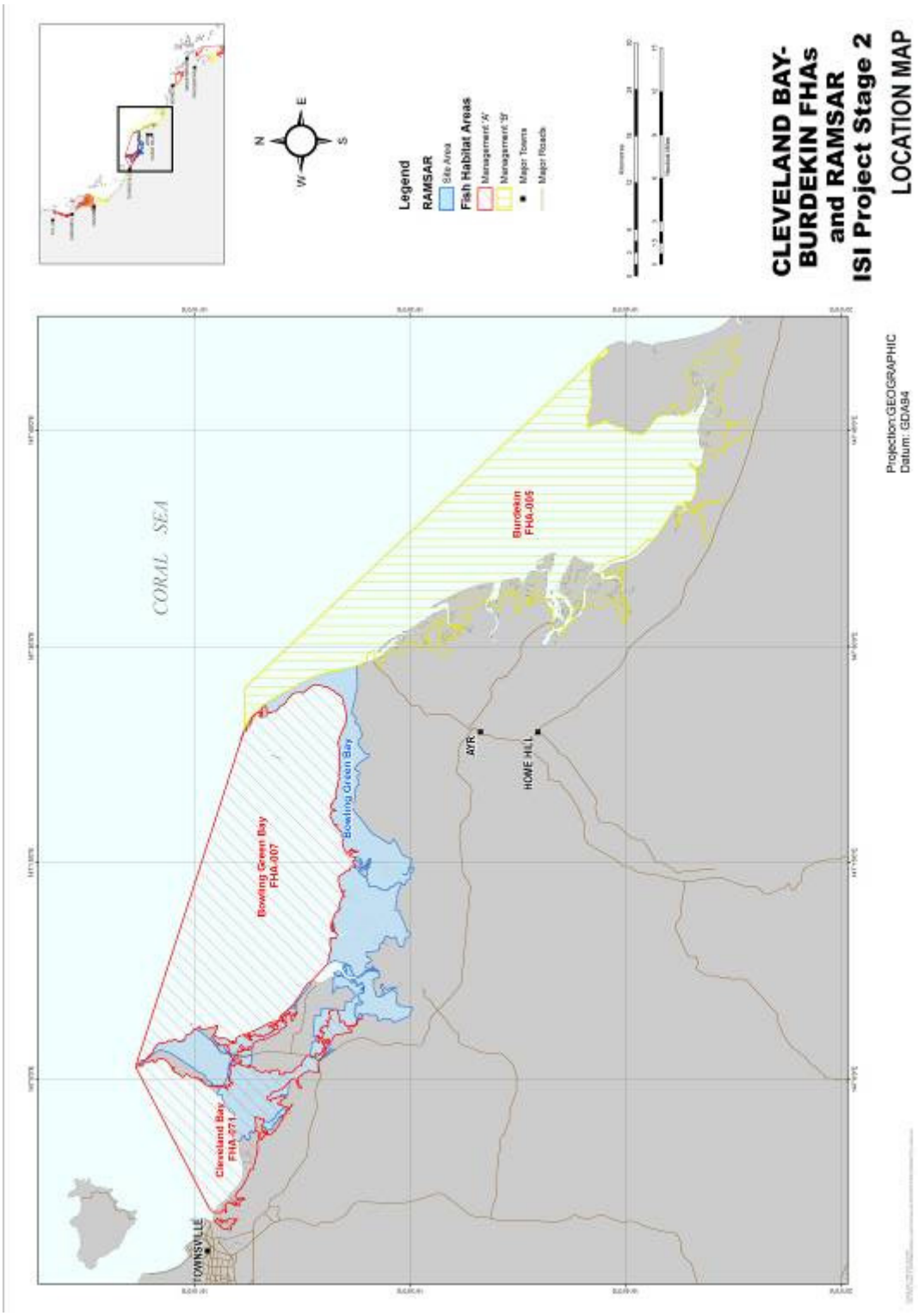
Bowling Green Bay

Name	Organisation
Diana O'Donnell	North Queensland Dry Tropics
Donna Audas	Great Barrier Reef Marine Park Authority
Col Adams	Department of Environment and Resource Management
Eddie Smallwood	Juru Traditional Owner Group; Gudjuda Reference Group
Cassie Price	WetlandCare Australia
Cameron Talbot	Fisheries Scientist, Planning & Assessment, Townsville, Fisheries Queensland
Mary Lawrence	Fisheries Scientist, Marine Fish Habitat, Fisheries Queensland

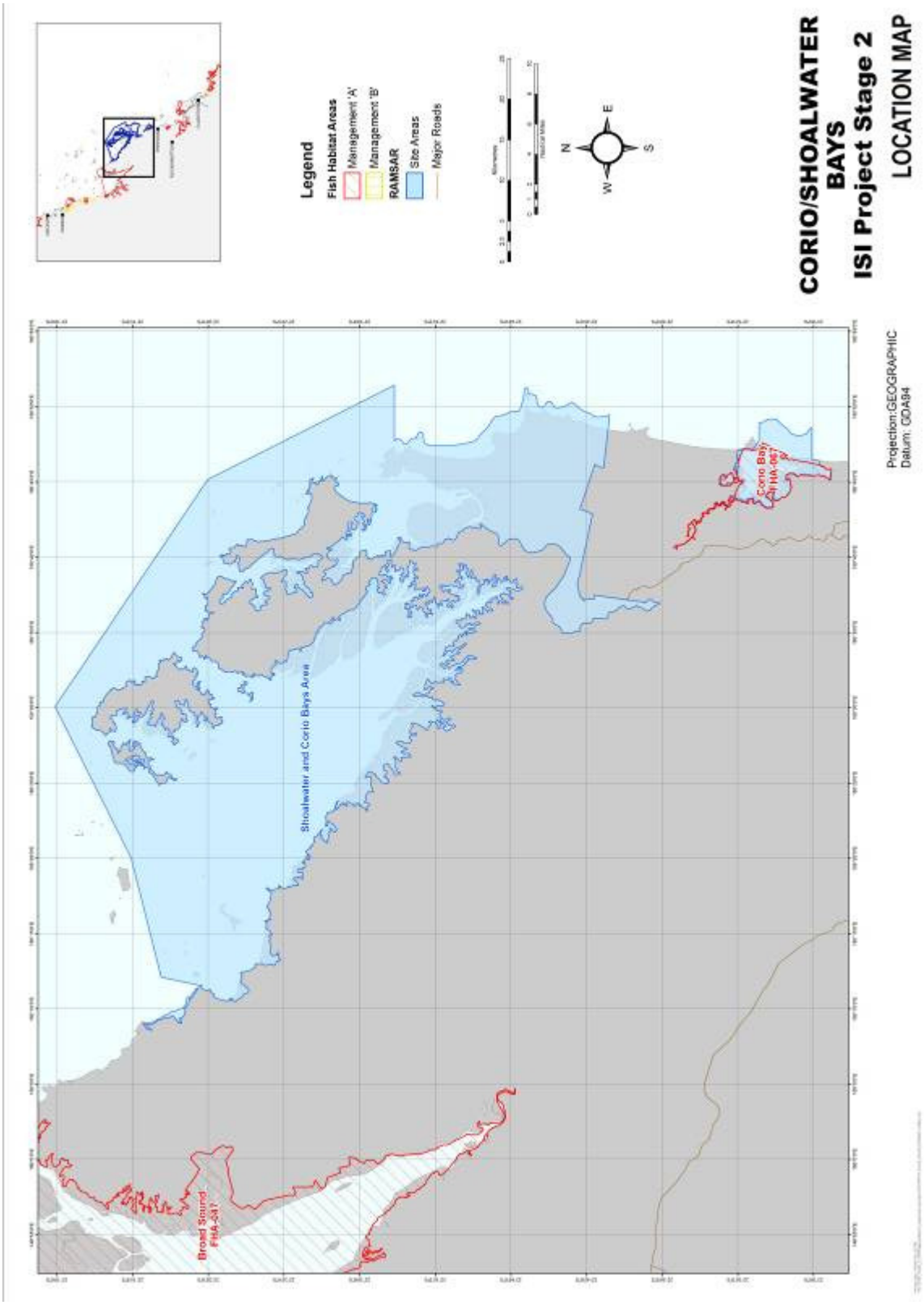
Shoalwater and Corio bays

Name	Organisation
Shannon Van Nunen	Fitzroy Basin Association
Cameron Mulville; Malcolm Mann	Department of Environment and Resource Management
Wendy Hoadley	Rockhampton Regional Council
John Platten	Department of Environment and Resource Management
Amanda Tennent	Queensland Boating and Fisheries Patrol, Fisheries Queensland
Shaun Pobar	District Fisheries Advisor, Rockhampton, Fisheries Queensland
Mary Lawrence	Fisheries Scientist, Marine Fish Habitat, Fisheries Queensland

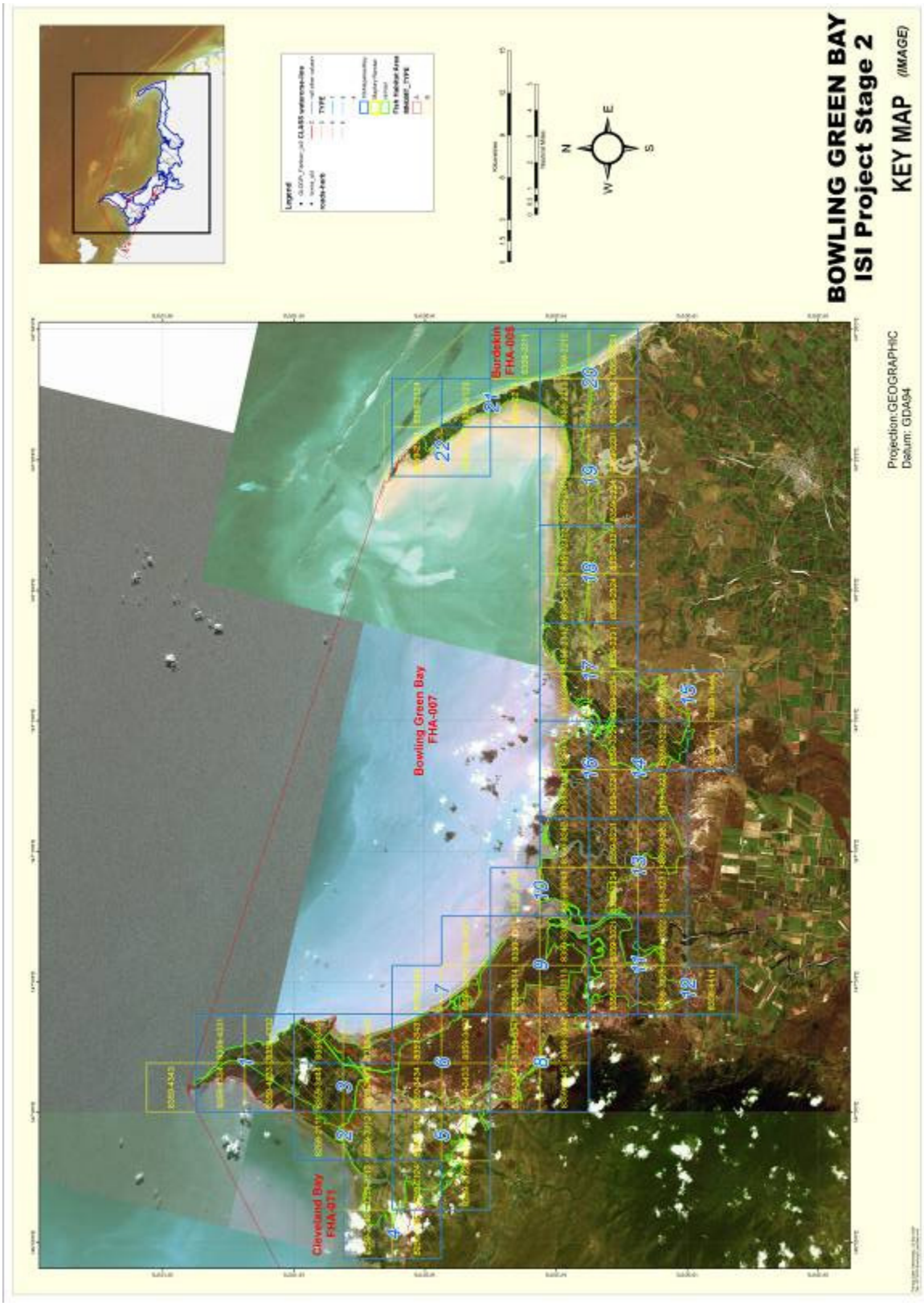
Appendix B BGB Ramsar and declared FHA location map



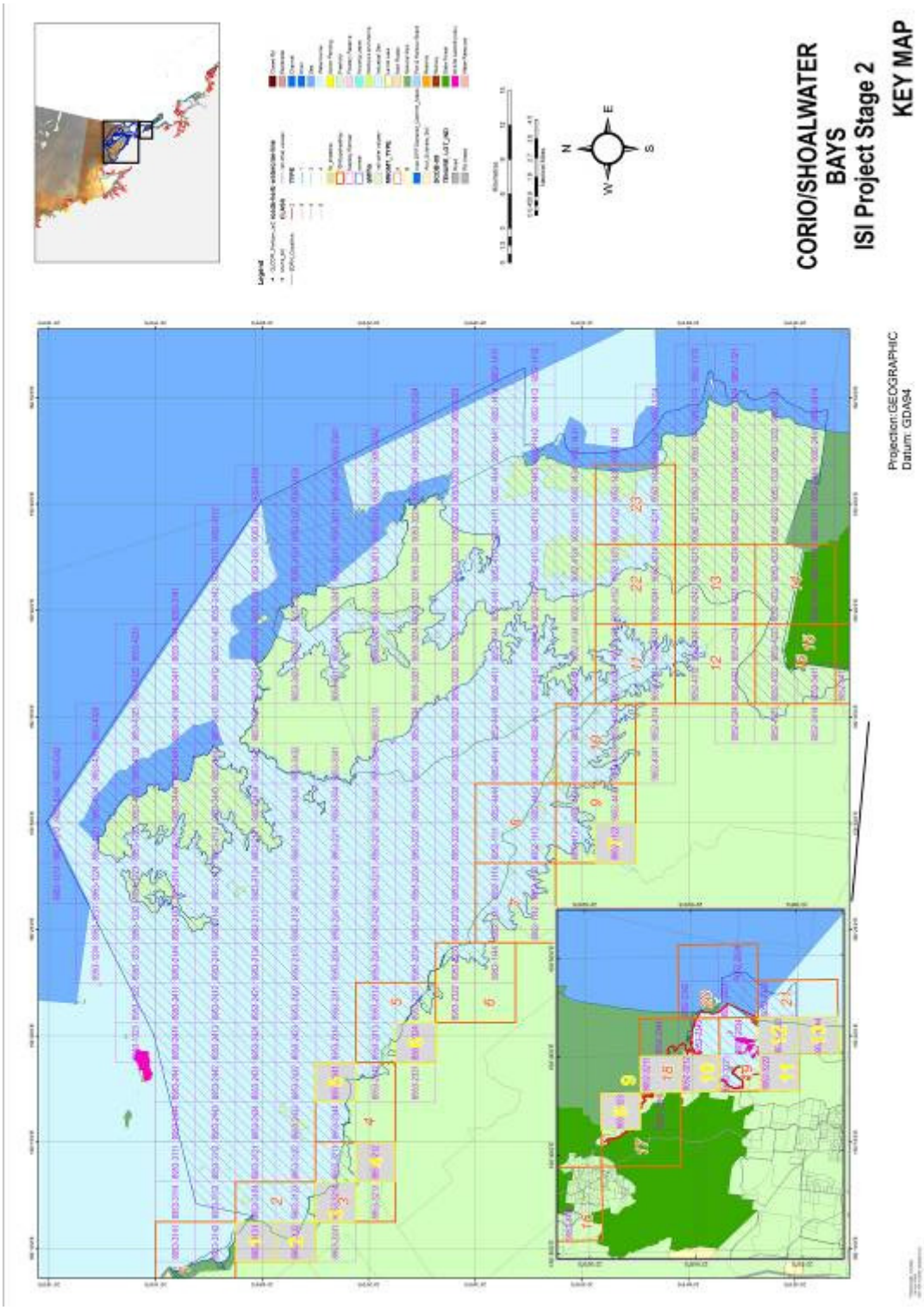
Appendix C Shoalwater and Corio bays Ramsar and declared FHA location map



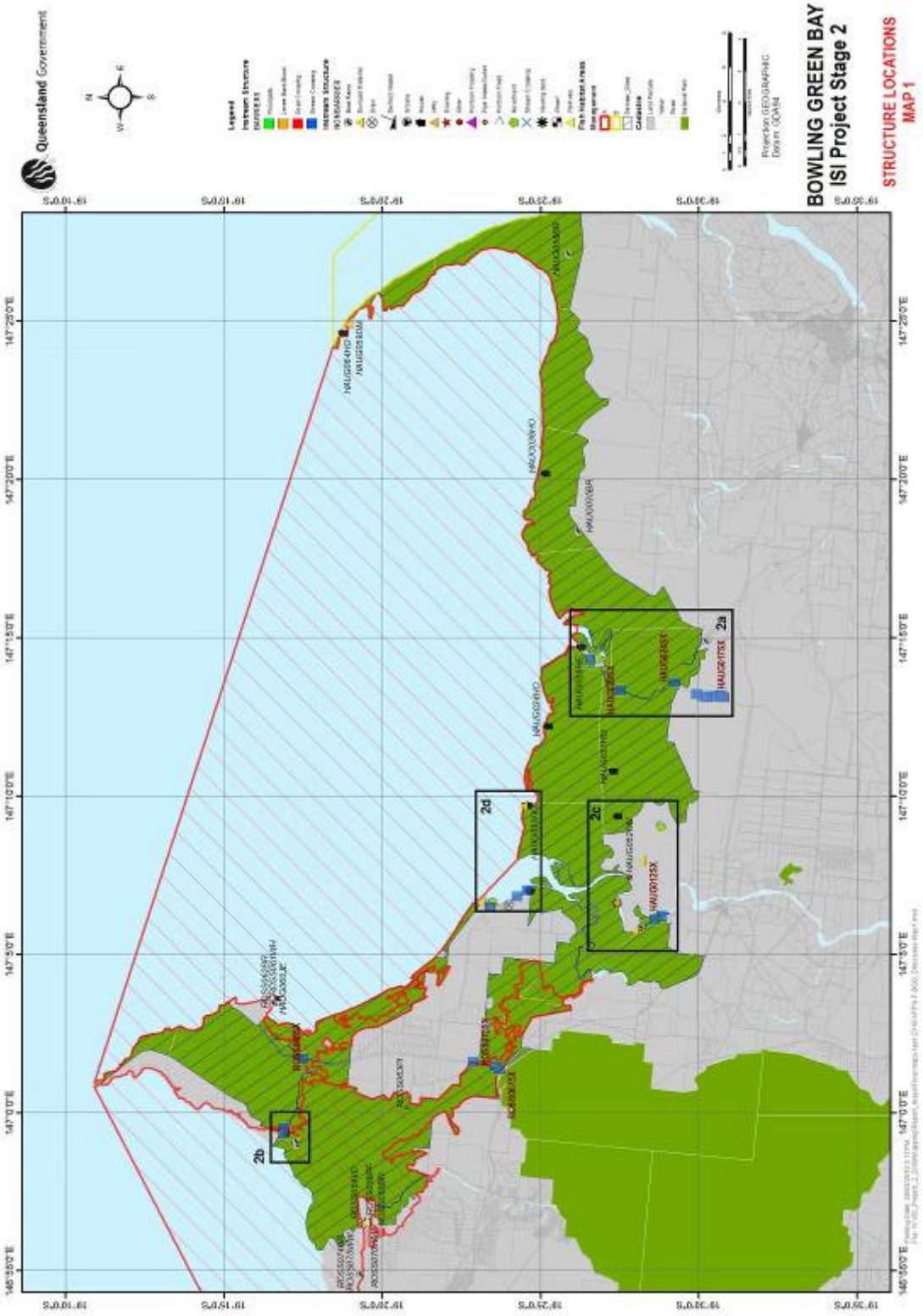
Appendix D Key map for Bowling Green Bay



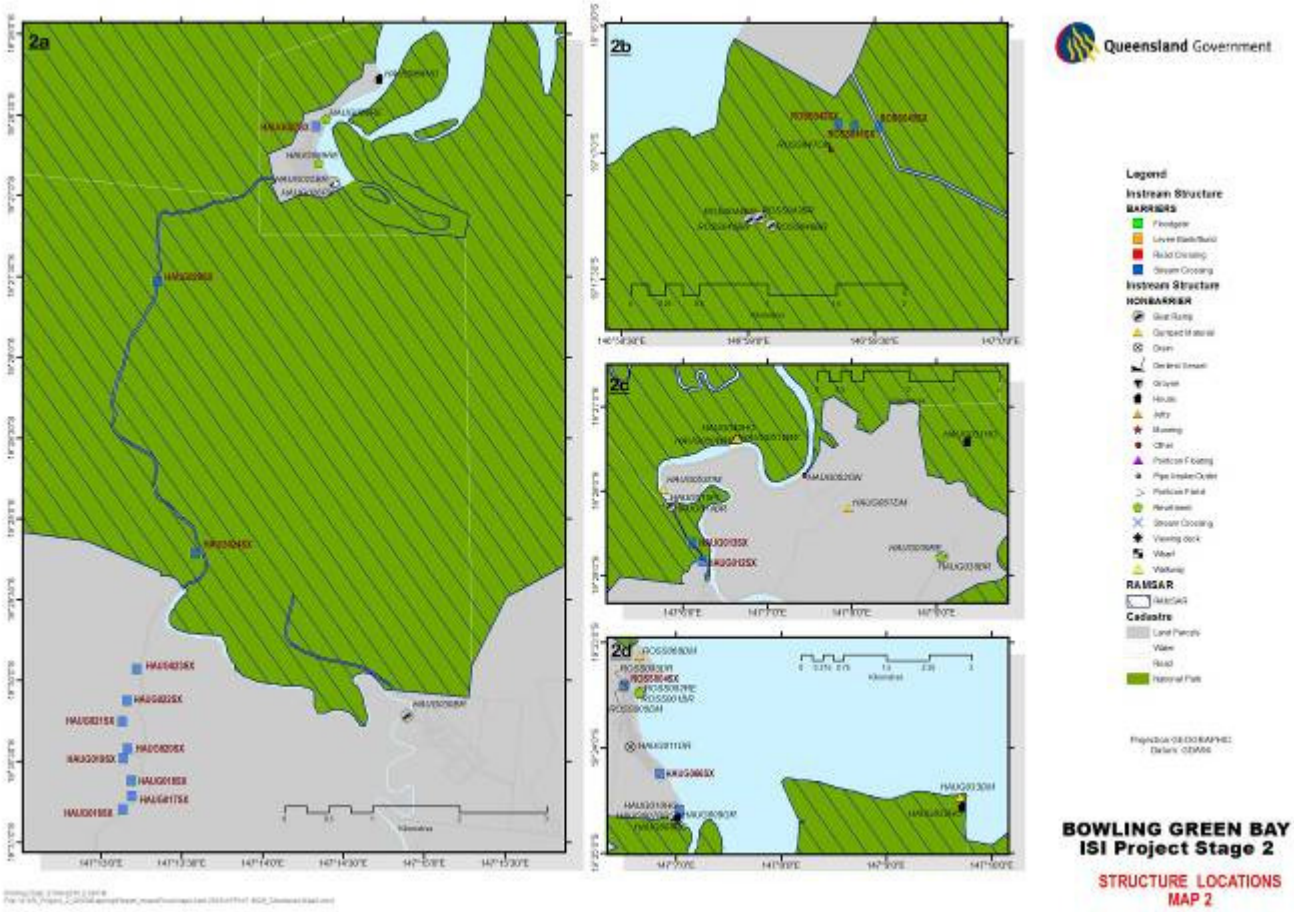
Appendix E Key map for Shoalwater and Corio bays



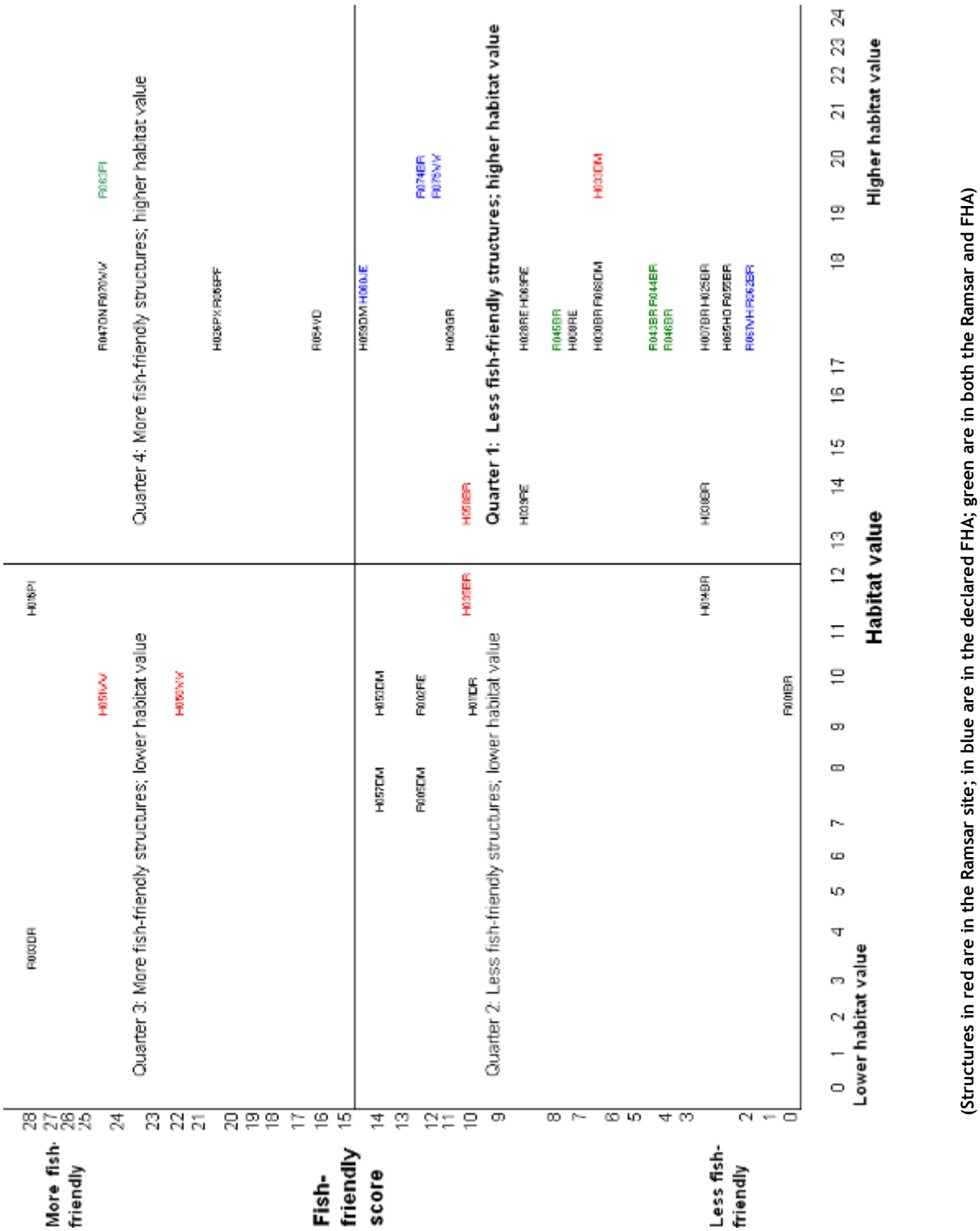
Appendix F BGB structure locations map 1



Appendix G BGB structure locations map 2

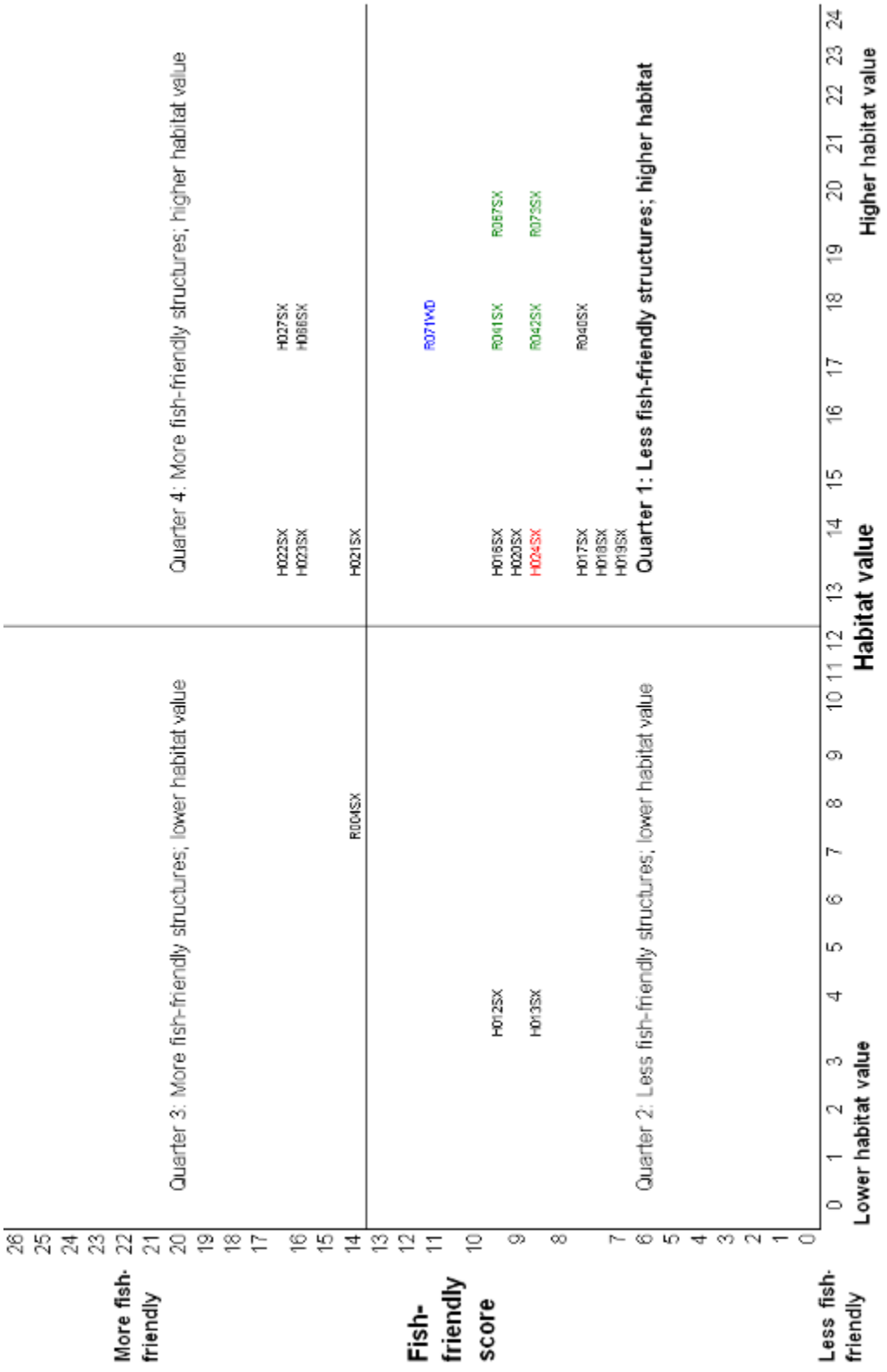


Appendix H BGB non-barrier prioritisation matrix



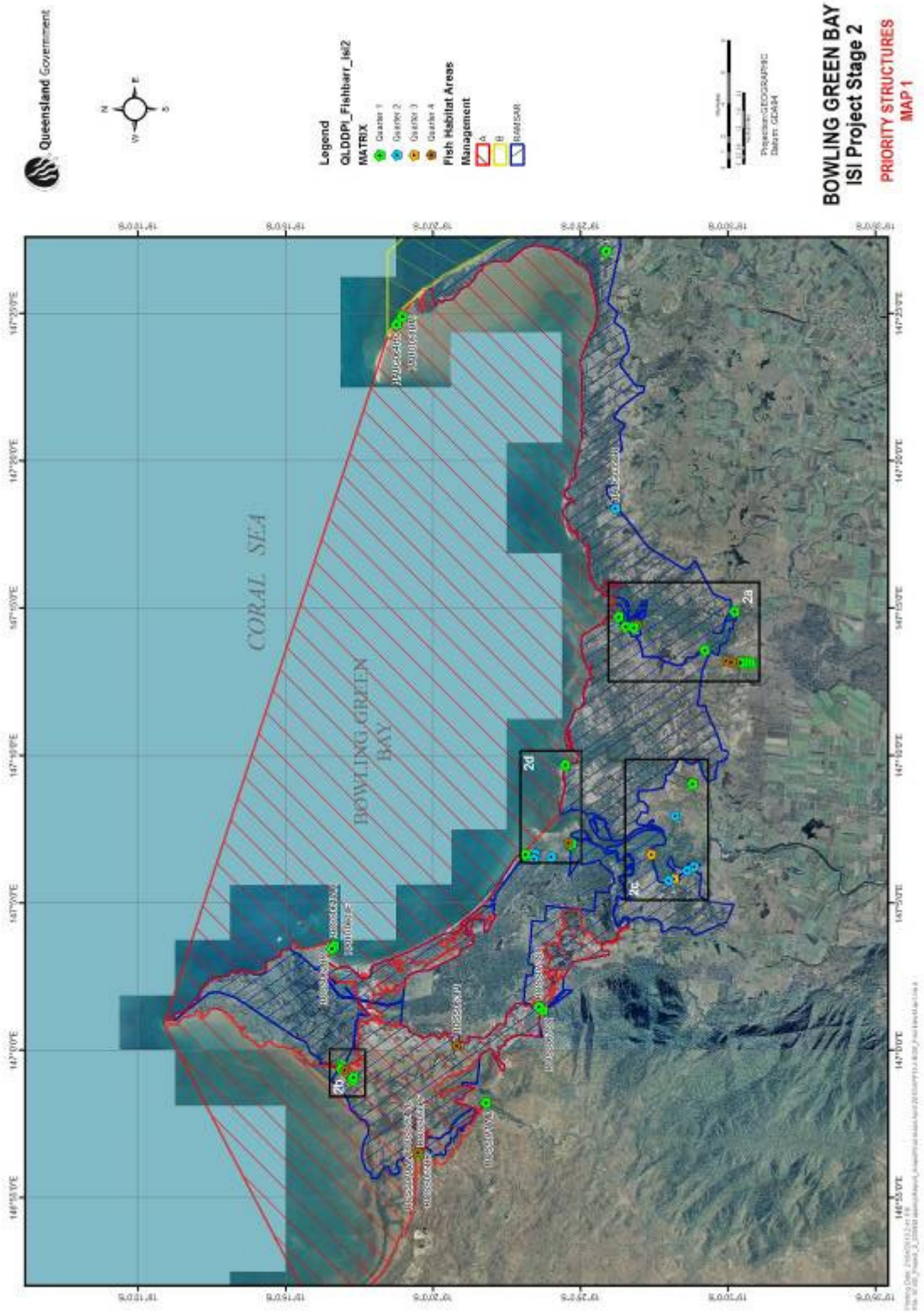
(Structures in red are in the Ramsar site; in blue are in the declared FHA; green are in both the Ramsar and FHA)

Appendix I BGB barrier prioritisation matrix

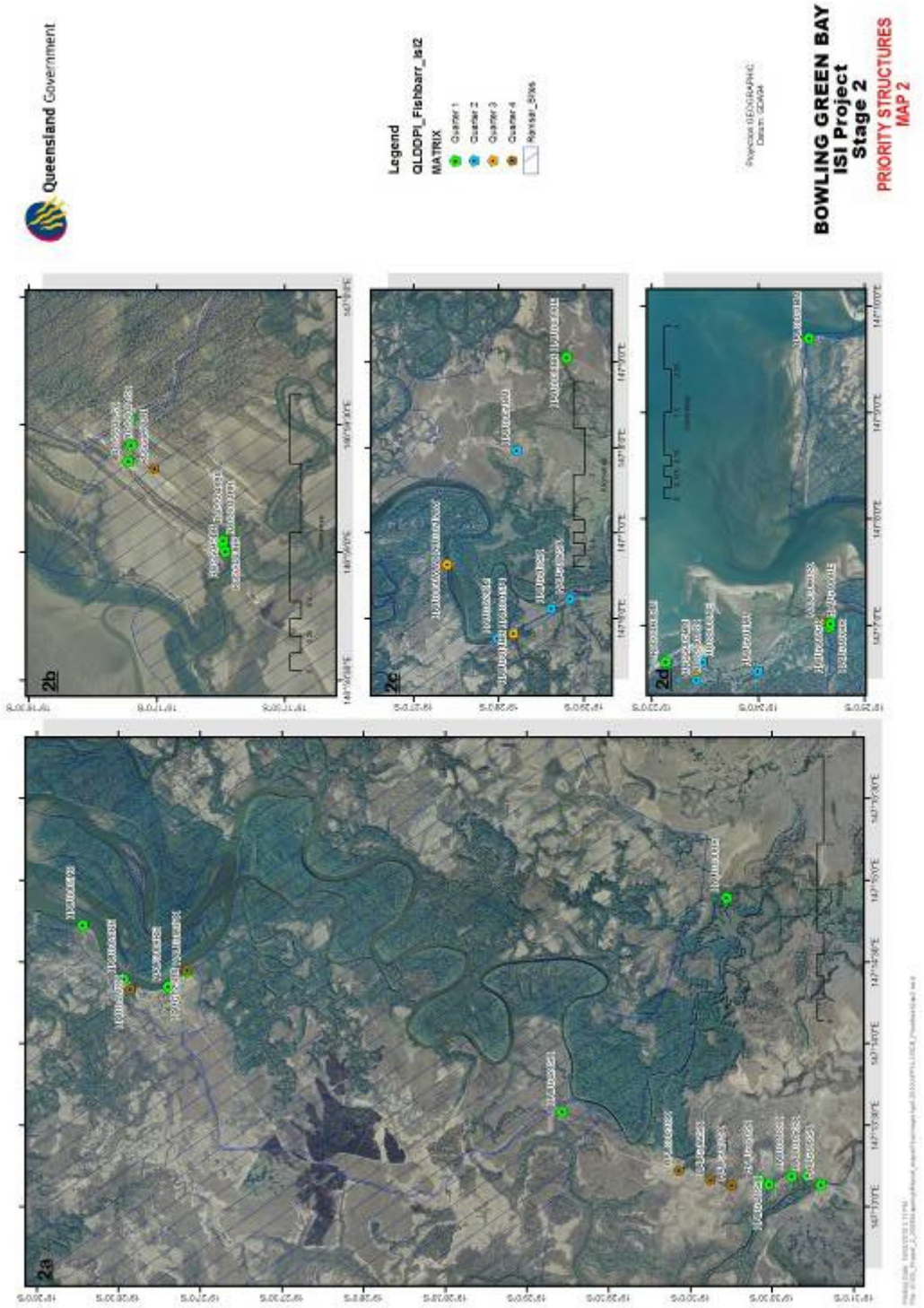


(Structures in red are in the Ramsar site; in blue are in the declared FHA; green are in both the Ramsar and FHA)

Appendix J BGB priority structure locations map 1



Appendix K BGB priority structure locations map 2



Appendix L Bowling Green Bay Response Action Plan

Response Action Plan for priority instream structures in Bowling Green Bay, identified during the project Inventory of Instream Structures Impacting on Ramsar Wetlands'

(July 2009–April 2010)

The project Inventory of Instream Structures Impacting on Ramsar Wetlands (herein the Ramsar inventory project) was managed and conducted by Fisheries Queensland, a service of DEEDI and funded by SEWPaC as part of the Queensland Wetlands Program. The aim of the Ramsar inventory project was to locate, identify, map and assess instream structures in each of the Bowling Green Bay and Shoalwater and Corio bays Ramsar sites, using inventory and response protocols developed in a pilot project undertaken by Fisheries Queensland in 2008–09 (Lawrence et al., 2009a; 2009b).

This Response Action Plan (RAP) identifies potential management actions to address the high priority structures (non-barriers and barriers) located and assessed as part of the Ramsar inventory project in Bowling Green Bay. A copy of the full project report (Lawrence et al., 2010) and Corio Bay RAP can be accessed via the Wetland*Info* website, <www.derm.qld.gov.au/wetlandinfo>. The Shoalwater Bay RAP is included in a supplement to the project report.

The priority structures include all those non-barriers and barriers that were assessed to have relatively high impacts (less fish-friendly) to fish habitats and were also in ecologically high value areas (near pristine habitats) as described in the prioritisation matrix which graphically displays priority structures in Quarter 1.

Priority non-barrier and barrier structures have been separated into different structure categories, given that some of the impacts and related management considerations for each category are similar.

There are two types of management recommendations specific in the RAP:

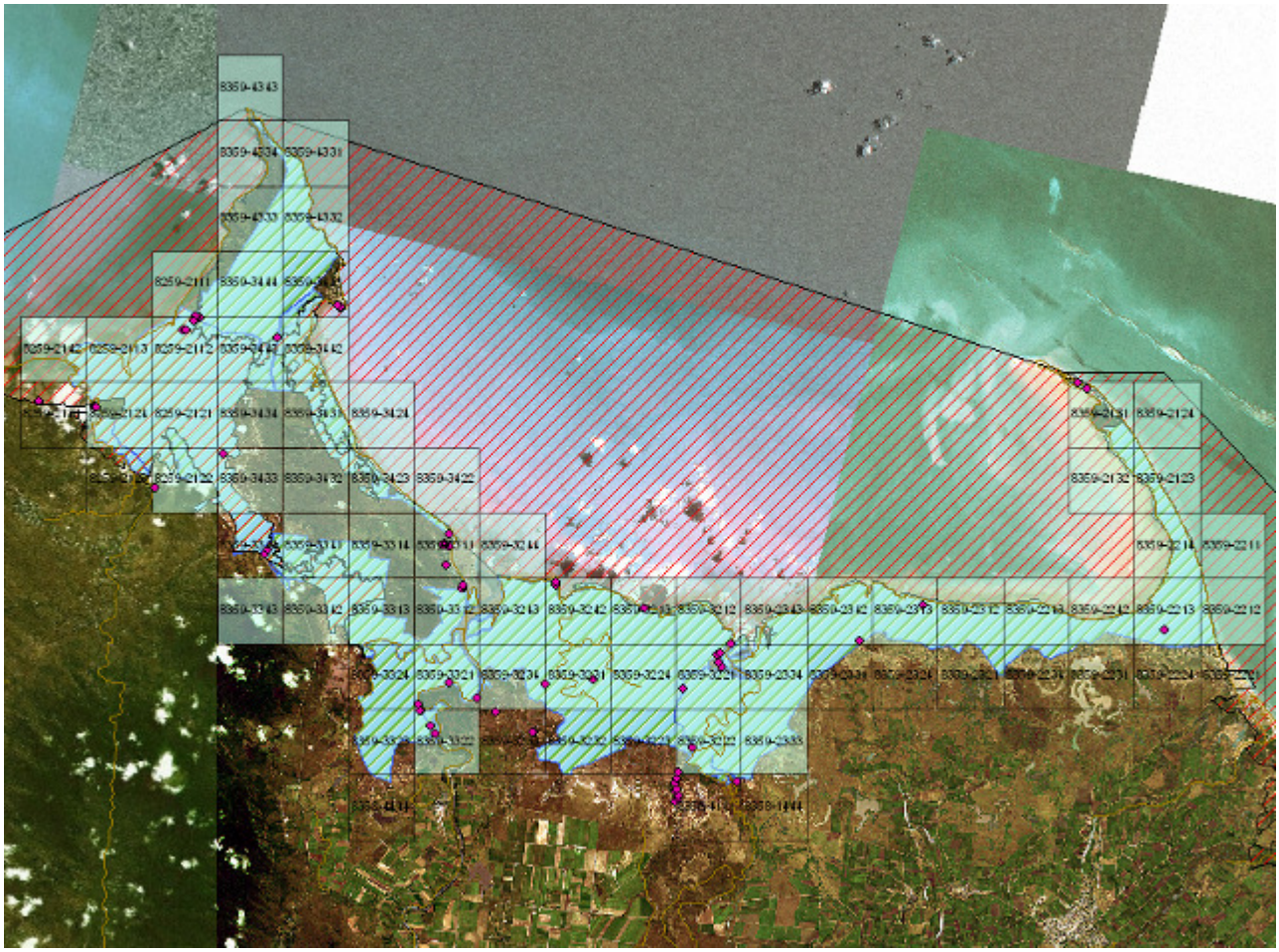
- general recommendations that apply to structure categories
- specific recommendations that apply to individual structures.

The selected management responses vary depending on the type of structure and nature of impacts. Management responses are not restricted to but may include:

- further investigation or assessment of impacts
- developing strategic approaches to identified management issues
- decommissioning informal or unauthorised structures
- restricting access to informal or unauthorised structures
- raising awareness of ecological values
- removal of structures and rehabilitation of the site.

Project area coverage

The map below (Figure 9) shows the project area covered in relation to the mapping and prioritisation of non-barrier and barrier structures in Bowling Green Bay.



BGB RAP Figure 9. Inventory coverage of the Bowling Green Bay project area. Entire Ramsar site (in light blue hatching), in addition to project area grid squares (in light blue). Locations of all structures, non-barriers and barriers, are shown in pink and declared FHA in red hatching. Entire or part grid squares not shaded were not inventoried.

Source: DEEDI

Priority non-barrier structures

The 22 priority non-barrier structures which were located, assessed and mapped are listed below (Table 1).

1) Fill/slab structures

A large proportion of the priority structures from Quarter 1 belong to the fill/slab category. Fill/slab structures are identified as high impact structures and for priority future management because these typically have relatively large footprints and result in a direct and permanent loss of fish habitats.

Boat ramps

Of the 22 priority structures from Quarter 1, 11 are boat ramps. The boat ramps have either been constructed through permanent stabilisation of the foreshore with concrete and other materials or by removal of foreshore vegetation (protected marine plants) to provide unauthorised (informal) 'mud slide' launching sites. With the placement of these 'hard' structures on river banks, local current, wave and drift regimes are altered, resulting in scouring, erosion and accretion either downstream and/or upstream of the structures. Similar impacts occur adjacent to unauthorised mud-slide vessel launching sites.

BGB RAP Table 1. Priority structures, separated into different structure categories, from Quarter 1 of the prioritisation matrix. Less fish-friendly structures in higher value habitats (black—structure location outside the Ramsar/FHA; red—structure location within the Ramsar site; blue—location within FHA; and green—structure location within both FHA and Ramsar)

Structure category	Structure ID	Location
Fill, slab	ROSS043BR	Mud boat launch, Cocoa Ck
	ROSS044BR	Mud boat launch, Cocoa Ck
	ROSS045BR	Mud boat launch, Cocoa Ck
	ROSS046BR	Mud boat launch, Cocoa Ck
	HAUG058BR	Mud boat launch, Groper Ck
	HAUG038BR	Boat ramp, Morrissey's Ck
	HAUG030BR	Boat ramp, Barratta Ck
	HAUG007BR	Boat ramp, Doughboy Ck (near Cungulla)
	ROSS055BR	Boat ramp, Alligator Ck (Cleveland Palms)
	HAUG025BR	Boat ramp, Barratta Ck (Jerona)
	ROSS062BR	Boat ramp, Chunda Bay (AIMS)
	ROSS061WH	Wharf, Chunda Bay (AIMS)
Huts/Houses	HAUG065HO	Hut, Barratta Ck (Jerona)
Stabilisation	HAUG008RE	Revetment, Doughboy Ck
	HAUG069RE	Revetment, Barratta Ck (Jerona)
	HAUG028RE	Revetment, Barratta Ck (Squatters huts, Jerona)
	HAUG009GR	Groyne, Doughboy Ck
	HAUG039RE	Revetment, boat ramp, Morrissey's Ck
Rubbish/dumped material	ROSS068DM	Dumped material, Haughton R (Cungulla foreshore)
	HAUG059DM	Old water tank, Cape Bowling Green
	HAUG033DM	Remains/dumped material, Barramundi Ck
Pile supported	ROSS060JE	Jetty, Chunda Bay (AIMS)

Significant fish habitat impacts from vehicle access roads and parking areas are associated with boat launching and retrieval. At ramps where facilities are informal, unauthorised and/or inadequate, marine plant disturbance is often the result. Being located either within or adjacent to the Bowling Green Bay Ramsar site, declared FHA and National Park (NP), impacts associated with both formal and informal boat ramps and facilities in the Bowling Green Bay region may threaten the values and functions of these protected areas.

General recommendations:

1. **Adopt a strategic approach, including adequate erosion control management, to the provision of public boat ramps and to manage the usage of and access to these ramps and their associated parking facilities in the Bowling Green Bay region. All ancillary facilities (e.g. parking for vehicles and trailers) to be located on non-tidal land to minimise fish habitat impacts.**
2. **Decommission informal or obsolete boat ramps ('mud slides'), rehabilitate the sites, and prevent further access.**

3. **Raise awareness of the area's Ramsar, National Park and fish habitat values and promote behaviour that ensures these values are maintained by investigating opportunities for joint signage at public boat ramp sites.**

Table 2 below.

BGB RAP Table 2. Recommended response actions for individual management of individual priority boat ramp structures

Structure	Location	Response Actions / Recommendations
Mud-slide boat launching sites (ROSS043BR, ROSS044BR, ROSS045BR, ROSS046BR)	Cocoa Creek	Four 'mud-slide' boat launching sites are located within a 170 m section of the northern bank of Cocoa Creek, located in the Cleveland Bay FHA, BGB Ramsar site and National Park. Situated on an erosive river bend and likely to have first formed via natural erosion processes, the mud-slides are now well established launching sites used by the public to access Alligator and Crocodile Creeks. Wooden 'runs' have been placed on one of the ramps to provide traction (ROSS043BR). Increased use and bogging of vehicles are accelerating erosion of the creek bank and causing disturbance of adjacent saltmarsh and terrestrial vegetation through associated vehicle access, parking and camping activities. Continued similar use will result in further bank erosion at the site and sedimentation of the creek, resulting in reduction of habitat values of the FHA, Ramsar and NP. The issues highlighted above for Cocoa Creek are typical of a bigger access issue in the wider BGB region. Though not assessed as part of this project, it is noted that there appears to be a similar problem with public access across tidal habitats to informal boat launching areas along sections of Alligator Creek to (map ref. 8259-2123). **Recommendation a):** • **Work towards establishing a public boat ramp and associated facilities in the area** • **Mud-slide launching sites be decommissioned, public access prevented and sites rehabilitated** • **Spatial layer showing locations of mud vs concrete / formal boat ramp locations in the project area will support discussions relating to management of public boat ramps in Cocoa Creek and the wider BGB region.** **See general recommendations 1, 2 and 3.**
Mud slide boat launching site HAUG058BR	Groper Creek	This mud-slide launch is on Groper Creek, near Fish and Deep Creeks just to the south of the sand spit of Cape Bowling Green. The site is within the BGB Ramsar site and National Park. Several small boats (five at the time of aerial survey) appear to be permanently located on the bank of the creek near the mud launch site. The main fish habitat impacts are associated with access to the launching site. Numerous access tracks have been forged by off-road vehicles across vast areas of saltmarsh to the south-east of the launching site and west of Alva beach. Some of these tracks, spanning across a total area of ~7-8 hectares, lead to the Groper Creek launching site. Beach access to Cape Bowling Green via the north of Alva across the saltmarsh / lagoon area has recently been formalised (NQDT, 2009). Burdekin Shire Council has constructed a formalised dirt access track (approx. 2 km long) and designated access point over the dunes to access Lynch's Beach. Fencing is also being constructed along the boundary of the road to prevent vehicle access to dunes and saltmarsh to the west (NQDT, 2009). **Recommendation b):** • **The launching site be decommissioned, public access prevented and sites rehabilitated** • **Appropriate maintenance of BSC access track and fencing and continued regulation of access to saltpan areas to allow saltmarsh to naturally recolonise the area.** **See general recommendation 1 and 2.**

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BGB RAP Table 2. Continued

Structure	Location	Response Actions / Recommendations
Morrissey's boat ramp (public ramp) HAUG038BR	Morrissey's Creek (DTMR/ Council)	This is a well-used public ramp that provides reliable all-tide access to BGB. The ramp is located on Morrissey's Creek. While this creek is outside of the BGB Ramsar and declared FHA boundaries, it flows into Combe Creek and later, Barramundi Creek, both of which are located included in the BGB Ramsar site. Either side of the ramp is revetted with a combination of cemented and loose rock, with small mangrove seedlings growing up through the loose rock portion of the revetment. **Recommendation c):** **See general recommendations 1 and 3.**
Public ramp HAUG030BR	Barratta Creek	Previously used by the public to access Barratta Creek, this boat ramp is currently closed. Use of the ramp declined following the upgrade of the road to Jerona and subsequently the increased use of the superior public boat ramp facilities at Jerona. The ramp is located just upstream of the Ramsar site. Sediment on the ramp's concrete surface, either placed to prevent public use of the ramp or accumulated due to lack of use, has enabled terrestrial weeds to colonise within the ramp's footprint. This has resulted in ongoing loss of fish habitat at the site and the replacement of the previous natural mangrove habitat with weed species. **Recommendation d):** • **Weeds, sediment and concrete from this already disused ramp be removed and the bank graded to allow natural recolonisation of mangroves** • **Restrict access to the ramp site until vegetation is well established.** **See general recommendation 2.**
Public ramp HAUG007BR	Doughboy Creek near Cungulla	This public boat ramp is at the mouth of Doughboy Creek. Doughboy Creek enters the Haughton River near its mouth, approximately 2.5 km upstream from the main ramp at Cungulla. The ramp provides alternate access to the bay at low tide when the main ramp at the Cungulla township is inaccessible. The bottom of the ramp is starting to break up, which could affect useability at low tide. There is an area of firm sand just downstream of the ramp that may be used as a beach launch. The main fish habitat impacts arising from use of this ramp are related to access, which is obtained via a dirt track off Empress Close. The track traverses tidal land in parts and has caused loss and fragmentation of marine plant communities. A 400 mm concrete pipe and cracker dust had recently been placed at the entry of the access track to provide for vehicle access to the Doughboy Ck ramp. The entry area is at the upper limits of a tidal swale that runs behind the frontal dune and links up with the road side drain from Empress Close. The placement of the pipe appeared to restrict traffic from several informal tracks to a single access track. Recruitment of grey samphire was evident across the redundant tracks. More recently, additional pipes have been placed and this small crossing has been built into a substantial causeway. Fish movement impacts are not obvious however given the absence of scour protection, it is possible that the causeway may erode during medium to large flood events, resulting in increased downstream turbidity. **Recommendation e):** • **Support council in any follow-up actions in relation to the unauthorised crossing.** **See general recommendations 1 and 3.**

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BGB RAP Table 2. Continued

Structure	Location	Response Actions / Recommendations
'Phantom retreat' private ramp ROSS055BR	Alligator Creek at Cleveland Palms development	This concrete boat ramp is part of the gated Cleveland Palms residential development. A viewing deck/fishing platform is located approx. 30 m downstream of the ramp, and a pontoon for the loading and unloading of vessels is located approx. 40 m upstream. Access to and use of these structures is restricted to Cleveland Palms residents. Mangroves are well established on both sides of the ramp and no ongoing impacts are apparent. The ramp provides the only formal access in this area to Alligator Creek and Cleveland Bay. Though not surveyed as part of the inventory process, several mud-slide launching sites on other waterways in this area (e.g. on a creek that branches off Alligator Creek and also on the creek system to the west of Alligator Creek) are evident from aerial photography and mapping. **Recommendation f):** **See general recommendations 1, 2 and 3.**
Barratta boat ramp (public ramp) HAUG025BR	Barratta Creek at Jerona (Burdekin Shire Council & community)	This concrete ramp is located at the township of Jerona and is a main public boat ramp for access to Barratta Creek and BGB. Located in an area adjacent to the BGB Ramsar site and National Park, the ramp incorporates a floating pontoon and is managed by Burdekin Shire Council. There is a large rock revetment (HAUG069RE – see below) extending from the downstream side of the ramp and spanning the length of the foreshore (~600 m) adjacent to the community at Jerona. The car and trailer parking area is bordered by saltmarsh to the south and there appears to be some vehicle disturbance of this area based on aerial photos. Further investigation of this area is required to quantify any marine plant disturbance. **Recommendation g):** • **Investigate potential marine plant disturbance to the south of the ramp.** **See general recommendations 1 and 3.**
AIMS boat ramp ROSS062BR	Australian Institute of Marine Science (AIMS), Chunda Bay	This structure has been identified as a high priority for management consideration due to its relatively large footprint which has caused a direct and permanent loss of fish habitat within that footprint. The ramp is located within the BGB FHA and adjacent to the BGB Ramsar site and National Park. This is a legitimate structure utilised for AIMS research purposes and no ongoing fish habitat impacts are apparent. **Recommendation h):** • **Provide project findings to AIMS for their information.** **The boat ramp be maintained appropriately to avoid further impacts.**

Wharves

Wharves, used for the landing of ships for loading and unloading purposes, are generally constructed via placement of a concrete slab directly onto the substrate or consist of decking supported by pylons. Placement of these structures in shallow subtidal areas within estuaries and embayments can result in disturbance and/or loss of protected marine plants (i.e. seagrass). With the placement of these 'hard' structures on foreshores local current, wave and drift regimes are altered, resulting in scouring, erosion and accretion around structures.

BGB RAP Table 3. Recommended response actions for management of priority wharf structures

Structure	Location	Response action / Recommendation
AIMS wharf ROSS061WH	Australian Institute of Marine Science (AIMS), Chunda Bay	This structure has been identified as a high priority for management consideration due to its relatively large footprint which has caused a direct and permanent loss of fish habitat within that footprint. The wharf is located within the BGB FHA and adjacent to the Bowling Green Bay Ramsar site and National Park. This is a legitimate structure utilised for AIMS research purposes. While the wharf consists of a concrete slab bordered by rock batters, resulting in a higher impact on fish habitat relative to a piled structure, the rock batters would provide some level of habitat for fish. **Recommendation i):** • **Provide project findings to AIMS for their information.** **Structure be maintained appropriately to avoid further impacts.**

Huts

Illegal housing (or permanent 'squatting') on and adjacent to tidal habitats is an activity that isolates fish habitats and prevents public access to and through tidal waters. Associated negative impacts on fish habitats from incidental disturbance occur as a result of accessing housing.

Access to the waterway is either through the construction of instream structures (authorised and unauthorised) or is obtained in the absence of any formal structures. Accessing housing in the absence of any formal structures presents a higher threat to fish habitats, as disturbance is usually spread across a larger area of foreshore rather than being minimised via concentration to one point.

Habitats may be impacted through ongoing loss of protected marine plants, disturbance of substrate and alteration of substrate profiles and bank erosion. While the impacts of individual structures used to access housing may be relatively small, the cumulative impacts can be large.

While a total of nine houses/huts were located within the project area, only one of these structures is located on tidal land and therefore considered to be 'instream'. With the placement of these 'hard' structures on river banks local current, wave and drift regimes are altered, resulting in scouring, erosion and accretion either downstream or upstream of the structures. Similar impacts occur adjacent to areas with no hard structures where the bank is still being accessed.

General recommendations:

4. Remove illegal housing and any associated structures from unallocated State land (USL) or NP and rehabilitation of impacted areas as appropriate and in accordance with protocols and funding.

The appropriate agencies to take the recommended response actions in relation to specific houses/huts are listed in Table 4 below.

BGB RAP Table 4. Recommended response actions for management of priority house/hut structures

Structure	Location	Response action / Recommendation
House on tidal land HAUG065HO	Barratta Creek, Jerona	This structure has been identified as a high priority given its large disturbance area which includes a significant adjacent area of saltmarsh that has been disturbed via vehicle access to the area. The house is located approximately 700 m to the north of the squatters' settlement at Jerona that is a short distance to the north of the housing development. Entry to the squatters' settlement is gained via an extension of the main road to Jerona that has been constructed across tidal USL. There is a no formalised access track leading from the squatters' settlement to the house (HAUG065ON) and as a result a number of tracks having been forged across the saltmarsh. When overlaying the DCDB and aerial imagery the house appears to be on USL however there is a lands lease block in this location that it may be associated with. Further investigation of tenure is required in this regard. The house is located on land immediately adjacent to the declared BGB FHA, BGB Ramsar site and National Park. The house and other unauthorised developments such as the one at Jerona threaten the values and functions of these protected areas. **Recommendation j):** • **Investigate tenure issues of the Jerona communities and house (HAUG065HO).** **See general recommendation 4.**

2) Stabilisation structures

Stabilisation structures such as revetments, walls, groynes and gabions are designed to protect the structural integrity of beaches, foreshores, banks and adjacent properties. Many are public structures while others are constructed privately. Stabilisation structures usually replace natural habitats and alter tidal regimes and the extent of tidal inundation at the site. The main impacts are from permanent loss of fish habitats, alteration of the extent of tidal inundation and changing tidal regimes. These may also have impacts on adjacent shorelines and fish habitats through physical processes such as scouring.

The project identified three stabilisation structures, including two revetment walls and one groyne, as high priority structures. Being located either within or adjacent to the Bowling Green Bay Ramsar site, declared FHA and National Park, impacts associated with boat ramps and facilities in the Bowling Green Bay region threaten the values and functions of these protected areas.

BGB RAP Table 5. Recommended response actions for management of priority stabilisation structures

Structure	Location	Response action / Recommendation
Revetment HAUG008RE	Adjacent to a private dwelling at Doughboy Creek, near Cungulla	This revetment consists of a range of man-made materials including concrete blocks, concrete filled tyres, corrugated iron and other materials. The structure borders the western and northern boundaries of a house located near the public boat ramp into Doughboy Creek. It is likely the revetment was constructed in order to prevent tidal inundation/erosion adjacent to the house. Mangroves are now well established on the seaward side of the revetment. While the house is located on land under a lands lease, the revetment has been constructed within a road reserve. Both the revetment and house are located adjacent to the declared BGB FHA, BGB Ramsar site and National Park. **Recommendation k):** • **Consult with the landholder in order to discuss the ongoing requirement for the current revetment, now that mangroves have recolonised the area and provide natural protection from erosion.**

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BGB RAP Table 5. Continued

Structure	Location	Response action / Recommendation
Revetment HAUG069RE	Barratta Creek, community at Jerona	This structure has been identified as a priority given its large footprint area, as it armours an approx. 600 m long and 2.5 m wide section of the river bank adjacent to the community at Jerona. The revetment was constructed to address erosion at the site and now protects the Jerona development from further bank erosion. Constructed of loose rock, the revetment wall would provide some level of fish habitat. Some marine plant seedlings are evidently growing up through the rocks in the wall. The wall is adjacent to the BGB FHA, BGB Ramsar site and National Park. **Recommendation l):** • **Determine legality (may be associated issues with maintenance of the structure, including with mangroves that have colonised).**
Revetment HAUG028RE	Barratta Creek, squatters huts at Jerona	This structure has been identified as a high priority given its large footprint area, as it armours the river bank along an approx. 185 m length of the adjacent squatters community at Jerona. The community is situated on an erosive river bend and the revetment is now protecting the integrity of the squatters huts at Jerona from further bank erosion. Constructed of loose rock, the revetment wall would provide some level of fish habitat. Some marine plant seedlings are growing up through the rocks in the wall. The wall is adjacent to the BGB Fish Habitat Area, BGB Ramsar site and National Park. **Recommendation m):** • **Determine legality/status of council approval (will be an issue for maintenance of the structure); consider fate of the mangroves that have colonised.**
Small groyne HAUG009GR	Adjacent to house at Doughboy Creek boat ramp, near Cungulla	This small rock groyne extends out from the house and adjacent revetment (HAUG008RE) near the public boat ramp at Doughboy Creek. Historically rocks have been placed adjacent to the boat ramp by the local community fishing club to provide protection. However it is unclear who constructed the groyne (approx. 50 m downstream from the ramp) and what its current purpose is. The groyne is adjacent to the declared BGB FHA, BGB Ramsar site and National Park. It is having an effect on wave and sand movement patterns and the growth of mangroves around the groyne. **Recommendation n):** • **Consultation with landholder and local fishing club to obtain further information in relation to the purpose of the groyne. If the groyne is no longer required/has become obsolete, it could be removed and mangroves allowed to naturally recolonise the area.**
Revetment HAUG039RE	Adjacent to Morrissey's boat ramp, Morrissey's Ck	This structure armours the bank along an approximate 50 metre length of the downstream foreshore and an approx. 15 m length of the upstream foreshore adjacent to the public boat ramp. While Morrissey's Creek is outside of the BGB Ramsar and declared FHA boundaries, it flows into Combe Creek and later, Barramundi Creek, both of which are located in the BGB Ramsar site. The revetment is now protecting the integrity of the ramp from bank erosion that typically results from placement of hard structures (e.g. concrete ramps) in natural environments. The revetment is constructed of a combination of cemented and loose rock. The loose rock portion of the revetment would provide some level of fish habitat and some marine plant seedlings are evidently growing up through the gaps between rocks. The wall is adjacent to the BGB FHA, BGB Ramsar site and National Park. **Recommendation o):** **See general recommendation 3.**

3) Dumped material

The materials and structures in this category are of concern as their presence is usually from unauthorised activities and the impacts are both direct and indirect and ongoing.

The main impacts are those of materials covering and smothering intertidal habitats and communities and derelict vessels not having been properly decommissioned (e.g. hydrocarbons drained off, batteries removed, etc.) or scuttled in approved sites. Management of these materials and structures relates to the physical removal of rubbish from fish habitats and restoration of the impacted sites.

BGB RAP Table 6. Recommended response actions for management of priority dumped rubbish structures

Structure	Location	Response action / Recommendation
Dumped rubbish ROSS068DM	Along the foreshore at Cungulla	Rubbish has historically been dumped over a large area along an approximate 2 km stretch of the foreshore at Cungulla. Some residents are of the view that the rubbish is providing erosion protection to properties. A report conducted in 1995 (Hopley & Rasmussen) concluded these structures are disrupting natural sand movement along the foreshore and contributing to localised erosion. TCC is undertaking ongoing work with the Cungulla residents to address this issue, with the aim of removing materials from the beach and foreshore area. A significant amount of rubbish collection was undertaken as part of 'Clean-up Australia day' in October. **Recommendation p):** • **Support council in the removal of rubbish from the foreshore where possible** • **Support the use of appropriate materials to provide foreshore protection where authorised.**
Old water tank HAUG059DM	On Cape Bowling Green	This structure, observed from the air, resembles an old water tank. It is located approximately 600 m from the hut (HAUG064ON) located on Cape Bowling Green. The vehicle tracks through the saltmarsh on the cape lead to the water tank and hut beyond. The structure is located directly adjacent to the declared BGB FHA, Ramsar site and National Park. Vehicle access to the saltmarsh habitats of Cape Bowling Green is obtained via Alva Beach, a popular recreational beach that is also subject to vehicle disturbance across sand dunes and salt pans (NQDT, 2009). Beach access to the north of Alva across the saltmarsh/lagoon area has recently been formalised. BSC has constructed a formalised dirt access track (approx. 2 km long) and designated access point over the dunes to access Lynch's Beach. Fencing is also being constructed along the boundary of the road to prevent vehicle access to dunes and saltmarsh to the west (NQDT, 2009). **Recommendation q):** • **The water tank be disposed as part of an integrated approach that includes removal of the nearby hut (HAUG064ON)** • **Appropriate maintenance of access track and fencing and continued regulation of beach access to ensure no further disturbance to the wetlands of Cape Bowling Green and to allow saltmarsh to recolonise the area.**
Old hut remains HAUG033DM	Near the mouth of Barramundi Creek	These old hut remains occupy a raised area of foreshore that is surrounded by saltmarsh and mangroves. The remains consist of a range of materials, including metal frames and tyres. There is potential for some of these materials to be shifted by tidal action from the foreshore into Barramundi Creek and/or the bay. It is likely that some materials have already entered the waterway via this process. The remains are located within the Ramsar site and adjacent to the BGB FHA, threatening the values of these protected areas. **Recommendation r):** • **Materials be disposed of at an approved refuse site, enabling the recolonisation of mangroves/saltmarsh as appropriate. To facilitate disposal of materials, add site to the list for the next 'Great Northern cleanup'/'Clean Up Australia day'.**

4) Piled structures

Piled structures include jetties, pontoons, boardwalks and viewing decks. These structures provide access to vessels and fishing platforms and provide for passive recreation and appreciation of adjacent fish habitats through interpretive signage and education. The main fish habitat impacts are those of location relative to intertidal marine plant communities, shading of the substrate and loss of the fauna and flora communities, physical disturbance of habitat through anchoring with chains/wires, and localised scouring/erosion through the disruption of natural flow conditions.

One piled structure was identified as a priority for management response.

BGB RAP Table 7. Recommended response actions for management of priority pile supported structures

Structure	Location	Response action / Recommendation
AIMS jetty ROSS060JE	Australian Institute of Marine Science (AIMS), Chunda Bay	This structure has been identified as a high priority based on the prioritisation criteria that include a mix of structure impact and habitat value criteria. The jetty has a relatively large footprint area and its surface does not appear to be allowing light penetration through to bottom substrates. However it is of a height that would reduce any shading effects. The jetty is located within the BGB FHA and adjacent to the BGB Ramsar site and National Park. Although the jetty has been identified as a high priority, this is largely a result of the footprint area. It is unlikely that the jetty will have any significant additional impacts on fish habitats. While the jetty consists of numerous pylons and therefore would impact on a larger area of substrate than a jetty with fewer pylons, it is likely that the structure is providing some level of habitat for fish. This is a legitimate structure utilised for AIMS research purposes. No further action is proposed. **Recommendation s):** • **Provide project findings to AIMS for their information.**

Priority barrier structures

Within the project area, 13 potential barrier structures (one weir and 12 stream crossings) have been identified as a priority for management. Of these structures, six occur within the Ramsar site. These structures are listed in Table 8.

1) Weir/dams

Weirs and dams are typically constructed to supply water for irrigation or human consumption or to provide flood mitigation. While weirs are generally smaller structures built across river channels rather than entire river valleys, both structures form significant physical barriers to fish movement.

The impact that a dam or weir has on fish passage is influenced by the frequency, timing and duration of drown out. Drown out occurs when there is sufficient water flow across the structure to breach it. Fish movement is optimised during drown out when the water levels above and below the barrier are equal and there is sufficient water depth across the barrier for fish to swim through. Some weirs and dams may drown out completely and continuously, while others do not drown out at all, preventing all upstream fish passage and disrupting life cycles.

The appropriate agencies to take the recommended response actions in relation to specific weir/dam structures are listed in table 9.

BGB RAP Table 8. Priority structures from Quarter 1 of the prioritisation matrix. Less fish-friendly structures in higher value habitat (red indicates structure location within the Ramsar site; green indicates structure location within both FHA and Ramsar)

Structure grouping	Structure ID	Location
Weir/dam	HAUG071WD	Weir, Alligator Creek
Stream	ROSS048SX	Pipe culvert, Unknown waterway (branches off Salmon Creek)
Crossings	HAUG016SX	Box culvert, Jerona Rd, Salty Gully
	HAUG017SX	Pipe culvert, Jerona Rd, Salty Gully
	HAUG018SX	Pipe culvert, Jerona Rd, Salty Gully
	HAUG019SX	Pipe culvert, Jerona Rd, Salty Gully
	HAUG020SX	Box culvert, Jerona Rd, Salty Gully
	HAUG024SX	Box culvert, Jerona Rd, Salty Gully/Barrattas
	ROSS040SX	Causeway, Pipe culvert, Cocoa Creek
	ROSS041SX	Causeway, Pipe culvert, Cocoa Creek
	ROSS042SX	Causeway, Pipe culvert, Cocoa Creek
	HAUG067SX	Culverts, AIMS Rd near highway, Crocodile Ck
	HAUG073SX	Culverts, AIMS Rd near highway, Crocodile Ck

BGB RAP Table 9. Recommended response actions for management of priority weir/dam structures

Structure	Location	Response action / Recommendation
Weir HAUG071WD	Lower Alligator Creek	This weir is located approximately 1 km upstream of the BGB Ramsar site and National Park and is within the Cleveland Bay FHA. The weir ranked number 9 in the list of barriers identified for priority management as part of the NQDT Fish Passage Assessment Project (BAR17; Carter et al., 2007). The report recommended that further investigation be undertaken to determine the effects of the weir on fish passage. A concept fishway design report has since been completed by Fisheries Queensland (Marsden & Moore, 2009). Built to retain water for irrigation and prevent saltwater intrusion, the weir drowns out in high flow events. However during periods of lower flow velocities, the weir creates a barrier to fish passage (Marsden & Moore, 2009). Further action to remediate the weir is dependent on funding. **Recommendation t):** • **The weir be remediated/fishway installed as soon as funding becomes available.**

2) Stream crossings

The 12 priority crossing structures consist of nine road crossings that incorporate culverts and three causeway crossings that incorporate pipes.

Stream crossings are generally built across waterways to provide access for vehicular traffic. Poorly designed crossings can have major impacts on fish passage and tidal and freshwater flows.

Culverts

Culvert crossings are often built at an elevated level from the stream bed. This creates a drop on the downstream side of the crossing that presents a physical barrier to fish movement. Over time, erosion and scouring can form pools on the downstream side of these structures. These lead to undercut areas that exacerbate the drop on downstream sides.

Culvert crossings typically restrict the channel width, concentrating the waterway into a relatively small culvert width and causing increased velocities that pose a hydrological barrier to fish passage. The smooth, symmetrical shape of culverts further increases water velocities, often to speeds that exceed the swimming ability of many native fish species. Culverts can also form a behavioural barrier for fish, with fish hesitating to travel through culverts that are too long and dark.

Causeways

Although causeway crossings are low-level crossings designed to drown-out, the drop that results from the raised crossing can function like a small weir in low flow conditions. These structures often do not incorporate pipes and are a problem particularly during low flows, as the shallow water depth across the structure during these conditions can restrict fish passage. If pipes have been incorporated in these structures they are often dark and create high velocities that restrict upstream movement of fish.

General recommendations:

5) Undertake further investigations, including discussions with local stakeholders, to assess significance of stream crossings as a barrier for fish passage.

6) Adopt a strategic approach to the management of vehicle access and associated impacts to tidal fish habitats in the Bowling Green Bay region.

BGB RAP Table 10. Recommended response actions for management of priority stream crossing structures

Structure	Location	Response action / Recommendation
Road crossing ROSS048SX	Cape Cleveland/AIMS Rd, Waterway name unknown (branches off Salmon Creek)	This road crossing is located along the Cape Cleveland Road that provides access to Australian Institute of Marine Science. The crossing is located approximately 4 km south of the AIMS facility. It provides access across the tidal reach of a waterway (name unknown) that branches off Salmon Creek. The crossing includes 10 culvert pipes. A large drop on the downstream side of the crossing is likely to be causing a barrier to fish passage during periods of low flow. The crossing is located within the Cleveland Bay FHA and while the road corridor has been excluded from the BGB Ramsar site, the road and crossing is immediately adjacent to the Ramsar site and BGB National Park. Therefore any impacts of this crossing would have implications for the Ramsar site.
Road crossings ROSS067SX ROSS073SX	Cape Cleveland/AIMS Rd, upper reaches of southern end, near the Bruce highway	There are approx. four crossings located along the AIMS road, including ROSS067SX and ROSS073SX. Both culvert crossings are located at the southern end of the road near the highway. The remaining two structures are located at the northern end of the highway near the AIMS facility (though these were not surveyed during the course of the project). The most southern crossing, ROSS067SX, is approximately 180 m from the Bruce highway. Both ROSS067SX and ROSS073SX are within the Cleveland Bay declared FHA. They provide access across a large intertidal floodplain near the upper tidal reaches of Crocodile Creek. Similar to Jerona Road and the Cocoa Creek access road, the alignment (and crossings) of the southern section of the Cape Cleveland/AIMS road are within the boundaries of the current Ramsar site despite intensions for exclusion. A more detailed assessment of all crossings along the Cape Cleveland/AIMS road should be undertaken to determine the extent of fish passage impacts resulting from the current design and placement of these crossings. **Recommendation u):** **See general recommendation 5.**

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BGB RAP Table 10. Continued

Structure	Location	Response action / Recommendation
Road crossings HAUG016SX HAUG017SX HAUG018SX HAUG019SX HAUG020SX HAUG024SX	Jerona Road, Salty Gully, (DTMR/Council)	Jerona Road is a raised bitumen road that provides the only public access across the tidal floodplains of Salty Gully to the small town of Jerona. These crossings are a mix of box and pipe culverts that are situated along the length of the road which facilitates dry access to Jerona throughout the year. It appears that the boundaries of the Ramsar site were drawn to exclude the original alignment of Jerona road. However some sections of the road have diverged from the original, intended alignment and as subsequently fall within the Ramsar boundaries. An example of this is at the site of the road crossing HAUG024SX. The entire gully floods during the wet season and Jerona Road runs perpendicular to the bay rather than parallel to it, therefore the road would have minimal disruption to the vertical flow paths of tidal inundation. However the road may cause some disruption to connectivity and to flows across the floodplain in a horizontal fashion during times of lower flows. Further investigation in relation to the extent of impact of the road on fish passage across the floodplain, considering tidal flow paths in the area, is required. However it is likely that fish passage impacts would be relatively minimal. Unregulated vehicle access and associated disturbance to marine plants and intertidal fish habitats is a major issue that extends to a range of tidal mangrove and saltmarsh habitats in the wider Bowling Green Bay region and is highlighted by use of Jerona Road. Numerous tracks have been forged by off-road vehicle access leading off Jerona Road and across tidal flats, disturbing and disconnecting vast areas of marine plants and having a negative impact on intertidal fish habitats. This is most clearly demonstrated at the northern extent of the main road to Jerona, where an informal access track has been forged to gain entry to the squatters' settlement and house beyond (HAUG065ON). The extent of this problem in the BGB region is of concern. A vehicle management plan of action has been developed for the NQDT NRM region with a focus on managing vehicle access to and disturbance of beaches and sand dune environments (NQDT, 2009). The BGB region would benefit from a similar plan to control and regulate vehicle access to areas of intertidal saltmarsh. **Recommendation v):** **See general recommendation 5.** **See general recommendation 6.**
Road crossings ROSS040SX ROSS041SX ROSS042SX	Cocoa Creek	These crossings are located along a raised, unsealed road (gravel/crusher dust) that provides access to informal boat launching and camping sites (ROSS043BR, ROSS044BR, ROSS045BR, ROSS046BR) along Cocoa Creek. Similar to Jerona Road (e.g. at the site of HAUG024SX), it seems the boundaries of the Ramsar site were drawn to exclude the original alignment of the Cocoa Creek access road. However some sections of the access road currently fall within the Ramsar boundaries. The road also traverses the BGB National Park in part and is within the Cleveland Bay FHA. This area is flooded during the wet season, but at other times of the year may have impacts for fish passage. The road is unsealed and there may be some impacts from sediment entering Cocoa Creek. **Recommendation w):** **See general recommendations 6.** **See general recommendation 1—this response is linked with the strategic approach referred to general recommendation 1, in relation to the provision of public boat ramps and managing usage of and access to public boat ramps and associated parking requirements in the BGB region.**

Other structures in areas adjacent to the Ramsar site

This section includes a summary of other non-barrier and barrier structures in Table 11 (below) that were noted during the project to exist in the Bowling Green Bay region, outside the surveyed part of the project area. While more detailed assessments of these structures are required to enable prioritisation based on the inventory criteria, they are mentioned because their locations within areas adjacent to the Ramsar site have implications for fish habitat or passage impacts on the Ramsar site downstream.

BGB RAP Table 11. Other barrier structures in the BGB region in areas adjacent to the Ramsar site

Structure	Location	Response action / Recommendation
Mud-slide boat launch (ROSS074BR)	Creek that flows into Cleveland Bay, to the west of Alligator Creek	This unauthorised mud-slide launch is located within the Cleveland Bay FHA. **Recommendation w):** • **Undertake further investigation to quantify fish habitat impacts.**
Tyre walkway (ROSS075WW)	Creek that flows into Cleveland Bay, to the west of Alligator Creek	This concrete filled tyre walkway extends across an area of saltmarsh and through mangroves to the edge of the creek. The structure is located in the Cleveland Bay declared FHA **Recommendation x):** • **Undertake further investigation to quantify fish habitat impacts.**
Cromarty's landing Public ramp HAUG014BR	Cromarty Ck / Haughton River (DTMR/Council)	This public boat ramp is located immediately adjacent to the BGB Ramsar site, provides the main access to the Haughton River, and is a popular camping spot with travelling recreational fishers. Almost 1.5 ha of saltmarsh adjacent to the boat ramp/camping area is subject to vehicle disturbance. Vehicles utilise the area as a turn around point and to access the bank of the Haughton River immediately to the north of the saltmarsh area for recreational fishing. The water pipeline that provides Cungulla's water supply is located approximately 20 m upstream from the ramp and runs along the creek bed. The isolation valve is housed in a concrete pit along the bank and there is some localised bank erosion around the concrete pit. BSC is planning to replace and rebury the pipeline, which may include some erosion protection works (dependent on DERM's recommendation). **Recommendation y):** • **Ensure public access to the ramp is regulated and access to the saltmarsh area prevented (e.g. fencing)** • **Rehabilitation of the saltmarsh area may be appropriate** • **Formal car parking facilities are required** • **Investigate opportunities for a fishing platform.** **See general recommendations 1, 2 and 3.**

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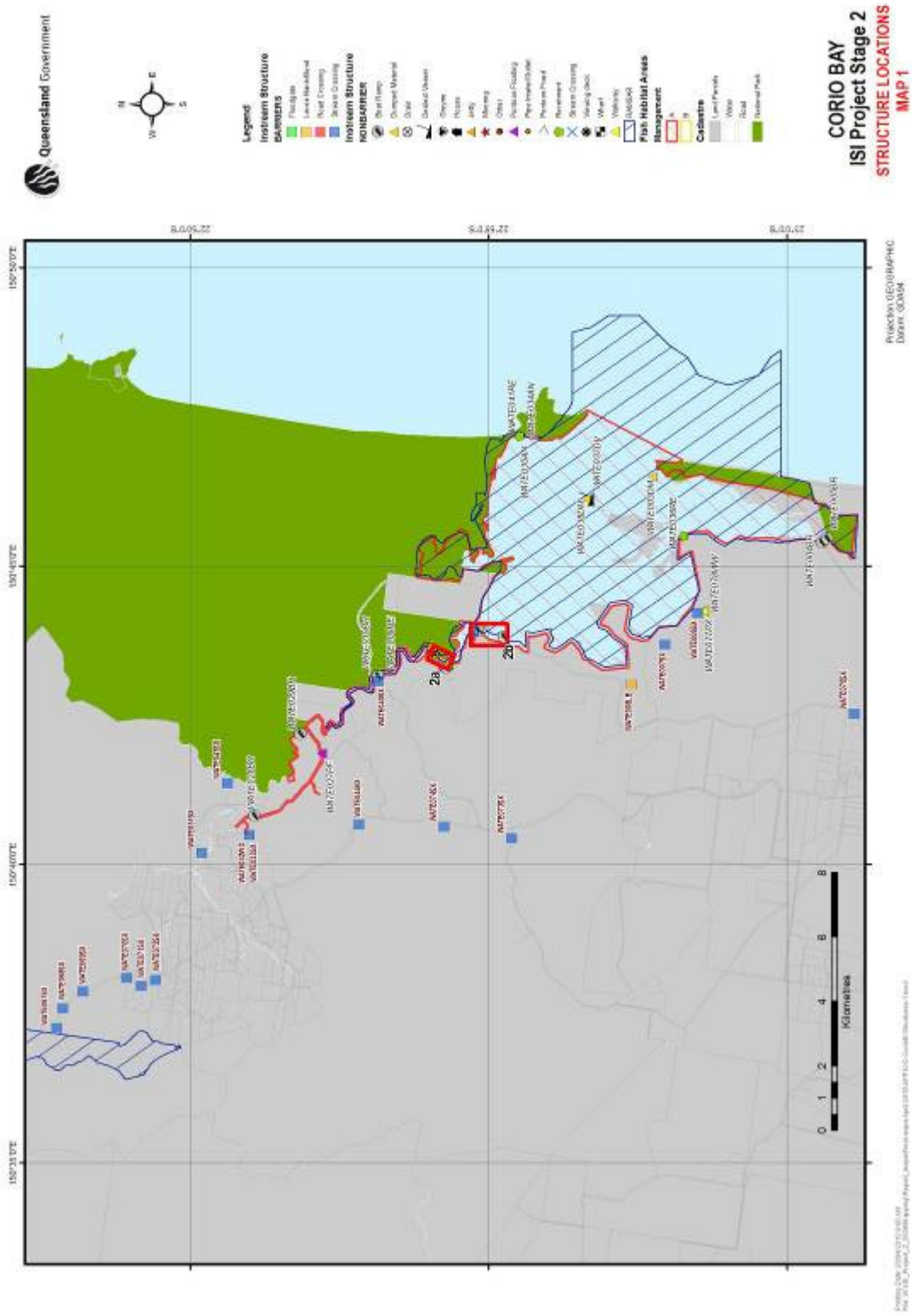
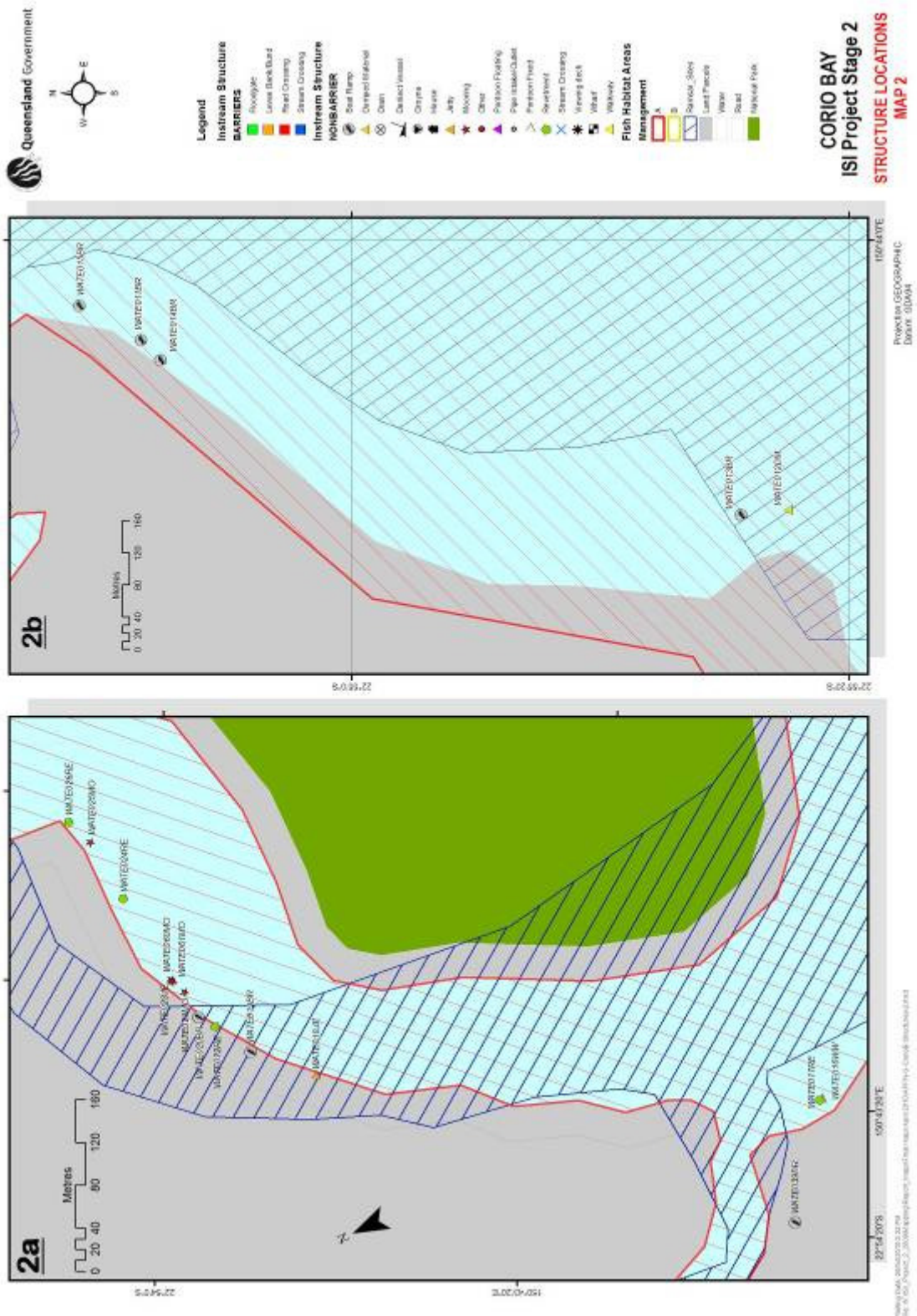
BGB RAP Table 11. Continued

Structure	Location	Response action / Recommendation
Weir (ROSS071WD)	Lower Alligator Creek	This weir is located approximately 1 km upstream of the BGB Ramsar site and National Park and is within the Cleveland Bay FHA. The weir ranked number 9 in the list of barriers identified for priority management as part of the Fish Passage Assessment Project undertaken by Alluvium Consulting for NQDT (BAR17; Carter et al., 2007). Built to retain water for irrigation and prevent saltwater intrusion, the weir drowns out in high flow events. However during periods of lower flow velocities, the weir creates a barrier to fish passage (Marsden & Moore, 2009). A concept fishway design report has since been completed by Fisheries Queensland (Marsden & Moore, 2009). Further action to remediate the weir is dependent on funding.
Giru & Val Bird weirs	Haughton River	These weirs are major structures along the Haughton River. Both are known to fully drown out during large flow events but have been identified as barriers to upstream fish movement. Carter et al. (2007) ranked the Giru and Val Bird weirs as number 4 and 8 respectively within the NQDT Fish Passage Study Final Report, and recommended working with Sunwater to investigate modification options.
North Coast Rail Line	Between Giru and Cromarty Station	A number of crossings exist along this section of the rail line that runs adjacent to the Ramsar site, including culverts and bridges. Further investigation of these crossings would be required to determine any fish passage impacts.
Earth bunds	Sheepstation Creek system	A number of earth bunds were identified as part of the BDTNRM Fish Passage Study (Carter et al., 2007) that present potential barriers to fish movement. The 2007 report recommends further investigation into this area, in cooperation with stakeholders including landholders, to undertake further investigations regarding options for barrier modification.

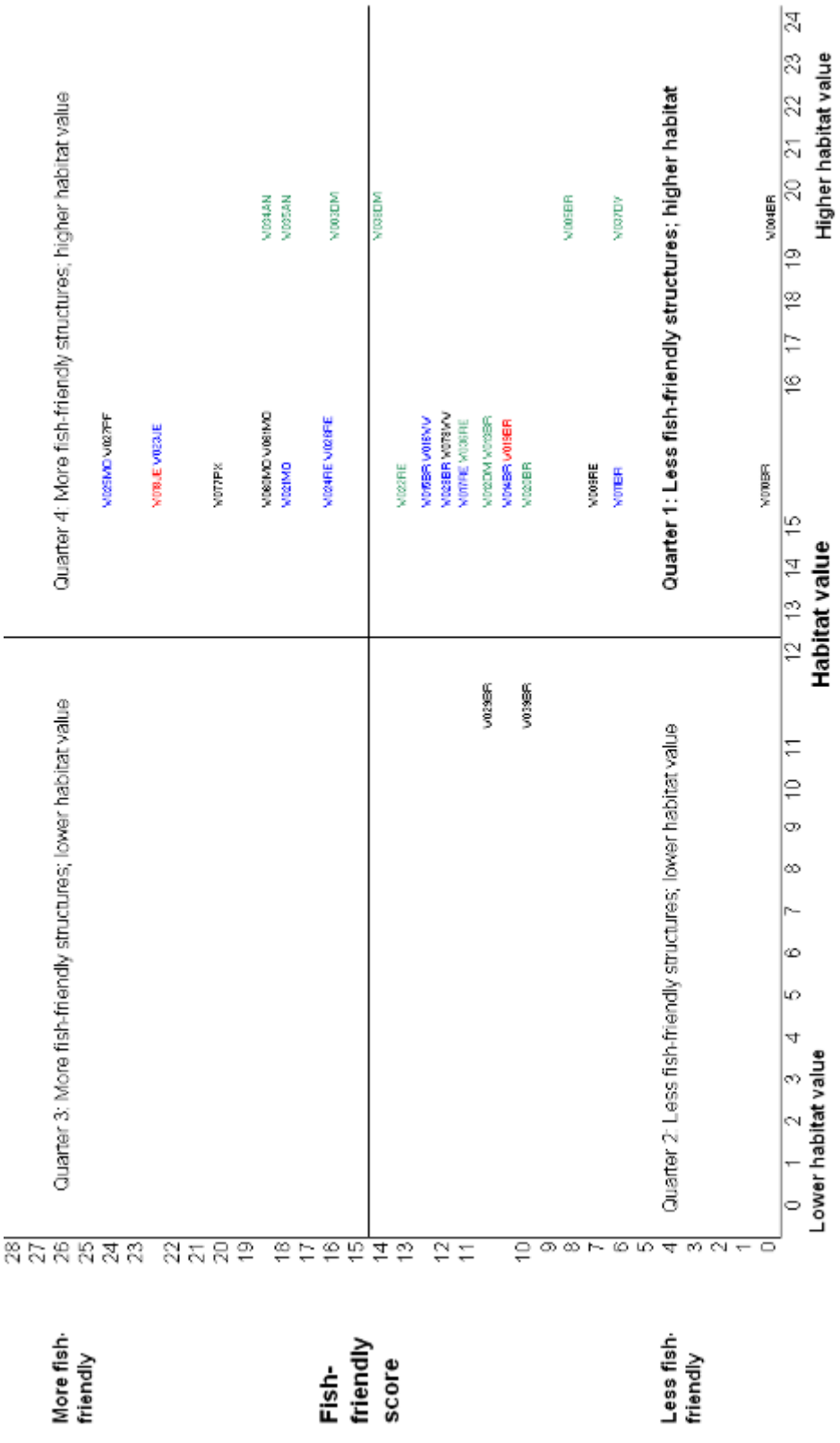
Appendix M Corio Bay structure locations map 1



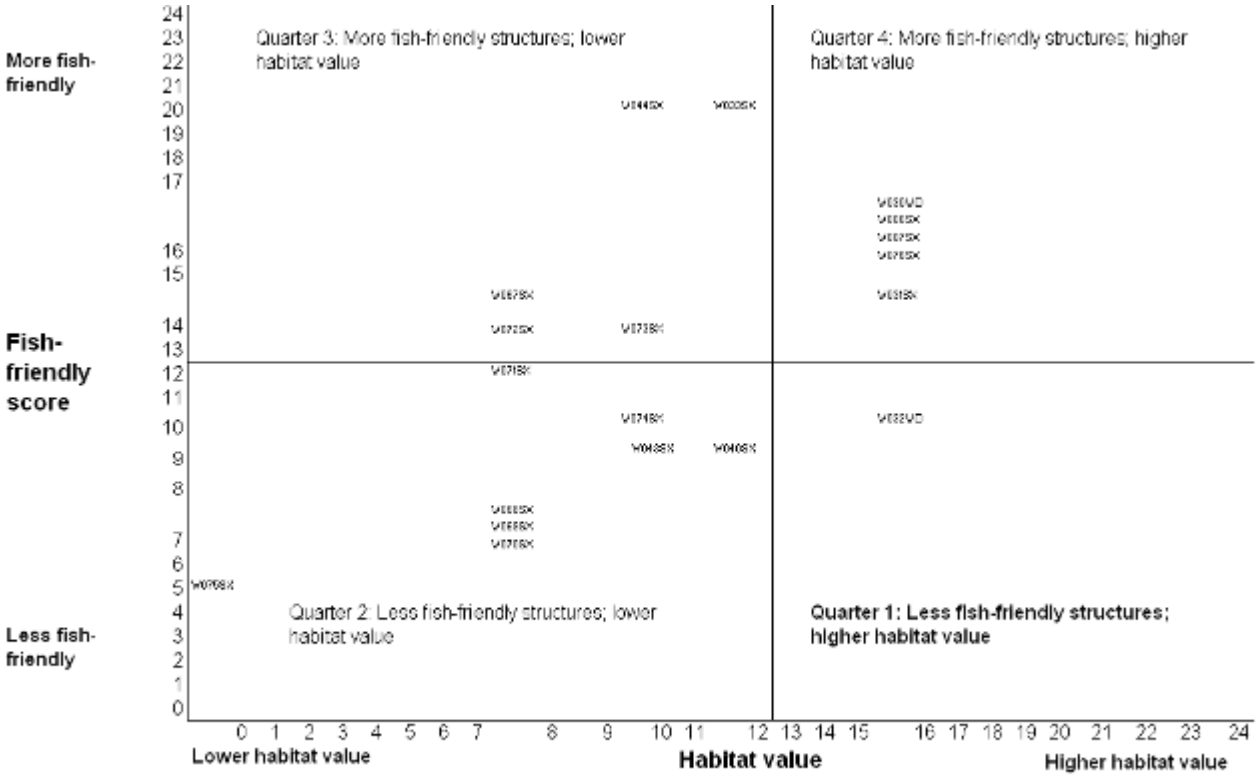
Appendix N Corio Bay structure locations map 2



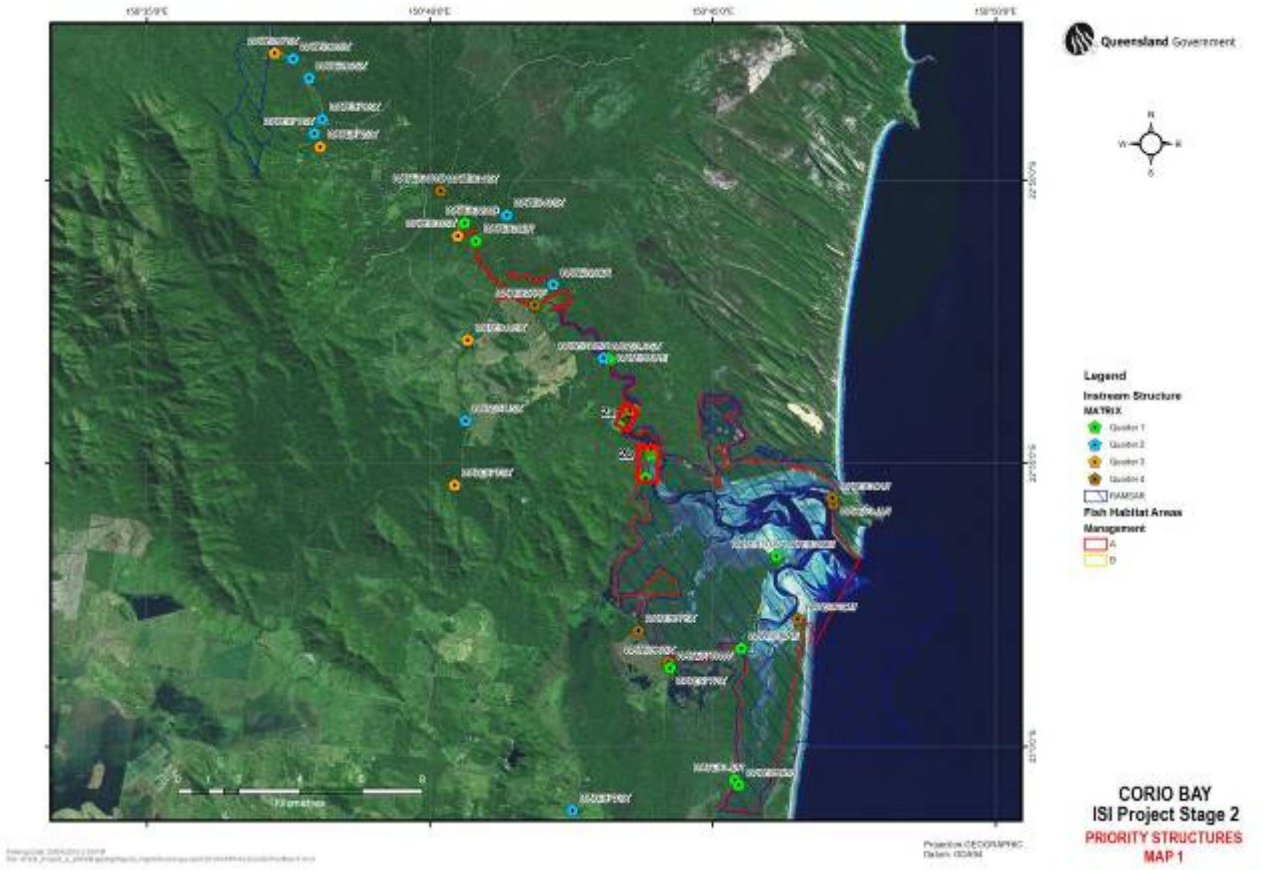
Appendix O Corio Bay non-barrier prioritisation matrix



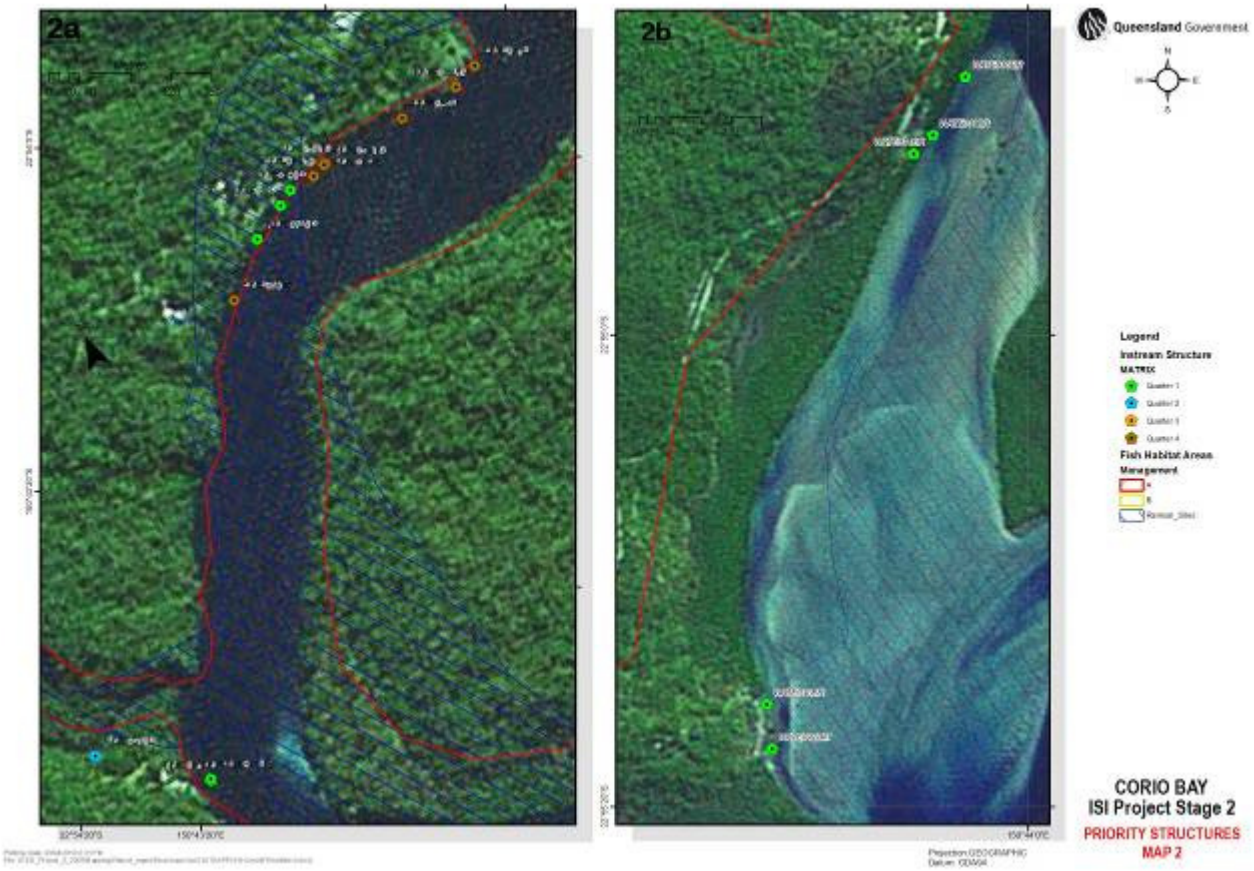
Appendix P Corio Bay barrier prioritisation matrix



Appendix Q Corio Bay priority structure locations map 1



Appendix R Corio Bay priority structure locations map 2



Appendix S Corio Bay Response Action Plan

Response Action Plan for priority instream structures in Corio Bay, identified during the project Inventory of Instream Structures Impacting on Ramsar Wetlands' (July 2009 - April 2010)

The project Inventory of Instream Structures Impacting on Ramsar Wetlands (herein the Ramsar inventory project) was managed and conducted by Fisheries Queensland, a service of DEEDI and funded by SEWPaC as part of the Queensland Wetlands Program. The aim of the Ramsar inventory project was to locate, identify, map and assess instream structures in each of the Bowling Green Bay and Shoalwater and Corio bays Ramsar sites, using inventory and response protocols developed in a pilot project undertaken by Fisheries Queensland in 2008–09 (Lawrence et al., 2009a; 2009b).

This Response Action Plan (RAP) identifies potential management actions to address the high priority structures (non-barriers and barriers) located and assessed as part of the Ramsar inventory project in Corio Bay. A copy of the full project report (Lawrence et al., 2010) and Bowling Green Bay RAP can be accessed on the Wetland*Info* website, <www.epa.qld.gov.au/wetlandinfo>. The Shoalwater Bay RAP is included in a supplement to the project report as it relates to the Shoalwater Bay Military Training Area.

The priority structures include all those non-barriers and barriers assessed to have relatively high impacts (less fish-friendly) to fish habitats and were also located in ecologically high value areas (near pristine habitats).

Priority non-barrier and barrier structures have been separated into different structure categories, given that some of the impacts and related management considerations within each category are similar.

There are two types of management recommendations specific in the RAP:

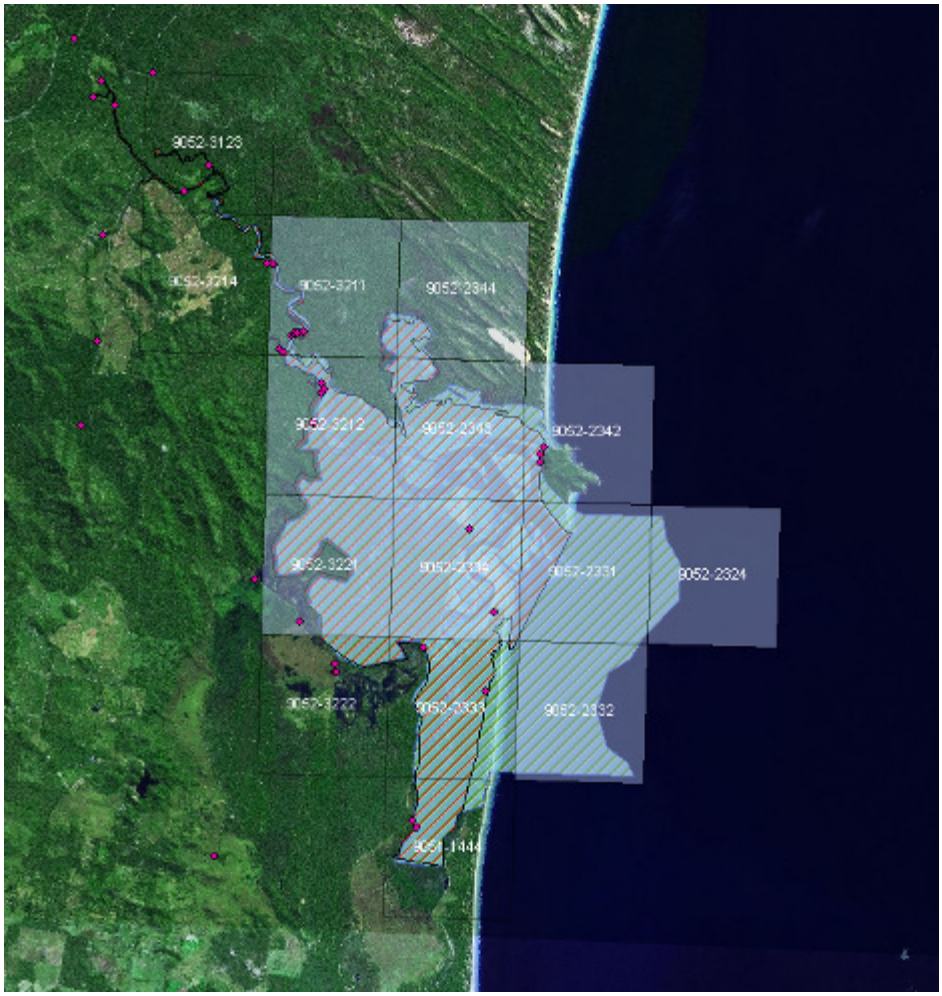
- general recommendations that apply to structure categories
- specific recommendations that apply to individual structures.

The selected management responses vary depending on the type of structure and the nature of the impacts. Management responses are not restricted to but may include one or more of:

- further investigation/assessment of impacts
- developing strategic approaches to identified management issues
- decommissioning informal/unauthorised structures
- restricting access to informal/unauthorised structures
- raising awareness of ecological values
- removal of structures and rehabilitation of the site.

Project area coverage

The map below (Figure 1) shows the project area covered in relation to the mapping and prioritisation of non-barrier and barrier structures in Corio Bay.



Corio Bay RAP Figure 1. Inventory coverage of the Corio Bay project area. Entire Ramsar site (in light blue hatching), in addition to project area grid squares (in light blue). Locations of all structures, non-barriers and barriers, are shown in pink and the declared FHA shown in red hatching. Entire or part grid squares not shaded were not inventoried.

Source: DEEDI

Priority non-barrier structures

The project located, assessed and mapped 18 priority non-barrier structures, which are listed below (Table 1).

1) Fill/slab structures

The majority of priority non-barrier structures falls into to the fill/slab category. Fill/slab structures are identified as high impact structures for priority future management because these typically have relatively large footprints and result in a direct and permanent loss of fish habitats.

Boat ramps

Boat ramps make up 10 of the 18 priority non-barrier structures from Quarter 1. The boat ramps have either been constructed through permanent stabilisation of the foreshore with concrete and other materials or by removal of foreshore vegetation (protected marine plants) to provide unauthorised (informal) launching sites. With the placement of these 'hard' structures on river banks, local current, wave and drift regimes are altered, resulting in ongoing scouring, erosion and accretion either downstream and/or upstream of the structures. Similar impacts occur adjacent to unauthorised mud-slide vessel launching sites.

Significant additional fish habitat impacts from vehicle access roads and parking areas are associated with boat launching and retrieval. At ramps where facilities are informal, unauthorised and/or inadequate, marine plant disturbance is often the result. Being located either within or adjacent to the Corio Bay Ramsar site, declared FHA and National Park, impacts associated with both formal and informal boat ramps and facilities in the Corio Bay region threaten the values and functions of these protected areas.

Corio Bay RAP Table 1. Priority structures, separated into different structure categories, from Quarter 1 of the prioritisation matrix. Less fish-friendly structures in higher value habitat (black—structure location outside the Ramsar/FHA; red—structure location within the Ramsar site; blue—location within FHA; and green—structure location within both FHA and Ramsar).

Structure category	Structure ID	Location
Fill, slab	WATE010BR	Corbett's Landing, Waterpark Creek
	WATE011BR	Kelly's Landing, Waterpark Creek
	WATE013BR	Gravel ramp, Waterpark Creek
	WATE014BR	Dirt ramp, Waterpark Creek
	WATE015BR	Small ramp, Waterpark Creek
	WATE019BR	Private ramp, Waterpark Creek
	WATE020BR	Dirt ramp, Waterpark Creek
	WATE028BR	Bank launch, Waterpark Creek
	WATE004BR	Fishing Creek mud launch
	WATE005BR	Fishing Creek mud launch
	WATE016WW	Concrete stairs, Waterpark Creek
Stabilisation	WATE009RE	Corbett's Landing revetment, Waterpark Ck
	WATE017RE	Carpeted revetment, upstream of WATE016WW, Waterpark Ck
	WATE022RE	Road rail revetment, Waterpark Creek
	WATE036RE	Private revetment at hut, Undiscovered Ck
Rubbish/dumped material	WATE012DM	Corio Bay
	WATE038DM	Near derelict vessel, Corio Bay
	WATE037DV	Derelict vessel, Corio Bay

2) Stabilisation structures

Stabilisation structures such as revetments, walls, groynes and gabions are designed to protect the structural integrity of beaches, foreshores, banks and adjacent properties. Many are public structures while others are constructed privately. Stabilisation structures usually replace natural habitats and alter tidal regimes and the extent of tidal inundation at the site. The main impacts are from permanent losses of fish habitats, alteration of the extent of tidal inundation and changed tidal regimes. These may also have ongoing impacts on adjacent shorelines and fish habitats through physical processes such as scouring.

The project identified four stabilisation (revetment) structures as high priority structures. Being located either within or adjacent to the Corio Bay Ramsar site, declared FHA and National Park, impacts associated with boat ramps and facilities in the Corio Bay region threaten the values and functions of these protected areas.

3) Dumped material

The materials and structures in this category are of concern as their presence is usually from unauthorised activities and the impacts are both direct and indirect, and can be ongoing.

The main impacts are those of materials covering and smothering intertidal habitats and communities and derelict vessels not having been properly decommissioned (e.g. hydrocarbons drained off, batteries removed, etc.) or appropriately scuttled in approved sites. Management of these materials and structures relates to the physical removal of rubbish from fish habitats and restoration of the impacted sites.

General recommendations for priority non-barrier structures:

1. **Adopt a strategic approach, including adequate erosion control management, to the provision of public boat ramps and to manage the usage of, and access to, these ramps and their associated parking facilities in the Corio Bay region. All ancillary facilities (e.g. parking for vehicles and trailers) to be located on non-tidal land to minimise fish habitat impacts.**
2. **Decommission informal or obsolete boat ramps ('mud slides'), rehabilitate the sites and prevent further access.**
3. **Raise awareness of the area's Ramsar, National Park and fish habitat values and promote behaviour that ensures these values are maintained by investigating opportunities for joint signage at public boat ramp sites.**
4. **Adopt an integrated approach to address the issue of historical and future unauthorised structures in Waterpark Creek and Corio Bay areas.**
5. **Develop a communications plan for the wider Corio Bay region to raise awareness of fish habitat values, restrictions on development in declared FHAs and involving marine plants and to address future unauthorised structures.**

Corio Bay RAP Table 2. Recommended Response Actions for management of individual priority non-barrier structures

Structure	Location	Response Actions / Recommendations
Corbett's Landing Public ramp WATE010BR And revetment WATE009RE	Waterpark Creek	Corbett's Landing is the main public boat ramp used for access to Waterpark Creek and Corio Bay. The concrete ramp is managed by RRC. An approximate 80 m long revetment constructed of timber logs is located about 20 m downstream of the boat ramp and armours the bank adjacent to the ramp's carparking area. Some local erosion on the downstream side of the ramp and the revetment integrity is failing in some places. The revetment (WATE009RE) has a different tenure though this requires confirmation; the Digital Cadastral Database (DCDB) indicates that both the ramp and revetment are located on Lot 1, CP905907, 'reserve' tenure. **Recommendation a):** • **Clarify tenure for revetment** • **The revetment be upgraded - potential for a rock/more fish-friendly structure (leave provision for off the bank fishers)** • **Review car park size.** **See general recommendations 1 and 3.**

continued over page

Corio Bay RAP Table 2. Continued

Structure	Location	Response Actions / Recommendations
Kelly's Landing Informal launches WATE011BR WATE014BR WATE015BR	Waterpark Creek	The site consists of one gravel launch (WATE011BR), immediately next to a dirt launch (WATE015BR) and a second smaller (1 m) dirt launch (WATE014BR) about 80 m upstream of the two main launches. All three launches are within the declared Corio Bay FHA and are immediately adjacent the Ramsar site. Launches are used for both powered and non-powered craft. The areas adjacent to the launch sites area is used as an unofficial camping spot and RRC compliance officers undertake inspections of the area. There is some scouring of the bank and bank erosion at the site, in addition to some loss of fish habitat through preventing mangrove re-colonisation within the footprint of launch sites. Local knowledge indicates that WATE011BR and WATE015BR have not changed in 40 years, though the marine plant disturbance associated with WATE014BR is more recent. The structures extend from an esplanade (adjacent to a freehold lot). Kelly's Landing Road is gazetted but is not as accessible as Corbett's landing. Initially the road is bitumen but then changes to gravel. The gravel section of the road traverses parts of the Iwasaki wetlands, which are mostly located immediately to the east of the road. The last 125 m section of the road (that extends past the launch sites) traverses an area of marine plants. The surface of this part of the road appears to have been constructed using fill/cracker dust and some fill mounds that are covered in weeds remain in the tidal area adjacent to the road. The road separates an approximate 1.5 ha area of marine plants within the FHA from the marine plant community adjacent to Waterpark Creek to the east. While the fragmented area is still inundated by the tide, the presence of smaller mangroves to the west of the road suggests that tidal flushing in the area has been reduced due to road construction. **Recommendation b):** • **The end section of Kelly's Landing Road located on tidal land be removed, to allow restoration of tidal flows and connectivity to the area and the natural recolonisation of marine plants.** **See general recommendations 1, 2, 3 and 5.**
Informal launch WATE004BR (downstream) Informal launch WATE005BR (upstream)	Fishing Creek	These two informal 'mud-slide' launches, known as Smalleys Landing, exist within a 250 m stretch of Fishing Creek. WATE005BR is located within the Corio Bay FHA and Ramsar site and the adjacent bank (also within the FHA and Ramsar) is used as a camping spot. WATE004BR is adjacent to the FHA and Ramsar boundaries. The maintenance of access to Smalleys Landing by Iwasaki Sangyo Co. (Aust.) Pty Ltd is specified in the *Queensland International Tourist Centre Agreement Act Repeal Act 1989*. Both mud-slides are located on an outside river bend that is susceptible to erosion, with evidence of natural erosion at the site. These launches are fairly well used to access Fishing Creek and the Bay via powered craft and are an accessible location for off the bank fishers. They are also occasionally used for canoe launches. Use of the launches, particularly trailer boat launching, is accelerating erosion of the creek bank and causing disturbance of adjacent saltmarsh and terrestrial vegetation through associated vehicle access, parking and camping activities. Continued similar use will result in further bank erosion at the site and sedimentation of the creek, resulting in reduction of habitat values of the FHA, Ramsar and NP. **Recommendation c):** **See general recommendations 1, 2, 3 and 5.**

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Corio Bay RAP Table 2. Continued

Structure	Location	Response Actions / Recommendations
Private boat launches WATE019BR WATE020BR Road rail revetment WATE022RE	Waterpark Creek	These three structures are within a road reserve adjacent to several houses located on freehold land. They are adjacent to the Corio Bay FHA and within the Ramsar boundaries. WATE019BR is constructed of timber slats, while the second ramp (WATE020BR) is a dirt launch. The revetment wall (WATE022RE) is located along the bank in between the two launches; there are also some concrete stairs at several locations along the bank in the same vicinity. These structures are located within a ~0.4 km section of Waterpark Creek that includes the residential houses and other associated instream infrastructure (e.g. stairs). There is some evidence of bank erosion and scouring at the site, in addition to loss of fish habitat through prevention of marine plant re-growth within the footprint area of the structures. **Recommendation d):** • **Clarify tenure and legality of multiple dwellings on upstream freehold and instream structures; investigate any public liability issues** • **Compliance check of lease conditions of WATE020BR** • **Explore implications for FHA management (subject to the outcome of first recommendation) - e.g. QBFP investigation.** **See general recommendations 4 and 5.**
Solero's landing Boat launch WATE013BR	Waterpark Creek	WATE013BR (Solero's landing) is a dirt/gravel boat launching site also utilised by the public as a camping area. Access to this area via Kelly's Landing Road. Adjacent to freehold land, the site is within the Corio Bay declared FHA and Ramsar site. Some loss of fish habitat associated with the prevention of marine plant growth within the footprint of the launch. **Recommendation e):** • **The launch site be decommissioned, public access prevented and site rehabilitated.** **See general recommendations 1, 2, 3 and 5.**
Dumped rubbish/materials WATE012DM	Waterpark Creek	An approximate 50–100 m² area of dumped rubbish, consisting of a range of structures including several tied up dinghies, is located here. The dumped rubbish is adjacent to freehold land and within the Corio Bay FHA and Ramsar site. The dumped material is resulting in loss of fish habitat at the site, through restricting/inhibiting marine plant growth. **Recommendation f):** • **The dumped materials be removed and mangroves allowed to naturally recolonise the area.** **See general recommendations 4 and 5.**
Dirt launch WATE028BR	Waterpark Creek	This dirt launch is just downstream of Stringybark Creek and is in the Corio Bay FHA, but outside Ramsar boundaries. The launch site is adjacent to the road corridor and freehold property that fronts onto Sandy Creek Road. There is some loss of marine plant/terrestrial vegetation within the footprint of the ramp. **Recommendation g):** **See general recommendation 5.**

continued over page

Corio Bay RAP Table 2. Continued

Structure	Location	Response Actions / Recommendations
Revetment WATE017RE Concrete stairs WATE016WW	Waterpark Creek	The revetment consists of a piece of carpet that has been thrown over the bank, possibly in an attempt to address an erosion issue. The revetment is just upstream of a set of concrete stairs (WATE016WW) that are built on the bank leading down to the water's edge. The structures are located along the boundary of the same property. The property owner maintains a permanent residence. These structures are located immediately adjacent to the Corio Bay FHA and adjacent to the Ramsar site. **Recommendation h):** • **Confirm tenure—compliance check of lease conditions** • **QBFP investigation.** **See general recommendation 5.**
Revetment WATE036RE	Undiscovered Creek	This is a timber revetment which appeared to be constructed some time ago as an erosion control measure. The revetment is adjacent to a house in Undiscovered Creek and is starting to deteriorate in some sections. The revetment is affecting the extent of tidal inundation and marine plant growth at the site. **Recommendation i):** • **Clarify tenure—investigate any public liability issues** • **QBFP investigation.** **See general recommendations 4 and 5.**
Dumped material WATE038DM Derelict vessel WATE037DV	Corio Bay	There is a range of dumped materials (eg. corrugated iron, concrete, metal drum, old timber, chains, engine parts) within an 11–50 m^2 area. The derelict vessel (WATE037DV) (and tender) is an abandoned fibreglass boat and occupies an area of approximately 100 m^2. These structures are within the declared FHA and Ramsar site. The presence of dumped materials is preventing marine plant growth at the site and there is the potential for materials to further degrade and pollute other parts of the Bay—it is likely that some materials have already washed away via this process. The vessel is preventing marine plant growth at the site and, though it may be providing a level of fish habitat, through providing a surface for the attachment of epibiota, this is unlikely to be significant given that the boat is resting on the bottom substrate (i.e. not floating), greatly reducing the surface area available for use as habitat. The boat is also smothering bottom habitats at the site. The vessel is located at the base of a sand spit that provides habitat for roosting shorebirds. **Recommendation j):** • **Explore options for removal of the derelict vessel and dumped materials and disposal at a designated dump site, ensuring removal does not cause more disturbance than a leave-alone strategy.** **See general recommendation 5.**

Priority barrier structures

One barrier in the Corio Bay region (listed in Table 3 and 4 below) was identified for priority management.

Corio Bay RAP Table 3. Priority barrier structures (separated into different structure categories) from Quarter 1 of the prioritisation matrix: less fish-friendly structures in higher value habitat

Structure category	Structure ID	Location
Weir/dam	WATE032WD	Weir, Waterpark Creek at the 'Pighole'

1) Weirs/dams

Weirs and dams are typically constructed to supply water for irrigation or human consumption or to provide flood mitigation. While weirs are generally smaller structures built across river channels rather than entire river valleys, both structures form significant physical barriers to fish movement.

The impact that a dam or weir has on fish passage is influenced by the frequency, timing and duration of drown out. Drown out occurs when there is sufficient water flow across the structure to breach it. Fish movement is optimised during drown out when the water levels above and below the barrier are equal and there is sufficient water depth across the barrier for fish to swim through. Some weirs and dams may drown out completely and continuously, while others do not drown out at all, preventing all upstream fish passage and disrupting life cycles.

Corio Bay RAP Table 4. Recommended Response Actions for individual management of priority weirs/dams

Structure	Location	Response Actions / Recommendations
Rock wall WATE032WD	The 'Pighole', Waterpark Creek	This structure is located approximately 2.5 km downstream of the Waterpark Creek weir (see below). While the rock wall is outside the Ramsar boundaries, it is located in Waterpark Creek that flows directly into the Ramsar site. The location of the rock wall marks the northern extent of the FHA and freshwater/tidal interface of Waterpark Creek. A second rock wall is located approximately 150 m upstream of WATE032WD. The wall (WATE032WD) consists of a rock base overlaid with concrete. The concrete was added to raise the wall to prevent saltwater intrusion. These works have apparently been carried out, despite Fisheries Queensland refusal of application (Feb 2005) to permanently raise the height of the original wall that consisted only of rock at that time. The wall is considered to be causing a barrier to both upstream and downstream fish passage. **Recommendation k):** • **An assessment by Fisheries Queensland Northern fishway team be undertaken to determine fish passage impacts and remediation options** • **QBFP investigation.**

Other structures in areas adjacent to the Ramsar site

This section includes a summary of other structures (barriers) that were noted during the project to exist in the Corio Bay region (outside Ramsar boundaries). These structures were not identified as management priorities as part of the current project, but are listed (Table 5, below) because their locations within areas adjacent to the Ramsar site have implications for fish habitat or passage impacts on the Ramsar site downstream.

Corio Bay RAP Table 5. Other barriers in the Corio Bay region in areas adjacent to the Ramsar site

Structure	Location	Response Actions / Recommendations
Weir WATE030WD	Waterpark Creek	Constructed in 1952 to measure stream flow, the weir presents a significant barrier to fish movement during periods of medium and low flows (Marsden et al., 2009). The weir was ranked the 16th most important barrier to fish passage within the Fitzroy Basin, as part of the project Fitzroy Basin Fish Barrier Prioritisation, undertaken by Fisheries Queensland in 2008 (Moore & Marsden, 2008). Installation of a vertical slot fishway is being planned for the weir (Marsden et al., 2009). The weir was assessed as part of the current project, however was not identified as a high priority for management, given that it does drown out during high flows allowing limited fish passage to occur. The prioritisation criteria are currently being revised to ensure that seasonal barriers may be considered as high priorities for management in addition to those structures that pose a complete barrier to fish under all flow conditions.
Bund walls	Iwasaki wetlands	A series of bunds occur along the southern boundary of the Ramsar site and declared Fish Habitat Area (FHA) within the Iwasaki wetlands complex (Fisk et al., 2008). The historic bunds are situated at the freshwater/tidal interface and were originally built to prevent saltwater intrusion into pasture land associated with the earlier use of the land for grazing. The bunds may pose a barrier to fish movement. While these structures are not located within the Ramsar and declared FHA boundaries, they are immediately adjacent to these protected areas and any impacts of the bund walls therefore have implications for the values and connectivity of the Ramsar site and declared FHA downstream. Several sites within the Iwasaki wetlands have been identified by Fisheries Queensland as potential locations for the installation of fishways.