DEVELOPING CONTAMINANT MANAGEMENT PRIORITIES IN AUCKLAND CITY

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ABSTRACT

In developing the management approach to address marine and freshwater ecological effects arising from the discharge of stormwater contaminants, Auckland City Council and Metrowater are developing the Best Practicable Option (BPO) at a network wide level. The BPO requires consideration of environmental effects, sensitivity of the receiving environment, practicality, technical, time and financial constraints. Priority areas for contaminant management have therefore been identified for further assessment of the range of management interventions, by looking at receiving environment types and values, high zinc contaminant loads, areas of high sediment discharge and receiving environments where sediment has been accumulating. In each case, the attributes have been scored and total scores summed to identify overall priorities in an iterative process. These priorities have been illustrated through a number of GIS-based maps.

These priority areas are a valuable step in considering the BPO for contaminant management in Auckland City. By looking at the wider picture of environmental risks related to stormwater discharges across the city Auckland City Council and Metrowater are better able to address adverse environmental effects from stormwater discharges in key receiving environments and across the whole city.

KEYWORDS

Contaminant management, Best Practicable Option, catchment loads

PRESENTER PROFILE

Roger Seyb and Rachael Ouwejan are environmental engineers at Pattle Delamore Partners in Auckland. Roger has particular interest in the management of stormwater issues and in particular how these can be applied across stormwater networks. Rachael has developed the GIS based tools used in this paper to allow the prioritisation of contaminants across Auckland City.

1 INTRODUCTION

1.1 BACKGROUND

Auckland City Council and Metrowater have lodged network resource consent applications for discharges from Auckland City's stormwater and wastewater networks with the Auckland Regional Council. Marine and freshwater ecological effects arising from the discharge of stormwater contaminants have been identified as one of the main environmental effects from the discharge of stormwater in Auckland City.

In developing the management approach to address these effects, the Proposed Regional Plan: Air, Land, Water requires Auckland City Council and Metrowater to develop the Best Practicable Option (BPO). The BPO requires consideration of environmental effects, sensitivity of the receiving environment, practicality, technical, time and financial constraints, and can be at either a catchment or network level. Given that the discharges already exist in a mature urban environment, Auckland City Council and Metrowater are developing BPOs at a network wide level, in order to enable city wide priorities to be determined.

Contaminant management is therefore a key issue. As a city urbanises, sediment yields are high from greenfield development, and zinc yields are proportional due to natural background levels of zinc in sediment. However, as greenfield development decreases, as in Auckland City's case, sediment drops off and zinc increases from roofs and roads. Auckland City Council have implemented stormwater treatment in a number of areas with few large scale opportunities remaining. However, studies have indicated that zinc loads are still high across the city, and zinc is now considered the contaminant of concern. Due to much of the zinc load being in the dissolved phase, management of zinc requires a different management approach to particulate contaminants, such as source control or targeted treatment.

While roof loads are expected to reduce over time, due to natural replacement of high zinc roofs (PDP, 2007), loads from other sources (such as roads) are expected to increase. Sediment load is also low, compared to pre-development levels, as a result of a high level of impervious surface, but specific sources such as streambank erosion and small site redevelopment are expected to remain.

This paper considers the effects arising from zinc and total suspended solids (TSS) in stormwater and identifies priorities for contaminant management. This information will later be used in establishing the BPO for stormwater contaminant management across the City.

1.2 OBJECTIVES AND OUTPUTS

The aim of this project was to identify priority areas for further assessment and where management intervention will result in the greatest environmental benefit. For zinc management, this has been based on the high zinc contaminant loads in the network from the work previously undertaken by NIWA and from looking at receiving environment types and values. For potential sediment discharge reduction, priority areas have been identified by looking at areas of high sediment discharge and accumulation in the receiving environments.

In each case, the attributes have been scored and total scores summed to identify overall priorities. Priorities are illustrated through a number of GIS-based maps.

2 METHODOLOGY

2.1 GENERAL

ArcView GIS has been used as a tool to overlay existing data in shape files to identify priority catchments and specific areas for further stormwater management intervention. In general, factors which present a risk to receiving environment values and factors representing those receiving environment values and/or physical properties have been used as set out below.

2.2 INPUTS

2.2.1 RECEIVING ENVIRONMENTS

Two receiving environment issues were considered:

- The physical settling properties of the receiving environment – ie. its susceptibility to settlement and accumulation of sediment and zinc;
- For zinc loads only, the ecological values of the receiving environment.

Ecological values were not considered for the determination of sediment priority areas due to the fact that sediment loads are generally relatively low and are unlikely to be at levels that affect ecological areas (unless they are specific areas of sediment accumulation). Zinc, however, is at higher levels and may affect receiving environments outside of those areas where it accumulates fastest due to local sources.

The receiving environments considered are shown in Figure 1. They have been grouped from high to low risk in terms of settling properties:

- Estuarine or Closed marine waters – settling zones/primary depositional areas
- Estuarine or Closed marine waters – outer zones/secondary depositional areas
- Open marine waters
- Groundwater via soakage

Stormwater discharges to ground and combined sewers were considered low risk, due to treatment effectively being achieved through either the wastewater treatment system or natural percolation of stormwater through the unsaturated zone. The base loads did not contain loads for the soakage areas. In terms of the marine receiving environment, discharges to ground were assumed to remove that load from the consolidated catchment.

Settling areas were originally identified by Diffuse Sources for the ARC (Diffuse Sources, 2002 and ARC, 2002) and are defined as “the area in which the most (nominally 75%) of the catchment derived contaminants (usually stormwater) settle and accumulate”. These boundaries have been slightly amended in this project for the primary and secondary depositional receiving environments, based on information on measured levels and trends and modelled rates of accumulation using harbour modelling (CREA) (Uniservices Ltd, 2005).

Areas with high ecological values have been selected based on Coastal Protection Areas (CPAs) and areas of significant conservation value as identified by DOC, both listed in the Regional Plan: Coastal. Coastal Protection Areas with ecological values are shown on the maps.

Previous work has been carried out to classify streams in Auckland City, to provide a broad indication of the relative values of the city's watercourses (NIWA, 2005). For freshwater receiving environments, the habitat values assigned in NIWA (2005) have been used to represent the ecological value of the stream. The exception to this is streams which are identified as either Type 5 or 6 under the Proposed Auckland Regional Plan: Air, Land & Water, or are concrete or rock lined. These reaches are considered to have low erosion potential and are not considered to be at risk.

2.2.2 LOADS

In addition to the above, other risk factors for zinc and sediment used as part of the scoring process to develop priority areas include the following data:

- Zinc – Traffic data for high use roads and contaminant load predictions (current and 2050);
- Sediment – Growth areas.

The load assessment takes existing Auckland City Council contaminant removal devices and/or practices into account.

Zinc

Zinc loads have been based on those calculated for Auckland City Council/Metrowater by NIWA (Reed & Webster, 2005). These loads have been updated to account for a review of founding assumptions – in particular, including the zinc loads from residential, commercial and industrial roofs (PDP, 2007).

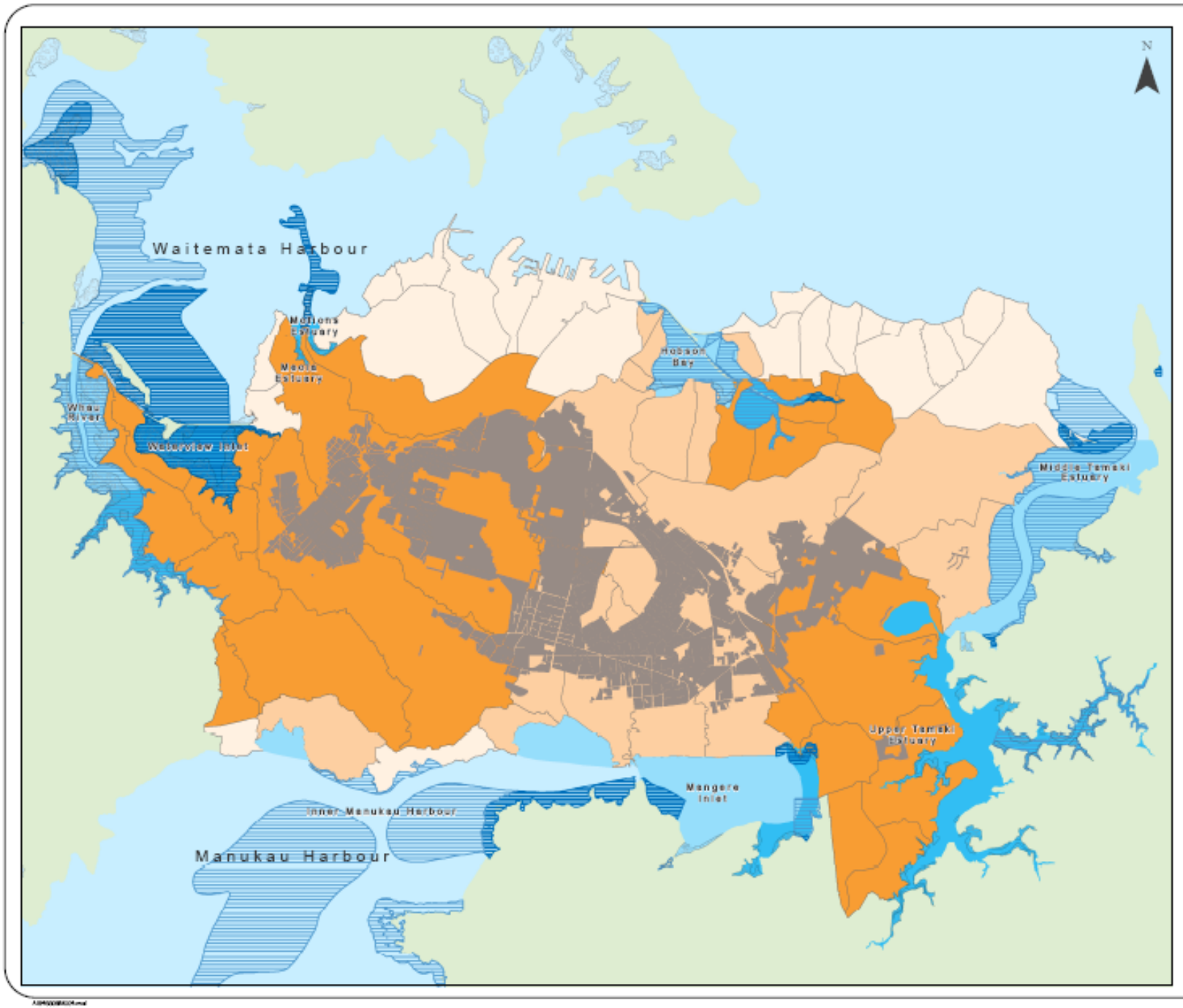
The loads from each consolidated catchment were placed into bands to enable scoring of the risk from high loads. A number of different band widths were considered and tested in the prioritisation process. The upper band of the zinc loading was set at 1000kg/annum to ensure that two catchments with very high zinc loads did not prevent other catchments from being identified as priorities.

Traffic count data was used for the separate assessment of priority roads and not in the overall catchment prioritisation. These roads were identified because roads were assumed to be a significant secondary source of zinc and so that as roading projects occurred, those roads with a high priority for stormwater management could be specifically managed.

Sediment

The presence of a growth area was taken to represent a potential increase in stormwater runoff volume and the potential for increased contaminant generation from stream erosion and small site erosion during development. Specific growth nodes have not been accounted for in the contaminant load estimates to date and they have therefore been included here as a separate risk factor for sediment generation.

This was assumed not to be the case for zinc as it was assumed low-zinc generating roofing products would be used for new residential applications and the number of new industrial and commercial growth areas was limited.



Key :

Marine receiving environment type

- Primary
- Secondary
- Open
- Scalaja Area

Coastal Protection Areas (ecological)

- CPA 1
- CPA 2

Enclosed marine areas

- Primary Depositional Rec. Environment
- Secondary Depositional Rec. Environment

No.	Revision	Date	App.
C	Receiving env update	Oct 07	R.O.
B	Revised Draft	Sept 07	R.O.
A	Draft	May 07	R.O.

Client : Auckland Waterways

Project :

Stormwater Quality Priority Areas Assessment

Title :

Receiving Environments

pdp

Scale 1:75,000 (A3)

Project No. :	Figure No. :	Revision :
AJ848308	1	C

2.3 PRIORITY AREAS

Table 1 below summarises the combinations of factors used to generate each priority areas map.

Table 1: Factors used to identify priority areas

Priority Area Type	Receiving environment factors	Risk factors
Zinc – catchment	Coastal Protection Areas - ecological Marine receiving environment type	Zinc loads
Zinc – roads	Coastal Protection Areas - ecological Marine receiving environment type	Traffic volumes
TSS – catchment	Marine receiving environment type	Growth nodes
Streams	Freshwater Ecological classification (NIWA)	Potential imperviousness increase

When determining priority areas, a score was given for the presence of each risk factor or receiving environment type. Scores were whole numbers, identified from ranking the factors and placing each item into a band as set out in Table 2 below.

Zinc loads were taken from the recent PDP study incorporating updated factors for zinc from residential roofs (PDP, 2007). While scores were allocated for most risk factors on a quantitative basis, the scores for growth nodes in consolidated catchments were allocated based on a visual assessment of the presence of that factor within the catchment.

Table 2: Scores for each factor

Receiving environment or Risk factor	Band	Score	Comment
Marine receiving environment	Primary depositional Secondary depositional Open water Soakage	3 2 1 0	See section 2.2.1 above. For Sediment rating, the receiving environment score was adjusted for the proportion of each catchment discharging to soakage or the

			combined sewer.
Coastal Protection Area (CPA) – ecological	None CPA 2 CPA 1	0 1 2	Scores allocated for CPAs bordering consolidated catchments
Zinc loads	< 250 kg/annum 250 - 500 kg/annum 500 - 750 kg/annum 750-1000 kg/annum > 1000 kg/annum	1 2 3 4 5	PDP, 2007
Traffic volumes	< 20,000 vehicles per day (vpd) 20,000-30,000 vpd 30,000-40,000 vpd >40,000 vpd	0 1 2 3	Annual average estimate of traffic volume retrieved from Auckland City Council Roading & Asset Management database (updated June 2006)
Growth nodes	No growth nodes within catchment 1 growth node within catchment 2 growth nodes within catchment	0 1 2	Auckland City's growth nodes (Priority 1)
Freshwater ecological classification	Concrete or rock lined channel Low (0-3) Medium (3-6) High (>6)	0 1 2 3	Habitat rating as classified in NIWA, 2005b.
Potential imperviousness increase	0-1% 1-10% 10-17.5% 17.5-25%	0 1 2 3	Catchment average, as assessed by Metrowater from District Plan zoning and 2001 aerial photos for Drainage System

	25%+	4	Reports, 2005

3 RESULTS

The results were evaluated in a number of stages to verify that the scoring process produced realistic answers. This meant that there was an iterative process of checking that appropriate factors were being applied. It is recognised that one of the issues with this type of approach, is that while quantified scores have been used to provide objectivity, it is still necessary to undertake a 'reality check' of the results to make sure they appear logical in terms of the overall physical characteristics of the catchments and receiving environments.

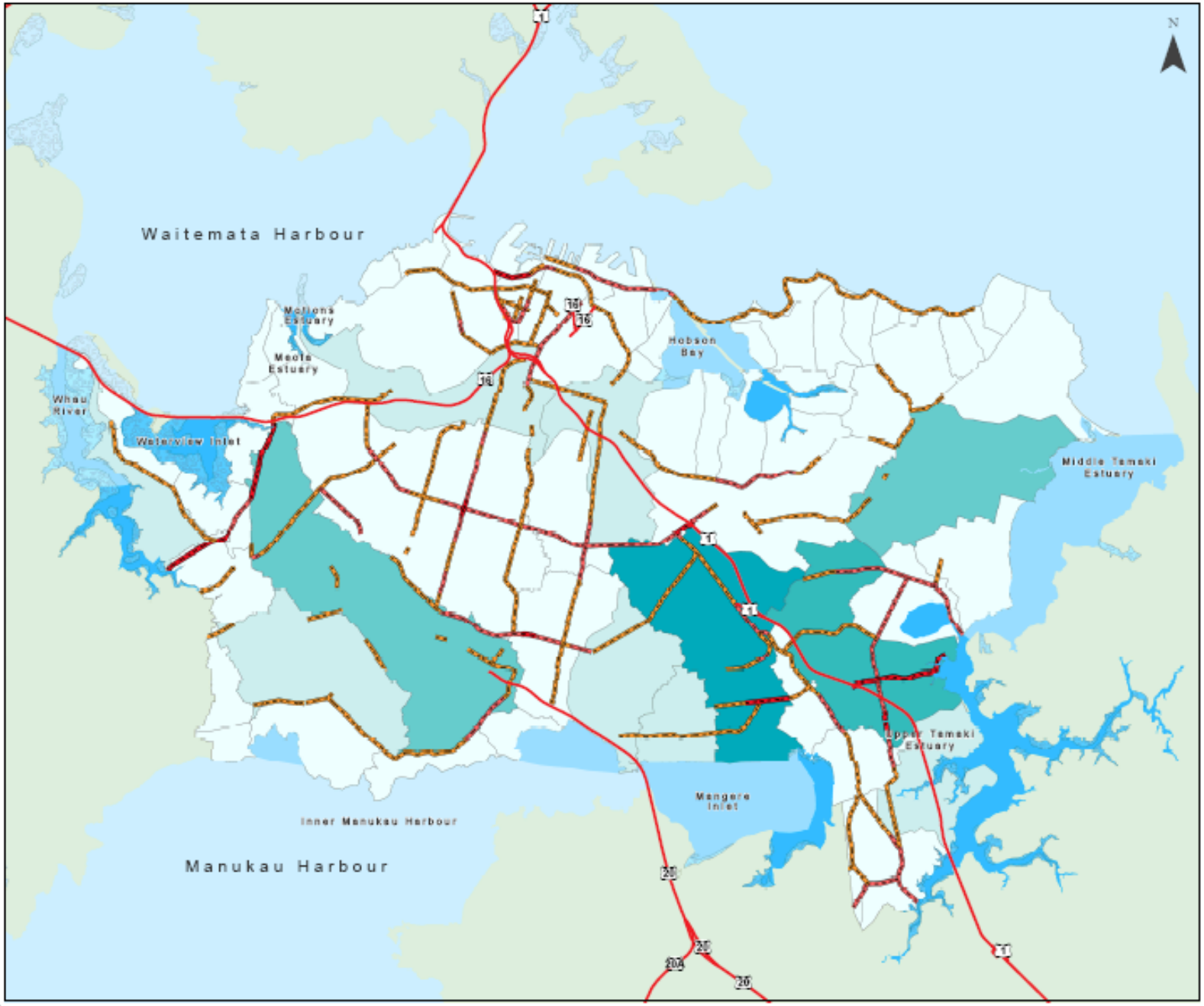
Risk factors and marine receiving environments for zinc are shown in Figure 3. Priority high use roads for zinc management are shown in Figure 4.

The resulting priority consolidated catchments for zinc management are shown in Figure 5. Figure 5A shows business zoning and priority roads within these priority consolidated catchments in order to assist in identification of what the specific priorities for management may be.

Risk factors and marine receiving environments for sediment are shown in Figure 6. Priority consolidated catchments for sediment management are shown in Figure 7.

Risk factors and freshwater receiving environments for streams are shown in Figure 8. Priority consolidated catchments for stream management are shown in Figure 9.

Due to the differing lengths of stream in each catchment, and the reasonably subjective nature of the analysis, streams have not been split into medium and high priorities.



Key :

Enclosed marine areas

- Primary Depositional Rec. Environment
- Secondary Depositional Rec. Environment

Vehicles per day (June 2006)

- 20,000 - 30,000
- 30,001 - 40,000
- 40,000 +

Total Zn load per catchment (kg/yr)

- 0 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 +

Note:
This figure shows key contaminant sources for zinc and receiving environments at risk from zinc accumulation. Zinc loads within consolidated catchments consist of residential, commercial and industrial landuses, divided into road, roof and natural sources (PDP, 2007).

No.	Revision	Date	App.
B	Revised Draft	Oct 07	R.O.
A	Draft	May 07	R.O.

Client : Auckland Waterways

Project :

Stormwater Quality Priority Areas Assessment

Title :

Zinc Sources & Marine Receiving Environments

pdp

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Project No. :	Figure No. :	Revision :
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Key :

Roads to sensitive receiving environments

(Vehicles per day June 2006)

- 20,000 - 30,000
- 30,001 - 40,000
- 40,000 +

Roads to open marine areas & soakage

(Vehicles per day June 2006)

- 20,000 - 30,000
- 30,001 - 40,000
- 40,000 +

Consolidated catchments

Enclosed marine areas

- Primary Depositional Rec. Environment
- Secondary Depositional Rec. Environment

Note:
This figure shows the management priorities for zinc with respect to high use roads.

No.	Revision	Date	App.
B	Revised Draft	Sept 07	R.O.
A	Draft	May 07	R.O.

Client : Auckland Waterways

Project :

Stormwater Quality Priority Areas Assessment

Title :

Zinc Priority Areas: High Use Roads

pdp

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Scale 1:75,000 (A3)

Metres

Project No. :	Figure No. :	Revision :
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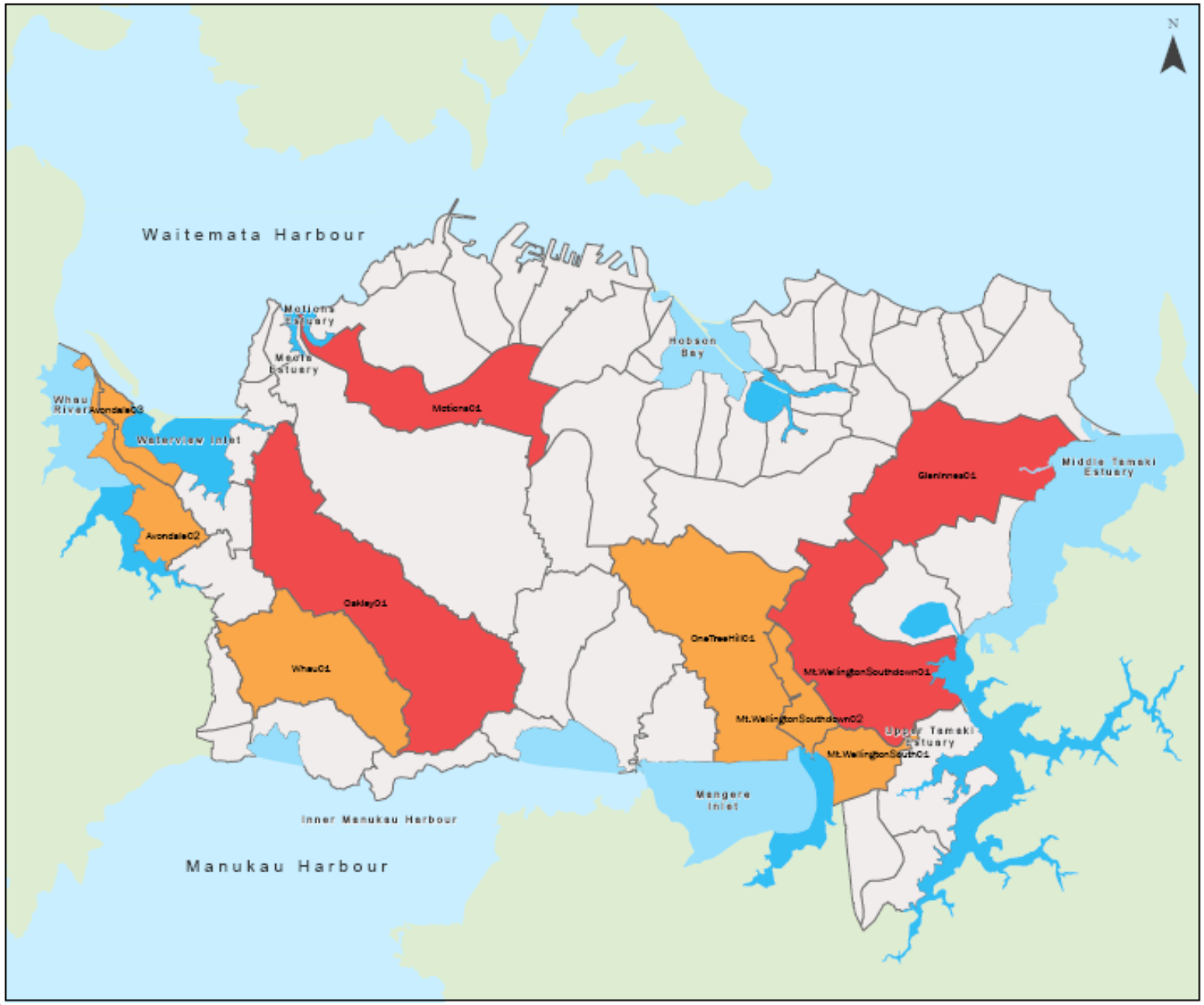


Key :

Zinc management priority

- Low
- Medium
- High

Enclosed marine areas

- Primary Depositional Rec. Environment
- Secondary Depositional Rec. Environment

Note:
This figure shows the overall results for the priority assessment for zinc in terms of marine receiving environments.
The priorities were obtained by combining factors for receiving environment sensitivity and total zinc loads from each consolidated catchment.

No.	Revision	Date	App.
B	Revised Draft	Oct 07	R.O.
A	Draft	July 07	R.O.

Client : Auckland Waterways

Project :

Stormwater Quality Priority Areas Assessment

Title :

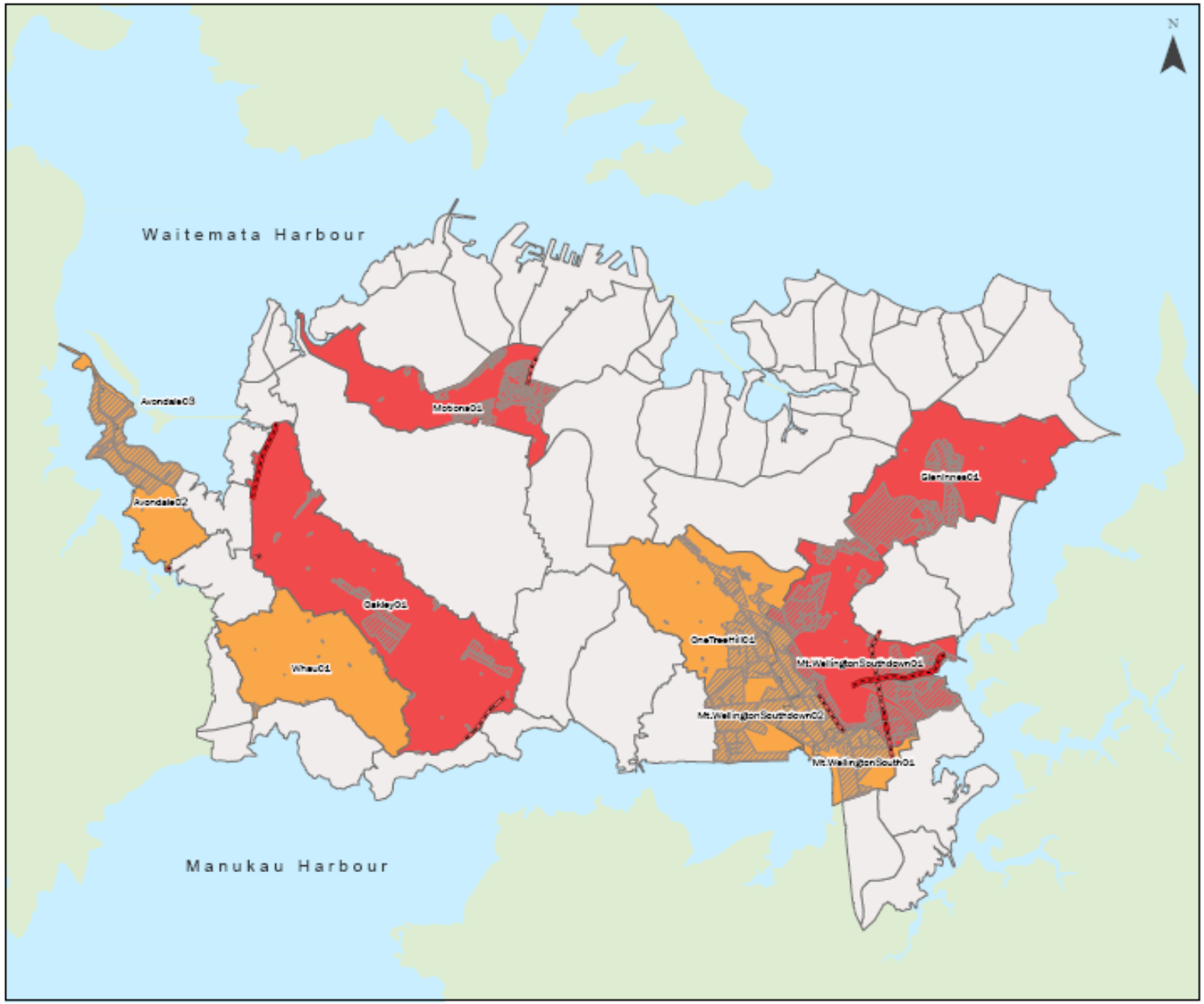
Zinc Priority Areas by Consolidated Catchment

pdp

Scale 1:75,000 (A3)

Metres

Project No. :	Figure No. :	Revision :
AJ848308	5	B



Key :

Priority roads within priority catchments

(Vehicles per day June 2006)

30,000 - 40,000

40,000+

Business zoning within priority catchments

Zinc management priority

Low

Medium

High

Note:
This figure shows priority roads and business (industrial/commercial) zoning within the zinc priority catchments identified in Figure 5.

No.	Revision	Date	App.
A	Draft	Oct 07	R.D.

Client : Auckland Regional Council

Project :

Stormwater Quality Priority Areas Assessment

Title :

Priorities within Zinc Priority Areas

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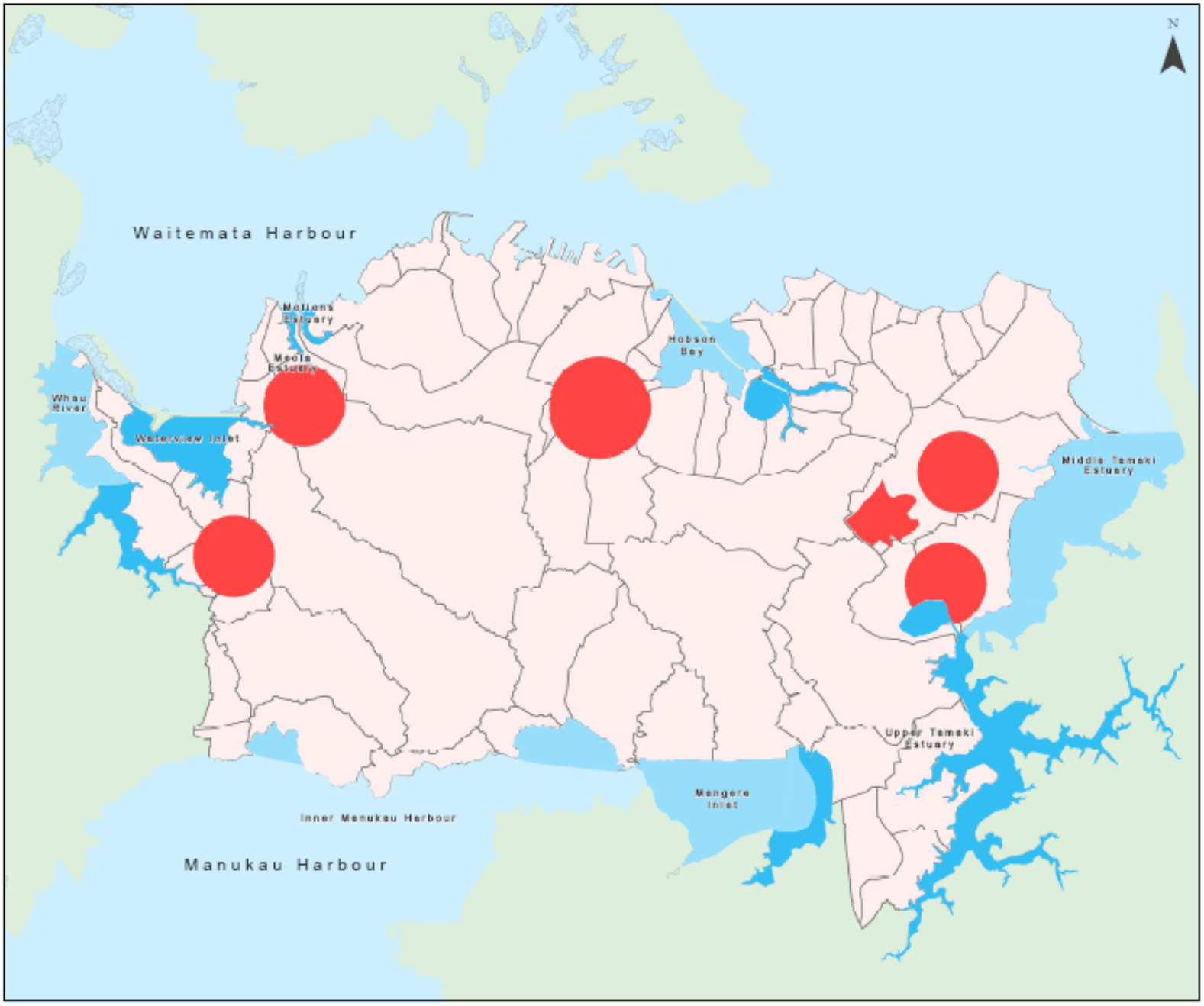
Scale 1:75,000 (A3)

Metres

Project No. :	Figure No. :	Revision :
AJ848308	5A	A



Key :

Priority 1 growth nodes

Consolidated catchments

Enclosed marine areas

Primary Depositional Rec. Environment

Secondary Depositional Rec. Environment

Note:
This figure shows key sources for sediment and marine receiving environments at risk from sediment accumulation.
Key sediment sources were identified as the presence of priority 1 growth nodes.

No.	Revision	Date	App.
C	Revised Draft	Oct 07	R.O.
B	Revised Draft	Sept 07	R.O.
A	Draft	May 07	R.O.

Client : Auckland Waterways

Project :

Stormwater Quality Priority Areas Assessment

Title :

Sediment Sources & Marine Receiving Environments

pdp

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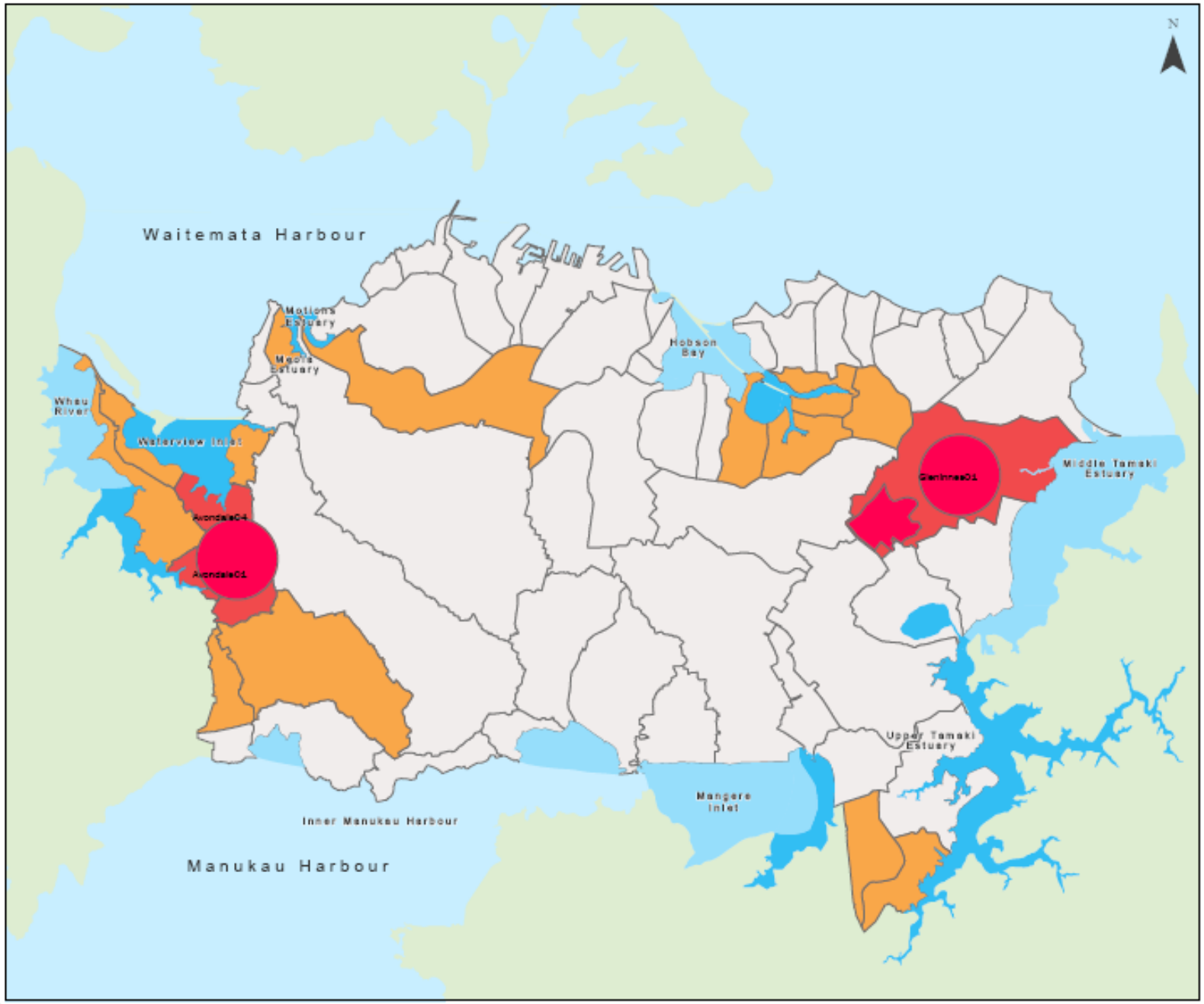
Scale 1:75,000 (A3)

Project No. :	Figure No. :	Revision :
AJ848308	6	C



Key :

Sediment management priority

- Low
- Medium
- High

Priority 1 growth nodes within priority areas

Enclosed marine areas

- Primary Depositional Rec. Environment
- Secondary Depositional Rec. Environment

Note:
This figure shows the overall results for the priority assessment for sediment in terms of marine receiving environments.
The priorities were obtained by combining factors for receiving environment sensitivity and growth from each consolidated catchment.

No.	Revision	Date	App.
C	Revised Draft	Oct 07	R.O.
B	Revised Draft	Sept 07	R.O.
A	Draft	July 07	R.O.

Client : Auckland Waterways

Project :

Stormwater Quality Priority Areas Assessment

Title :

Sediment Priority Areas by Consolidated Catchment

pdp

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Project No. :	Figure No. :	Revision :
AJ848308	7	C

Key :

Potential imperviousness % change

- Site developed to proposed limit
- 0 - 20%
- 20 - 40%
- 40 - 60%
- 60 - 80%
- 80 - 100%

Special Purpose 2 zoning (education)

Open Space zoning

Urban streams

Habitat value

- Low
- Medium
- High

Consolidated catchments

Note:
This figure shows key risk factors for freshwater receiving environments. Risk factors were identified as potential imperviousness change and sensitivity of receiving environment.

No.	Revision	Date	App.
C	Final	Dec 07	R.O.
B	Revised Draft	Oct 07	R.O.
A	Draft	July 07	R.O.

Client : AUCKLAND WATERWAYS

Project :

Stormwater Quality Priority Areas Assessment

Title :

Stream Risks & Freshwater Receiving Environment

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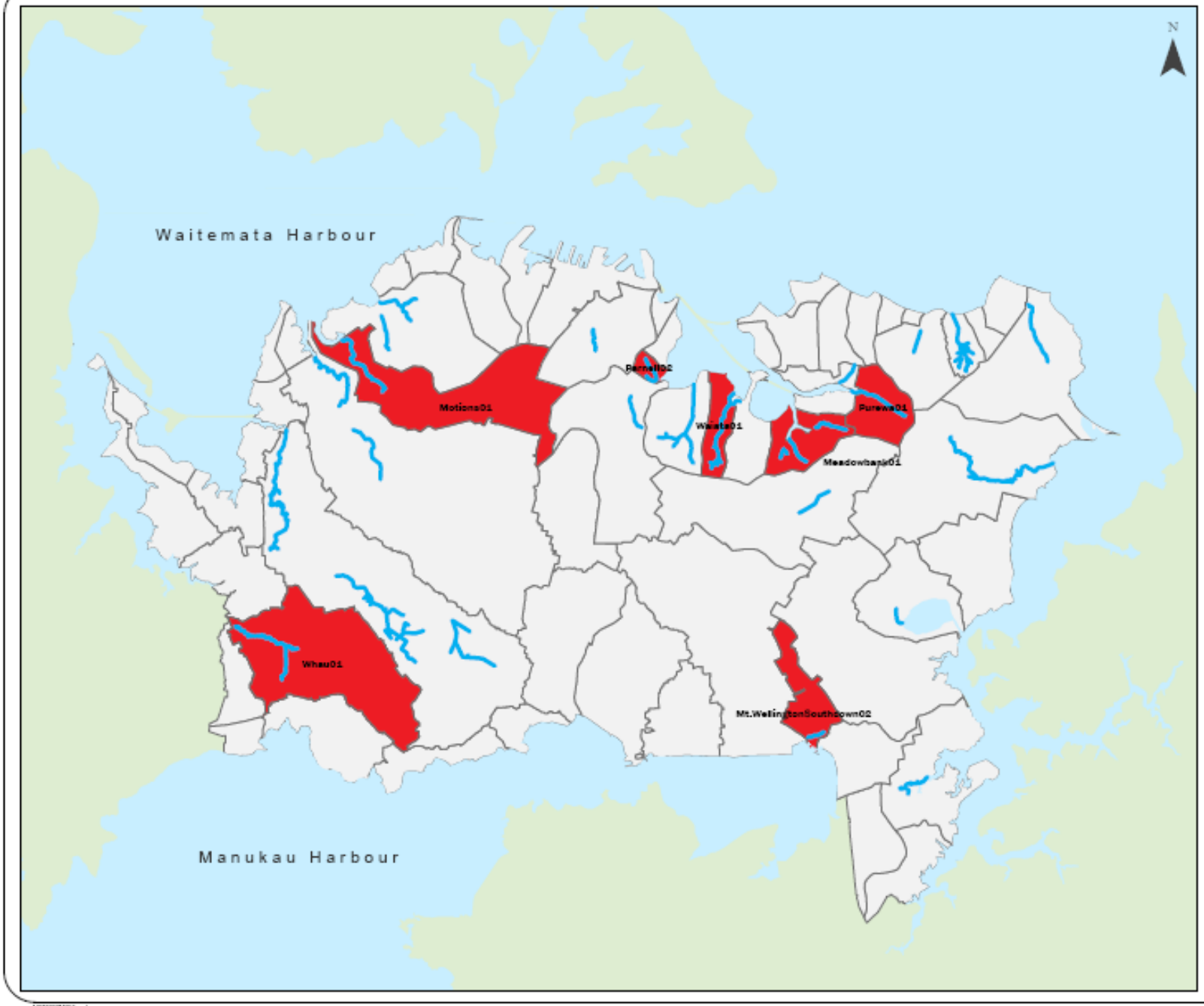
Project No. :	Figure No. :	Revision :
AJ848308	8	C



Key :

Urban Streams

Stream management priority

Low

Medium - High

Note:
This figure shows the overall results for the priority assessment for freshwater receiving environments. The priorities were obtained by combining factors for potential imperviousness change in the catchment and receiving environment sensitivity.

No.	Revision	Date	App.
C	Final	Dec 07	R.O.
B	Revised Draft	Oct 07	R.O.
A	Draft	July 07	R.O.

Client : AUCKLAND WATERWAYS

Project :

Stormwater Quality Priority Areas Assessment

Title :

Stream Priority Areas by Consolidated Catchment

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Scale 1:75,000 (A3)

500 250 0 500 1,000 1,500 2,000 2,500 3,000
Metres

Project No. :	Figure No. :	Revision :
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4 CONCLUSIONS

A series of maps have been produced identifying at-risk receiving environments, contaminant loads, risk factors, and priority catchments for management of zinc, sediment and streams in Auckland City. Through an iterative process, a number of identified risk factors were combined to allocate scores to the various consolidated catchments, to identify those catchments which require further assessment. These identified priority areas will be used to help determine where stormwater contaminant management methods should be prioritised in order to obtain the most environmental benefit. This is a key element in Auckland City Council and Metrowater's network wide approach, and an input into the process of determining the BPO for stormwater contaminant management in the city.

Consolidated catchments that are considered high priority for zinc only are Oakley, Avondale 3, Motions, Glen Innes, Mt Wellington South and Mt Wellington Southdown 1 & 2. Avondale 1 and Avondale 4 are considered a high priority for sediment only.

The consolidated catchments (and streams) that have been identified as high priority areas for stream management are Whau, Motions, Parnell 2 (Newmarket), Waiata (Orakei), Meadowbank 1 (Meadowbank) and Purewa 1.

A number of other catchments have been identified as medium priority for management of zinc and/or sediment.

These priority areas are a valuable step in considering the BPO for contaminant management in Auckland City. In order to translate these priority areas into a BPO, a number of options need to be compared, along with their financial implications, time constraints and expected environmental outcomes. By looking at the wider picture of environmental risks related to stormwater discharges across the city, it is expected that Auckland City Council and Metrowater are better able to address adverse environmental effects from stormwater discharges in key receiving environments and across the whole city.

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