Attachment One

I410.11.1: Attachment 5 (Drury South Appendix)

APPENDIX: DRURY SOUTH PRECINCT – SUBDIVISION DESIGN ASSESSMENT CRITERIA

PURPOSE OF APPENDIX I410.11.1

Within the Drury South Precinct, applications for any subdivision or any development of land which precedes a subdivision being undertaken which complies with Standard I410.6.3 as a restricted discretionary activity will be assessed in terms of a series of matters to which the Council will restrict the exercise of its discretion. One of the matters which the Council will have regard to as set out in standard I410.8.2(1)(d)is:

> *the extent to which subdivision design and layout gives effect to the objectives and policies identified for the Drury South Precinct and the subdivision design assessment criteria set out in Appendix I410.11.1.*

In addition, the criteria will also be used in the consideration of discretionary applications for subdivision, as appropriate.

This appendix sets out assessment criteria under a number of "Design Elements". Accompanying illustrations are intended to support the text and represent good design solutions, but are not intended to represent the only design solution. All illustrations are indicative only.

Each Design Element includes an explanation, which summarises the rationale for the particular Design Element and expands on the individual criteria. The explanation may be used as further guidance in interpreting the intention of the criteria and assessing the extent to which the proposal accords with them.

INFORMATION REQUIREMENTS

The applicant shall provide a written assessment describing how the criteria for each Design Element are addressed. Applicants will have to demonstrate that the provisions of the criteria have been acknowledged.

It is recognized that certain proposals will not achieve absolute accordance with all criteria. Where necessary, in regard to a criterion demonstrably not met, the applicant shall explain with reference to the explanation for the particular Design Element:

- whether site constraints inhibit the ability to address the criterion, and/or;
- how the intention of the criterion is met by the proposal, and/or ;
- whether the proposal represents a better design solution than that suggested by the criterion.

Planting plans and maintenance plans for recreation and esplanade reserves and stormwater management areas will need to be submitted with applications for subdivision consent and approved by the Council.

Design Element 1: Road, Reserve and Access Networks:

1. Earthworks should be undertaken principally at the initial subdivision stage, and where appropriate the creation of reasonably flat sites should occur at the bulk earthworks stage (in order to avoid creating retaining walls at site development stage).

2. Road patterns should maximise convenient / direct access to the Maketu Road and limit connection to existing rural roads (such as Ararimu Road) except where this relates to the wider essential network.

3. The road pattern should facilitate access to and accessibility within Sub-precinct C Mixed Use.

4. Road patterns should be logical and contribute to the legibility of and ease of wayfinding within the area *(refer Diagrams 1 and 2 for generic legibility and proposed street hierarchy)*.

5. Subdivision layout design should achieve protection and enhancement of all significant streams / tributaries to be retained and their riparian corridors (20m minimum either side from edge of stream) and concentrate open space as part of the riparian network *(refer Diagram 3)*.

6. Subdivision layout design should achieve an interconnected open space and movement network.

7. Safe pedestrian and cycle routes through the structure plan area should be integrated with the riparian, reserve and road design.

8. Equestrian bridle trails should be integrated with riparian reserve development and provide access to the large centrally located public open space / stormwater management area.

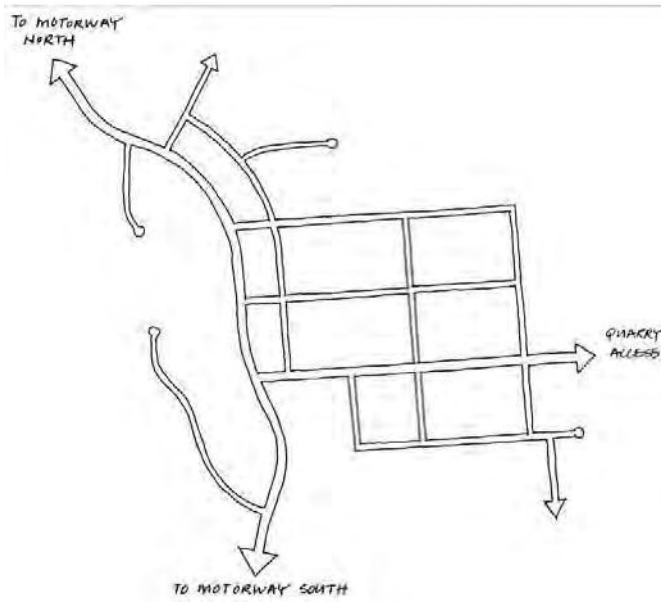


Diagram 1: Legible road hierarchy to assist wayfinding

Diagram 2: Road hierarchy

9. Layouts should retain mature trees within the riparian corridors, particularly those of indigenous species.

10. In Motorway Edge Sub-precinct areas layouts should seek to retain as many existing established trees, particularly those of indigenous species, as possible.

11. In Motorway Edge Sub-precinct, areas access to sites off the Maketu Road should be combined wherever practicable.

Explanation:

Design Element 1 pertains to the overall site topography and the general layout of the networks of roads, reserves and other access linkages that make up the public space of the Drury South Precinct. These should be considered in an integrated fashion together with the development blocks that they create.

The existing site topography within the proposed Precinct is relatively flat although bulk earthworks including cut and fill will
be required to establish levels for future development above the flood plain and appropriate falls across the land.

Diagram 3:Open space concentrated along Hingaia, Maketu, Roslyn and Northern Diversion Stream corridors

The riparian corridors of the Hingaia and Maketu Streams and their significant tributaries will remain an important feature of the site topography once the Precinct is established. Vegetation associated with these corridors is also important to the structuring, screening and ecology of the area and its proposed activities.

The riparian corridors also provide a focus for future recreation and open space development and form part of the enhancement framework for the Precinct.

The road network and hierarchy (refer Diagrams 1 and 2), has been designed to efficiently direct traffic into and out of the Precinct connecting to the Southern Motorway (SH1) at both the Ramarama (south) and Drury (north) interchanges. The proposed Spine Road is important to the legibility and traffic efficiency of the Precinct; this route will provide the primary connection into and out of the Precinct with other streets connected to the Maketu Road through corridor.

The proposed street network has also been designed to limit the impact of vehicles destined for the Precinct on existing rural residential and community roads such as the road accessing and adjacent to the Ramarama School. Implementation of the street network to achieve the beneficial improvements to heavy vehicle (including quarry truck) and other Precinct related traffic movement is imperative as a part of delivery of the zone.

By its nature the Sub-precinct C Mixed Use will require a finer grain street network with smaller street blocks, greater walkability, good service access and parking.

A legible road pattern (refer Diagram 1) is one that is easily understandable for the people that use it and that provides cues for first time users as well as those habitual users. Consistent road design and landscape themes can further emphasise the position of each street in the road hierarchy and in the pattern of streets in the wider area. Road patterns that are logical and easy to comprehend and navigate make an area feel more comfortable and help to provide a sense of identity.

Design Element 2 - Block Size, Lot Type and Orientation:

1. Blocks should be of a scale and shape to achieve a permeable street layout suited to the functional requirements of the proposed land use.

2. All lots should front onto and be accessed directly from a legal road. Rear lots are to be avoided *(refer Diagram 4)*.

3. Through lots (with dual road frontage) are permissible *(refer Diagram 4)*.

Explanation:

Design Element 2 describes the principles for consideration in the layout of blocks and lots within the Precinct.

Blocks within an industrial area are typically larger than those within finer grain residential or Mixed Use areas. A good permeable and well connected-street network is however still required in Light and Heavy Industry Sub-precincts A, B and E to facilitate access, provide an appropriate street address and reduce traffic volumes on side streets. Within Sub-precinct C Mixed Use, Design Element 1 also provides opportunities for views through to the open space corridor to the west of the Sub-precinct from Maketu Road.

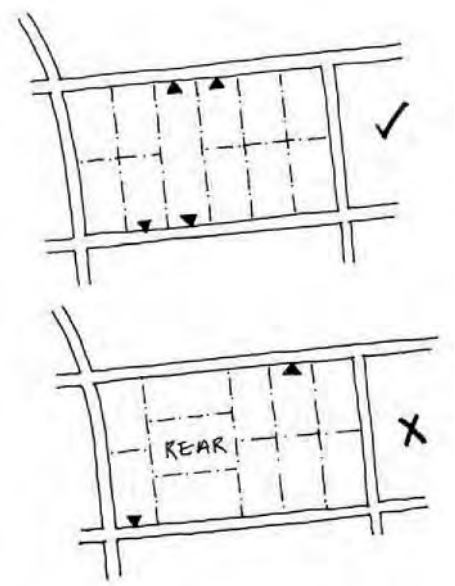


Diagram 4: All lots should front onto a legal road; through lots are permissible

Lots need to be of a size and shape to accommodate large scale, land extensive land uses and flexible to enable reasonable long term growth. At the same time rear lots are considered undesirable with a preference for development to address the street.

Design Element 3 - Roads and Accessways:

1. In addition to Auckland Transport Code of Practice and Council's Development Code requirements, minimum road and design elements should be appropriate to the nature of the function that they provide and also reflect urban design legibility considerations – i.e. wayfinding, as set out in Table 1 below.

2. Cyclists should be accommodated on the street carriageway.

3. A consistent palette of traffic management tools should be used across the Precinct. Traffic management devices such as chicanes, speed humps and other such restrictive management devices are not expected, however the use of thematic planting and measures such as localised narrowing to create thresholds or define changes in the street environment could be used.

4. All streets are required to accommodate strong avenue specimen tree planting. Refer Cross Sections Attachment 1. This planting is required to achieve the breaking up of the overall scale of the development particularly as seen from elevated locations, as well as to establish the enhanced expected amenity and character of the Precinct.

5. In addition to the street avenue planting a planted central median is also required on the roads identified as 'Arterial' and 'Parkway'.

Explanation:

Design Element 3 pertains to principles for the design of roads and other access routes within the Precinct. Road design should be appropriate to function and provide practical widths for vehicular access, including for emergency vehicles, parking, planting and services.

Pedestrian and cycle paths should generally be integrated with road and reserve design. Paths which are separated from vehicle routes should be designed for safety.

Table 1 below sets out the indicative function and design elements of the collector roads within the Drury South Precinct.

Table 1 – Indicative Road Function and Required Design Elements

Road Name	Proposed Role and Function of Road in Precinct Area	Freight or Heavy Vehicle Route	Minimum Road Reserve[2]	Total Number of Lanes	Design Speed (kph)	Access Restriction	Bus Provision[4]	Median	Cycle Provision[5]	Pedestrian Provision
Maketu Road[1] South of Link Road	Arterial	Yes	33.45m	4	60	Yes[3]	Yes	No	Yes – separated	Both Sides
Maketu Road (North of Link Road)	Collector	Yes	27.65m	2	60	Yes[3]	Yes	Yes (Flushed)	Yes	Both Sides
New Quarry Access Road[1]	Collector	Yes	27.65m	2	50	No	Yes	Yes (Flushed)	Yes – shared path	Both Sides
Link Road	Collector	Yes	27.65m	2	60	No	Yes	Yes (Flushed)	Yes	Both Sides
Ramarama Road (Fitzgerald Road Connection)	Collector	Yes	21m	2	50	No	Yes	Yes (Flushed)	Yes	Both Sides

Note 1: Already have Engineering Plan Approval and are under construction
Note 2: Typical minimum cross section which may need to be varied in specific locations where required to accommodate batters, structures, intersection design, significant constraints or other localised design requirements.
Note 3: Refer to Assessment Criteria I410.8.1(2)
Note 4: Carriageway lanes and geometry of intersections capable of accommodating buses.
Note 5: Type of cycle provision, i.e. separated or shared path, to be confirmed at the Engineering Plan Approval stage, based on nature and character of the Local Road.

Design Element 4: Reserves, Stormwater Management Areas and Riparian Planting:

1. Stormwater detention and treatment reserves should be located in general accordance with the locations shown in the Drury South Precinct Plan and in accordance with the relevant stormwater discharge consents, the Council's Development Code and relevant technical publications. The Cross Sections (Attachment 2) illustrate the Typical Wetland Stormwater Pond and Typical Stream Corridor Cross Sections.

2. Stormwater ponds should be designed to fit in with the surrounding landscape and appear as an integrally designed infrastructural component of the overall setting.

3. Vegetated buffers, not less than 40m in total width for any retained permanent or diverted stream, should be provided on the margins of streams, ponds and wetlands and should:

    - Include native species as identified in Attachment 3;
    - Include native trees on the lower and upper banks of ponds predominantly to the north and west to provide shade;
    - Provide a minimum of 10m of native planting either side of the stream corridor including shallow water rushes and sedges;
    - Avoid vegetation that will exacerbate flooding and the blockage of water flood flows along the immediate riparian corridor.

    The only exception to these requirements is the retained permanent stream in the northwest of the Precinct (adjacent to the Transpower site) which will be subject to a minimum requirement of 10m of native planting either side of the stream corridor only.

Note: Attachment 5 sets out 'Stream and Wetland Rehabilitation Guidelines (June 2013) for the DSSP area.

4. Walkways / cycleways along riparian corridors and through buffer planting should be designed to minimise any impacts on ecological function and give due consideration to personal safety and Crime Prevention Through Environmental Design (CPTED) principles.

5. Edge buffer reserves should be located in accordance with the Drury South Precinct Plan, be a minimum of 30m in width and be planted in generally accordance with Diagram 5 below. Planting should be fast growing rural shelter belt species capable of attaining a minimum height of 6 metres at maturity.

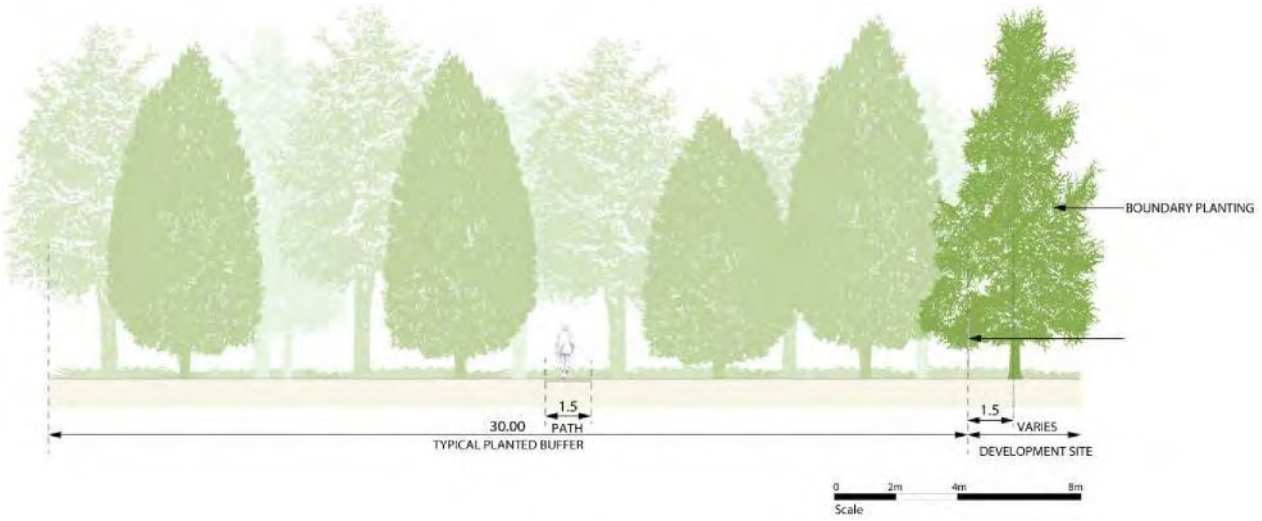


Diagram 5: Typical landscape buffer cross section

6. Suitable mechanisms to ensure the establishment and ongoing maintenance of landscaping of reserves and stormwater management areas until those areas are vested in the Council will be required to ensure the long term success of any landscaping.

Explanation:

Design Element 4 pertains to matters for consideration for locating, sizing and designing reserves stormwater management areas and riparian planting. These areas will be generally located in accordance with the locations shown in the Drury South Precinct Plan; regard should also be given to Design Element 5 when designing reserves within the Precinct.

The principal reserve network within the Precinct, as illustrated in the Drury South Precinct Plan, is structured around riparian protection and enhancement as well as stormwater management including detention and treatment. The reserve network is however designed for multiple functions and values including passive and active recreation, pedestrian / cycle commuter access, ecological values, visual screening / separation and aesthetic amenity.

The Precinct Plan also includes buffer reserves, adjoining the Light Industry zoned Sub-precincts A and B. The main purpose of these reserve is to physically and visually screen and separate adjacent existing land uses and residents from these areas. These reserves are planted to maintain a robust rural character with a woodlot/ shelter belt form of land management. Whilst providing multiple functions including biodiversity and aesthetic values, their primary function will remain as that of a buffer to land uses outside of the Precinct.

Design Element 5: Reserve Interface Design:

1. Reserves intended for public recreation and use should be designed to be bounded by public roads as much as possible given topographical and natural feature constraints. (Note proposed buffer reserves are not intended to be bounded by public roads)

2. Where reserves or riparian buffer areas adjoin lots, the boundary should be securely delineated and fenced to avoid encroachment (refer Diagram 5).

Explanation:

Reserves intended for public use that are well fronted by public roads are more secure because of the informal surveillance from the road and activities that interface with the road across the carriageway. Ideally not less than half the total length of legal boundary of any reserve should adjoin a legal road.

Design Element 5a: Earthworks and Retaining Walls

1. Changes of level adjoining streets and open space corridors should be achieved by gently battering and contouring land.
2. Where retaining walls are required, they should be screened from public view. This may be achieved by planting and breaking up the vertical extent of walls through physical stepping.

Additional Sub-Precinct Criteria

In the case of subdivision within Sub-precinct B Motorway Edge and Sub-precinct C Mixed Use, the following criteria shall also apply and take precedence over the general assessment criteria for subdivision stated above, where this is inconsistency or conflict.

Additional Design Element 6: Subdivision within Sub-precinct B Motorway Edge

1. Earthworks should be designed to retain a more natural, undulating topography and character outside of building platforms and other areas required through function to retain a flat topography.

2. Intersections between public roads serving the sub-precinct and the north south primary road (Maketu Road corridor) should be minimised.

3. Specimen tree planting should be provided on all public and internal private access roads within the Motorway Edge Sub-Precinct.

Additional Design Element 7: Subdivision within Sub-precinct C Mixed Use

1. Where through lots with dual street frontage are created, these should provide frontage to both street edges (i.e. no rear elevations to the street). However, where buildings are required to be setback from Maketu Road for acoustic amenity reasons, a safe and attractive edge to Maketu Road should be provided. Methods to achieve this include providing landscaping at the street edge and providing a good degree of glazing on the building facade overlooking Maketu Road.

APPENDIX I410.11.2: DRURY SOUTH PRECINCT – SUB-PRECINCT B MOTORWAY EDGE PRECINCT AND SUB-PRECINCT C MIXED USE ASSESSMENT CRITERIA

PURPOSE OF APPENDIX I410.11.2

In Sub-precinct B Motorway Edge New buildings (excluding buildings for network utilities) or additions to buildings not otherwise provided for as permitted activities' are controlled activities and in Sub-precinct C Mixed
Use, 'New buildings' and 'Additions and alterations not otherwise provided for' are restricted discretionary activities.

Rule 6.15.1 sets out controlled activity assessment criteria for all restricted discretionary activities in the industrial zones and contains the following clause:

> *"In the case of the Motorway Edge Precinct and the Commercial Service Precinct within the Drury South Structure Plan Area (Part 5B.4 in Section One of the District Plan) the Council will, in addition to the criteria set out in (a) to (f) above, assess the application against the criteria set out for those precincts in Appendix 5B.4.B in Section One of the District Plan."*

This Appendix sets out assessment criteria under a number of "Design Elements" for both Sub-precinct B Motorway Edge and the Sub-precinct C Mixed Use.

The criteria listed under each Design Element are intended to give flexibility, enabling site responsive designs, while ensuring that development provides a positive contribution to the amenity of the Precinct.

The criteria are intended to guide development rather than prescribe exact design and layout. Most criteria are illustrated. The illustrations are intended to support the text and are representative of good design solutions, but are not necessarily intended to represent the only design solution.

Each Design Element includes an explanation, which summarises the rationale for the particular Design Element and expands on the individual criteria. The explanation may be used as further guidance in interpreting the intention of the criteria and assessing the extent to which the proposal accords with them.

INFORMATION REQUIREMENTS

The applicant shall provide a written assessment describing how the criteria for each Design Element are addressed. Applicants will have to demonstrate that the provisions of the criteria have been acknowledged. It is recognised that certain proposals will not achieve absolute accordance with all criteria. Where necessary, in regard to a criterion demonstrably not met, the applicant shall explain with reference to the explanation for the particular Design Element:

- whether site constraints inhibit the ability to address the criterion, and/or;
- how the intention of the criterion is met by the proposal, and/or ;
- whether the proposal represents a better design solution than that suggested by the criterion.

Applicants will also be required to provide a Landscape Concept Plan with sufficient detail to ensure that the relevant assessment criteria are able to be considered, identifying hard and soft landscaping treatment, large grade specimen trees (species and planting size), groupings of ground covers and shrubs with species schedule.

SUB-PRECINCT B MOTORWAY EDGE ~~PRECINCT~~ DESIGN ASSESSMENT CRITERIA

The following criteria shall apply to 'New buildings (excluding buildings for network utilities) or additions to buildings not otherwise provided for as permitted activities Sub-precinct B Motorway Edge Precinct.

Design Element – Internal Private Access Roads:

1. Specimen tree planting should be provided on all public and internal private access roads within the Sub-precinct B Motorway Edge.

Design Element – Existing Vegetation:

1. Where ever possible layouts should retain and protect existing mature trees, particularly those of indigenous species, where these contribute to the site character and amenity.

Design Element – Planting:

1. Planting should be designed to have a large scale landscape effect and combine native as well as appropriate exotic species to provide seasonal change and quality amenity.

2. Where reserve land adjoins the motorway, boundary planting that creates a continuous visual barrier to eastward views from the SH1 (Southern Motorway) corridor should be avoided, however landscape design should emphasise the current sequence of intermittent views to the Hunua Ranges from the SH1 corridor and the pattern of variable depth of such views.

3. Where industrial sites adjoin the motorway boundary, a detailed rule applies requiring a double row of Leyland Cypress to create the appearance of a rural shelterbelt providing a continuous visual barrier defining the curve in the motorway alignment.

Design Element – Buildings:

1. Buildings should be located with design consideration for their visibility and reduced visual impact as viewed from the SH1, (Southern Motorway) corridor and the desirability of maintaining a sense of openness as seen from the motorway.

2. The visual mass of larger buildings should be minimised by employing the following methods:
    - Utilising subdued, recessive colours;
    - Providing variation in materials and finish for facades viewed from the motorway;
    - Creating variation of roof profiles with consideration given to the overall roofscape viewed from the motorway;
    - All rooftop servicing and plant should be designed as an integral part of the roofscape with particular consideration given to the view from the motorway.

Design Element – Parking Areas:

1. Parking areas should be designed to incorporate trees to break up the scale of hard surface areas.

2. Adoption of the Fully Planted Permeable Carpark Design Layout (refer Diagram 6) style of parking is advocated within Sub-precinct B Motorway Edge.

Design Element – Internal Site layout:

1. Storage and waste management activities should be located and / or designed to be screened from view of the State Highway.

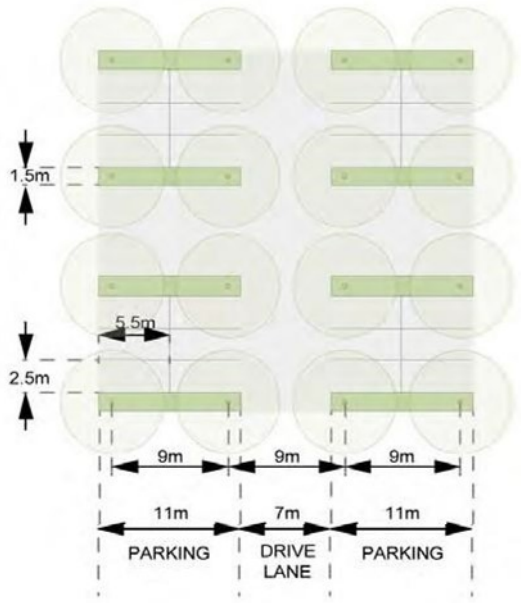


Diagram 6: Fully planted permeable carpark design layout - detail

SUB-PRECINCT C MIXED USE DESIGN ASSESSMENT CRITERIA

The following criteria shall apply to 'New buildings' and 'Additions and alterations not otherwise provided for' in Sub- precinct C Mixed Use.

Design Element – Block Size, Lot Type and Orientation:

1. Buildings on corner lots should be designed to provide for a quality architectural response to the corner. Appropriate design responses include provision of additional height at the corner and windows and activities addressing both street frontages. Service activities such as loading docks or storage yards should not be located on corners or any site frontage, however, where this is required to support the functional and operational requirements of the activity, the service area visible from the street should be minimised as much as practicable and attractively screened from public view with landscaping.

Design Element – Street Interface Design:

1. Built development should front the street with a quality, recognisable pedestrian entry to the street.

2. At-grade parking should be located and designed in such a manner as to avoid or mitigate adverse effects on pedestrian amenity and the streetscape. This includes through positioning carparking away from street frontages, to the sides or rear of buildings and the use of extensive landscaping within the carpark, including tree planting. Refer to Attachment 4 for an example of a layout and design consistent with this guideline.

Design Element – Signage:

1. Signage for each Sub-precinct C Mixed Use development

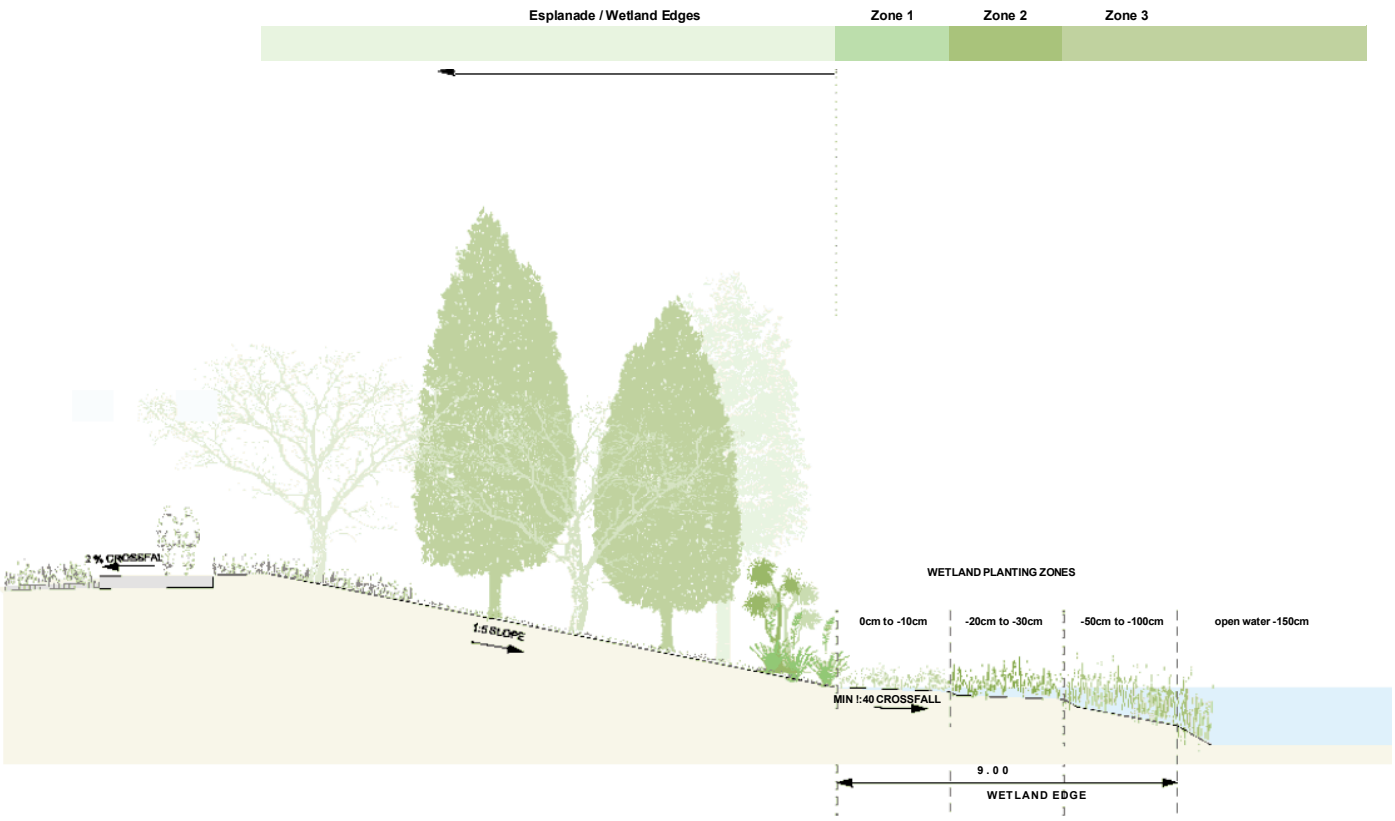
should be coordinated including the physical location of signs, their type face, style and content with a maximum of two signs per business, one located to address the street frontage and one to identify the building entry (a third sign is permissible where the service access is separate from building entry or there are multiple entries).

Design Element – Service Areas:

1. Service areas should be located so as to avoid observation from a public road with access either from a service lane, incorporation within the main building or full screening of service / storage and dock areas. However, where this is required to support the functional and operational requirements of the activity, the service area visible from the street should be minimised as much as practicable and attractively screened from public view with landscaping.

Attachment 2

Typical Wetland Stormwater Pond and Typical Stream Corridor Cross Sections

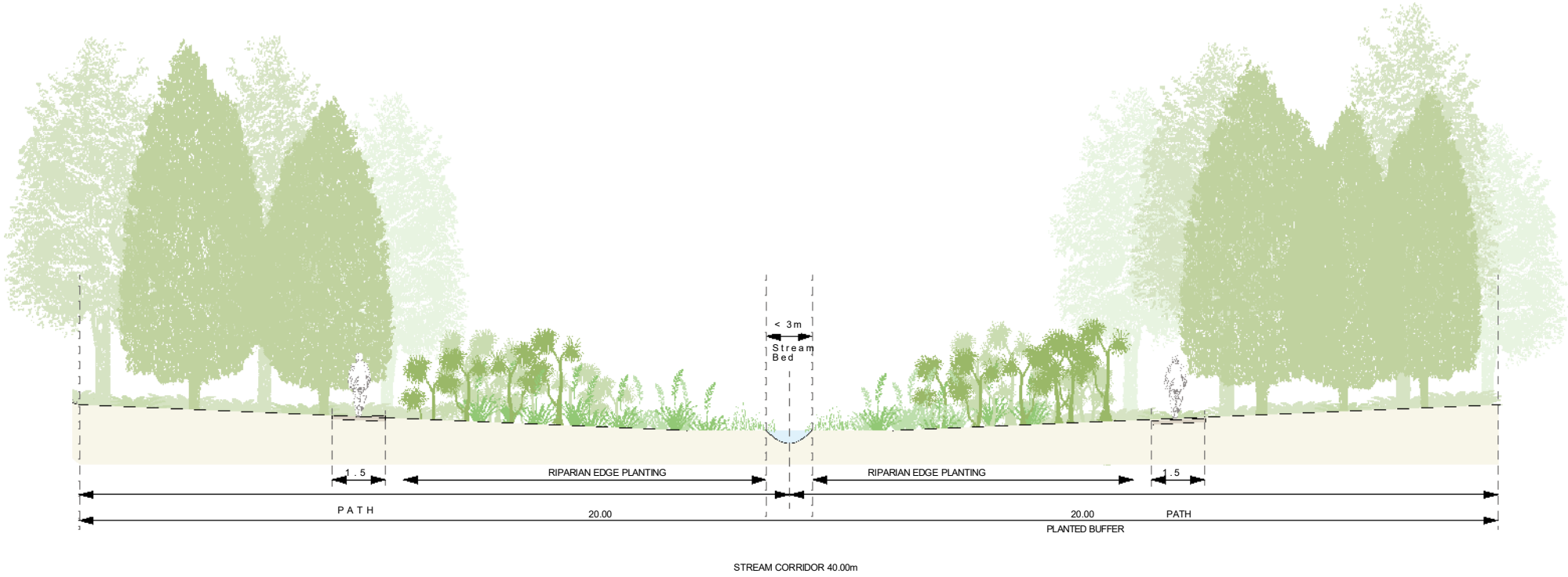


Location	Botanical Name	Common Name
Esplanade / Wetland Edges	*Salix babylonica*	Weeping Willow
	Dacrycarpus dacrydiodes	Kahikatea
	Cordyline australis	Cabbage palm
	Anemanthele lessoniana	Wind grass
	Carex secta	Purei
	Carex testacea	
Zone 1 Wetlands (0 to -10cm)	Carex geminata	
	Cyperus ustulatus	
	Cordaderia fulvia	Toetoe
Zone 2 Wetlands (-20 to -30cm)	Schoenoplectus validus	Kopupu / kuta
	Eleocharis acuta Juncus gregiflorus	Spike rush
	Bolboschoenus fluviatilis	Wiwi rush
	Leptocarpus similis	Ririwaka
		Oioi /Jointed Rush
Zone 3 Wetlands (-50 to -100cm)	Baumea rubiginosa	
	Baumea articulata	
	Baumea teretifolia	
	Eleocharis sphacelata	Ngawha / Great spike rush
	Juncus pallidus	Giant rush

0 5m 10m 20m

Scale

INDICATIVE WETLAND EDGE DETAIL



INDICATIVE 40m RIPARIAN BUFFER FOR STREAM BEDS LESS THAN 3m WIDE

0 2.5m 5m 10m

Scale

0 2.5m 5m 7.5m

Scale

TYPICAL ONE SIDED RIPARIAN BUFFER FOR STREAM BEDS LESS THAN 3m WIDE

INDICATIVE ONE SIDED RIPARIAN BUFFER FOR STREAM BEDS 3m AND GREATER

Attachment 3

Drury South Precinct

Indigenous Species Plant List

Note: The species underlined are recognised as being rare / uncommon in the Auckland region.

WetlandSpecies	
Schoenoplectus tabernaemontani also Eleocharis sphacelata	Multiple Māori names include kukuta and kutakuta.
Carex virgata and Carex secta	pukio
Baumea articulata	jointed twig-rush
Typha orientalis	raupo
Myriophyllum robustum	stout water milfoil
Baumea tenax	
Isachne glabosa	swamp grass
Phormiun tenax	particularly the variety known to Maori as 'Muka" - soft for weaving

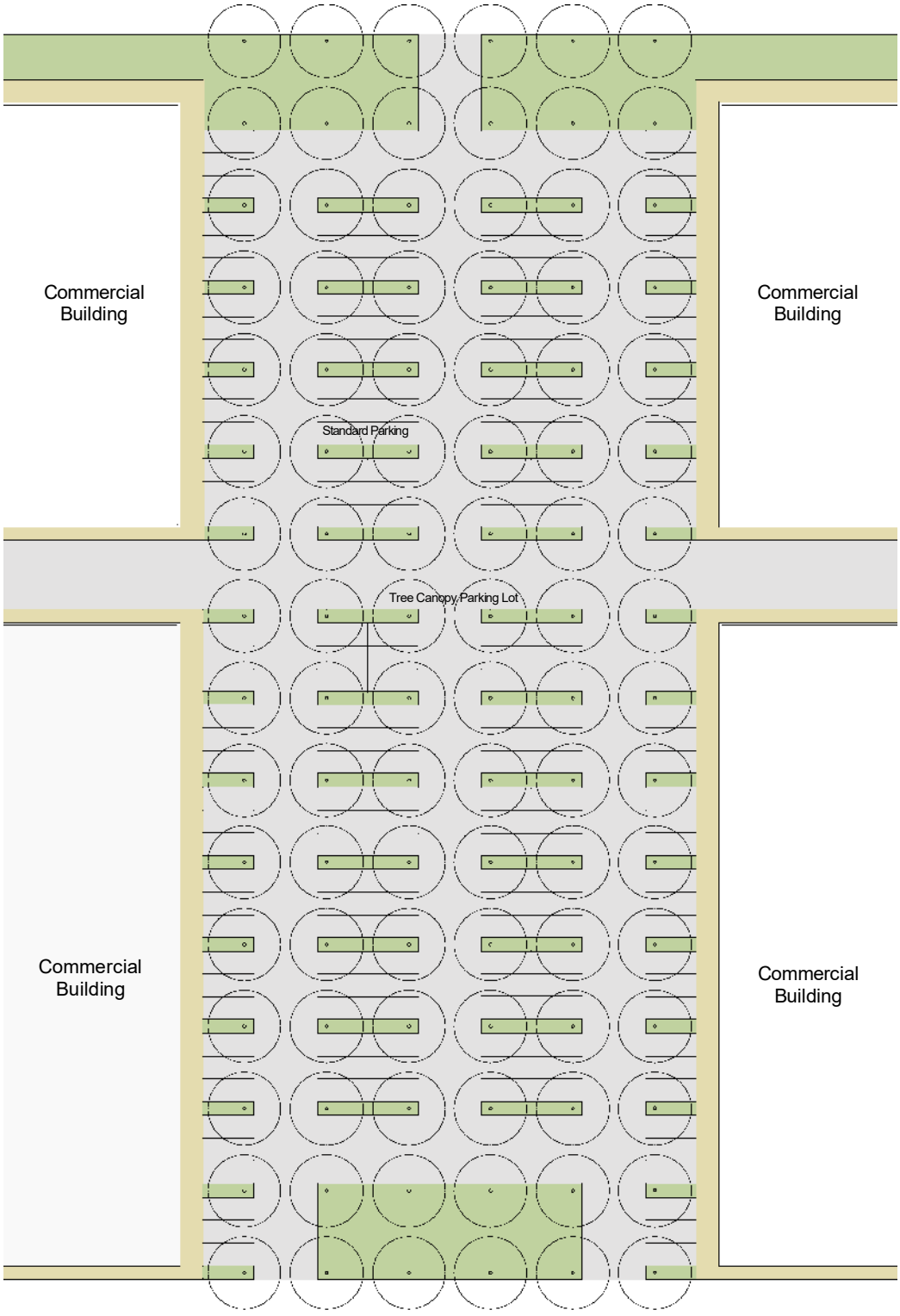
Riparian Marginal Species	
Freycinetia baueriana	kie kei
Alectryon excelsa	titoki
Vitex lucens	puriri
Prumnopitys taxifolia	matai
Sophora microphlla	kowhai
Rhopalostylis sapida	nikau
Hoheria populnea	lacebark
Corynocarpus laevigatus	karaka
Plagianthus betulinus	manatu
Pennantia corymbosa	kaikomako
Hedycarya arborea	pigeonwood
Aristotelia serrata	makomako
Kunzea ericoides	kanuka
Cordyline australis	ti whanake
Dysoxylum spectabile	kohekohe
Coprosma grandifolia	kanono
Streblus banksii	towai
Streblus microphylla	turepo
Myrsine divaricata	weeping matipo
Marratia salicina	king fern

Swamp Forest Species

Syzygium maire	maire, tawake
Laurelia novae-zelandiae	pukatea
Carpodetus serratus	putaputaweta
Phormium tenax	harakeke
Coprosma tenuicaulis	hukihuki
Dacrycarpus dacrydioides	kahikatea
Blechnum novae-zelandiae	swamp kiokio
Cortaderia fulvida	toetoe
Astelia grandis	swamp astelia
Schefflera digitata	pate
Podocarpus totara	totara

Attachment 4

Typical Sub-Precinct C Mixed Use Precinct Access and Car Park Layout



TYPICAL COMMERCIAL LAYOUT

Attachment 5

Drury South Precinct: Stream and Wetland Rehabilitation Guidelines (June 2013)

Drury South Industrial Precinct

Stream and Wetland Rehabilitation Guidelines

June2013


Boffa Miskell

Table of Contents

1.0 Introduction

1.1 Purpose of this Document

The Drury South Industrial Precinct (DSIP)Stream and Wetland Rehabilitation Guidelines provide a summary of proposed stream and wetland works associated with the DSIP project. This includes all stream corridors to be removed, realigned, or restored, and wetlands created associated with stormwater management. The purpose of this document is to achieve the following:

1. To provide technical input to the planning process (to be read in conjunction with the Ecological and Landscape Assessments, Assessment of Environmental Effects (AEE) and Infrastructure Assessment report (IAR).
2. To provide the project team with a set of principles for treatment of riparian (stream and wetland) areas within the DSIP area.

1.2 Proposed Stream and Wetland Rehabilitation Works

In line with the proposed Drury South Industrial Precinct, the existing Hingaia and Maketu streams will be protected and enhanced by corridors of riparian restoration 40 metres in width (20mon each bank). Dense riparian planting will also occur along SH1 in association with the Roslyn Stream realignment and along the northern boundary of the site in association with anewly formed northern stream realignment.

Some streams and farm drains within the DSIP area will be filled. Piped infrastructure or vegetated swales will direct these modified catchments to the Hingaia Stream. These systems, as well as stormwater runoff from business activities will be treated for water quality in extensive wetland areas associated with the Hingaia stream corridor. These wetland areas will function for stormwater quality and quantity, ecosystem function and values, landscape amenity, natural character, and recreation.

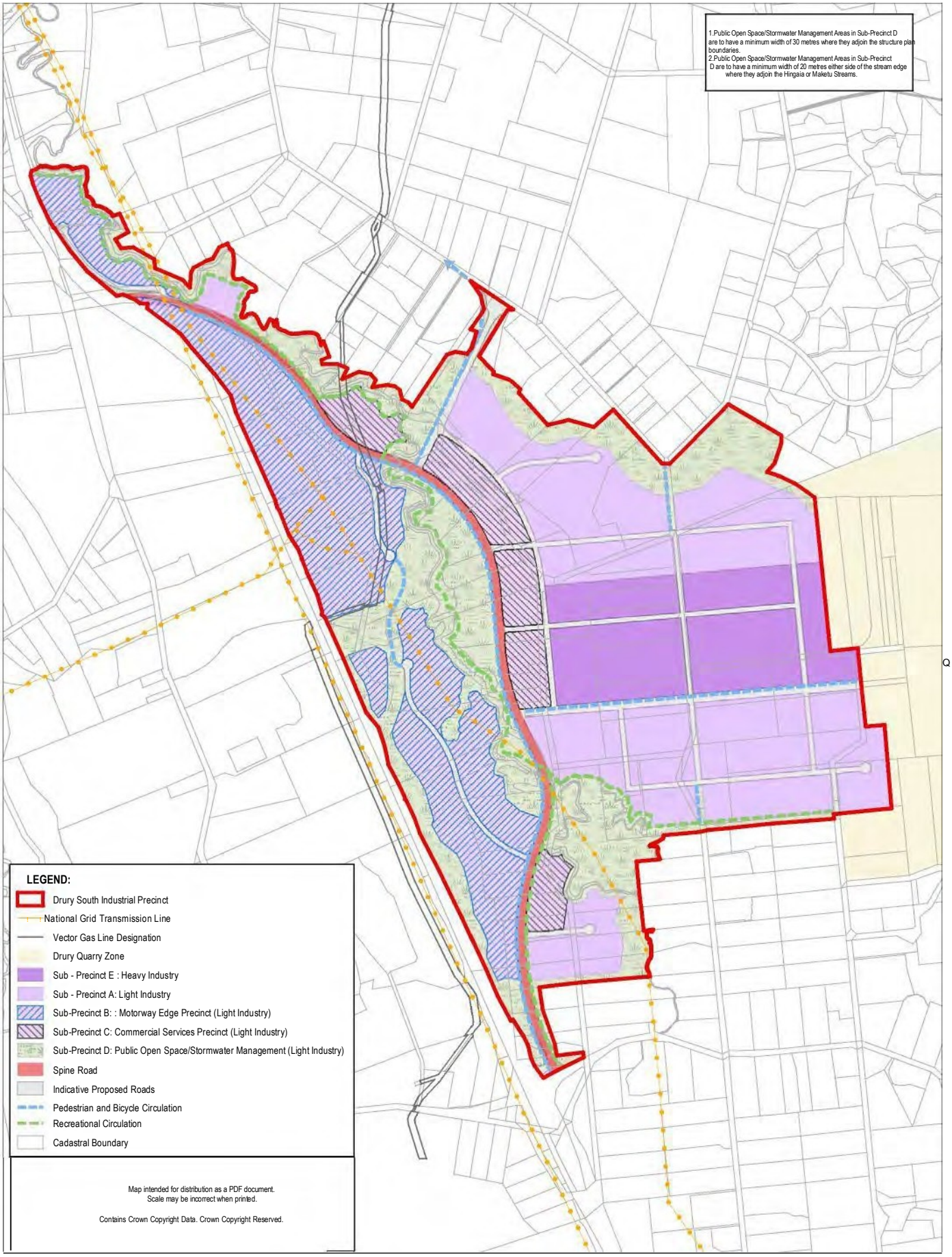


FIGURE1:DSIP Concept Plan - December 2010 (Source: BECA Ltd)

2.0 Streams of the Project Area

2.1 Existing Streams and Proposed Mitigation

The Hingaia Stream flows through the DSIP area from south to north before continuing through the Drury Township to discharge to Drury Creek and eventually the Pahurehure Inlet to the Manukau Harbour. The Maketu Stream flows into the site at the south eastern corner of the DSIP area, and joins with the Hingaia Stream. The Roslyn Stream flows from the west under the State Highway and joins a further tributory to the Hingaia Stream. The remainder of streams traversing the site do not have officially recorded names, are smaller, highly modified, and in some cases have been piped.

An assessment of the existing surface water network and receiving environment has been carried out as part of the Hingaia Stream ICMP. This included a stream ecology study, "The Hingaia Catchment Environmental Assessment, Golder Associates, August 2009". This study included field survey of streams within the DSIP area with respect to water quality, and aquatic flora and fauna. Each stream potentially affected by the DSIP has been evaluated by the 'stream ecological valuation' method (SEV) in accordance with the technical publication ARC TP302:2008.

Existing watercourses and modified farm drains between Stevensons Quarry and SH1 will need to be filled or re-aligned to accommodate the DSIP earthworks footprint. This includes intermittent and permanent streams (refer Figure 2). Many of the existing overland flowpaths are farm drains, constructed for active drainage. All streams to be affected by the proposed DSIP have been heavily modified by farming or roading operations, including dredging, spraying, straightening, and ongoing impact by stock. In general all of these streams have low to moderate functional values for stream ecology.

Proposed mitigation for stream loss includes the restoration of riparian zones along the length of the Hingaia and Maketu Streams within the DSIP Area. This includes a 40m wide planted riparian buffer along all streams. In addition, streams to be re-aligned will have an appropriate stream profile and riparian planting to provide for sustainable stream function.

One of many existing intermittent farm drains showing evidence of earthworks, spraying and access by stock

LOCATION A (FIGURE 2) - The northern stream is directed along Quarry Road in a highly constrained and modified environment, with low ecological values

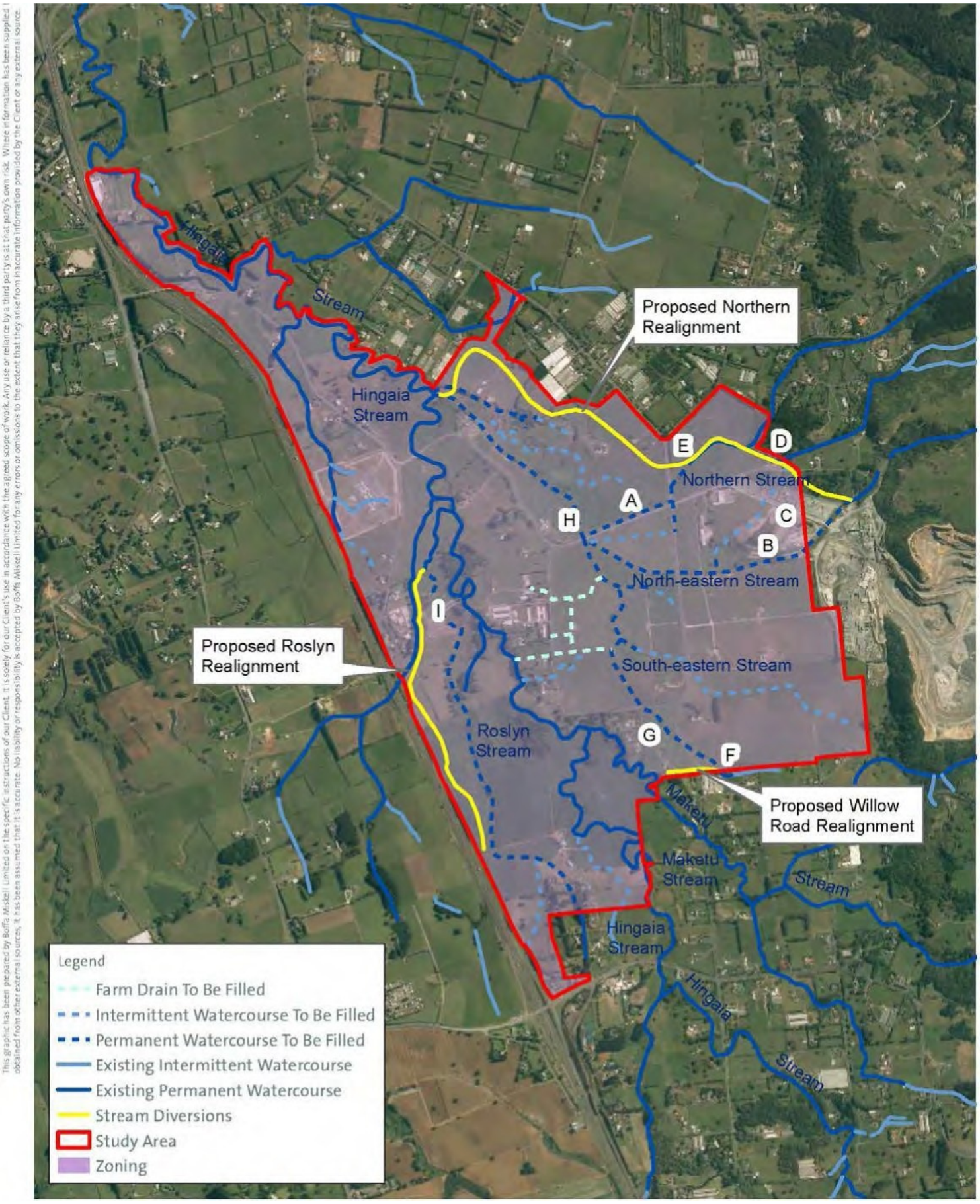


FIGURE2: DSIP Existing and Proposed Water Courses (Source: BECA Ltd)

2.1.1 Northern Streams

A tributary to the northeast of Stevenson Quarry is currently dammed in its headwaters for quarry operations before being reticulated to a channel (refer Figure 2, Location B below). The northeastern stream also receives stormwater from the quarry via adjacent treatment facilities (Location C). As part of the works to accommodate the DSIP, the upper catchment of this stream will be directed to the existing northern stream corridor (Location D).

This northern stream will be rehabilitated with an enhanced stream profile, and restored streambank and floodplain vegetation. The northern re-alignment will be 1,800m in length, comprising 1,500m of new channel and 300m of rehabilitated channel.

LOCATION B (FIG 2) - The north-eastern channel flowing through mixed exotic vegetation

LOCATION C (FIG 2) - The north-eastern channel directed alongside the quarry settlement ponds

LOCATION D(FIG2)-The existing northern stream channel will be enhanced to receive there – aligned north- eastern tributary

LOCATION E (FIG 2) - The northern stream at the base of the northern escarpment will be rehabilitated as part of the proposed works

2.1.2 Southern Streams

The streams to be filled between the quarry and the Hingaia Stream are relatively small, with low gradient catchments that do not extend beyond the project area. A stream from the southeast of the site (refer Figure 2 and Photos Location F and G) conveys a number of intermittent stream tributaries from the centre of the project area, before joining with the existing northern stream and northeastern tributary previously mentioned (Location H). The southeastern stream and its tributaries have no vegetation cover beyond aquatic macrophytes and pasture species. These watercourses have been heavily modified by pastoral land use.

d

LOCATION F (FIG2)-The southeastern stream ponding behind a road culvert, 50 metres downstream of the proposed Willow Road Re-alignment

LOCATION G (FIG2)-The southeastern stream wends through the middle of the project area before combining with the northern stream

At least 230 metres of the headwaters of the southeastern stream will be retained, enhanced, and linked westward to the Maketu Stream via an 180m section of new channel (the Willow Road Realignment). This realignment will be planted with a riparian buffer. The remaining watercourses between the Hingaia Stream and quarry will be filled.

2.1.3 3 Eastern Streams

The Roslyn Stream (Location I) to the west of the Hingaia Stream will be re-aligned toward the SH1 corridor. The current stream is an open farm channel with low summer flows and dense growth of the exotic reed sweet grass (Glyceria maxima). The re-alignment will include filling of 450m of the upper reach of this stream, and formation of 1,600m of newly aligned channel. The realigned channel will be formed with an appropriate profile and rehabilitated for enhanced ecological function, with a 20 metre wide riparian corridor on both sides.

LOCATION H (FIG2)-The channel flowing to the Hingaia, containing the combined flows of the south-eastern, northern, and north-eastern streams following a rain event

LOCATION I (FIG2) – The Roslyn Stream (mid-ground), a farm channel with low flows, is to be realigned and rehabilitated

2.2 Existing Streambank Erosion

Streambank erosion has been identified in the ICMP studies as an existing issue at a number of locations. The Hingaia Stream is subject to extensive bank erosion, identified near the Quarry Road bridge on the Hingaia Stream and near Davies Road Bridge on the Maketu Stream.

Stormwater wetlands prior to the Hingaia channel are proposed for the DSIP in order to detain any additional flows that may adversely impact stream erosion (refer Section 3.5). Riparian vegetation is proposed along the Maketu and Hingaia and for all re-aligned stream channels to stabilise banks in the short term and reach a sustainable stream equilibrium in the long term.

A lack of riparian vegetation and active erosion along the Hingaia channel

The Maketu channel with erosion scour at the outside bank

2.3 Existing Aquatic Ecology

As part of the Hingaia Stream ICMP, Golder and Associates undertook SEV surveys of representative stream reaches (Golder 2009). Most of the stream environments in the project area had poor functional values due to extensive modification by agriculture.

The Hingaia ICMP surveyed thirteen sites within the DSIP Area. The best quality site was on the Maketu Stream, with higher scores across all functional categories. Another site, located on the lower Hingaia Stream, also scored relatively high. The best value site for the tributaries was located on the northeastern quarry stream. Full descriptions of functional ecology values can be found in the DSIP Assessment of Ecological Effects (Boffa Miskell 2010).

A total of 6 species of fish were recorded across the project area. Shortfin eels were the most common species, with occurrences of longfin eel, common bully, inanga and cran's bully. Five of the seven tributary sites had no fish, or mosquito fish only. The mosquito fish is an exotic pest fish classified as 'Unwanted' under Biosecurity legislation. These sites had very low fish community values.

Macroinvertebrate communities indicated low environmental quality at most sites. Except for the northeastern stream, tributary sites were characterised by worms, dipteran flies, leaches, and flatworms, suggesting nutrient enrichment and fine sediment. The Maketu site had a notable portion of mayflies (Zephlebia spp.), possibly due to better water quality (e.g lower water temperature).

3.0: Stream and Wetland Rehabilitation

3.1 Rehabilitation Principles

The following rehabilitation principles are intended to inform the rehabilitation of streams and wetlands in the DSIP area. The principles have been prepared by an inter-disciplinary project team, including landscape architects, planners, ecologists, and engineers. Principles seek to enhance the landscape and ecology values of the riparian systems, while providing appropriate design responses for hydraulic flow and stormwater management.

3.1.1 Landscape Values

There is significant opportunity to improve the natural character values within the DSIP area. Stream and wetland environments will also be integrated within a wider open space network, providing opportunities for enhanced recreation and landscape buffers. The following landscape principles apply to proposed stream and wetland rehabilitation:

- Contribute to landscape amenity values
- Provide vegetated buffers to specific land use activities as appropriate
- Integrate stream and wetland rehabilitation with streetscape and open space planning
- Provide for visual and physical access to rehabilitated natural areas
- Optimise natural character values through the planting of representative native communities
- Provide a diversity of natural habitats and plant communities to achieve a variety of landscape and spatial character, and to demonstrate a legible sequence of habitat types.
- Structure riparian vegetation to screen/define undesirable views, offer broad views to wetland environments, and frame distant views to eastern Hunua hills from SH1
- Apply appropriate standards for CPTED and IPTED for public or maintenance access
- Place pedestrian bridges as necessary to ensure landscape connections, and investigate opportunities to use existing stream spans (infrastructure) for this function
- Identify opportunities to involve the community in stream restoration planting
- Liaise with relevant representatives and apply appropriate protocols for any archaeological sites or heritage elements associated with rehabilitation works
- Enhance Cultural Value through the re-establishment of indigenous species and investigating cultural harvest opportunities

3.1.2 Ecological Functions

Enhancing ecological functions within the DSIP area will require a combined response to aquatic and terrestrial environments, in order to restore target species, representative habitats, and ecological processes. The following ecology principles apply to stream and wetland rehabilitation:

- Plant stream margins, banks and floodplain areas to achieve not less than 40m total width (10m min width either side of stream corridor)
- Utilise species sourced from the Manukau Ecological District that are representative of natural vegetation communities as predicted by LENZ
- Restore representative in-stream heterogeneity, providing for pool, riffle, run and cascade sequences as appropriate.
- Provide fish passage to the extent possible, including bullies and inanga to within their natural range
- Preserve groundwater influence and inundation regimes for existing floodplain forest in proposed stream corridors
- Provide appropriate transitional edge vegetation to remnant mature vegetation
- Optimise site coalescence between remnant vegetation areas along the Hingaia Stream
- Provide for breeding populations of water and wetland birds species
- Provide for appropriate staging and construction techniques to avoid potential impacts to downstream environments and in-stream aquatic habitat.

3.1.3 Hydrology and Hydraulics (H&H)

Stream and wetland rehabilitation will provide opportunities for water quality treatment for the DSIP, and appropriate hydraulic flows, and hydrologic capacity for the catchment. The following H&H principles apply to the rehabilitation areas:

- Use biotechnical stream stabilisation to restore a sustainable streambank morphology
- Apply a cross sectional profile that resembles a natural staged channel, including a permanent flow channel, a stream channel based on a bankfull (approximate two year average recurrence interval (ARI)), and associated floodplains and berms to hold the one hundred year ARI.
- Provide for an appropriate stream meander patterns for the floodplain extent, longitudinal stream profile, flow velocities, and expected bankfull event.
- Provide for hydraulic connections and fish passage to stormwater wetlands wherever extended detention is not required
- Place all forebay devices for stormwater wetlands outside of the 5 year ARI flood extent.

FIGURE 3: DSIP Concept Planting plan. (Source Boffa Miskell and Source Design)

3.2 Open Space Network

The stream and wetland rehabilitation concepts (refer Figure 3) integrate with a broader open space network to optimize specific requirements for public use and access, to ensure diverse representative habitats, and to enhance environmental services for the DSIP.

The open space network reinforces existing features and patterns of the project area. The Hingaia Stream corridor will be reinforced by wide riparian margins of representative planting of early successional forest, as well as kahikatea floodplain forest. In the north a substantial open space buffer is set aside to reinforce the natural escarpment separating the DSIP basin from the Fitzgerald Road ridgeline. This occurs in conjunction with the northern stream realignment and associated riparian rehabilitation works. In the south west of the project area, riparian planting along there – aligned Roslyn stream will form a landscape buffer to SH1.

Larger remnants of existing vegetation will be coalesced along the Hingaia Stream. Planting in association with stormwater wetland areas will further buffer and augment the conservation values of these remnants.

3.3 Stream Rehabilitation

The land use change associated with the DSIP provides a significant opportunity to restore the Hingaia Stream, a low gradient moderate order stream, which retains remnant kahikatea floodplain forest. The project also provides the opportunity to coalesce modified drainage channels across the site into a larger order stream channel and floodplain, with supporting streambank and floodplain vegetation. Stream rehabilitation proposals are the result of an iterative design process between ecologists, landscape architects, and engineers to optimise the principles of these guidelines.

3.3.1 Hingaia Stream

The Hingaia Stream is a significant watercourse, with a wide, actively meandering channel across the floodplain. The stream currently runs through pastoral and agricultural land uses, and receives runoff from existing farm drains in the project area. The rehabilitation of the Hingaia stream is a key objective of the DSIP, with a 40 metre vegetated buffer proposed along the corridor where it corresponds with the project area. The width of the riparian buffer would extend to accomodate a stormwater treatment swale proposed along a northern reach, and stormwater wetlands proposed within the Hingaia Stream's extended floodplain.

The rehabilitation of the Hingaia Stream will include:

1. The coalescence of the floodplain forest remnants (including significant natural areas) already occurring within Hingaia floodplain
2. The restoration planting of streambanks along the length of the stream within the Project Area, with the potential for specific interventions to restore the stream profile at erosion hot spots
3. The planting of banks and proposed riparian buffers with simple lowland plant communities with the expectation that these communities will secede with time to include more diverse species
4. Planting of feature areas of flax-cabbage tree and broadleaf species on extended floodplains
5. Hydrological connections and fish passage to stormwater wetlands where practical

3.3.2 Stream Realignments

A number of farm drains and watercourses will be replaced with overland flow paths and reticulated networks associated with the proposed development. In addition, some headwaters will be realigned to newly formed watercourses along the boundaries of the DSIP area. The Hingaia and the Maketu Streams will not be altered beyond restoration activities.

A detailed description of the potential effects on stream ecology and the proposed mitigation measures is presented in Boffa Miskell, 2010, "Drury South Business Project Assessment of Ecological Effects Associated with the Proposed Plan Change". These guidelines inform the potential design response to optimise the flood management function of the rehabilitated streams, and their landscape and ecology values.

3.3.2.1 Design Parameters

The profile of each re-aligned stream channel is based on the cross-sectional area to accommodate a 1.5 to 2 year average recurrence interval (ARI). This flow is traditionally associated with a 'bank-full' event with active stream erosion and re-deposition.

The morphology of realigned streams is also based on their substrate, longitudinal gradient, and association with their floodplain. These functions can be used to prescribe channel sinuosity and width to depth ratio (Rosgen 1994). The bankfull width is used as a function to predict the stream meander wavelength and the radius of curvature for bends (Leopold 2003 and Thorne et al 2003). Refer to Figure 4 below.

Proposed stream morphology is intended to minimise friction within the channel to prevent active erosion, and also to provide a floodplain width that can accommodate the stream in equilibrium.

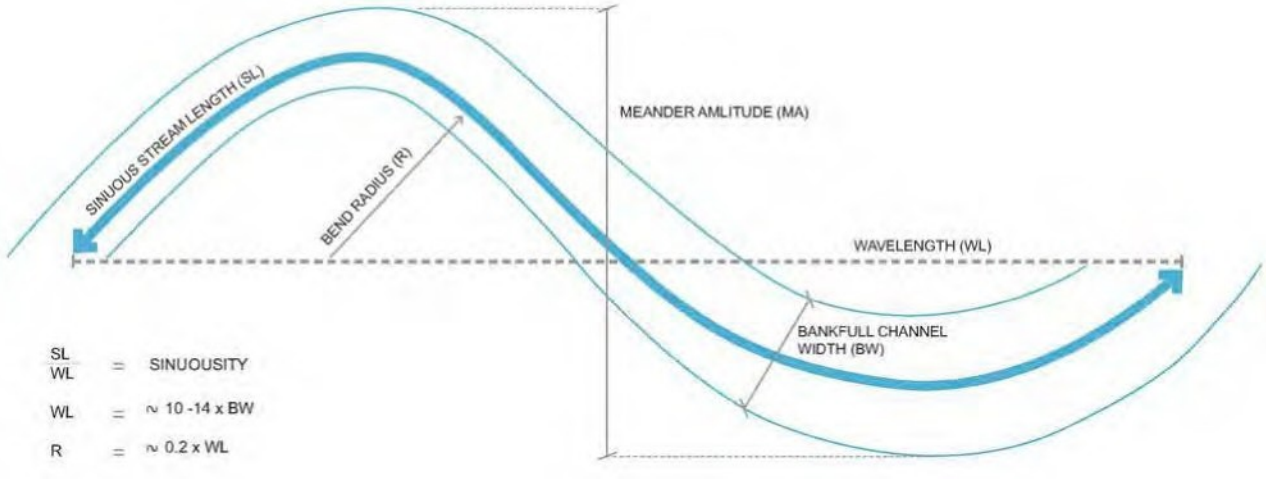


FIGURE 4: (above) The indicative relationship between channel width, and meander pattern

BELOW: A natural meander occurring as an overland flow event during flood conditions in the project area

3.3.2.2 Construction

Construction of the realigned channels is intended to occur off-line where possible, or to be staged to avoid potential impacts to downstream environments and in-stream aquatic habitat. Material selection is expected to be inert and where possible to be the equivalent of materials expected in these stream environments in their natural state.

It will be possible to utilize 'natural' materials through the application of biotechnical construction, which utilises a combination of persistent and biodegradable materials to retain channel shape until plants can establish. In general biotechnical responses for stream stabilisation can include:

- Stream profiling to respond to specific flow events
- Floodplains to dissipate flood velocities
- Stabilised bank toe and outside bends with hard materials such as rock, root vanes etc
- Directing flows and forming riffles through rock vanes
- Reinforcement of stream banks through planting established in erosion control blankets
- Stabilising the crown of banks with appropriate vegetation
- Provision of appropriate pool-riffle-run sequences.
- Grade control structures that accommodate fish passage
- Specific biotechnical treatments to accommodate 'nick' erosion points and stormwater outlets

3.3.2.3 Planting

Plant species selection will provide ecological functional values and representative plant communities. Stream planting objectives may include:

- Shade for temperature moderation
- Weed suppression
- Slope stabilization
- Tolerance to inundation
- Growth form to accomodate/obstruct views
- Stature to accomodate hydraulic flow rates
- Inherent aesthetic or spatial qualities of single plants or grouping of vegetation.

Based on LENZ predicted natural vegetation layers, representative plant communities for the DSIP area include lowland alluvial floodplain species, generally consisting of kahikatea forest. Other communities include tawa and pukatea, while matai, rimu and totara are generally restricted to better-drained soils. Titoki and puriri are locally abundant, with the potential for other broadleaf such as taraire, occurrence of kauri on the flanks of the basin, and occasional rimu and pukatea.

The project area extending into the flanks of the project basin and the hills beyond would be expected to support kauri, kahikatea, rimu and/or totara emergent over a diverse canopy dominated by varying mixtures of taraire and kohekohe Other widespread tree species might include hinau, pukatea, rewarewa, and miro. Puriri is locally abundant at lower elevations, particularly on alluvial surfaces and tanekaha would be locally abundant, particularly on disturbed sites.

Where basalt occurs at the surface of the project area there may occur unique basalt forest environments, with an expected predominance of mahoe, karaka, kohekohe, totara, puriri, and titoki.

Until climax communities establish, it is expected that large areas of the riparian corridors will be planted with early succession and hardy species, such as riparian shrubs, kanuka, and totara to rapidly establish cover and to act as a nurse crop for later succession species. It is expected that certain low vegetation types will be applicable in places along the riparian corridors to accommodate hydraulic flows, to preserve viewshafts, and provide useable open space areas. Such planting may involve mown grass areas, sedge-rushlands, and flax-cabbage tree communities.

3.3.3 Northern Stream

A stream is proposed along the northern boundary of the DSIP area at the base of the northern escarpment. An existing section of this northern stream receives flows from three tributaries. A fourth tributary, previously described as the 'northeastern stream' (refer Section 2.1.1 and Figure 2) will also be directed to this channel from the quarry zone. The northern stream will accommodate the flow from these four tributaries, as well as localised catchments before discharging to the Hingaia Stream west of the proposed Link Road.

A typical northern stream cross section is shown in Figure 5, where a 'bankfull' channel represents the 1.5year ARI event, and the associated floodplain conveys a 100 year ARI event with 500mm freeboard to the proposed development. Detailed design will provide pool-riffle and run sequences with adapted profiles. Biotechnical construction techniques will form narrower riffle sections, shallower point bars, and steeper outside bends.

The proposed sinuosity of the northern stream is relatively high, close to 1.5 times the wavelength (refer Figure7). This is appropriate, based on the cross section of the bank full channel (with a low width to depth ratio) the longitudinal profile of the floodplain (a relatively flat lowland environment), and the general character of the bed materials and banks (being generally resistant but somewhat erodible).

The sinuosity is expected to reduce the longitudinal profile of the channel, reduce erosion of stream banks, provide strong connections to floodplain environments, and increase the overall length and diversity of stream habitat. Some stream reaches have constrained floodplains, where riffle sequences with local rock may be appropriate.

The northern re-alignment follows the northern boundary to combine stream environments with adjacent open space and to form a buffer to adjacent land use. The stream corridor and floodplain will be densely vegetated as indicated in figure 7. Planting will be dominated by early succession kanuka-totara forest. Kahikatea forest planting is proposed beside the Link Road entrance to act as a natural threshold at the DSIP entrance. Pockets of broadleaf forest are proposed to add diversity to the northern riparian corridor. Low areas of sedge-rushlands, grass areas, and flax-cabbage tree associations could provide views into the stream corridor from select locations.

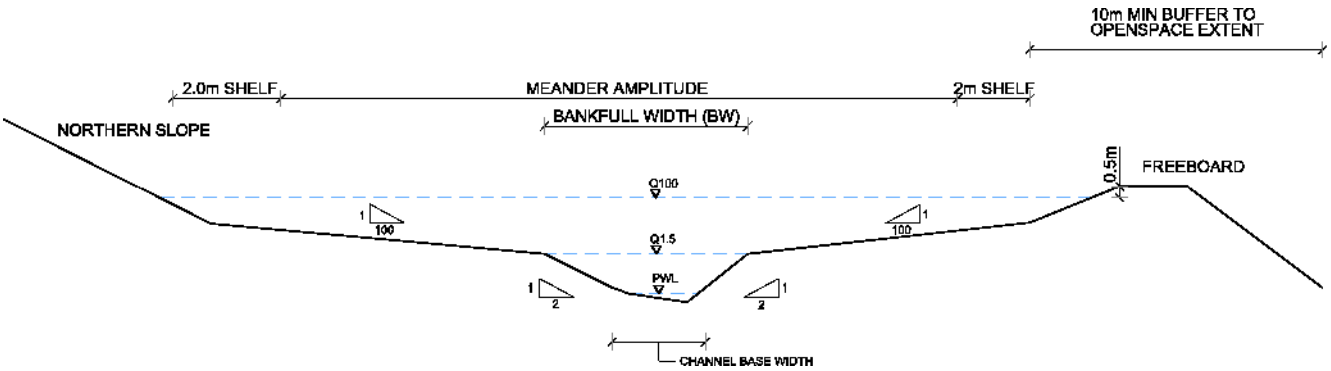
3.3.4 Roslyn Stream Realignment

There is an existing water course running south to north through Roslyn Farm at the south west corner of the project area, which picks up flow from two culverts. Site assessment also revealed an existing spring feeding the stream. This stream will be realigned for part of its length whilst retaining links the to existing spring and culvert in flows, the realigned corridor will provide a stronger vegetated element to adjacent to SH1 (refer Section 2.1.3 and Figure 2).

A typical Roslyn Stream diversion cross section is shown in Figure 6, where a dedicated 'bankfull' channel contains the 1.5 year ARI event, and the associated floodplain conveys a 100 year ARI event with 500mm freeboard to the proposed development. The Roslyn channel has a wide stream base with a lower depth to create a combined wetland/overland-flow-path appropriate for the small catchment, the low longitudinal gradient, and a strong groundwater influence.

Because the Roslyn channel is a lower energy environment than the northern re-alignment, with less likelihood of erosion, it is reasonable to expect a less sinuous character. Therefore a low sinuosity of 1.1 times the wavelength has been applied.

Planting along the Roslyn stream is proposed to be a combination of sedge-rushland planting and large swathes of flax-cabbage tree associations to create a wide wetland environment. Kanuka-totara forest may occur in existing knoll areas beside SH1 to frame views to the eastern Hunva foothills. Kanuka forest may continue along mid reaches of the stream and groups of kahikatea may occur alongside of a stormwater wetland to frame views from boardwalk locations and to shade permanent water features.



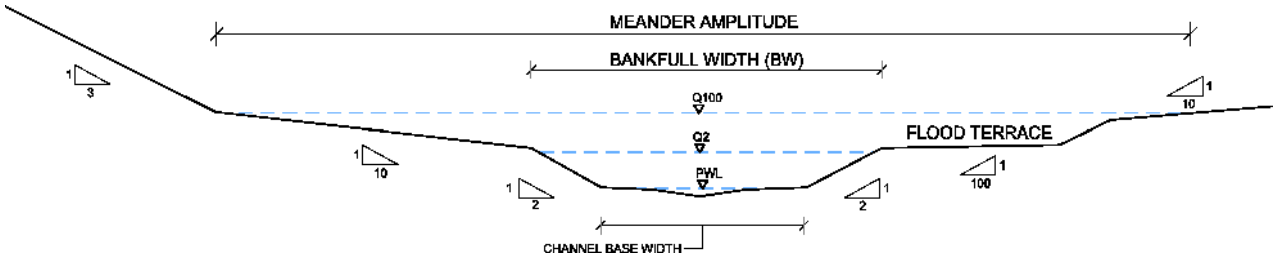


FIGURE 5: Typical section of the northern realignment in terms of flooding profiles

FIGURE6: Typical section of the Roslyn Stream realignment in terms of flooding profiles

3.3.5 Willow Road Realignment

There is a small roadside drain running east to west along Willow Road. The stream currently crosses Willow Road through a culvert near the intersection with Ramarama Road and continues north through the proposed DSIP area, eventually joining the Hingaia Stream. As discussed previously, this stream is heavily modified by pastoral land use and is largely unvegetated. It is proposed to divert this roadside drain directly west to the Maketu Stream along a vegetated riparian corridor that provides for a 1.5 year stream profile and accommodates a 100 year ARI event.

FIGURE 7: Proposed DRAFT planting plan for the Northern Re-alignment

FIGURE 8: Proposed DRAFT planting plan for the Roslyn Realignment

3.4 Riparian Revegetation Guidelines

3.4.1 Introduction

Riparian revegetation is proposed for the main stems of the Hingaia and Maketu Streams. In addition the Northern and Roslyn realignments will also be restored with riparian vegetation (as depicted in Figures 7 – 8). The progressive planting of these realignments as well as the present grasslands alongside the Hingaia and Maketu Streams will ultimately provide a greater extent of riparian bush, increasing the habitat opportunities and potential carrying capacity of the DSIP area as well as providing vegetated riparian corridors within the local landscape.

The following revegetation guidelines outline an accepted industry-wide approach to large scale revegetation programmes that should inform the development of the final detailed planting plans for the DSIP riparian margins.

3.4.2 General Procedure

The general procedure for the proposed revegetation plantings should be as set out below.

- Slope stabilization
- Seed should be sourced as is available from the Manukau Ecological District. However, notwithstanding the desire to use only genetic material sourced from this specific area in the revegetation programme, additional source material from the wider Auckland Ecological Region may be used.
- Planting of species into existing pasture should require pre-planting repeat herbicide applications to reduce the potential for grasses to compete with the seedlings planted.
- Blanket spraying in close proximity to the existing native bush areas needs to be avoided or very carefully managed so as to avoid by-kill. Herbicide should be carefully applied at least 2 weeks before planting.
- Where the earth has been previously compacted the areas to be revegetated should have a single treatment of earth tilling, in order to loosen the sub-soil and encourage successful rooting.
- Planting should be undertaken in favourable conditions, at the earliest opportunity during the planting season, preferably over the autumn months.
- The revegetation plantings should be supplemented with weed and browsing pest control to allow good establishment of the planted material. Ongoing weed control should be carried out until canopy closure is sufficient to suppress weed growth. Browsing pest control may be required over the longer term in order to allow there vegetated areas to progress in good health. However, once pest numbers are reduced to a minimal level, continued control should require a reduced effort.
- All planting and maintenance operations should be carried out by an approved contractor, experienced in native revegetation planting programmes.

3.4.3 Plant Material

- The plant material needs to be of the specified size and condition. All plants will have well developed root systems and a well-shaped stem and head free of disfigurements or injury, pests and disease.
- The plant material should have been sufficiently “hardened off” at the nursery prior to being passed on to the planting contractors.

3.4.3 Planting Methods

- Planting should follow an approved planting plan, indicating set-out, species, size, density and spacing.
- A dual system of planting is proposed, involving the establishment of a nurse crop of hardy pioneer species such as kanuka. These will be enriched with appropriate native tree species when the nurse crop has sufficiently established, which should be at approximately 3 years age.
- Nurse plant stock should be set out at appropriate spacing and percentages, and according to each species niche preferences.
- Once a good cover of the nurse plantings is established, enrichment plantings should be implemented. Enrichment species trees should be distributed (at wider centres) amongst nurse planting and according to site preferences in copses/groves spread further apart in subsequent seasons.
- The enrichment plantings may include the pruning or removal of modest numbers of nurse shrubs in order to create the necessary light wells.
- Plants should be set out and appropriately spaced in an informal manner avoiding straightlines and regular geometric patterns, while ensuring an even cover across the planting area. Species should be distributed at appropriate percentages and according to each species niche preferences, microclimate and ground conditions.
- Planting holes should be dug out to spade depth and seedlings located next to pre-dug holes in the correct species mix. Actual planting should be by hand only. The base of the planting hole should be filled evenly without compaction to a level where the top of the plant root ball is level with surrounding ground. The plant should be plumb and orientated so that the weathered face of the main stem faces north. When the backfilling is complete the plant should be gently firmed in. All plants should been encouraged to grow to maturity as naturally as possible to achieve their desired character and form, through sound management practices including weeding, and other accepted horticultural practises.
- Slow release fertiliser should be used within the proposed planting operation, with at least one tablet of 20-4-4(N-P-K) that is designed to last at least 12 months (preferably 24 months).The controlled release fertilizer tablets need to be inserted into each planting hole approximately half way up the back fill material, ensuring placement of the fertilizer on the upper slope side of each plant
- Approved chipped tree mulch or post-peeling bark mulch could be spread around the base of individual plants used in the mass revegetation plantings, but only in areas outside of the floodplain (to avoid mulch being washed away in floods).

3.5 Stormwater Management

Stormwater design is discussed in greater detail in the DSIP Infrastructure Assessment Report (BECA 2010). The general approach is to utilize the large floodplains associated with the Hingaia Stream to accommodate stormwater wetlands. Each wetland would include a forebay and accommodate the water quality volume. There is also allowance for extended detention to limit potential effects of stormwater volumes on downstream erosion.

Wetlands have been placed above the stream invert to not unduly effect ground water levels, and forebays have been placed above the 5 year flooding event to prevent re-suspension of contaminants stored in these areas.

Safety considerations have allowed for benching around the perimeter of each wetland and a reverse bench along each embankment. Appropriate maintenance access will be provided to forebays and to the base of wetlands for restorative maintenance if required.

Biotechnical approaches similar to those described for stream realignment works will be considered during detailed design, with specific consideration for the formation of access and outlets to the Hingaia, with fish passage possibile to wetlands that are not required to detain extended detention volumes.

Planting would be exclusively sedges, rushes, and small riparian shrubs around wetlands for water quality treatment, to stabilize the wetland profile, and to allow ease of maintenance. Trees and taller shrubs would be expected at the edges of wetlands, at their interface with stream environments, and around the northern edges of forebays for shade.

3.5.1 StormwaterWetland One

Stormwater Wetland One has been designed as a landscape amenity feature through an iterative design process between landscape architects, engineers, and ecologists. This has driven the design of forebays, the shape and extent of the permanent pools and wetland planting, the integration of multiple public access structures, and a pedestrian circulation path that crosses the Hingaia stream corridor (refer figure 9). Wetland One has been tiered to suit the local topography and the bathymetric design directs flows along three separate treatment paths.

3.5.2 Northern Swale

A swale is proposed for stormwater management along the western edge of the lower Hingaia Stream. The total width of the swale and vegetated buffer contributes an additional 25m of vegetation to the riparian buffer. The length of swale is significantly longer than required for water quality and is expected to exceed regulatory expectations at the entry point to the Hingaia.

Planting will be selected with the ability to sustain temporary ponding and saturated soils, and will allow appropriate hydraulic flows and residence time.

FIGURE 9: Proposed Planting Plan for Stormwater Wetland One

4.0: Summary

The DSIP area is traversed by the main stems of the Hingaia and Markeu Streams and several other permanent and intermittent streams and farm drains. Watercourses other than the Hingaia and Maketu Streams will be modified or re-aligned in order to facilitate the proposed landuse. Stormwater management will also lead to the creation of additional naturalised wetland areas in association with the Hingaia Stream corridor.

All streams affected by the proposed DSIP have been previously modified by farming or roading operations, including dredging, spraying, straightening, and ongoing impact by stock. Stream bank erosion has been identified in the Hingaia ICMP as an existing issue at a number of locations. In general all of these streams have low to moderate functional values for stream ecology. Five of the seven tributaries to the Hingaia were observed as having very low to absent fish community values.

The DSIP Stream and Wetland Rehabilitation Guidelines establish a set of principles to enhance the landscape and ecology values of riparian systems in the DSIP area. The document is intended to provide technical input to the planning process and to provide guidance to ongoing more detailed design and implementation. The guidelines apply an inter-disciplinary approach to riparian rehabilitation.

Stream rehabilitation is proposed for the length of the Hingaia and Maketu Streams within the DSIP Area, including a 40m wide planted riparian buffer along the streams. In addition, streams to be realigned will have appropriate stream profiles and riparian planting to provide for sustainable stream function. Riparian rehabilitation will contribute to a wider open space network and enhanced natural character.

5.0: References

ARC (2008a). Proposed Auckland Regional Plan; Air, Land and Water. Auckland Regional Council, Auckland. May 2008.

ARC (2008b). State of the Environment Monitoring. Freshwater Invertebrate Monitoring: 2003-2007. Analysis and Evaluation. October 2008. Auckland Regional Council Technical Report 2008/010.

BECA 2010. Draft DSSP Infrastructure Assessment Report. Prepared for Stevenson Group Ltd (Client) by Beca Infrastructure Ltd (Beca) 1 November 2010

BECA 2010. Drury South Business Project Earthworks Concepts. Prepared for Stevenson Group Ltd (Client) by Beca Infrastructure Ltd (Beca) 12 February 2010

Boffa Miskell 2010. Assessment of Ecological Effects Associated with the Proposed Plan Change. Prepared for Stevenson Group Ltd by Boffa Miskell March 2010

Golder Associates 2009. Hingaia ICMP report. Unpublished preliminary report.

Golder Associates 2009a. Hingaia Catchment Environmental Assessment. Draft report. Report No. PAPDC- PPK-003. Prepared for Papakura District Council. July 2009.

Hitchmough, R.; Bull, L.; Cromarty, P. (2007). New Zealand Threat Classification System list 2005. Department of Conservation, Wellington.

Leopold, L. A View of the River (2003). Harvard Press, USA 2003

Rosgen, David L. A classification of natural rivers. Catena 22 (1994): Wildland Hydrology

Thorne, C.; Hey, R.; and Newson, M. Applied Fluvial Geomorphology for River Engineering and Management. John Wiley and Sons, England 2003.