BELFAST AREA PLAN

Phase 1 Report: An Assessment of Natural Values

February 2008

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EXECUTIVE SUMMARY

The aim of the Natural Values Report is to provide an overview of the key ecological values in the Belfast Area and to initiate a discussion for protecting and enhancing those values from the impacts of changing land uses.

Belfast comprises approximately 1349 hectares of land encompassing the urban, rural and industrial Belfast area, and extending northwards to the margin of the Otukaikino River tributaries and south to the southern boundary of the Styx River. It includes parts of the Kaputone River and the upper and middle reaches of the Styx River.

During recent years, this area has experienced significant urban growth and this has resulted in the modification of, and increased impacts on, Belfast's natural and physical resources. There is continuing pressure to convert both rural and industrial land into residential land uses and this is likely to be accompanied by a further loss and reduction in the quality of natural values.

The Belfast Area contains a range of ecosystem and habitat types including wetlands, ponding areas, and waterways. These ecosystem types contribute to the distinctive character of the area. The waterways, wetlands and associated spring-fed lowland river ecosystems have considerable significance.

The waterway component of the Belfast Area includes the upper and middle reaches of the Styx River and its tributaries; Smack's Creek and Kaputone Stream. The Styx River flows along the southern boundary of the area with the Kaputone Stream flowing through the centre. The upper section of the Styx River also includes Smacks Creek. In addition, there is a network of environmental asset waterways and utility drains (as defined in the Christchurch City Plan), which flow throughout the area. In the north, there are wetlands, including the Otukaikino Wetland (Wilson's Swamp) and its neighbouring low-lying land to the south. The entire Styx River has very high local ecological and recreational values and includes important sites for wildlife, such as the Styx Mill Conservation Reserve in the south. The Area also lies along the flyway between the Waimakariri River to the north and the Avon-Heathcote Estuary to the south. Habitats along this flyway within the Belfast Area provide significant areas for birdlife to rest.

The waterways and wetlands provide habitat for a variety of birds, fish and aquatic and terrestrial invertebrates and plants. The fish and aquatic invertebrates found within the waterways of the Belfast Area are typical of lowland waterways. There are a wide variety of birds which use the area, and projects such as the restoration of the Styx Mill Conservation Reserve will increase their numbers and diversity in the future. Bush birds are largely limited to the riparian margins and suburban gardens as there are no significant terrestrial forest habitats. Remaining forest vegetation comprises native remnants in a willow-dominated forest along with rural margins, and rural and residential plantings. There have been major riparian plantings undertaken along waterways that now provide wildlife habitat, particularly where these are in public ownership. Dryland vegetation is not longer present in the Area.

The majority of remaining habitats in the Area are highly modified and show significant signs of degradation. Existing land use impacts are evident in wetland drainage, vegetation removal, and the reduction in surface water quality and quantity.

To optimize opportunities to improve and protect natural values, it is recommended that habitat patterns develop around existing natural features such as open space, wetlands, waterways and ponds. Using a pattern of core habitat areas, neighbourhood habitat patches and tree groves, habitat can be provided for many native species.

The Belfast Area Plan needs to take into consideration the surrounding land and water environment. Sites identified as having value will require ongoing management, including weed and pest management, enhancement, protection and a programme of public education.

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1.0 INTRODUCTION

The aim of this report to identify natural values and associated issues that need to be considered as part of land use planning for Belfast. This report is one of a series of preliminary documents providing background information for the development of an Area Plan for Belfast. The underlying purpose of the Area Plan is to provide for the sustainable development of natural and physical resources by identifying key values, and opportunities for the protection and enhancement of those values.

As part of preparation of the Belfast Area Plan, a Greenprint will be developed which will define what is to be protected, maintained or enhanced in the face of land use changes. This natural values report will guide the development of the Greenprint by proposing mechanisms for the enhancement of ecological values and identifying areas that require significant protection or enhancement.

Numerous reports have been written which contain valuable information and discussions about the various natural values within the Belfast Area (these are cited at the end of this report). Gaps in this information were identified earlier in the process of writing this document, and two separate reports were commissioned to address these. The first was a resurvey of the terrestrial natural habitats (Partridge, 2007), and the second a review of the aquatic ecology of the water courses in the area (Boffa-Miskel, 2007). Both these studies are discussed throughout this document.

The study area comprises approximately 1350 hectares of land within the upper catchments of the Styx River, Kaputone Stream, and Smack's Creek. These boundaries do not follow the natural catchments, but rather land use boundaries. There are a range of land uses in the Area including; residential, industrial, rural and open space.

Table 1: Existing Land use in the Belfast Area.

Land use	Area (ha)	Percentage
Industrial	171.50	12.7
Residential	283.55	21.1
Rural	755.93	56
Recreation/Open space	103.13	7.6
Other	34.67	2.6
Total	**1348.78**	**100**

Prior to human settlement, Belfast comprised areas of shrub, forest and wetland habitats with various waterways flowing between them. This would have included the Styx River and its tributaries which provided significant natural drainage for water from the surrounding wetlands. A wide range of indigenous fauna such as wetland and bush birds, insects, bats and native fish existed in these habitats.

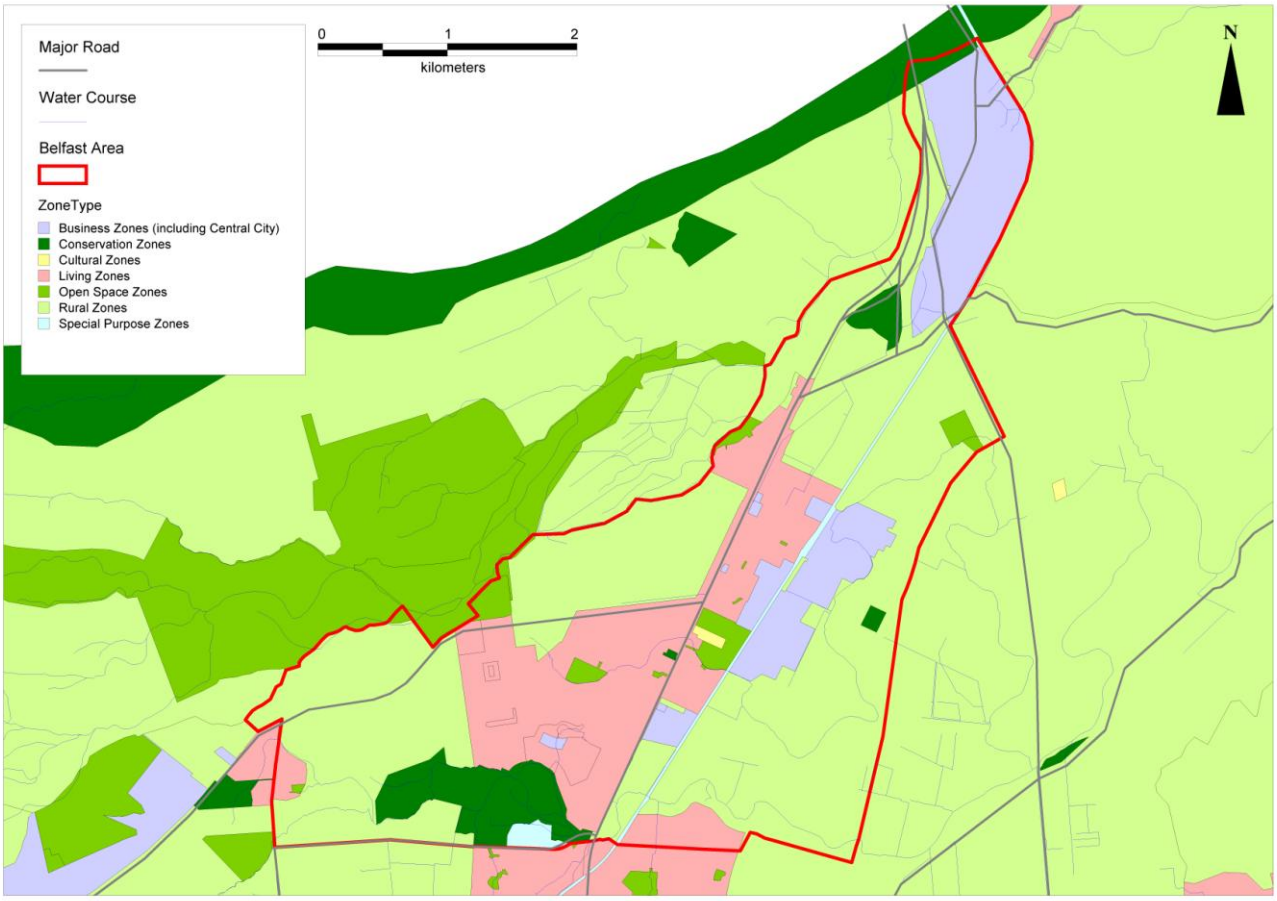
Much of the original forest, especially that on the drier areas was lost in Polynesian fires during the period of Māori occupation. During European settlement, almost all of Christchurch's remaining forests, including those around Belfast, were cleared. Wetlands were drained and the water courses straightened and realigned and often replaced by timber- or concrete-lined drains or pipes. Land in Belfast was drained initially by the Europeans for agriculture, and later for residential and industrial uses. Drains replaced small waterways while larger waterways were also significantly modified. Although there has been a reduction in base flow in upper reaches of the Styx River and associated tributaries, and significant modifications to the profiles of wetlands and waterways, the original floodplain landforms are still evident in many areas, and form a distinct part of the underlying landscape.

Floodgates have been installed downstream at the mouth of the Styx River and they significantly alter the upstream habitats and ecosystems. The original floodgates were constructed in 1930 by the Waimakariri River Trust as part of flood protection works in the Lower Waimakariri River. The aim was to prevent Waimakariri floodwaters entering the Styx River. New and larger floodgates were constructed in 1982. The floodgates have resulted in the replacement of estuarine habitat by freshwater in the lower reaches of the river.

The original indigenous riparian, wetland and forest vegetation has now been largely replaced by a mix of exotic and cultivated plant species. The banks of water courses are often mowed in residential areas, or grazed by stock in rural and industrial areas. The ecological repercussions of these activities has been significant, including both the loss of natural values, a reduction in surface water and habitat quality due to increased erosion, sedimentation and loss of riparian habitat.

Land use activities have significant impacts on natural values, primarily due to habitat loss and disturbance. Impacts include increased flooding, lower flows during dry periods, changes in watercourse substrate, removal of riparian vegetation and a reduction in species diversity. Each of these impacts is evident to varying degrees in Belfast.

Figure 1: Overview of Belfast



2.0 RECENT ASSESSMENTS OF NATURAL VALUES

2.1 Ecological Heritage Sites and Terrestrial Habitat Surveys

Christchurch City has undertaken a significant indigenous vegetation assessment process, which has resulted in the most significant areas being included as 'Ecological Heritage Sites' (EHS) in the City Plan. These EHS sites were derived from a list of sites containing indigenous vegetation, undertaken by Meurk, Ward and O'Connor (1993). Using five 'Ecological Criteria' and four 'Technical Feasibility Criteria', the sites were graded into one of five 'Primary Conservation Evaluation' categories. The City Plan included the 'A' category sites as the basis of the 51 EHS throughout the City. The sites listed in categories 'B to E' have no statutory protection status. From the 1993 survey the area covered by the Belfast Area Plan contained the following:

- One 'A' rated site (the lower Styx Mill Basin);
- Four 'B' rated sites;
- Eleven 'C' rated sites;
- One 'D' rated site; and
- One 'E' rated site.

In 2007, 15 years since the original assessment of sites, all of the sites that were surveyed in 1993 were reassessed. A large proportion (61%) of the sites found by Meurk, Ward & O'Connor (1993) occurred along the Styx River and its tributaries. However, their original survey resulted in only certain segments of the river being identified as having indigenous vegetation. Subsequent surveys have revealed that native plants are scattered throughout the riparian margins of these waterways, often under stands of willows. These areas are linked by the river and need to be assessed as parts of a continuum, rather than as isolated fragments. The 2007 assessment of the Belfast area for indigenous vegetation values comprises two parts: the Styx River and tributaries corridor, and areas beyond the Styx River. Using these methodologies, an up-to-date profile of the status and values of the remaining indigenous vegetation in the Belfast area has been

determined. This provides the basis for determining potential for enhancement of sites through restoration of appropriate ecosystems.

Table 2: Terrestrial habitat assessment findings 2007

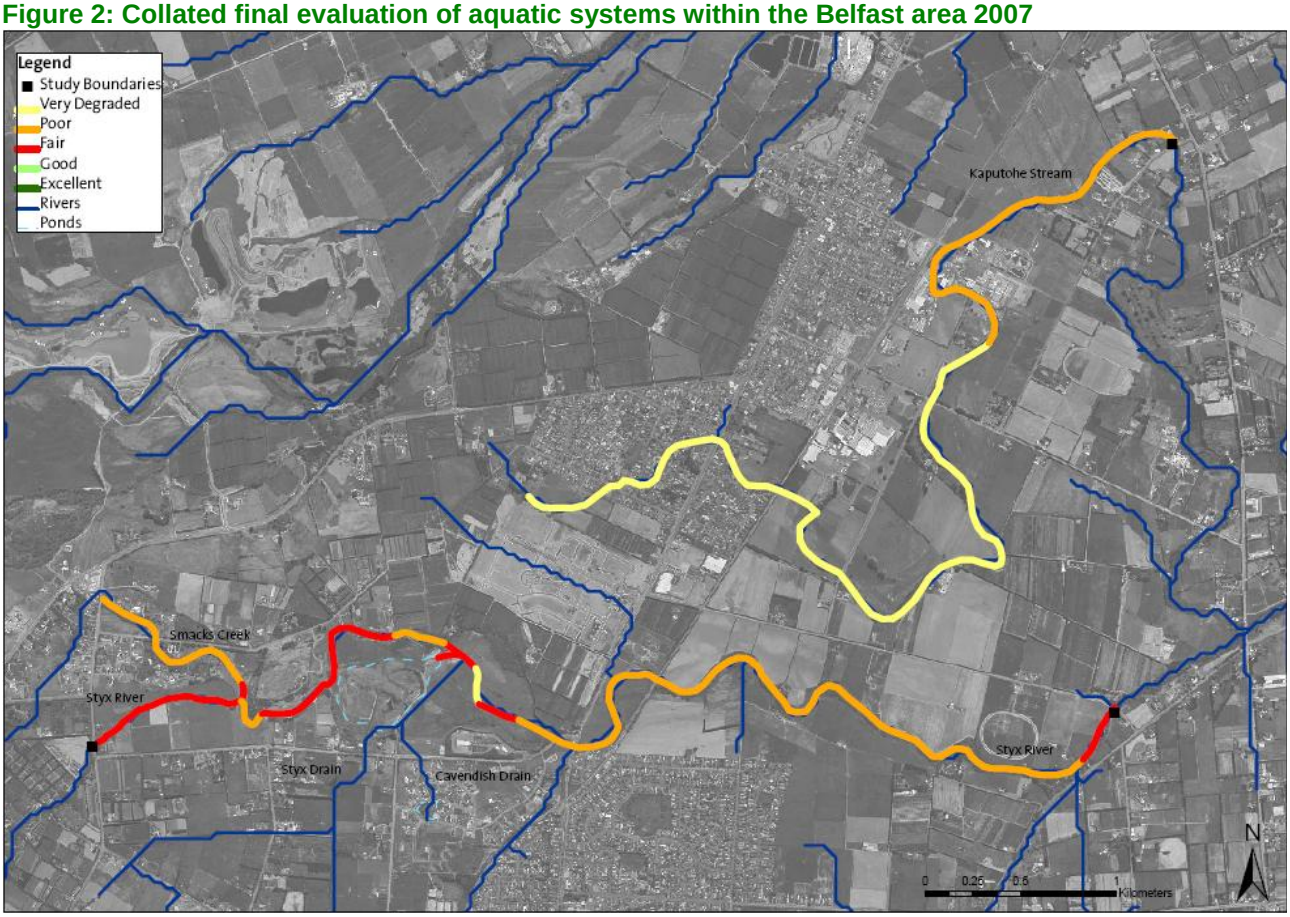
Site Rating	Site name
A	Styx Mill Basin, Lower
	Otukaikino (Wilsons) swamp
B	Redwood aquatics
	Styx Mill Basin, Upper (site one)
	Pentland
	Smacks Creek Fen
C	Hummerana Road
	Styx Mill Basin, Hussey Road Park
	Kaputone Stream, Belfast Park
	Kaputone Stream, corner of Belfast and Blakes Road.
	Hummerana Road to Groynes
D	Kaputone Stream, Englefield Belfast
	Between main north road & railway
	Marshland road
E	Styx Mill Basin, Upper (site two)
	Kaputone Stream, Factory Road
	Gardiners Road near Johns Road

(Partridge, 2007)

2.2 Aquatic Ecology Review

Due to fragmented and historic data regarding aquatic ecology in Belfast, it was decided that a review and re-assessment of aquatic values was required. Boffa-Miskell (2007) reviewed historic studies, undertook an initial visual assessment of waterways and conducted fieldwork to sample macro invertebrates, fish, water quality parameters and visual measures of aquatic plants and riparian vegetation. The results of this study are discussed in greater detail throughout this report.

Figure 2: Collated final evaluation of aquatic systems within the Belfast area 2007



(Boffa-Miskel, 2007)

3.0 THE EXISTING ENVIRONMENT

This section provides a general overview of the existing natural values in Belfast and identifies significant threats. Specifically, this section provides an overview of the following:

- Geology and Soils;
- Hydrology (water quality and quality, both surface and groundwater);
- Vegetation (both terrestrial and aquatic);
- Aquatic invertebrates and fisheries; and
- Wildlife (in particular birdlife).

3.1 Geology and Soils

Geology influences the topography of an area, and Belfast has a relatively consistent topography. It is low-lying, with areas of ponding and old river channels. The Styx River, Smacks Creek and Kaputone Stream flow through the area, and there are river terraces associated with these waterways.

Alluvial gravels underlie the soil. These have been formed from old river channels flowing across the Waimakariri River fan, which now forms the permeable gravel surface strata below Christchurch. These gravel units together with strata of finely grained silts and clays form the confined aquifers of Christchurch. The fine-grained silts and sands are thickest near the coastal margin and thin out in a westerly direction. In the east of Christchurch these are overlain and separated by marine and alluvial sands and silts.

Together the geology, soil and water resources determine the original ecosystems present in the Belfast area, and in particular the past soils strongly correlated to the vegetation types present. With changing land uses and loss of the original vegetation, these connections have been largely lost. The soils, however, still retain many of their original characteristics, and remain an important factor in the success of ecosystem restoration and enhancement.

The soils of the upper catchment of the Styx River and much of the Belfast Area are classified as Waimakariri deep silt loams. The Smacks Creek soils largely comprise Selwyn stony sandy loams with Te Kakahi stony sandy loams in the upper reaches and along much of the mid Styx River. The Kaputone Stream flows through Waimakariri sandy loams and Kaiapoi sandy loams. A Landcare Report (2000) examined the suitability of soils for horticultural and urban use. It indicated that Selwyn, Waimakariri and Kaiapoi soils are all suitable for urban use. Te Kakahi soils are classified as unsuitable for urban use without substantial modification. Te Kakahi soils found in the area have a high water table and would require significant drainage before they could be built upon. These wetter soils retain the major remnants of native vegetation, contain many of the springs which feed the waterways and, therefore, are most suitable for wetland restoration, enhancement and management. The drainage requirements have resulted in these areas remaining in rural use for some time, providing habitat for wetland and wet pastureland birdlife. See Appendix 1 for a map of the soils in Belfast.

3.2 Hydrology

3.2.1 Surface water

The surface water resources of the Belfast Area include natural, modified and artificial water courses, springs, wetlands and ponding areas. In addition, many of the surface water bodies are hydraulically linked to the groundwater resource. As Belfast has developed, water resources have been significantly modified. Wetlands and ponding areas have been drained for both urban and rural land uses. Drains have been created to remove water from wetlands to the larger waterways. The Styx River, Kaputone Stream and Smacks Creek channels and margins have also been modified and realigned significantly. Surface water quantity has been reduced for a variety of reasons, including increased development, and groundwater resources have been utilised to support a variety of land uses and activities.

There is relatively limited knowledge of the groundwater resource in this area. However, it appears that a reduction in groundwater flow hydraulically linked to surface waters is likely to lead to a reduction in surface water flow in the waterways and in springs.

The quantity and quality of the water resources in Belfast are vital for the viability of existing ecosystems and the health of enhanced or restored habitats. Research undertaken by Boffa-Miskel (2007) identified that the effects of changing land uses on the water resource may include the following:

- Removal of vegetation from riparian margins leading to loss of habitat and potentially increasing erosion potential, which can reduce the quality of the water.
- Straightening, widening and hard edging of waterways providing a homogenous environment with few habitat values. This also increases the rate of water flow in these waterways and may increase immediate flood levels in times of high rainfall.

- In stream obstructions such as weirs and dams, block routes for wildlife such as fish. Natural obstructions such as some fallen vegetation can actually provide habitat. Obstructions, both natural and artificial, also alter flow patterns.
- Contamination arising for discharges; including point source discharges, such as stormwater, and non-point source, such as agricultural discharges, will reduce water quality.
- Water abstraction; both of surface waters and hydraulically linked groundwater can reduce groundwater levels, spring flows and surface water quantities.
- Removal of plants from waterways can alter water quality parameters. This can be a negative or positive effect depending on the type of material and method of removal.
- The infilling of springs, wetlands and waterway margins can affect water quality and quantity and reduce habitat. Loss of wetlands, which act as sponges in times of floods and reservoirs in times of drought, leads to significant changes in water flow patterns.

In the past, land use changes have lead to an increase in constructed drains and piping. Drains are generally straight, timber-lined, deeply incised and shallow. In this state their natural values are limited. The larger water courses, including the Styx River and Kaputone Stream, have been significantly modified but still retain some naturalness of flow and some of their original floodplain.

Surface water quality varies within the Belfast Area. Smacks Creek has the highest comparative water quality. The poorer quality in other waters is due to a number of factors including siltation from stormwater, land use activities, pollution and loss of riparian cover. Monitoring of the Kaputone Stream was undertaken between 1989 and 1999. The BOD (Biological Oxygen Demand, a measurement of the biochemically degradable substances in the water) was high and worsened between 1989 and 1997. There were also high levels of ammonia and reactive phosphorus in the upper reaches. Ammonia is of concern as it is toxic to fish and their eggs. Ammonia levels dropped between Blakes Road and Belfast Road, and showed a decline between 1998 and 1999. Water quality measures taken through the Aquatic Ecology Study (Boffa Miskell, 2007) were generally indicative of no issues of pH, conductivity, or low contamination (i.e. fertilizer effects). Turbidity ranged between 0 and 6 NTU (average 2-5) throughout the river, which is surprisingly low given the predominant substrate of sediments. A very high turbidity was recorded in the headwaters of the Kaputone Stream. Most sites had a fair to good dissolved oxygen levels.

The present sediment yield within the Styx River Catchment is 6 to 78 tonnes per square kilometre every year. In both the Styx and the Kaputone, most sediment appeared to be carried in suspension and comprised both clay and fine sand. Sedimentation rates increase with changing land uses (for example, from rural to residential), and from the direct effects of activities that disturb the waterway margins. Sediment deposition in the Styx River is strongly influenced by the level of the bed in Brooklands Lagoon. The bed of this Lagoon is not only influenced by what is coming down the Styx River, but also in its location as a backwater to the Waimakiriri River. A rise in the bed of the Lagoon will result in a greater deposition of sediment in the Styx.

The major surface waterways within Belfast include the Styx River, Smacks Creek, Kaputone Stream and the Otukaikino River (also known as the south branch of the Waimakariri River.

The Styx River flows through Belfast, although its source is on private property just outside the area. The upper river is dry until approximately Sawyers Road (beyond the Belfast boundary), with the dry bed continuing up through Nunweek Park. The Smacks Creek enters the Styx River at the western edge of the Styx Mill Conservation Reserve and flows through Belfast under Main North Road. From here, the river flows in an easterly direction as passes out of the Belfast Area. Beyond this, the river flows northeast until it meets Marshlands Road. The Kaputone Stream joins the Styx River beyond the Belfast area. It is possible that water flow in the Styx River may once have been provided not only by springs but also channels connecting it to the Waimakariri River system in the north of the City. There is some evidence in early maps showing the Harewood channel of the Waimakariri River leading directly into the headwaters of the Styx River. There is also is a strip of very young soils along the middle reaches of the Styx River and Smacks Creek, which suggests a recent connection between the two river systems. It also appears that Kaputone Stream may once have been connected to the Waimakariri River, at least during flood flows.

Smacks Creek is a spring-fed tributary of the Styx River; with its source south of Wilkinsons Road. Springs along its two kilometre length contribute to its flow. The width of the Creek varies up to 4 metres and has a depth between of between 100 to 500mm. The bed of the waterway is comprised predominantly of gravel with some silt, and the water quality appears high and supports a diversity of aquatic life. The surrounding land use includes residential, rural and industrial. Willowbank Wildlife Reserve is located near the confluence of the Smacks and Styx River just upstream of the Styx Mill Conservation Reserve.

A section of Kaputone Stream flows through the middle of the Belfast Area. The source of this spring fed waterway is south of the eastern end of Johns Road. At Shenely Reserve which is adjacent to Sheldon Park

the stream is reduced to pools and flow does not occur until Blakes Street. There are concerns about loss of water flow in this stream, and investigation to augment the flow back to natural levels with groundwater is underway. Like other waterways in the area, the Kaputone Stream passes through various land use types, including residential, industrial and rural.

There are numerous other waterways and drains within the Belfast Area. To the west, a portion of the Otukaikino River flows into the Belfast area. There are numerous utility drains and environmental assets located within the area.

There are a large number of springs within the Belfast Area, and many of these are associated with the Styx and Kaputone Rivers (refer to Appendix 3). Belfast's waterways are all spring-fed, so it is vital that local springs are protected from changing patterns of land use. Protection may involve safeguarding spring sites, or managing land uses that have an adverse effect on spring flows and water quality. It is also likely that there are a significant number of springs which have not yet been identified in Belfast. It will be important that, prior to land use change, site visits are undertaken to identify and protect springs within site specific developments.

3.2.2 Groundwater

Protecting groundwater quality is particularly important as Christchurch City's water supplies are sourced from the untreated aquifers. While the water quality in these aquifers is generally very high, it is vulnerable to contamination from a range of sources:

- Leachates entering groundwater from landfills;
- Hazardous substance spills;
- Quarries and gravel extraction;
- Stormwater seepage; and
- Leaching of fertiliser and agrichemicals.

Groundwater degradation can have negative impacts on aquifer ecosystems, spring-fed wetlands and waterways as well as water supplies. Once groundwater pollution occurs, it is very difficult to reverse as movement is often slow. The susceptibility of the aquifers to contamination depends on their hydro-geological properties. For management purposes the proposed Natural Resources Regional Plan divides the Christchurch groundwater system into three main zones:

- Zone 1: High hydro-geological vulnerability. Sub-zone 1a recognises the part of Zone 1 that is currently or is planned to be used for urban purposes;
- Zone 2: Transition hydro-geological vulnerability; and
- Zone 3: Low hydro-geological vulnerability.

There are eight water quality monitoring sites in the upper Kaputone and mid/upper Styx Rivers, including the following:

- State Highway 1 Bridge (ECan and CCC)
- Gardiners Road (CCC)
- Hussey Road (ECan and CCC)
- Main North Road (CCC)
- Blakes Road (CCC)
- Factory Road (ECan)
- Guthries Road (CCC)
- Belfast Road (CCC)

There were seventy two surface water monitoring sites located within the Styx Catchment, twenty one approved surface water takes, five consented discharges, and thirteen springs. In addition to this, there are 896 groundwater wells, three groundwater level monitoring sites and numerous groundwater abstractions. There are also seven discharges to land and seven closed landfills in the Belfast area. Water quality monitoring sites are shown in Appendix 1 at the end of this document.

3.3 Vegetation

The remaining indigenous vegetation in the Belfast area is a small fragment of those that existed prior to the 1850s. Much of the indigenous vegetation now present is the direct result of recent habitat enhancement and restoration. Historically, the Styx River catchment's terrestrial vegetation was made up of a combination of ecosystems. The Black Maps (refer to Appendix 5) show areas of grassland, flax and raupo wetlands, covering much of the area. This suggests that by the time the maps had been drawn the majority of forested land had been cleared. This is due to Polynesian land clearance and early European activities. In addition, the movement of the Waimakariri River across the floodplain had major impacts upon the vegetation patterns.

On the older plains there were two main types of forest ecosystems: Totara and Matai forest on the moist and deep Kaiapoi soils; and Kahikatea on the wet Taipapu soils. The Totara and Matai forest would have included in some areas, large Hinau trees, with sub canopy trees and tall shrubs of Karamu, Cabbage tree, Fuchsia, Broadleaf, Kanuka, Manuka and Lemonwood. These forests were destroyed during Polynesian clearance and early European activities. The Kahikatea swamp forest had larger trees of Kahikatea as well as Hinau and Matai. These forests are also likely to have contained Titoki, Pigeonwood and possibly Miro above a tall shrub and tree layer of Putaputaweta, Cabbage tree, Karamu, Poataniwha, Lancewood and Wineberry.

On the mid-age plains the vegetation was shorter and less structured, comprising scattered trees of Totara and Matai, with shrubs and smaller trees of Karamu, Cabbage tree, Broadleaf, Narrow-Leafed Lacebark, Kanuka, Manuka, Akeake, Black Matipo, Lancewood and Kowhai. Smaller shrubs including many divaricate shrubs such as Mingimingi and the climbing Pohuehue would have been common.

Today, there are no sites within the Belfast Area that contain anything resembling the variety of species or ecosystems that once existed. Existing terrestrial vegetation is highly modified and largely exotic. The riparian margins have retained some native vegetation in a few areas, but the majority of native vegetation within the Belfast Area is the result of enhancement and restoration projects for example, work done in the Styx Mill Conservation Reserve.

Historically, indigenous riparian, wetland and swamp vegetation would have lined the waterways. This vegetation included wetland swamp species such as flax and raupo. Shorter species would have existed in fens, of which only tiny fragments remain. In the waterways, indigenous aquatic species such as the pondweeds would have flourished in the areas of open water.

The indigenous vegetation has now largely been replaced by pasture and gardens, with significant areas of willow woodlands along the river margins. Although a few native plant species have found a new home in such locations, either as garden weeds or in cultivation, exotic species dominate. The grasses and weeds of pasture are almost exclusively exotic, and the trees in plantations or gardens are not those of the original forests. Even in places left to run wild, the plants that flourish are mostly exotic, possibly because there is so little indigenous vegetation left to act as a seed source.

In their survey of the natural areas of Christchurch, Meurk, Ward & O'Connor (1993) listed 18 sites with indigenous vegetation that fall within the Belfast area. In 2007, Partridge (2007), resurveyed and assessed these sites and, and also identified three new non-riparian sites. Partridge's main conclusions are as follows:

- In 1993, only the Styx Mill Basin was classified as an "A" site. The 2007 survey recommends the Otukaikino (Wilsons) Swamp also joins that category;
- The sites of lower category declined considerably and a number of sites in the "C" class disappeared altogether;
- Fragmentation of habitats causes are reason for concern;
- A new "B" rated site was identified along Smack's Creek, which contains native plant species rare in Christchurch;
- Restoration plantings are the cause of the increased ratings for a number of sites. Sites that declined or disappeared are those where little or no restoration planting had taken place;
- Belfast is not an ecological unit and needs to be considered in relation to surrounding landforms and ecosystems.

CREAS is a monitoring programme undertaken by the CCC that surveys the waterways within Christchurch City and monitors various values that relate to the City's Asset Management Programme. Some of the findings from CREAS for the Styx River, Kaputone Stream, and Smacks Creek are as follows:

- The riparian vegetation of the upper Styx River was noted as relatively uniform comprising occasional stretches of exotic deciduous canopy trees (in particular, willows, mixed gorse and broom, and pastureland). In addition, there are some areas of native plantings. Outstanding areas for biodiversity and natural regeneration were the Styx Mill Reserve and the area between Styx Mill Reserve and Gardeners Road, Willowbank Reserve, Smacks Creek, Rhodes Drain and native plantings at Regents Park, Aylsham Reserve, Springvale Gardens and Harewood Crematorium. Overall, the riparian vegetation of Kaputone Stream was limited to mainly exotic species (willows, with gorse, elder and exotic grasses). The tree canopy was relatively consistent providing 50 to 75 percent cover for the waterway. Relatively little native vegetation was present, except for a section west of Blake's Road culvert. Locally, rare native watercress was found upstream of Englefield Reserve and rare native nettle was found at the confluence of the Styx River.
- The survey noted that high numbers of aquatic plant species were recorded in Kaputone Stream. Stonewort (up to 40%) and filamentous algae (up to 80%) were the most abundant. High filamentous algae cover occurred in a small number of stretches: along Sheldon Park, a 200 metre stretch upstream

of Belfast Road, and a one kilometre stretch upstream of the northern boundary of the Everglades Country Golf Club. Results in the Styx River main stem and Smacks Creek indicated an abundance and variety of aquatic plants. For the first two kilometres upstream of the Styx Mill Bridge curly-leaved pondweed, watercress, stonewort, and Canadian pondweed were the predominant species. In the tributaries, the abundance of aquatic plants was reduced and filamentous algae were more dominant.

The main areas of native vegetation associated with Belfast include Styx Mill Conservation Reserve, a small area of native trees on the corner of Hussey and Gardiner Roads, the Groynes recreation area, the Belfast Oxidation Ponds

The Styx Mill Conservation Reserve is an area of 57 hectares of riparian and wetland habitat located within a largely suburban area. The Reserve is located on both sides of the middle reaches of the Styx River. The reserve is owned and managed by the Christchurch City Council. Several uncommon plant species are present within the site. It comprises a mosaic of vegetation types including: Willow/New Zealand tree fern swampland forest; New Zealand flax rush-sedge tussock swamp; sedge-rush-grass tussock swamp; and aquatic herbs. The lower portion of the reserve has been listed as an ecological heritage site (EHS 8.10) in the Christchurch City Plan and has a degree of protection as a result. The Styx Mill Conservation Reserve Concept Plan indicates how the reserve is to be enhanced and managed. The CCC is presently constructing a predator proof fence around the most ecologically valuable part of the reserve, which will create a safer area for wildlife.

A small area of land at the corner of Hussey Rd and Gardiners Rd is the site of a major planting programme and the construction of a walkway. The area contains a small but significant area of wetland fen, which is extremely rare in Christchurch (Partridge 2007).

Part of the northern boundary of the Belfast Area Plan area cuts along the Otukaikino (Waimakariri South Branch) River and through the Groynes Reserve. This reserve has many areas of native vegetation, but these almost exclusively occur on the bank outside the Belfast Area.

The Belfast Oxidation Ponds are located in the northwest of the Belfast Area. Although the ponds are artificial, they provide a significant habitat for birdlife. The ponds have been decommissioned with sewage treatment being undertaken by at the Bromley Sewage Treatment Plant on the edge of the Avon Heathcote Estuary.

In addition to the sites where native vegetation is located, there are also a number of important taonga plant species within the area, which hold special cultural value to tangata whenua. Taonga species include Bracken, Harakeke, Lancewood, Kahikatea, Kanuka, Broadleaf, Coprosma, Korokia, Fushia, Kowhai, Sedge, Red Matipo, Matai, Ngaio, Black Matipo, Rimu, Lemonwood, Cabbage Tree, Titoki, Totara, Tutu, Silver tussock and Rushes. These species occur naturally in various sites, in enhanced and restored Christchurch City Council Reserves as well as on private property.

Aquatic vegetation is a general term for plant species that are adapted to spend at least part of their lifecycle completely or partly submerged in water. Their growth and distribution varies seasonally. These plants are necessary for many aquatic invertebrates which use them for food, habitat and shelter. Larger aquatic plants are also important for fisheries, providing shelter and shade. Excessive aquatic vegetation can, however, choke waterways and reduce ecosystem values. Surveys of aquatic plants in the Styx catchment have shown a marked reduction in red pondweed and water milfoil since 1953 (Taylor et al., 2000, Christchurch Drainage Board 1980 & 1986; and Robb et al., 1994). This decline coincided with stream alignment work and reflects the intolerance of these species to physical disturbance.

Aquatic vegetation in the Styx River within Belfast have also been included as part of larger studies. Connor (1956) described general patterns based on sample sites in the Styx, Avon and Heathcote Rivers. This work was expanded and updated in a more detailed sampling of sites by Robb (1973). More recent data was collected in the 1990s. McCombs (1992 and 1997) sampled 4 sites as part of the CCC monitoring programme. The results show that the number of aquatic plant species dramatically declined in the two lower Styx sites surveyed, and there was also a significant decline in the upper catchment. As a subset of this, the number of vascular native species had also declined. Aquatic weeds can be seasonally present, and therefore even if they have not been noted at a site during a survey they may be present at a different time. The spread of aquatic weed species can be very rapid and effective management is very important. However, management using dredging techniques can also have adverse effects on habitat values for other species.

3.4 Aquatic Invertebrates

Aquatic invertebrates provide an important link in aquatic food webs. They are an important food source for fish and birds, and the adults of aquatic invertebrates may also be eaten by predatory terrestrial

invertebrates. In addition to their direct feeding activities, invertebrates remove particles from the water column, reduce the size of organic matter and act as habitat modifiers. Urban stream faunas differ considerably depending on locality-specific factors. In general, mayfly and stonefly taxa decline in urban streams, which are instead dominated by pollution tolerant groups such as; worms, snails and midges.

Early surveys in 1979 recorded 61 taxa of invertebrate fauna in the Styx River. The river supported a more diverse and abundant invertebrate fauna than either the Avon or the Heathcote Rivers (Christchurch Drainage Board, 1980). Further surveys in 1987/88 identified that the diversity was generally similar to the previous survey and that water quality was generally high (Christchurch Drainage Board, 1986).

The assessment of water quality by the presence of specific invertebrates has been formalised by the development of the MCI (Macro Invertebrate Community Index). This index has been used to assess the 1999 data collected on the Styx River in order to determine any direction or degree of change in water quality. A high MCI score is indicative of high water quality. The scoring was low upstream of Sawyer's Arms Road due to the ephemeral nature of the waterway. The water quality of the upper Styx River was reasonably good but started to drop beyond the Main North Road and continued to reduce after the confluence with the Kaputone Stream. Looking at data indicated by the MCI profile, it would appear that the quality of the water had improved in the Kaputone Stream since the first sampling in 1979 and the later sampling in 1988. However, even then the water quality was still considered poor.

Smacks Creek showed a very high invertebrate diversity in 1979 including good numbers of caddis flies which are known to be intolerant of poor water quality. As caddis flies are predators, their presence indicates a good source of food.

The Aquatic Ecology Report (2007) recognised 50 aquatic taxa from 35 sample sites in the mid Styx catchment (the Belfast Area). No taxa of particular conservation note was sampled, despite the knowledge that the spring amphipod has been found in the Styx River. Treating the data collected in this survey as a whole showed a MCI value of 97.6, indicative of quite a healthy lowland stream. The report also states that in examining the mid Styx as a whole, the faunal composition pattern is complex. Soft bottomed, sediment and macrophyte-associated fauna dominate and suggest moderate to high levels of sedimentation, bank erosion and the shift to a soft bottom stream, however, the abundance and diversity of the EPT taxa remains surprisingly high.

Macro invertebrate values for the sampled site were categorised as very degraded through to good. Two sites (4 and 7) were identified as good. Site four was on Smacks Creek before the confluence with the Styx River and site seven being just beyond the confluence. Much of the Kaputone Stream, on the other hand, is described as very degraded.

3.5 Fisheries

The NIWA freshwater database lists 10 fish species within the Styx River catchment. In order of abundance they include Shortfin Eel, Longfin Eel, Brown Trout, Common Bully, Lamprey, Common Smelt, Inanga, Giant Bully and Black Flounder. None of these species are endangered either regionally or nationally although Inanga and Shortfin Eels are vulnerable to over fishing. The Brown Trout population is also considered a locally significant fishery and provides food angling opportunities. The catchment as a whole compared to coastal, rural and pastoral streams of similar size is ranked as average to fair in terms of species diversity. Modified rural streams such as the Styx River possess inferior fish values in comparison to unmodified streams, which have fewer galaxiid and bully species.

The upper and middle reaches of the Styx River main stem are dominated by Trout, and most spawning takes place between Marshlands Road and the Kaputone Stream confluence. The absence of trout in the Kaputone Stream may be due to a number of factors including poorer water quality in the upstream area, the presence of the weir at PPCS meat works and lack of riparian planting.

There has been concern about the loss of trout fisheries in the Styx catchment. Trout Redd surveys in 1990 (Eldon and Taylor) and 2000 (Taylor) revealed a 50 percent decline in Redd numbers as well as a shift in distribution towards the upper part of the 1990 range. By 2000 most of the Redds were found within the Styx Mill Conservation Reserve (Dolphin 2000). Dolphin (2000) made the following conclusions:

- Sedimentation rates in the middle reaches had increased from levels that were present prior to 1990 and caused trout to abandon their spawning sites;
- The riparian planting was likely to have improved the habitat for trout within the Styx Mill Conservation Reserve; and
- If sediment inputs were not reduced, trout populations could become locally extinct.

Water quality in the Kaputone Stream was found to be poor with high levels of ammonia, BOD and reactive phosphorus (Taylor 2000). Key issues summarised for the Kaputone Stream include the following:

- In stream obstructions may have stopped sub-catchments being used by fish;
- Degradation of downstream habitats may have prevented fish passing through them to healthier upstream environments;
- Low water levels in the Kaputone Stream are a concern for ecosystem health;
- It will be important to protect and enhance remaining trout spawning sites;
- The increased sedimentation rate, decline in water quality and loss riparian vegetation caused by surrounding land use changes, may have had an impact on the health of the aquatic ecosystem;
- Ditches which enter the Styx River may hold significant value as habitats for native species especially Inanga and common bullies. This is because in the main stem these fish are the prey of trout and eels, and the small ditches may afford some protection.

As part of the Aquatic Ecology Report (2007), fish sampling was undertaken from 6 sites on the Kaputone Stream, four species of fish were identified: Common Bully, Redfin Bully and Short and Longfin Eels.

3.6 Birdlife

Prior to European settlement, the Belfast Area supported abundant birdlife including both wetland and bush birds, many of which are now locally extinct. Locally extinct species include the New Zealand Weka, Bittern and Crakes. Present day birdlife is characterised by waterfowl, common wetland/wet pastureland species and exotic passerines. Due to the mobility of birds and their range of habitat requirements, birdlife within Belfast needs to be considered in terms of the entire Styx catchment. The Styx catchment is ecologically very significant as it lies beneath the Avon-Heathcote Estuary to Waimakariri River Flyway. Birds flying between these two areas will use available habitats located within the Belfast Area.

Bird habitat types remaining within the Belfast Area include ponding areas, rivers, streams and drains, freshwater wetlands, horticultural, agricultural and recreational grasslands. Industrial and residential properties also provide some wildlife values. Some landowners try to restrict birds (particularly Pukeko) being on their land due to the threat to crops. Waterways and their associated wetlands and floodplains are the most important birdlife habitats as these are the most natural environments still available and collectively provide a network of habitats throughout the area and beyond.

Data on birdlife in the Styx catchment was collected between 1992 and 2000 and is presented in a report by Crossland (2000). The Crossland Report identifies priority species for the Styx catchment. These include the New Zealand Scaup, Cormorants, New Zealand Shoveler, Grey Duck, Paradise Shelduck, Grey Teal, White Heron, White-faced Heron, Pied Stilts, New Zealand Kingfisher, Silver-eye, Grey-warbler, South Island Fantail, Bellbird, Kereru and Shining Cuckoo. In an earlier report, Crossland (1989) identified that the narrowness of the Kaputone Stream and the water depths limit the potential for habitat for wetland birds. Despite the good riparian vegetation and gardens opening up on the stream, mallards and welcome swallows were the only wetland bird species that appeared to be using most parts of the stream during the survey period. The river stretch flanking Englefield Road Recreation Reserve had a wide swampy zone and supported Pukeko and Spur-winged plover. Ponding areas at Sheldon Park also supported Mallard, Grey Duck, Gulls and White-faced Heron. The potential exists to increase wildlife with more ponds and planting along the stream. Crossland also highlighted the linkages to important wetland habitats, such as the Groynes, Belfast Oxidation Ponds, Lake Rotokahutu, Peacock Springs, the Styx Mill Basin and the Waimakariri riparian wetlands. Birds moving across northern Christchurch along the Waimakariri-Avon Heathcote flyway are likely to pass close to Kaputone Stream and may be attracted down to suitable habitat.

Within the Belfast area are a number of significant habitat areas. The most important of these include the Styx Mill Conservation Reserve, the Belfast oxidation ponds and Kaputone stream.

In the Styx Mill Management Plan, Crossland stated that the current value of the Styx Mill Reserve lies in its size, its swampy nature and its relative inaccessibility. Present birdlife, however, is limited to Pukeko (50-70), Mallard (100+) and smaller numbers of Spur-winged Plover, White-faced Heron, Welcome Swallow, Harrier and Southern Black-backed Gull. A few other wetland species, for example, the Little Cormorant, Kingfisher, Pied Stilt, Paradise Shelduck, Grey Duck and Shoveler probably visit irregularly. In comparison, Travis Swamp has 24 wetland species; Horseshoe Lake has 22 and the Groynes 23. Most of the introduced passerines occur in the Christchurch area as well as native Fantails, Grey Warbler and Silvereye are common. Most wetland bird species occur in the wetter and less disturbed eastern end of the basin, although Spur-winged Plovers favor the drier western parts. The Styx River is generally too confined and fast flowing to be utilised by wetland birds. This factor, and the general lack of suitable bodies of open water accounts for the absence of Shoveler, Grey Teal, Scaup and three native duck species which all occur at nearby sites such as the Groynes.

The Styx Mill area has great potential as a wetland habitat and in the future will undoubtedly become a very significant link in the chain of wetlands spanning Christchurch City. Provided that habitat requirements are

met, in time the river, riparian strip, fields, vegetated wetland areas, islands and margins of the lakes can be expected to attract nesting Black Swan, Canada Goose, Paradise Shelduck, Mallard, Grey Duck, Shoveler, Grey Teal, Pukeko, Coot, Harrier, Pied Stilt, Spur-winged Plover, Kingfisher, Welcome Swallow and possibly Little Cormorant and White-faced Heron. Larger numbers of these species as well as others, such as gulls will occur in the non-breeding season. In addition, it may prove viable to introduce a number of locally rare or extinct species once the wetland habitats have become fully established and if predation does not prove to be a problem. Likely candidates include the Bittern, Marsh Crake, Fernbird and Mute Swan. Common native bush birds such as Tomtit, Bellbird and New Zealand Pigeon might also, at some point in the future, be introduced into the Swamp Forest.

At the present time, the City Council is involved in the creation of a predator proof area in the Styx Mill Reserve. This area aims to eliminate predators and humans and provide a site within the catchment where more sensitive species can survive and breed. Bird species which may be introduced to the area include Weka, and Keruru.

With regard to the Belfast Oxidation Ponds, Crossland (1996) stated that at times the ponds supported relatively low numbers of bird species compared to the nearby shingle pits, and were dominated by mallard, NZ Scaup, Grey Teal, NZ Shoveler, Welcome Swallow, Southern Black-backed Gull, Red-billed Gull, and Spur-winged Plover. Crossland noted that there was a great deal of movement between the ponds and nearby shingle pits. The future of the oxidation ponds as a potential bird habitat is unclear as the proposed western bypass road may pass through this area.

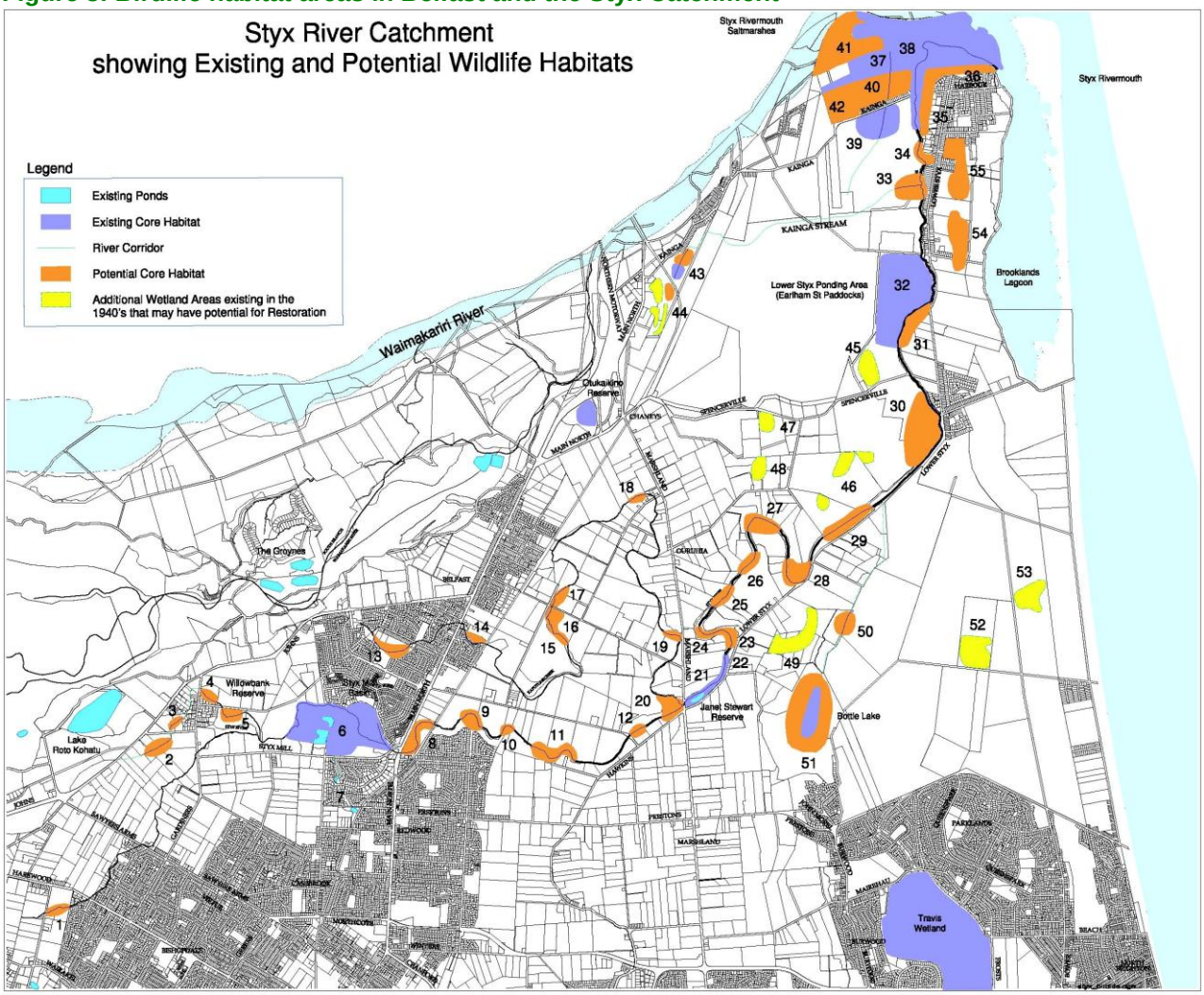
Regarding the Kaputone Stream, a short survey was undertaken by Crossland in 1997 upstream of Factory Road on the Kaputone Stream, and although there were only Mallard sighted, it was noted that Pukeko were likely to be present. Suitable habitat also exists for Spur-winged Plover, White-faced Heron, Paradise Shelduck and Harrier. Three bush species were noted, Silver-eye, Fantail and Grey Warbler. Crossland also noted that the upstream area would benefit from restoration, and he encouraged habitat enhancement of Kaputone Stream between the freezing works and Belfast. Crossland suggested that the marshy riparian streams to the true right could be expanded into mixed fern and tall, freshwater wetland, and habitat improvement to support wetland species such as Grey duck, New Zealand Shoveler, New Zealand Scaup, Paradise Shelduck, Pukeko, Little Cormorant, Black Cormorant, White-faced Heron, New Zealand Kingfisher and Welcome Swallow. Small-scale enhancement would also provide habitat for the introduced species, pheasant and possibly quail. Crossland (2000) provides the following recommendations in relation to birdlife in the Styx catchment.

- Discourage dabbling ducks other than grey duck (native) and concentrate on enhancement for native ducks, wetland and bush birds. Geese, Swan, Mallard and Greylag also tend to foul water when in high numbers. These species do not like long vegetation such as Carex and Raupo and prefer short grass. The feeding of ducks should also be discouraged.
- Aim for diversity, rather than high numbers of birdlife. Aim for moderate populations of many bird species, thereby utilising many niches.
- Target species such as Heron and Bittern, which occur at Otukiakino and Coutts Island Swamp, and therefore, have potential at larger sites such as Styx Mill Conservation Reserve.
- Native bush birds need more areas of forest so they can visit from the Port Hills and Bottle Lake Forest.

Crossland (2000) also identified the type of habitats and birdlife that he suggests should be focused on within the Styx catchment. Preferred habitat types include the following:

- Natural low-lying areas, which act as habitat stepping stones (waterfowl, herons, swamp birds, harriers and some waders);
- In stream ponding areas, which are created by restricting water flows and are suitable for waterfowl, Cormorants, Herons, Kingfishers and Swallows;
- Surface water ephemeral areas such farm paddocks and sports field, which provide feeding habitats for Herons, Pukeko, Gulls, and nesting and feeding habitat for waders;
- Hinterland Wetlands such as Bottle Lake and Chaney, which provide habitats for a range of feeding and nesting waterfowl, swampland birds, waders and Herons;
- Woodland habitat patches no longer exist in Belfast, but if recreated would provide habitat for common native bush birds;
- Wooded corridors along waterways are currently comprised of willows and other exotics, which could be replaced in the long-term by natives to recreate Kahikatea swamp forest and stands of Cabbage trees. Native bush birds, such as fantails and bellbirds, would benefit from these habitats as would, kingfishers, cormorants, herons, owls and introduced game birds.

Figure 3: Birdlife habitat areas in Belfast and the Styx Catchment



(Crossland, 1999)

4.0 ISSUES AND OPPORTUNITIES

Protection of natural values in Belfast requires maintenance of the functioning of the area's ecosystems, and this is dependant on habitat quality and quantity. Land use activities and their effects, may result in loss, fragmentation and degradation of the quality of ecosystems and habitats, and this will lead to the reduction of populations and biodiversity. Highly managed ecosystems and habitats, such as pasturelands, have been recently developed, but these have fewer functional characteristics, are less diverse and contain fewer indigenous species than the original or remaining natural ecosystems they have replaced. This section discusses the present and future threats and opportunities related to Belfast.

4.1 Habitat Fragmentation

Ecosystem fragmentation occurs when contiguous habitat is broken into smaller patches by land use activities, such as, housing, industrial development, intensive agriculture and roads. Past surveys of the Belfast Area confirm that there has been significant fragmentation of the habitats both within Belfast and the surrounding catchment. This has resulted in a very significant reduction in natural values. Waterways are significantly modified, riparian vegetation has been lost from large areas and all original areas bush and shrublands have been destroyed. Additionally, pond and flooding areas have been significantly reduced. Restoration and enhancement of reserves along the Styx River and of the Otukaikino Reserves have enhanced natural values in pockets of the catchment; however, there is still a significant threat to remaining habitats and potential habitats from existing and changing land use activities.

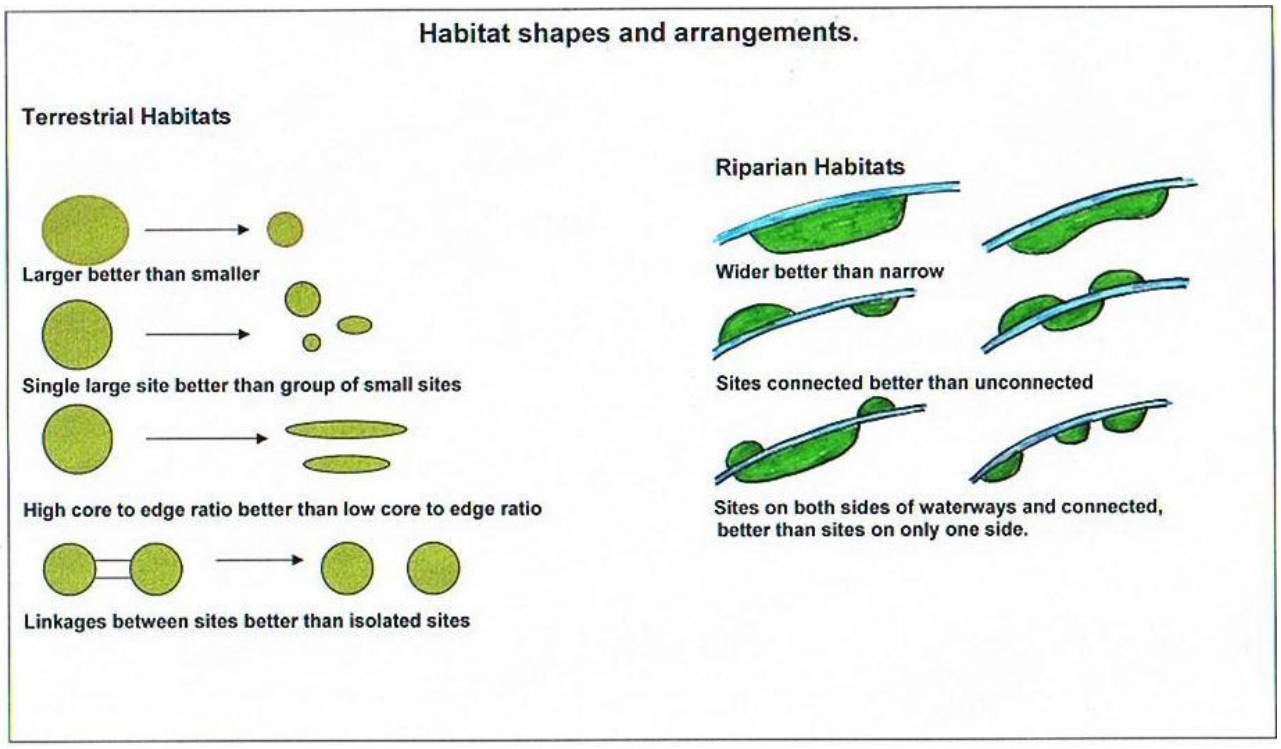
Studies of wildlife in remnants of vegetation have shown that habitat size, location and shape are particularly important influences on maintaining natural values. Relevant habitat principles are as follows:

- Larger areas provide a greater variety of habitat types for plants and animals than do smaller areas.
- The number of species present increases with habitat size. This species-area relationship has been shown repeatedly in studies of birds, mammals and reptiles.

- The population size of a species is larger in larger habitat patches, and consequently the species has greater capacity to cope with varying seasonal conditions and disturbance.
- Large habitats are more likely to include species that are rare or have specialised requirements. Small habitats may be dominated by common species or those that frequent surrounding land. A wetland of less that one hectare may have numerous insects, plants and a few common bird species. Less mobile animals may be able to survive because their home range requirements are small, however, the survival of medium sized animals may be compromised over time, with larger or more mobile animals becoming rare.
- Narrow habitat patches are less viable than wide habitat patches. This is because a narrow habitat is more vulnerable to adverse effects and effectively the entire habitat becomes the margin which differs from the intact centre. It is noted, however, that some types of habitats such as riparian areas are by their nature more likely to be narrow.
- Habitat patches should be located near to each another to facilitate the movement of plants and animals. Groups of habitat patches are generally better than long strings of very small habitats. If possible, habitats should be physically linked or have stepping-stones between them. An example of the importance of linkages is the connecting of reserves along waterways, such as the Styx Mill Reserve with reserves further downstream on the Styx River.
- A wide range of habitat types and sizes are required to enable species to meet their seasonal and daily requirements.

As Belfast develops, care will need to be taken to ensure that habitat fragmentation is mitigated and that sufficient natural areas are maintained and developed to promote biodiversity in the area.

Figure 4: Habitat Shapes and Arrangements



4.1.1 Core Habitats

Core habitats are the larger areas of habitat that support more abundant and diverse range of species and are essential for maintaining biological diversity. They provide a large island of habitat with a better range of shelter and food compared with smaller patches; although linkages between core habitat and smaller patches are also important. An example of an existing core site in Belfast area is the Styx Mill Conservation Reserve. Existing core habitats will have to be extended and new core habitats developed to ensure that local wildlife is protected and enhanced in the face of urban development.

4.1.2 Edge and Interior Habitats

The outer edges of habitats are the most vulnerable to adverse effects and often differ ecologically from the interior or cores of habitats. These edges contain a graduation of species from the core to the surrounding vegetation, and this is often called an ecotone. The amount of edge habitat is increased by fragmentation, and tends to promote the occurrence of edge species at the expense of more interior species. For example, edges tend to contain more weed species and the common exotic birds rather than native birds. These species are called opportunistic species and are more adaptable than many native species. Some fragments

are so small that they are in reality just an edge or margin. To protect and develop the interior or core of a habitat, sufficient buffering will need to be provided in natural areas.

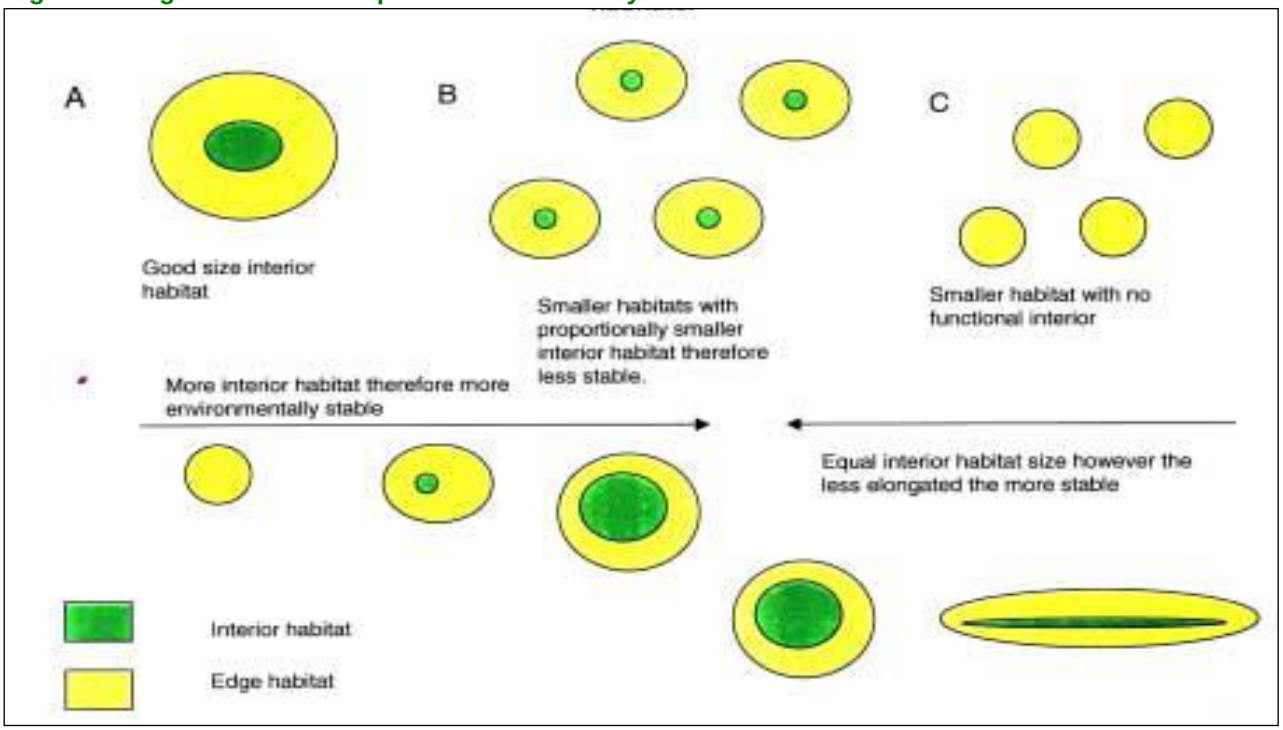
4.1.3 Habitat Buffers

Buffers are the areas designed to protect the core of a habitat and the sensitive species and communities within them. The function of buffers is as follows:

- Protection of habitats from land use activities and their adverse effects and from hazards associated with habitat dynamics.
- Increased soil conservation, which is an important foundation for habitat stability. For example, through the stabilisation of waterway banks.
- The filtration of sediments, nutrients and pollutants in runoff, such as from agricultural land uses.
- The maintenance of water temperatures due to overhanging vegetation.
- Provision of habitat for fish and other aquatic life.
- Provision of habitat for terrestrial wildlife species.
- Creation of recreation buffers and aesthetic use of habitats, for example an exclusion zone in a predator proof reserve, such as planned at Styx Mill Reserve.
- The preservation of archaeological and historic sites located in natural habitats.

It will be important to develop habitat buffers around areas such as Styx Mill Conservation Reserve to ensure that existing habitat is maintained and enhanced in the face of urban development in Belfast.

Figure 5: Edge effects and impacts on the viability of habitats



4.2 Habitat Quality

Not only are the dimensions and location of habitats important for the sustainable management of natural areas, but the quality of the component elements strongly influences the viability of habitats and ecosystems. In Belfast, one of the major influences on habitat quality is water quantity and quality. Decreases in water quality and quantity in Belfast can have significant effects on natural values in the area. The issues and effects on natural values are summarised below. As Belfast develops, there will be a need to ensure that water quality and quantity is protected to recognise the important influence that these areas have on habitat viability throughout the area.

Table 3: Land use effects on water quality and quantity

ISSUE	CAUSE	EFFECTS ON NATURAL VALUES
	Water quantity	
Loss of surface waters	• Abstractions • Land drainage • Alteration in flows; due to diversions, increased flows due to hard surfacing, low	• Loss or reduction of habitat. • Loss of wildlife or reduction in diversity and population size. • Loss of linkages, both in Belfast

ISSUE	CAUSE	EFFECTS ON NATURAL VALUES
	flows. • Loss of springs, ponding and wetlands areas, due to land modification and reduction or modification of hydraulically linked groundwater levels.	and beyond • Loss of biodiversity.
Loss of spring flows	• Land disturbance and changes. • Groundwater depletion. • Draining and diversions. • Climate change.	• Lows of spring flows. • Reduction in surface water quantity. • Reduction in water quantity. • Loss of habitat, species and biodiversity.
Increase in water quantity	• Augmentation. • Diversions. • Flooding.	• Increase in contaminants. • Impacts on habitats and diversity. • Change in river morphology and erosion rates. • Mixing of water types and species.
	Water quality	
Discharges	• Non-point source discharges – from example runoff from land. • Point source discharges – from contaminated land, closed landfills, stormwater discharges, and other specific discharges to water or hydraulically linked groundwater.	• Contamination of waterways leads to changes in/and reduction in habitats quantity and quality.
Temperature	• Discharges. • Loss of vegetation cover.	• Reduction of in stream values.
Light	• Loss of in stream and out of stream cover	• Loss of in stream values. • Increase in weed growth.
	Riparian margins	
Loss of riparian cover	• Removal of riparian plantings. • Loss of width of planting.	• Loss of habitat, and riparian and aquatic values. • Increase in erosion and sedimentation, leading to reduction in water quality.
Bank instability	• Stock trampling. • Land development. • Removal of plants.	• Increased sedimentation, erosion and increase contamination into water. • Loss of riparian and aquatic values.

4.3 Exotic Predators and Pests

The management of exotic predators and pests is important for the maintenance and the success of enhancement and restoration programmes. Exotic predators can have a devastating impact on wildlife, and this is a factor which needs to be considered when deciding on the types of habitat and wildlife species to encourage in an area. Wildlife throughout New Zealand faces threats from introduced predators and pets, but in the urban environment where there are only small remnant habitats and limited management predation from introduced animals, such as the domestic cat, is likely to be high.

Minimising the impacts of predators though trapping and poisoning are often the most effective control mechanisms, but they are also expensive. Physical protection mechanisms have varying levels of success. Predator-proof fencing is very effective, but also expensive. Creating water barriers helps to protect against wild cats, but offers no security against hedgehogs, possums, birds and dogs.

An example of a site within the Belfast area where vulnerable species may be successfully introduced is the Styx Mill Conservation Reserve where there is an intention to construct a predator proof fence around the central part of the reserve. This would create protected breeding areas for species such as Crakes and Bitterns.

4.4 Contaminated Sites and Closed Landfills

A desktop study undertaken by PDP (2005) assessed contaminated sites in the Belfast area. Assessed sites included cemeteries, pistol and rifle ranges, sites which are currently being used or historically have been

used as landfill or hard fill sites, areas where the use of persistent agricultural chemicals occurred, storage tanks and drum storage for fuel, chemicals and liquid wastes, and wood treatment and storage of timber. There is limited data on the contents of these sites, and, therefore, the actual or potential adverse effects of these sites on specific activities will need to be determined at the time of development. There is some concern in relation to these sites that leachates may enter the soil, groundwater or surface water and reduce the quality of natural values.

4.5 Community awareness and involvement

As Belfast develops and the residential population increases, there will be opportunities to inform and engage community members in the protection and enhancement of important natural values. Given the relatively degraded nature of some of the waterways in the Belfast area, particularly Kaputone Stream, it is important to encourage a greater level of respect for and understanding of these sites among local businesses and residents.

4.6 Research and monitoring

Ongoing research and monitoring will be required as Belfast develops to ensure that existing natural values are not compromised by the processes of land development, intensification and population increases. In particular, regular monitoring of waterways, such as the Styx River, Kaputone Stream and Smacks Creek will be a key to ensuring the health of ecosystems throughout Belfast.

4.7 Waterways

Waterways are among the most significant natural values in the Belfast area as they provide significant habitats for fish and aquatic invertebrates and a source of food and shelter for birds. Many waterways, however, show relatively high levels of degradation as a result of adjacent land use activities. Continuing urban development is likely to increase the pressure on urban waterways, and significant protection and enhancement measures will need to be undertaken to ensure that waterways continue to support significant indigenous biodiversity.

5.0 METHODS FOR PROTECTING AND ENHANCING NATURAL VALUES

The objective for Belfast's natural values is to maintain and enhance the ecological function for the ecosystems of the area and provide protection for the significant natural values which remain. Mechanisms for achieving protection and enhancement include the following:

- Maintaining naturally occurring ecological systems, communities and biodiversity;
- Protecting, enhancing and managing areas with high ecological values and locating development in less-sensitive areas;
- Minimising ecological impacts through good planning, design and management;
- Mitigating the potential loss of ecological values;
- Restoring lost ecological values where practical;
- Recognising the different habitat requirements of different species and the importance of linkages between habitats;
- Resolving compatibility of natural value objectives with social and economic objectives;
- Promoting native species;
- Recognising the resilience and adaptability of ecosystems;
- Minimising the impacts of development on the quality of the environment; and
- Using the remaining natural landscape to minimise land disturbance and manage ecosystem values.

5.1 Biodiversity Strategy

The Christchurch City Council Biodiversity Strategy includes a Biodiversity vision for the City. Areas identified as having major conservation importance within and close to the Belfast Area include the upper Otukaikino River, the Groynes, the Styx River corridor and the Styx Mill Conservation Reserve. Enhancing and protecting biodiversity will require sufficient land and water available to extend and develop existing habitat areas to maintain species, ecosystems and populations.

5.2 Habitat Protection

Crossland (2004) has advocated the use of a two-tier habitat system for the protection of bird habitats. Although Crossland focuses on birds, this tool could also equally be incorporated into the protection of other ecological values throughout Christchurch. Characteristics of first tier habitats include the following:

- Maximise species richness and population size;
- Large/distant from development and exposure to edge effects to provide safe environment;
- Large area to perimeter ratio;
- Central core area, with wide buffer zones, water barrier, fencing and or dense vegetation.

Examples of first tier habitats in the Belfast area include; Styx Mill Conservation Reserve, Otukaikino Wetland and the Upper Otukaikino River.

Characteristics of second tier habitats include the following:

- They attract mainly robust species;
- These habitats are compromised due to size, isolation, proximity to development and exposure to edge effects;
- Likely to have small area to perimeter ratio;
- Design considerations will be more strongly focused on botanical, other wildlife and landscape aspects;
- For larger sites, habitat area can be maximised by buffer zones, fencing, vegetation screening and moating where applicable and possible;

Examples of second tier habitats in Belfast include Sheldon and Englefield Parks.

Small and narrow habitats are more susceptible to damage and are only able to maintain small populations and limited species diversity. Therefore, ensuring that habitats are as large as possible and that there are strong linkages between sites will be vital for habitat sustainability. In Belfast, this means ensuring that habitats along the waterways are continuous and of sufficient width to provide meaningful habitat areas.

A wide range of habitats are necessary to meet the requirements of different species. In Belfast, this means ensuring that there are a range of wetland and riparian habitats available. Ensuring that these sites are of significant size will encourage the development of forest habitats, which will provide an environment for bush species.

Core habitats are critical to the viability of natural values. The Styx Mill Conservation Reserve is a major core habitat in the area and important for the wildlife of the City and in the region. It is important to identify any other potential core sites within the area and ensure they are maintained and enhanced. The Christchurch Biodiversity Strategy indicates the Groynes and the Upper Otukaikino may also be potential core sites.

5.3 Avon-Heathcote Estuary to Waimakariri River Flyway

The most important link between wetland bird habitats within the Belfast Area and other city habitats is the flyway linking the Avon-Heathcote Estuary with Waimakariri River. The benefit of having the flyway over the Belfast area waterways and catchment is that many of the birds passing overhead can be attracted down by the presence of suitable habitat. In such a situation, quick colonisation by wetland birds of newly created wetland is likely.

5.4 Addressing the effects of land use activities

Increased intensity and changes in land use activities, including the construction of structures such as roads and buildings can lead to habitat fragmentation and a reduction in the quality of the natural environment. Mitigation of these effects can be achieved by enforcing regulations, such as those relating to setback distances, and ensuring esplanade widths around waterways are sufficient. This provides an adequate buffer to ensure that water quality is maintained or enhanced and discharges are treated.

5.5 Policy-based protection tools

A range of statutory and non statutory tools are available to protect natural values. The table below summarises some of these tools.

Table 4: Statutory Protection Mechanisms

Implementation Tool	Main features	Ownership of Land	Other issues/comments
Reserves (General)	Managed by the Crown or local authorities under the Reserves Act 1977.	Becomes public land	Appropriate for all natural values. Level of protection high for static values e.g. vegetation.
Esplanade Reserves	Administrated by local authority, under the RMA 1991, Reserves Act 1977. Identified by width in the PCCP for waterway with average width greater than 3 metres.	Becomes public land	For protection of waterways and their margins and the coast. Level of protection can be high. Generally used in urban areas.
Esplanade Strip	Created under the RMA 1991.	Remains private land	For protection of waterways and their margins.

	Identified in the PCCP for waterways average of 3 metres width. Can also be created with agreement of landowner.		Level of protection general low as authority has no power of management. Generally in rural zones. Does allow access.
Setbacks	Created under the RMA 1991. Identified by width in the PCCP. Setbacks also used as tool in pNNRP	Remains private land	For protection of waterways and their margins. Level of protection low as authority has no power of management. Restricts development of land.
Easements	Created under the RMA 1991.	Remains private land	Usually for maintenance. Mainly used along waterways. No protection function other than easements cannot be built on.
Zoning	Under the RMA 1991.		Provide a framework for land development and sets a baseline, does not ensure any protection.
Resource Consents	Under the RMA 1991	May remain in public or private ownership.	Avoids, minimises, and mitigates adverse environmental effects.
Development Cost Sharing	Under the RMA 1991.	Likely to become public land. May be protected as a reserve.	This may be appropriate where multi purpose projects can be developed such as stormwater treatment. Level of protection can be high.
Purchase for reserve. Including Reserve Contribution.	Local Government Act, 2002, RMA 1991	Becomes public land.	Appropriate for all ecological areas. Level of protection high. In relation to reserve contributions this is determined at the time of subdivision and may be money or land in lieu of money. This has to cover all recreation reserve types.
Conservation/ Department of Conservation/QEII Trust Open Space/Nga Whenua Rahui Agreements Covenants	Administrated by local authority, under the RMA 1991, Reserves Act 1977, Conservation Act 1987, Queen Elizabeth II National Trust Act 1977, or Te Ture Whenua Māori Act 1993.	Remains Private land.	Appropriate for all ecological areas. Binding on landowner and authority. Level of Protection varies between sites.
Public Awareness Education.			Appropriate for all ecological areas and values. Level of protection varies and is uncertain. Difficult to monitor success. Long term method.

6.0 CONCLUSION AND RECOMMENDATIONS

In the past, urban development resulted in the fragmentation and removal of natural habitats. Exotic species now dominate the area and waterways and wetlands have been highly modified. The ecological repercussions have been dramatic. A lack of species diversity is indicative of this decline. However, despite the extent of land use effects on natural values, a number of important values remain and there are significant opportunities to protect, manage and enhance these.

The waterways and related habitats within Belfast are central to the remaining natural values as they provide important habitats for birds, fish, plants and aquatic and terrestrial invertebrates.

The majority of remaining habitats in Belfast are highly modified and show significant signs of degradation. Existing land use impacts include wetland drainage, vegetation removal and the reduction in surface water quality and quantity.

To optimize opportunities to improve and protect natural values it is recommended that habitat patterns develop around existing natural features including open space, wetlands and waterways. Using a pattern of core habitat areas, neighbourhood habitat patches, and tree groves, habitat can be provided for many native species.

Key recommendations for Belfast include the following:

- The extent of native terrestrial habitat should be increased by setting long-term goals relating to the configuration of habitats.
- It is recommended that existing natural values represented by parks, forest patches, swales and detention ponds or wetlands be included in the habitat matrix to provide for increased colonisation of species.
- Notable species should be protected through controls to ensure significant habitats are maintained and enhanced.
- Preventive measures for stormwater management should be implemented to reduce the amount of stormwater requiring treatment. Where stormwater is discharged using treatment train systems consisting of both detention basins and wetland systems which utilise mechanical and biological means of trapping sediment and contaminants should be implemented.
- It is recommended that weed clearance in waterways be minimised or less invasive methods used. As riparian plants mature, shade is increased and temperature decreased. In some of the smaller waterways, this may significantly reduce the need for in-stream weed removal.
- Weed and pest management options should be explored and implemented as part of habitat development. This is particularly important in urban areas where there is increased risk of the spread of exotic species from private gardens.
- Springs in the headwaters and near the edges of waterways, wetlands and ponding areas are threatened by further development and require protection.
- Continued monitoring and adaptive management where objectives are not met is also recommended.

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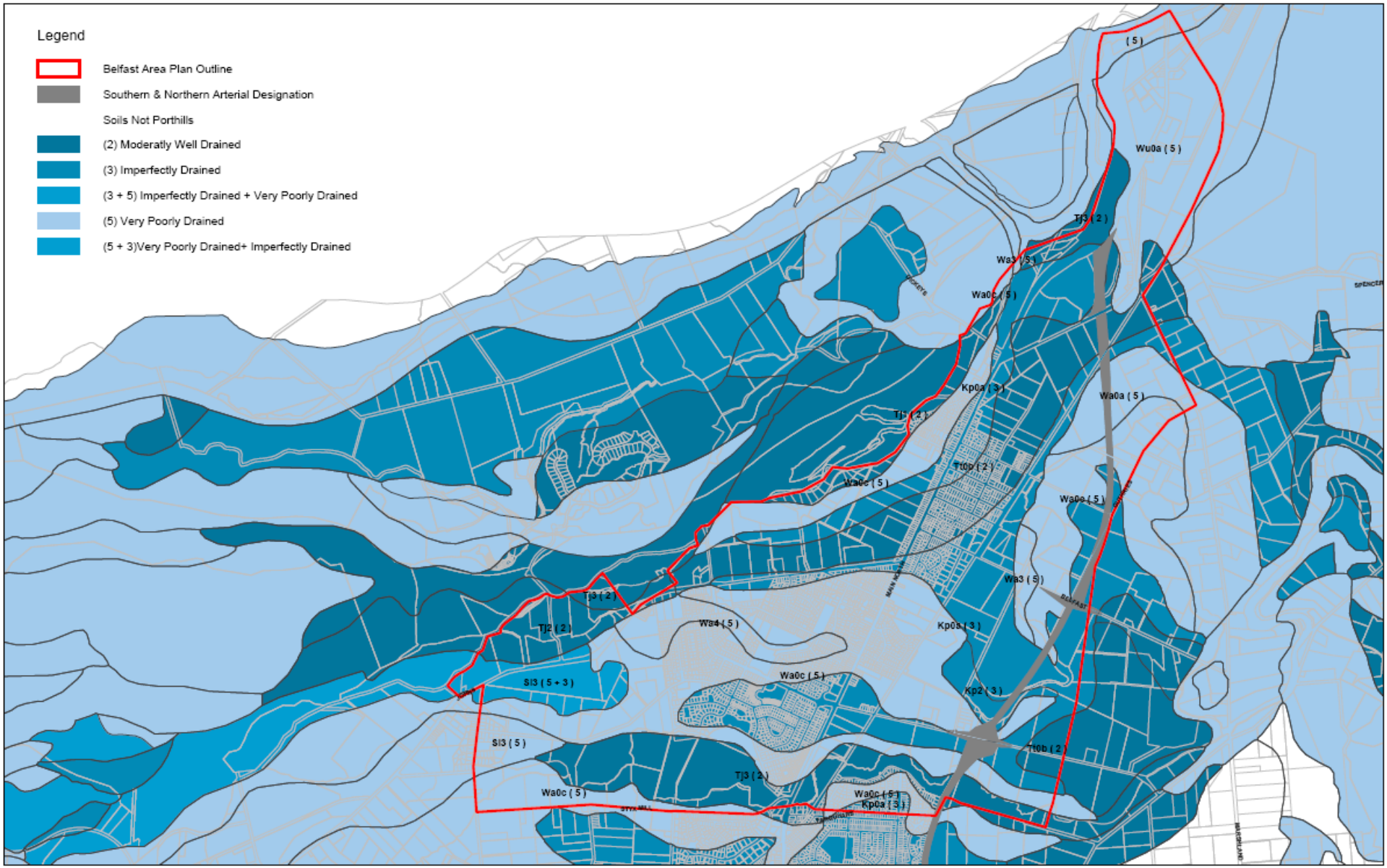
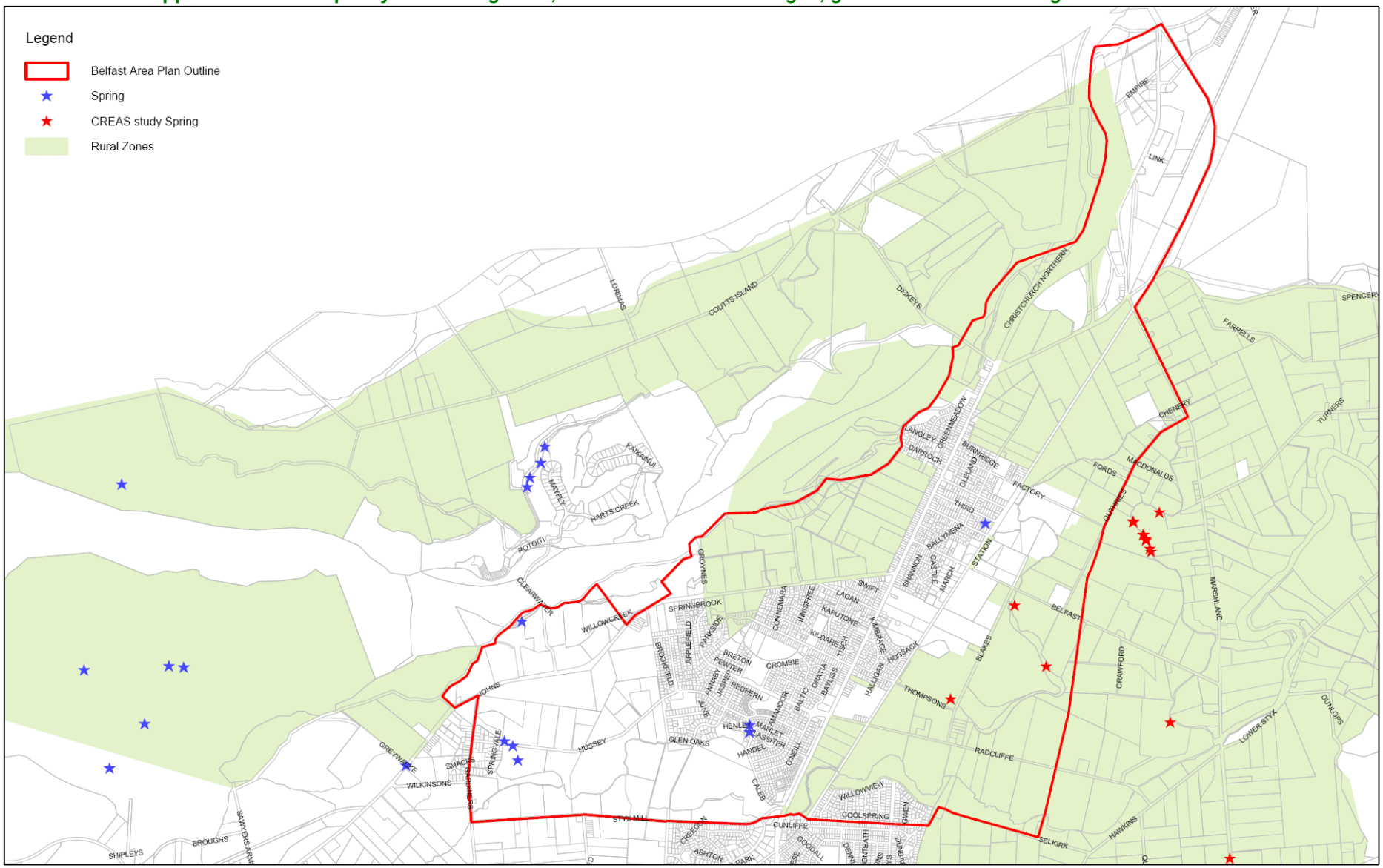
Appendix 1: Soils of the Belfast Area



Appendix 2: Water quality monitoring sites, water takes and discharges, groundwater wells and groundwater abstractions



Information Services
Christchurch City Council
MapAp001740LocationOfSprings.gws

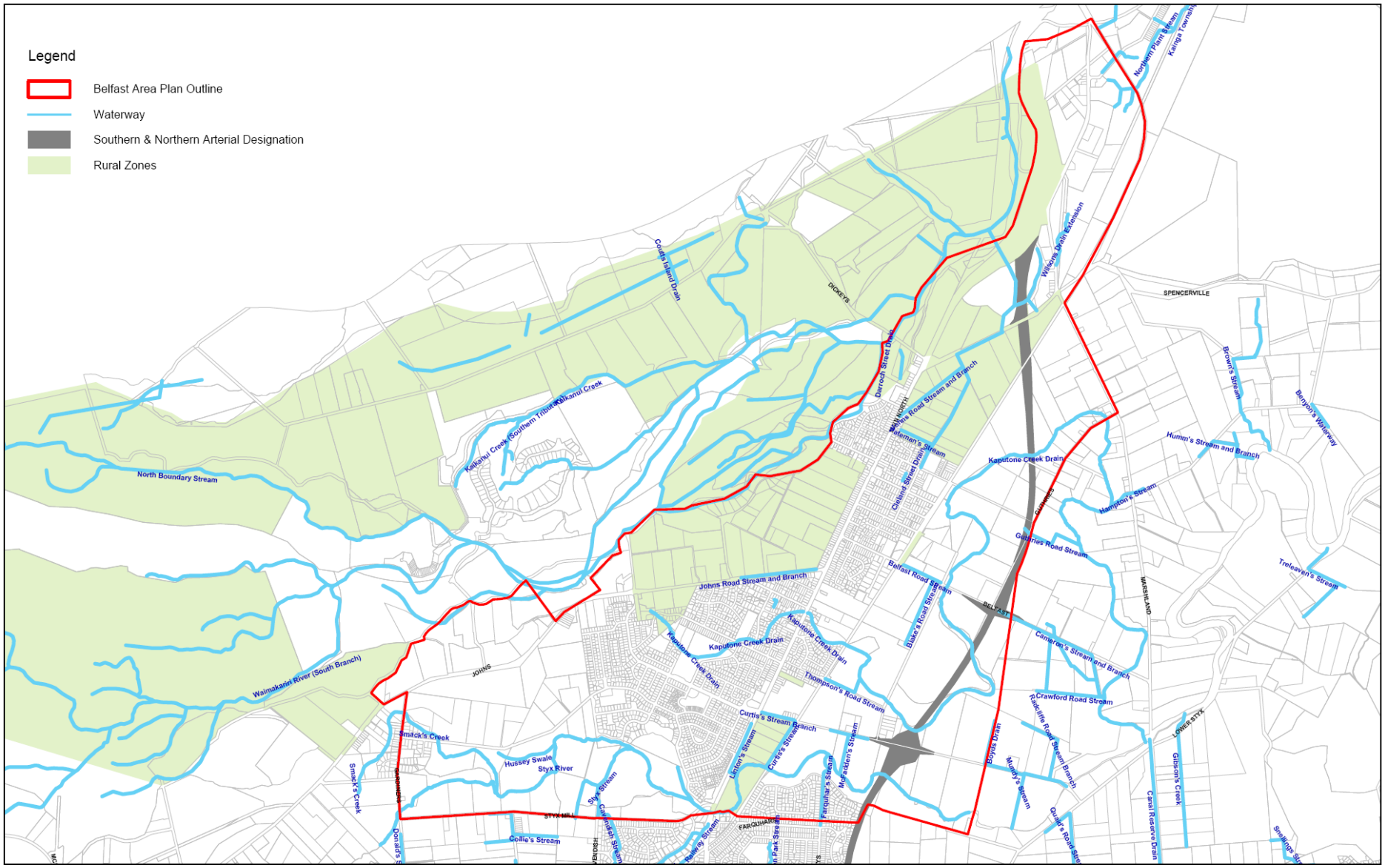
CHRISTCHURCH

Belfast Area Plan:
Location of Springs

0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

Scale: 1:25,000
Layout: A3
Date: 14/12/2006

Appendix 3: Belfast area and major waterways

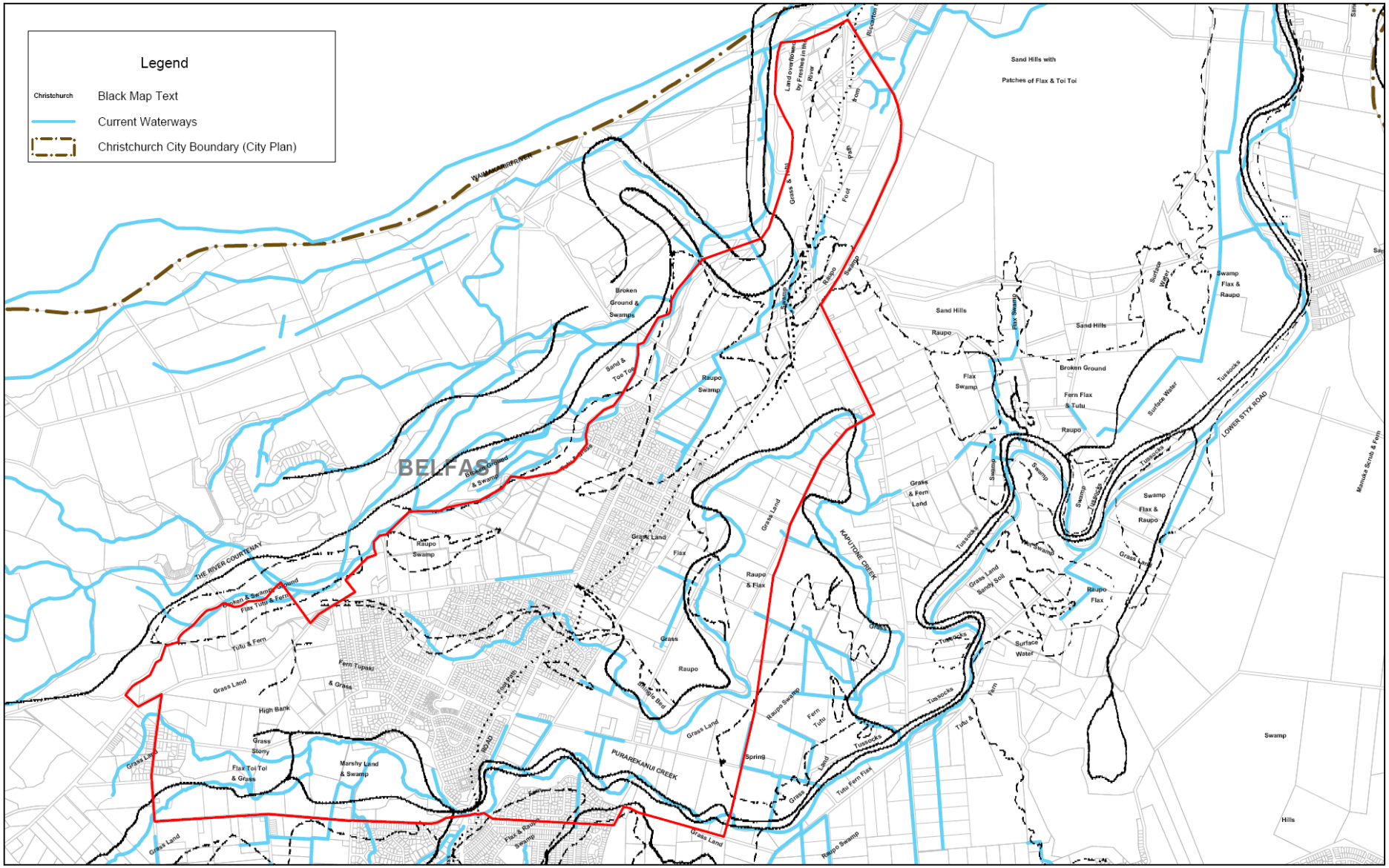


Information Services Christchurch City Council Map:AP001740Base.gws	CHRISTCHURCH CITY COUNCIL · YOUR PEOPLE · YOUR CITY	**Belfast Area Plan: Base Map**	Scale: 1:25,000 Layout: A3 Date: 14/12/2006

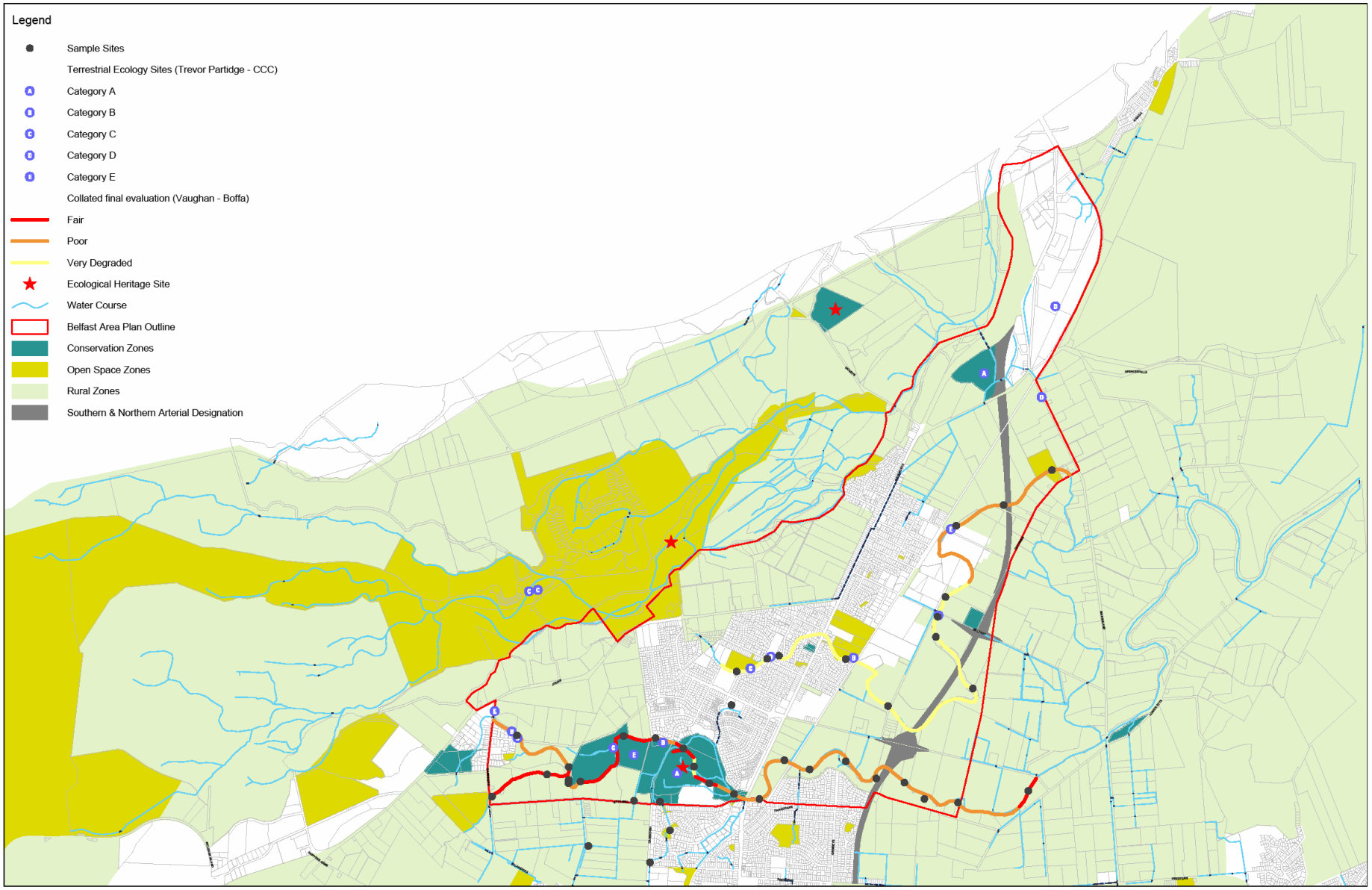
0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

N W E S

Appendix 4: Black Map



Appendix 5: Base Map for Ecological Values



Information Services Christchurch City Council Map:NE001252Ecology.gws	CHRISTCHURCH	**Belfast Area Plan: Green Print** **Base Map for Ecological Values**	Scale: 1:15,000 @ A1 Layout: A1Base Date: 12/02/2008

Appendix 6: Contaminated sites in the Belfast Area