Official Height Standard Change

From 1 July 2024, Auckland Council adopts the official height standard for New Zealand called New Zealand Vertical Datum 2016 (NZVD2016).

This model was carried out prior to the height standard change.

All levels included in this modelling report are in Auckland Vertical Datum 1946 (AUK1946/AVD1946).

Levels in this report can be transformed from Auckland Vertical Datum 1946 into New Zealand Vertical Datum 2016 by applying an offset value of 0.299 m.

For example:

$$H_{NZVD2016} = H_{AVD1946} - \text{Offset Value}$$

A single offset value for the catchment has been taken from the Land Information New Zealand (LINZ) Auckland 1946 to NZVD2016 Conversion Raster therefore this offset should be taken as an approximation only for the catchment.

A more accurate height transformation value can be derived by downloading the conversion raster available on the LINZ website below:
https://data.linz.govt.nz/layer/103953-auckland-1946-to-nzvd2016-conversion-raster/

Lake Pupuke Catchment Management Plan

Prepared for
North Shore City Council

May 2000

Lake Pupuke Catchment Management Plan

Prepared for

North Shore City Council

By

Beca Steven
A division of Beca Carter Hollings & Ferner Ltd

Report Prepared By:	Maree Watson
Report Reviewed By:	Paul Mitchell
Approved for Issue:	……. Stephen Priestley Job Director

5 May 2000

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Note: This report is based on the information supplied from the North Shore City Council's GIS database, the District Plan, aerial photographs, plus the NZMS DOSLI 260 series of topographic maps, and a site walk over. This report and recommendations are based on our understanding and interpretation of the available information. The recommendations of the report are therefore subject to the accuracy and completeness of the information available at the time of the study. Should any other information become available, then this report should be reviewed accordingly.

This is a strategic study ***for*** *the North Shore City Council aimed at developing an overall management plan for the catchment. The scope of the study and the information available did not permit a detailed assessment of the stormwater system at all points. For individual sites it will be necessary to carry out site specific studies using the catchment wide data provided in this plan.*

It should not be copied or used or relied on for any purpose or by any person other than was originally intended. Any questions regarding the contents of this report or recommendations therein should be directed to a Director of Beca Steven.

REFERENCES

Beca Steven (October 1998)	North Shore City Stormwater Strategy Statement
Auckland Regional Council (April 1999)	Guidelines for Stormwater Runoff in the Auckland Region, Technical Publication No. 108. (Prepared by Beca Carter Hollings and Ferner Ltd, April 1999)
Auckland Regional Council (November 1992)	Stormwater Treatment Devices Design Guideline Manual, Auckland Regional Council Technical Publication No. 10. (Prepared by Beca Carter Hollings and Ferner Ltd, November 1992)
Auckland Regional Council (April 1999)	Erosion and Sediment Control: Guidelines for land Disturbing Activity in the Auckland Region, Auckland Regional Council Technical Publication No. 90
Beca Steven (May 1999)	North Shore City Council Hazard Mapping Report
RA Hoare & Associates (August 1990)	The Hydrology of Lake Pupuke
North Shore City Council (July 1993)	Lake Pupuke – Pupuke–Moana, Management Plan

Glossary

AEP	Annual Exceedance Probability, which is the probability of exceeding a given storm discharge or flood level within a period of one year. Equivalent return period terms are: 1% AEP = 1 in 100 year 2% AEP = 1 in 50 year 10% AEP = 1 in 10 year 20% AEP = 1 in 5 year 50% AEP = 1 in 2 year
ARC	Auckland Regional Council
ARPS	Auckland Regional Policy Statement (July 1999)
At Risk	Potential for damage to property or persons due to flooding.
BCHF	Beca Carter Hollings and Ferner Ltd
BPO	Best Practicable Option
Catchment	An area of land above a point or outlet, the topography of which carries by force of gravity the stormwater originating therein into a drainage channel or watercourse.
CMP	Catchment Management Plan
Design Flows	the critical flows derived from a range of design storm durations, selected as a basis for the design of works in watercourses and catchments.
Design Storm	the rainfall event calculated from historical records that can be expected for a specific AEP.
Drainage system	The network of pipes, streams, open watercourse and secondary flowpaths which carry flows within a catchment.
D/S	Downstream
Floodplain	The plan extent of flooding in a given AEP storm.
Freeboard	Design margin to allow for factors omitted in the overall design (e.g. settlement of building foundations, uncertainties in flood level estimations, wave action, localised water level variations).
Habitable floor	A living area floor level such as lounge, dining room, rumpus, kitchen, bedroom etc.

Level of Service	That flood event that the NSCC primary drainage system can safely accommodate without the need to rely upon the secondary drainage system. (Typically 10% AEP event for residential drainage systems and 5% AEP event for industrial, commercial drainage systems).
Main watercourse	The system of open channels, culverts and associated floodplains forming the main backbone of the drainage system within the catchment.
MSL	Mean Sea Level
NSCC	North Shore City Council
Overland flow	Surface water runoff travelling to a channel over the ground surface.
Primary system	The pipes, streams and open watercourses that carry the main, frequent or primary flowpath of stormwater within a catchment.
RMA	Resource Management Act 1991
Runoff	The fraction of rainfall which runs off the land to the drainage system.
Secondary system (flow)	The route taken by excess stormwater when the capacity of the primary flowpath system is exceeded.
Subcatchment	A smaller sub-area of the catchment draining to a watercourse.
U/S	Upstream
Watercourse	Watercourse includes every stream, passage and channel on or under the ground, whether natural or not, through which stormwater flows, whether continuously or intermittently, and includes all land within the 1% AEP floodplain

1 Executive Summary

The aim of Catchment Management Planning is to manage and control flooding and stormwater related issues on a catchment wide basis. This report summarises the approach and analysis of issues relating to flooding and stormwater quality management in the Lake Pupuke catchment. It presents recommendations and sets out a catchment management strategy, a collection of guidelines and recommended works for implementation of effective management of existing and future development in the catchment.

The objective of the catchment management plan process is to identify and assess the extent of flooding, to evaluate issues related to stormwater quality and to determine solutions for problems identified. This Management plan will form the basis for a comprehensive stormwater discharge consent application to ARC Environment.

In summary the main findings of this study are:

Flooding

The only significant flooding problem identified in the catchment through the questionnaire process is secondary flow occurring on the Road outside No. 40 Killarney Street. The problem has been identified and it is recommend that splaypits are installed (Project 1.0, $10,000). There are no other significant flooding problems identified within this catchment, however, residents are concerned about the seasonally high lake levels flooding lakefront properties and walkways. Lake Pupuke hydrology has previously been assessed (refer Hoare, August 1990). It is our opinion that there is insufficient information available to accurately calculate the 1% AEP lake levels. The only other issue relating to stormwater flooding is flooding as a result of overland flow. Council should implement such strategies as low-impact design, recycling roof water and educating residents about effective management of their soakage pits, to deal with this issue, or service unreticulated properties (Project 2.0, $1,500,000-2,000,000).

Stormwater Quality

The water quality of Lake Pupuke should not be allowed to decline further as it is used widely by the community for a number of recreational activities. Recommended works to alleviate quality problems include:

- Catchpit inserts at Carmel College (Project 3.0, $2,500) and Killarney Park (Project 4.0, $5,000) carparks.
- A pond-type device for treating the runoff from North Shore City Hospital impervious areas (Project 5.0, $86,000).

Streambank Erosion

There are no streams that drain to Lake Pupuke, hence there is no stream bank erosion. However, localised erosion has been identified in two places.

Recommendations to mitigate erosion include:

- Piping discharge from the primary drainage system (within Sylvan park) to the Lake (Project 6.0, $16,000).
- Planting the Lake bank in the area identified in Figure 8.1 (Project 7.0, $35,000).

2 Introduction

2.1 Scope

In line with the North Shore City Stormwater Strategy Statement (Beca Steven 1998), Council is undertaking a programme of developing stormwater catchment management plans for all catchments within the City. This plan has been prepared for the Lake Pupuke Catchment as described in Section 3.1. In preparation of this plan the following elements have been studied.

- Information gathering and survey.
- Public Consultation (including a stormwater questionnaire).
- Flood estimation, catchment modelling and drainage system upgrade requirements.
- Assessment of flood mitigation options.
- Water Quality.
- Erosion Control.
- Environmental Impact Assessment of proposed works.
- Management Strategies.

2.2 Objective

The primary objective of this plan is to assess flood mitigation, stormwater quality and erosion issues within the catchment as follows:

2.2.1 Flood Mitigation

To identify existing flooding conditions and any which may arise from future development within the Lake Pupuke Catchment, to recommend remedial works to alleviate flooding, and prepare a management strategy to guide development within the catchment.

2.2.2 Water Quality

To determine potential sources of stormwater contamination and to identify works or policies to mitigate or control the effects of that contamination. However, it must be noted that while sediment runoff is a significant water quality issue, especially in developing upper catchments, sediment control is a function of the ARC and is managed through the land use consent process.

2.2.3 Erosion Control

To make recommendations for protection measures and to examine future risks associated with increased development.

2.3 Purpose

The plan will be used for the following purposes:

- As the basis of an application to the Auckland Regional Council (ARC) under the Resource Management Act 1991 (RMA) for a Comprehensive Consent to discharge stormwater from the catchment.
- Prioritising and planning of future stormwater capital works.
- Preparation of flood hazard plans.
- Establishment of land use controls and other stormwater management policies where required.
- To provide guidance for system management and maintenance.

2.4 Legislative Background

Under the RMA, the ARC has powers to control, by way of resource consents, the discharge of contaminants or water into water (Sections 15, 30(1)(f) and 87). Current stormwater discharge consents held by the ARC within the Lake Pupuke catchment are shown in Table 2.1.

Table 2.1 Stormwater Consents Currently held by ARC in the Lake Pupuke Catchment

File Ref	Consent ID	Consent Holder	Purpose	Site Address	Map Ref. R11	Status
12790	21824	R&J Goldsbro Ray & Joan Deepacre Motel	To discharge s/w from 0.53 ha of the redevelopment on an existing motel complex via an existing 225mm pipe to Lake Pupuke.	5 & 7 Killarney St.	2668700 6489500	G
BL761090	1785	Auckland Area Health Board	-	Shea Terrace	2667500 6489700	G
BL865481	5676	NZ Fire Service Commission	-	Ander Place, Takapuna	2667900 6489100	G

s/w = Stormwater
CMA = Coastal Marine Area
G = Granted

In response to the requirements of the RMA, the ARC has identified the upper Waitemata Harbour as an area that is susceptible to degradation (ARPS, 1999). The objective on water quality in the ARPS is "*to maintain water quality in water bodies and coastal waters which have good water quality, and to enhance water quality which is degraded particularly for the following purposes:*

Estuaries and harbours: protection of aquatic ecosystems, recreation, fishing and shell fish gathering, cultural and aesthetic purposes. ...

iv) Lakes, rivers and streams: protection of aquatic ecosystems, recreation, food gathering, water supply, cultural and aesthetic purposes.

Policy 8.4.7 of the ARPS covers stormwater and sediment discharges:

"All new developments discharging stormwater, whether allowed as a permitted activity or by a resource consent, shall adopt appropriate methods to avoid or mitigate the adverse effects of urban stormwater runoff on aquatic receiving environments.

The ARC will promote stormwater quality control on a catchment wide basis to avoid or mitigate the adverse effects of urban stormwater runoff on aquatic receiving environments.

All land disturbance activities which may result in elevated levels of sediment discharge shall be carried out so that the adverse effects of such discharges are avoided, remedied, or mitigated.".

The ARC propose the following methods to achieve policy 8.4.7:

"A strategy to prioritise catchments for retro-fitting within existing development will be developed and agreed jointly at a date to be agreed upon by the ARC and relevant TAs [territorial authorities].

5. *The ARC will encourage TAs to reduce stormwater contamination by adopting the 'best practicable option' for catchment wide stormwater quality control in consultation with the ARC.". ...*

Policy 8.4.21 relates to areas susceptible to water quality degradation, and states that

2. *"Priority shall be given to maintaining, and where possible improving, water quality in areas which are susceptible to degradation and/or have special values (as listed in Tables 8.1 and 8.2 and shown in Map Series 5 - Sheets 1-4)."*

The Proposed North Shore District Plan (1994) also sets out objectives, policies, and methods with respect to catchment management, thus:

Objective: Stormwater Control

To adopt a comprehensive approach to river and stream system management and minimise stormwater contaminants and sediment discharge from land based activities.

Policies

1. *By identifying, in advance of development, streams, watercourses and wetlands to be protected from development.*

2. *By prohibiting development in areas which are subject to a 1-in-100 year flood for the fully urbanised catchment.*

3. *By taking all necessary steps to achieve a stable hydrologic system during urbanisation.*

4. *By identifying opportunities for employing natural means of control of urban runoff.*

5. *By identifying in advance of development areas of land required for detention ponds and wetland filtering systems.*

6. *By requiring silt detention and water quality treatment for stormwater runoff, post development as well as during land development.*

7. *By continuing to develop comprehensive catchment management plans in advance of developing urbanisation.*

8. *By imposing an integrated set of land development controls in order to limit the potential generation of urban runoff through:*

   - *restrictions on earthworks and vegetation removal in particularly vulnerable areas*
   - *limiting impervious within the catchment, and encouraging the use of porous surfaces*
   - *using natural features for treatment purposes where practicable*
   - *by encouraging the use of holding tanks for roof runoff, wherever practicable.*

9. *By using specific design, and maintenance of vegetation, within and adjacent to natural river or stream valleys, so as to intercept sediment, protect against erosion and provide suitable habitats for birds and aquatic fauna.*

10. *By retaining land in floodplains as open space wherever practicable.*

11. *By ensuring that flood channels and open main drains are unobstructed by development.*

12. *By avoiding the construction of barriers to migratory fish.*

Objective: Stream Protection

To protect the natural character and ecological amenity and recreational value of rivers, streams and other natural bodies of water.

Policies

1. *By restricting the diversion or modification of natural watercourses.*

2. *By requiring stormwater discharges to be kept within environmentally acceptable levels at the point of entry into receiving waters.*

3. *By requiring treatment for stormwater quality as well as flow and sediment control in sensitive catchments with high ecological value.*

4. *By acquiring land alongside rivers, including streams, for public access, habitat, water quality and landscape protection.".*

"Objective

To minimise the adverse effects of urbanisation on water courses and receiving environments.

Policies

1. *By ensuring that the potential for sediment generation during development is minimised by limiting the intensity of development on steeper land and land close to sensitive water bodies, protecting natural water courses and valley systems, and keeping natural vegetation cover on steeper slopes, esplanades and other reserve areas.*

2. *By ensuring that the extent of earthworks proposed as part of any subdivision application is assessed on the basis of slope, length of slope , soil type, vegetative cover, proximity to water-courses and erosion control measures proposed within any sub-catchment, and restricted where necessary.*

3. *By ensuring that in the case of lots on steeper land, the location of building platforms and vehicular access is selected to minimise earthworks.*

4. *By ensuring that satisfactory means, within subcatchments, of achieving long-term water quality in adjacent waterways, without environmental damage, is developed before subdivision is approved."*

2.5 Responsibility for Flood Mitigation

It is the responsibility of NSCC to ensure that the passage of stormwater through a catchment does not pose a hazard to residents. Appendix A gives NSCC policy on open watercourses and piped drains. NSCC must ensure that in addition to the primary drainage system, effective and efficient secondary flowpaths exist to pass excess flows safely. Ideally, these secondary flowpaths will be protected by a covenant on the title even where they pass through private land, with the owner being advised (or educated) of the necessity of keeping the flowpath free from obstruction. When permitting infill or new development, NSCC must ensure that new floor levels are constructed clear of the 1% AEP flood level. Where development is allowed to encroach into a designated or identified secondary flowpath, provision must be made to allow the excess flows to pass without causing damage.

Owners have a responsibility to manage their own site to ensure that localised surface water does not cause a problem to themselves or their neighbours. They have a legal obligation to accept stormwater, which is generated upstream, provided that water is not illegally concentrated onto their property.

Flooding of habitable floors can arise from a number of conditions that occur naturally on properties. Owner / resident responsibilities and Council responsibilities for flood mitigation are described as follows:

Responsibility of Property Owner/Resident

- Overland flow entering buildings.
- Alteration or restriction of the natural secondary flowpaths by any means, e.g. landscaping, construction of retaining walls, layout of driveways, building extensions or modifications, fencing or walling, etc.
- Private alteration of primary drainage systems either open drains or piped systems.
- Ground water seepage into buildings.
- NSCC require owners, when carrying out development, to prepare a site stormwater management plan to show how the above issues are to be managed.

Responsibility of NSCC

- To define and protect floodplains associated with the main watercourse.
- To manage the primary drainage system that give rise to damage to buildings (either directly or because of excessive flow in the secondary drainage system) or excessive nuisance to the public (e.g. frequent blocking of access).

- To ensure adequate maintenance and capacity of the primary and secondary systems.

Administration of:

- Floor level controls.
- Protection to secondary flowpaths.

2.6 Responsibility for Stormwater Quality

ARC have a Proposed Regional Policy Statement (ARC, 1993). Within this document, the ARC seek to obtain the:

"steady reduction of sediment, sewerage overflows and other contaminants into waterways, and the

prevention of discharges of toxic and persistent contaminants which may have an adverse effect on aquatic ecosystems."

The ARC aim to meet these objectives through the implementation of the following policies (amongst others):

"All new developments discharging stormwater, ... shall include stormwater quality controls which are demonstrated to be the best practicable option

Catchments containing existing urban development and experiencing stormwater quality problems shall be retrofitted with stormwater quality controls which are demonstrated to be the best practicable option in accordance with a prioritised programme."

NSCC have to ensure (under the consent conditions) that catchment water quality improves.

2.7 Responsibility for Erosion and Sediment Control

The owner has a responsibility to:

- Maintain streambanks within their property boundaries.

NSCC is responsible for the maintenance of streams located within Council reserves and any major work required on the streams within the catchment.

With concerns to further development within the catchment, developers have to apply for a land use consent. Under which is the provision to supply an Erosion and Sediment Control Plan as part of the application. Where the amount of earthworks involved is considerably large, the Contractor (under the provision of the developers land use consent) may provide the Erosion and Sediment Control Plan.

2.8 Health and Safety

Open spaces used by children are potentially dangerous if they function as watercourses or flood detention areas. Typical safety measures include:

- Culvert inlet grilles also acting as trash racks.
- Fencing detention areas.

Grilles at culvert inlets are prone to blocking and therefore the potential for any resultant flooding must be carefully evaluated. While grilles over culvert inlets may prevent a child from being swept down a storm sewer, they do not remove the threat to the child's life. The pressure of the water passing through the grille will trap objects on the grille generally below water level making them difficult to find and very dangerous to remove. If the culvert is only a short section of pipe (10 to 20m) then the grille may pose a greater threat to safety than being swept through the culvert.

Fences surrounding detention areas is not common practice. This particular safety measure may well prevent children from entering a detention area but does not allow them to exit the area freely. An alternative to fencing is to have a dry pond or a flat slope on the sides to allow for easy egress.

Health and safety is also associated with stormwater quality, since residents may come in contact with the Lake water into which the stormwater is discharged. Risks may arise from both infrequent exposures to acute concentrations of contaminants and frequent long-term, low-level exposure (for example from swimming in Lake Pupuke). Trace organics and some dyes and detergents are potential health hazards if they come in contact with the skin. Some of these substances will also promote dermal absorption of other contaminants. The following contaminants potentially pose a health risk if ingested in sufficient quantities.

- Bacteriological organisms (notably from foulwater overflows which may enter the stormwater system).
- Heavy metals.
- Hydrocarbons.
- Trace organics.
- Tannins.
- Dyes and detergents.

Threats to health and safety of those in the Lake Pupuke Catchment include:

- Fast flowing water from culvert outlets (particularly the outlet from the Hospital area) poses safety risks during storm events.
- Foulwater overflows may occur without warning due to blockages or pipe failures or during flood events and may enter the stormwater system to eventually discharge into Lake Pupuke.
- Water quality in some locations may pose a health risk.

Alternatives for reducing the risk include:

- Educating residents on the risks associated with fast flowing water and watercourse structures.
- Reducing or eliminating the frequency and duration of foulwater overflows, which enter the stormwater system.
- Advertise potential risks by placing signs adjacent to the relevant area.
- Contaminant treatment options.

3 Description of Catchment

3.1 Location and Extent

Lake Pupuke Catchment (refer Figure 3.1) is situated to the southwest of Milford Beach and is very small in comparison to surrounding catchments. Its unique character is consistent with initial explosive volcanic activity. This produced a hole in the ground approximately 64m deep, which is now filled with water. The catchment boundary encircles the Lake, generally following Shakespeare Road, Taharoto Road, Killarney Street, Hurstmere Road and Kitchener Road. Land use varies around the Lake, with health (North Shore Hospital) and educational (Carmel College) facilities, as well as recreational, residential and industrial areas. The total catchment area of 86 hectares drains to the Lake via approximately 30 discharge points. The Lake itself is used for a wide variety of recreational uses.

3.2 Geology and Soil

North Shore City is predominantly built on sedimentary rocks and soils of Miocene to Quaternary age, through which the younger basaltic volcanoes have erupted (Pupuke, Tank Farm and Onepoto volcanoes in the Takapuna to Northcote area and Mt Victoria, Mt Cambria and North Head volcanoes in Devonport). The soils in the Lake Pupuke Catchment consist mainly of those associated with the volcanoes. These include tuff, ash and weathered basalt and are relatively permeable. The North Shore Hazard Mapping Report (May 99) identifies the majority of Lake Pupuke catchment as "Possibly suitable for low flow soakage" with some minor areas being identified as "suitable for stormwater soakage". Disposing of stormwater via soakage pits is discussed further in Section 5.

3.3 Land Use

Current land use is shown in Figure 3.2 as per the North Shore City Proposed District Plan (1994). Residential zoning is the predominant land use within the catchment and includes Zones 4A, 6A & 2B. Zone 4A covers a larger proportion of the catchment than Zones 6A and 2B, and includes Carmel College and part of Milford Primary School. In addition to residential zoning, there are a number of special purpose zones. These include Zone 1 (North Shore Hospital), Zone 9 (Takapuna Aquatic Centre), Zone 5 (Transitional Quarry) and Recreation Zones 1 and 4 (Sylvan Park, Henderson Park, and Killarney Park).

The Proposed District Plan indicates that impermeable areas could increase to 70% of the site in residential zones. This is unlikely in lower density areas such as Residential Zone 2B, although it is more probable in higher density areas such as Residential Zone 4A. However, in estimating future flood flows, impermeable areas have been estimated to reach 70% of the total site area for all residential zones.

4 Public Consultation

4.1 Questionnaire

The main thrust of Public Consultation was conducted through a self-completed questionnaire, which was distributed to residents within the Lake Pupuke Catchment. Approximately 700 questionnaires were sent, and 51 responses were received, a return of approximately 7%. The aim of this approach was to enable the identification of priorities for the study and to provide a focus for the development of the Management Plan.

A copy of the questionnaire and summary of the results are included in Appendix B. Direct responses to residents' completed questionnaires were outside the scope of this report. The information gained from this part of the consultation process, however, has been invaluable in identifying stormwater quality and quantity issues.

The questionnaire results highlight a number of flooding problems, some of, which are 'private', and others which require Council works to remedy. Without a specific investigation of each case, a final demarcation of responsibility is not appropriate. The approach in this study has been to identify the nature of the problem and comment on this in the questionnaire summary table (refer Appendix B). Where a specific future works project has been identified, Council responsibility is assumed. 'Unserviced area' indicates that Council may need to address the issue, but further specific study is required. 'Overland flow' generally implies that it appears to be a local issue of surface water management, and the responsibility of the landowner. Where overland flow comes from the roadway or reference is made to blocked catchpits, there is likely to be a need for Council to investigate and remedy the situation.

Summarised below are the primary concerns of the residents in response to the questionnaire.

- Habitable floor and property flooding.
- Blocked catchpits.
- Seasonally high Lake levels.
- Stormwater quality and hence quality of the Lake.
- Lakeside erosion.
- Foulwater overflows contaminating the Lake.

Although foulwater overflows are not strictly a stormwater Catchment Management Plan issue and are outside the scope of the study, they become important if stormwater quality in the catchment is compromised.

In addition to those issues relating to stormwater quality, residents expressed concern about high Lake levels resulting in property flooding, walkway flooding and Lakeside erosion. The issue of high Lake levels is addressed in Section 5.3.1.

The questionnaire responses also indicate that residents in the Lake Pupuke Catchment are sensitive to the issue of stormwater quality and the perceived impacts on the receiving environment. This has been increased in part by the degree of attention water quality related issues are getting in the media at present.

4.2 Iwi Consultation

Consultation with iwi was carried out by way of a letter detailing the CMP process and its objectives. Input was sought from the following iwi groups:

- Kawerau a Maki Trust, Saul Roberts
- Te hao o Ngati Whatua, Bill Kapea
- Ngati Paoa Whanau Trust Board, Hariata Gordon
- Ngapuhi, Paea Barns
- Hauraki Maori Trust Board, Liane Ngamane
- Ngati Whatua o Orakei Maori Trust Board, Ngarimu Blair
- Te Tinana o Ngati Whatua, Pamera Warner

Letters received from iwi in response to consultation are included in Appendix B and will form part of the Resource Consent application.

4.3 Other Groups Consulted

A letter detailing the CMP process and its objectives was also sent to the following community groups:

- Royal Forest and Bird Protection Society of NZ Inc, Jim Lewis
- North Shore City Council Parks Department, Lee Busby

As result of the letter Beca Steven met with representatives of the Royal Forest and Bird Protection Society of NZ and the Three Streams Reserve. A list of their concerns is included in Appendix B.

4.4 Community Board

This process provides for a presentation of the CMP to be given to the appropriate community board. The presentation covers the general character of the drainage system, and issues and options applicable to the catchment. Discussion between board members and the public can occur and the feedback from this process is taken into consideration during final compilation of the report.

4.5 Resource Consent Process

Obtaining a resource consent involves a written application (including the CMP) by NSCC to ARC, followed by notification of the application to the public. The public replies with submissions to ARC, which are resolved through direct discussions with concerned residents or groups. Input from the public consultation process will be incorporated into the final CMP. Once this process of consultation is complete, the ARC will assess whether a resource consent is granted. The ARC decision can be appealed to the Environment Court.

5 Flood Management

5.1 Introduction

This section of the report discusses issues, which have been identified as being of concern in relation to flooding. Existing flooding problems have been identified through questionnaire responses and flood flow estimation. Future flooding problems have been assessed through the same process and an assessment made of the remedial works based on both existing and developed scenarios. A flood management strategy has been developed which includes policies for dealing with the identified issues, for maintenance of the existing system, and for infill development within the catchment.

In terms of addressing extreme flooding issues, the projects recommended in this CMP represent the best practicable option. These projects will enable the existing stormwater infrastructure to be used more effectively. It must be recognised, however, that the land use development and stormwater infrastructure are constraints to the safe discharge of stormwater during extreme flood events. Full implementation of the projects will not eliminate flooding, but will reduce the likelihood of critical infrastructure and habitable buildings being flooded. The priority attributed to each project is dependent on it being a recognised flooding problem, through consultation and the hazard register.

5.2 Flood Estimation

Due to the relatively small size of Lake Pupuke's catchment area, the drainage length from the outer limits to the Lake's edge is very short, and hence there are very few substantial stormwater pipes (>375mm diameter) in place. Figure 5.1 illustrates the small network of pipes that currently discharge stormwater via outlets into the Lake. Flow calculations have therefore been limited to only one subcatchment (LP1), which has a pipe outlet of approximately 900mm in diameter. Flows for the remainder of the subcatchments (LP2 – LP6) are based on yields estimated for typical land uses within the catchment.

Flood flows within the study area were derived using the graphical method outlined in the ARC's Technical Publication No. 108 (TP108) – *Guidelines for Stormwater Runoff Modelling in the Auckland Region* (refer Appendix C for technical description). TP108 is based on the US Soil Conservation Service (SCS) model. It includes a standard Auckland design rainfall storm, guidelines for selecting rainfall loss parameters for typical Auckland soils, a regionally calibrated equation for estimating catchment times of concentration and a standard unit hydrograph.

This graphical method was used on the smaller catchment areas rather than the graphics based stormwater modelling software package XP-SWMM32 (refer Appendix C for technical description). XP-SWMM32 is more applicable to larger catchments, which was not the case for the Lake Pupuke study area. A summary of flows for the catchment is shown on Figure 5.1. Our assessment of stormwater flooding is based on a review of NSCC records, questionnaire responses and visits to problem areas. Verification of the stormwater modelling was achieved through comparison with the questionnaire results. It is probable, however, that problem areas exist at some locations, but have not been identified at this stage.

5.3 Identification of Flood Hazard Areas

5.3.1 Existing Flooding Conditions

The results from the flood estimation analysis show that (for the existing scenario) the catchment typically yields 0.17$m^3/s/ha$ (10% AEP) and 0.28$m^3/s/ha$ (1% AEP), respectively. For the developed scenario the catchment typically yields 0.20$m^3/s/ha$ (10% AEP) and 0.30$m^3/s/ha$ (1% AEP), respectively. This would indicate that there are no flooding problems associated with the capacity of the primary drainage system at Node 1. The questionnaire responses, however, appear to identify one problem associated with secondary flow. This has been attributed to the catchpit outside Number 40 Killarney Street, which apparently blocks with debris causing flooding of nearby properties. Inspection of this particular catchpit showed that the overflow slot was broken and is in need of repair. This issue is best addressed through Council maintenance of the primary system. However, as a number of residents have reported flooding all relating to the same problem it is recommended that the catchpits are upgraded to splaypits (refer Project 1.0).

Existing flooding conditions identified in the NSCC Hazard Mapping Report (May 1999) have been assessed in Table 5.2 and are shown on Figure 5.2.

Table 5.2 Existing Flood Hazards

Hazard Ref. No.	Address	Site Descr.	Source	Date Reported	File Ref.	Assessment	Action
A422	13 Eric Price Avenue	R	SAC	23-Jun-98		Existing problem; Flooding of non-habitable floor, overland flowpath.	Addressed through reticulation of unserviced areas - Project 2.0 (review status of hazard once project is complete).
A871	46 Killarney Street	R				Existing problem; Flooding - secondary flowpath.	Addressed through Project 1.0 (review status of hazard once project is complete).

R = Residential
SAC = Action Line

At the time the questionnaire was delivered, residents were concerned with the high water level of the Lake (refer Figure 5.2 for 1% AEP floodplain). Some residents reported flooding of their lakefront properties, and others reported flooding of the walkway around parts of the Lake edge. Lake Pupuke hydrology has previously been assessed (refer Hoare, August 1990). It is our opinion that there is insufficient information available to accurately calculate the 1 % AEP lake levels.

There is some lake level data available, which were recorded at the North Shore Hospital jetty from November 1977 to the end of 1989. These are weekly and are of limited use in assessing peak lake levels. A report on storms in the Auckland Region by the (then) Auckland Regional Water Board from 1979 to 1988 highlights the difficulty in aligning peak lake levels with peak rainfall events. This is detailed below in Table 5.3.

Table 5.3 North Shore Storm Events 1979 to 1988			
Storm Event	***Estimated Return Period (ARI)***	***Lake Level Reading closest to storm***	***Peak Lake Level for Year***
30 June to 1 July 1979	50-70 years	5.78 MSL (4/7/79)	5.90 MSL (9/10/79)
16 & 17 February 1985	1-2 years	5.56 MSL (20/2/85)	5.88 MSL (19/9/85)
22 & 23 May 1985	50 years	5.68 MSL (23/5/85)	5.88 MSL (19/9/85)
30 December 1988	Not stated (approx. <10 years)	5.84 MSL (4/1/89)	5.88 MSL (19/10/88)

As can be observed from the data, the peak lake levels do not coincide with the peak rainfall events. This is because the readings are mostly weekly i.e. the only reading that coincides with a storm event is in May 1985. Peak lake levels are likely to have occurred in conjunction with the storm events but were not measured.

The development of a rainfall / lake level model would be required to accurately put a figure on the existing and future use 1% AEP lake levels as follows:

- Establishment of automatic lake level and rainfall sites (at the NS Hospital Jetty Site) with monitoring over 5 year minimum period
- Analysis of relationship between rainfall and lake level data to develop computer model
- Comparison of jetty rainfall record with long-term station (e.g. Albert Park) to derive synthetic long term rainfall record at jetty
- Run model for long-term synthetic rainfall record to derive long-term lake level record
- Frequency analysis of synthetic lake level record to derive 1% AEP lake level
- Analysis of climate change to define new rainfall sequence
- Make allowance in runoff characteristics for fully developed catchment
- Run model to derive 1% AEP future use lake level

For further information regarding the hydrology of Lake Pupuke B.T. Coffey & Associates have produced a report on the subject.

It is recommended that:

- ***Splaypits replace the catchpits outside No. 40 Killarney Street (refer Project 1.0).***
- ***Council identifies minimum floor levels for new development within the catchment.***
- ***Council develops a rainfall/lake level model as described above.***

5.3.2 Future Flooding Problems

Future flooding problems can be associated with infill development if not managed correctly. Infill development reduces the amount of pervious areas, increasing the amount of runoff. This results in more frequent flooding. The following section draws attention to potential flood management issues, which have been identified within the study area during the catchment overview.

5.4 Flood Management Issues

5.4.1 Overland Flow

The issues associated with this are:

- Inappropriate management, in some cases of overland flow on individual properties.
- Limited understanding amongst residents of the operation of the drainage system and their responsibilities as regards overland flow.
- Maintenance of soakage pits to ensure effective use and prevent unnecessary overland flow from unserviced areas (refer Figure 5.3).

If the ground soakage in the area (refer Figure 5.3 for soakage potential) is not suitable for alleviating excess surface water then it becomes overland flow. Questionnaire results indicate that some flooding reported by residents may be a result of overland flow from unserviced areas, particularly those properties along Kitchener Road which back onto Eric Price Avenue properties. This area should be targeted in Project 2.0 – Reticulation of unserviced properties (refer Table 8.1) at a cost of approximately $110,000.

The 'Unserviced Areas' maps were defined as part of the May 1999 NSCC Hazard Mapping project. An assessment of stormwater, potable and foulwater GIS files supplied by NSCC GIS section was undertaken as follows:

- Where there was sanitary sewer or water to a property, but no stormwater pipe or drain the property was identified as unserviced.
- Properties which were higher than the road were also assumed to be serviced by the road drainage. In some cases there was inadequate data to confirm if this was the case, and those properties are identified as unserviced.
- The CMP has not looked at every case individually. There may areas where there are adequate natural surface flowpaths, or where roofwater can be siphoned to the road. In some of these cases additional servicing may not be necessary.
- For future works project definition purposes, budgets have been set on the basis of servicing the full area identified as unserviced. Before these budgets are committed in an annual plan, the scope of servicing will need to be more clearly defined by assessing each area on an individual basis. We have therefore provided an upper and lower limit for the cost of reticulating unserviced areas within the catchment.

The Council can provide assistance by reticulating unserviced areas, educating residents about the drainage system, suggesting the use of alternative techniques such as recycling water and reminding residents of their responsibilities. They can also provide assistance to residents by mediation between property owners on private drainage issues and overland flow management, or they can assist with remediation of habitable floor flooding.

It is recommended that:

- ***Residents are reminded of their responsibilities with concerns to overland flow, and that Council initiates mediation between the residents of Eric Price Avenue and neighbouring Kitchener Street.***
- ***Unserviced properties are reticulated (refer Project 2.0).***

5.4.2 Secondary Flowpaths

Obstruction of secondary flowpaths or poorly defined secondary flowpaths needs to be addressed. Inspection of the catchment observed many obstructions to the secondary flowpath. Other secondary flowpath issues appear to have arisen due to localised problems e.g. blocked catchpits. These are comparatively minor but should be identified as general maintenance requirements of the reticulation system.

The recently introduced practice of addressing site stormwater issues as part of the Building consent process should be encouraged. Further to this, a recommendation of this study is that this practice becomes policy.

5.4.3 Secondary Flow on Roads

Where possible, it is beneficial to use roads as secondary flowpaths. This results in flooding of the road, in many instances preventing traffic use during these periods of flooding. Major roads should only be allowed such flooding in the less frequent events (i.e. flooding in excess of 10% AEP).

Where the low point of the road coincides with a reserve area or the Lake edge, it would be preferable to lower the footpath and the grass verge on the downstream side of the road. This would allow stormwater to flow off the road through a well-formed drainage path, with consideration given to erosion issues. This would reduce flooding on the road, allowing traffic to be relatively uninterrupted.

It is recommended that, where appropriate, roads are used as secondary flowpaths (for the less frequent flood events), and that contouring of the roadside at low points in the road be such that floodwaters flow quickly off the road to a suitable drainage system, rather than ponding and causing inconvenience to traffic.

5.4.4 Construction of Houses on Steep Land

On steeper sites within a catchment it is common for houses to be constructed with basements which are recessed into the steeper side of the site. Many stormwater problems identified in catchments with long-term residential use are due to seepage of the stormwater through basement walls when the ground is saturated. In addition to this seepage, problems are sometimes caused through surface flow entering windows, which open at the outside ground level and / or doors on the uphill side of the house. While careful sealing of the basement walls during construction can serve to alleviate these future problems, thought given to the contouring of the site can ensure that stormwater is directed away from the basement. This is usually a site management problem.

Lake Pupuke catchment slopes towards the Lake, and hence this is an issue for the steeper parts of the study area. It is likely that many of the houses will be constructed with basements or main house levels recessed into the site.

It is recommended that North Shore City Council adopt as policy the requirement for individuals to address site stormwater issues, including directing overland and secondary flows away from buildings, as part of the building consent application process.

5.4.5 Driveways Leading to Houses Set Below the Road

It is common practice with new houses to have garages attached to the main dwelling and frequently used rooms for habitable purposes are adjacent to the garage space. There are sites in the Lake Pupuke catchment where houses have concrete driveways up to the garage door and to the front door of the house. The large areas of concrete paving collect surprising quantities of stormwater even in relatively small storm events.

Where these houses are set below road level and the driveway slopes downhill towards the garage, the driveway acts as a secondary flowpath, collecting stormwater and directing it towards the house. It is usual in these cases to have a cut-off drain along the front of the garage door. However, these are designed for low flow events only, and when the capacity is fully utilised, the overflow is still able to flow into the house. Again, thought should be given to the direction of the secondary flows away from the house, and habitable floors adjacent to the garage set at least 200 mm above ground level.

It is recommended that North Shore City Council adopt as policy the requirement for individuals to address site stormwater issues (including direction of large flows away from garage entrances) as part of the building consent application process.

6 Stormwater Quality

6.1 Introduction

With the introduction of the RMA, Councils have been required to develop techniques and management strategies, to enable sustainable management of the environment and to avoid, remedy and mitigate adverse environmental effects.

The ARC recognises that urban stormwater is a significant carrier of pollutants. ARC Guidelines have been produced that require new developments to treat stormwater to 75% removal of sediment. Existing development is required to achieve this efficiency wherever practicable. This, however, can be expensive and land intensive. Taking this into consideration, ARC requires that best practicable options be used.

The objective of this section is to identify stormwater quality issues within the Lake Pupuke catchment and to identify options for dealing with these issues. Solutions have been identified to achieve both general and specific stormwater improvements.

To achieve improvements in stormwater quality, a combined approach of education, planning, and physical solutions needs to be implemented.

6.2 Stormwater Quality Issues

6.2.1 Background

For determining stormwater quality a key focus is placed upon the receiving environments and the land use (both existing and likely future development) in the catchment. A detailed description of the catchment is included in Section 3, which describes the location, the geology and soils and the current and future land use within the catchment.

Assessment of stormwater quality issues is required when considering the type of treatment that could be required. ARC Technical Publication 10 (TP10) details the methodology for determining and sizing stormwater quality treatment devices. Inputs include the degree of imperviousness of the catchment and consideration of the type of contaminants to be removed.

The receiving environment of the catchment is Lake Pupuke itself, which is located in the centre of the catchment. However, freshwater springs are known to emerge below the high-water mark along the east coast, from jointed lava flows that impound Lake Pupuke. Consequently the east coast also becomes a part of the receiving environment even though it is situated outside the catchment boundary. The depth of the Lake is considerable, with the exception of the immediate foreshore, which is relatively shallow in places. The Lake environment is unique not only because of its size but also because of its aesthetic quality, adding to the character of the area.

The Stormwater Liaison Group has prioritised the Lake Pupuke catchment based on the receiving environment, areas of new development and public use. A summary of the principles underlying their assessment is included in Appendix D. Based on their study, ARC and the NSCC have both

assigned the same priority level of C (on a scale of A being highest and D the lowest) to the Lake's catchment. Both priority ratings are presented in the North Shore City Stormwater Strategy report.

The land use in a catchment determines the amount of runoff that is produced and the range of typical contaminants generated within a catchment. Typical contaminants that could arise are summarised in Table 6.1.

Table 6.1: Typical Contaminants Resulting from Specific Land Use

Contaminant:	***Land Use:***			
	Residential	***Commercial***	***Special Purpose***	***Roads***
Sediment	*	*	*	*
Litter	*	**	*	*
Food wastes	**	*	*	-
Garden wastes	**	-	*	-
Nutrients	**	*	*	-
Detergents	*	*	*	-
Trace organics (e.g. solvents, herbicides, pesticides)	*	*	*	-
Hydrocarbons (e.g.: oils)	*	**	-	*
Fats, grease	*	*	-	-
Heavy metals	-	**	-	**

- None

* Minor

** Significant

Contaminants specific to this catchment are sediment, litter, hydrocarbons, detergents and nutrients.

A specific source of sediment is likely to be the transitional quarry. However, runoff from the quarry appears to drain to a pond (refer Photo 1) located deep in the ground within the quarry boundaries. Other likely sources of sediment include earthworks associated with subdivisional development and gravel from new seal/road works (refer Photo 2).

Carparks located within Carmel College (refer Photo 3), Sylvan Park, Henderson Park, Takapuna Aquatic Centre, Killarney Park, and North Shore City Hospital are significant contributors of heavy metals, hydrocarbons, trace organics and litter.

Detergent and nutrient sources are associated with residential activities, which include washing cars, fertilising gardens and composting garden and kitchen wastes. These contaminants enter the stormwater system via runoff from residential properties within the catchment.

In summary, stormwater quality issues derived from the questionnaire response and the catchment inspection are:

- Sediment deposition.
- Litter.
- Hydrocarbons, detergents and nutrient contamination of the Lake water.
- Foulwater overflows contaminating the Lake.

6.3 Stormwater Quality Options

There are four general options available to Council with respect to stormwater quality within the Lake Pupuke catchment:

- Do nothing.
- Source Control.
- Pollution Prevention Techniques.
- Catchment-wide treatment devices.

6.3.1 Do Nothing

To do nothing would be to accept the consequences of a continued deterioration of the Lake Pupuke receiving environment. This is inconsistent with ARC Policy Statement and District Plan. It is unlikely to be a favourable solution for the residents given the currently high profile of water quality related issues.

6.3.2 Source Control

This is applicable for both existing and future development or subdivision. Council should particularly recommend and encourage the establishment of source control in all new developments through:

- On-site stormwater treatment systems.
- Controls on the type of development allowed.
- Reduction in the amount of silt bearing and impervious / paved areas.
- Retention of open watercourses.

6.3.3 Stormwater Quality Management Techniques:

Methods for improving stormwater quality through the use of management techniques are listed below. Appendix E provides a more detailed summary of options available.

- Public education on stormwater quality.
- Conditions placed on resource/building consent approval.
- Regular cleaning of roads, catchpits and manholes.
- Foulwater audits.
- Enforcement of policies.

6.3.4 Catchment-wide Treatment Devices:

Ultimately, the preferred option in stormwater management is the implementation of source controls and stormwater quality management techniques. Treatment devices do, however, have an important role in improving stormwater quality. This is achieved by decreasing the reliance upon individuals to implement site specific controls or stormwater quality management techniques.

Some catchment-wide treatment mechanisms are:

- Pond systems.
- Vegetated systems (for example, swales, riparian zones).
- Filtration Systems.
- Oil Separators.

6.3.5 Experimental Techniques

There is a large body of literature held by the ARC and contained within the conference proceedings of the 'Comprehensive Stormwater and Aquatic Ecosystems Management' conference (Auckland, February 1999) outlining alternative methods of stormwater management. These include;

- Bypassing peak flows past sensitive receiving environments,
- Low-impact subdivision design aimed at minimising impervious and maximising source control of pollutants and,
- Collection and recycling of roof water.

Low impact design could be applied to new areas of development within the Lake Pupuke catchment, alongside recycling of roof water for gardening purposes.

6.4 Recommended Stormwater Quality Improvements

6.4.1 Source Control

On-site stormwater treatment places the responsibility of stormwater management on the developer and has the advantage of treating any potential problem before it enters the rest of the catchment.

On-site stormwater treatment systems would be of most benefit targeting specific areas such as the carparks within the catchment. Killarney Park and Carmel College carparks could be fitted with catchpit inserts to catch litter and other debris that would otherwise end up in Lake Pupuke. These inserts are similar to the Enviropod concept shown in Figure 6.1. Trials are presently being conducted to determine the efficiency of certain catchpit inserts. The Enviropod Polyester type insert provides an estimated 60 to 80% long term removal of suspended solids, so it is assumed that other types of catchpit inserts will provide approximately the same level of treatment. Inserting wool pillows would collect the oil in the first wash from the road surface. It is suggested that Carmel College take the opportunity to combine the recommended works with the Water Watch and Schools Scheme.

Planning controls that require a reduction in the amount of impervious and silt-bearing areas will decrease the amount of runoff and sediment entering the catchment. Future controls on the types of development allowed in the catchment will impact most directly on the type and amounts of contaminants to enter stormwater as well as the amount of runoff produced.

It is recommended that:

- ***Catchpit inserts are installed within the carparks associated with Killarney Park to trap litter and coarse sediments (refer Project 3.0).***
- ***Catchpit inserts are installed in the carpark located within Carmel College to trap litter and associated sediments (refer Project 4.0).***

6.4.2 Stormwater Quality Management Techniques

In reflection of catchment land use, these techniques would generally be implemented by NSCC. They would be applicable mainly for future development, but some of the techniques, such as education of the public and road sweeping, could commence immediately. Council maintenance, such as road cleaning, can immediately reduce the amount of litter and some of the sediments that enter the stormwater system.

Public education on stormwater quality would be valuable in light of the amount of coverage water quality issues are getting in the media at present. Improvement of stormwater quality could occur through better 'housekeeping' practices by individuals. This should include keeping compost heaps out of the way of floodplains and overland flowpaths, and to avoid tipping contaminants such as paint down the stormwater system. Education of residents with respect to the role they play in stormwater quality brings about a greater awareness of their role in maintaining and improving the quality of the catchment stormwater system. The ARC should undertake any public education, but NSCC involvement would be appropriate.

Introducing additional conditions on building consents would enable a tighter control on the impact of development on the catchment. As mentioned in Section 5, it is now practice for developers to fill out site stormwater management plans as part of building consent applications. This should include plans for the prevention of soil loss for the site. For example, stockpiles of topsoil or areas of land where topsoil is exposed for a long time could be covered in hay to prevent transportation into the stormwater system. If these sorts of controls are combined with enforcement of Council policies, extra conditions could result in decreasing short-term effects of sediment deposition, and in the amount of stormwater mitigation required.

It is recommended that:

- ***Residents within the Lake Pupuke catchment are educated as to how they can prevent contaminants from their properties entering the stormwater system.***
- ***It becomes Council policy to address erosion control as part of the building consent application process.***

6.4.3 Catchment-wide Treatment Devices

Pond-type devices are often the first to be considered. Treatment of the stormwater is by settling of the sediments in the pond. Ponds are often land intensive and require maintenance to remove deposited sediment, however they can provide a potential wildlife habitat. There are limited opportunities within the catchment to site a pond, as the catchment is small and relatively well developed.

An area to the east of Shea Terrace has been identified, however, as having potential for placement of a pond-type device (refer Figure 8.1 for location). This would collect runoff from impervious areas within the Hospital and Ambulance facilities and also from Shea Terrace itself. With some modification, this area could house a pond-type device (refer Figure 6.2 for a concept plan) that collects sediment and partially treats the stormwater prior to entering the Lake

Vegetated systems include swales and riparian zones. Swales are essentially grassed trenches that require considerable care and thought in the initial planning / design stages. Maintenance of swales generally involves mowing or harvesting of the vegetation to ensure that growth is controlled and does not intrude into other areas. Dead plant matter needs to be either removed to reduce the potential for it to enter the stormwater system and the potential for odour. Deposited sediment also needs to be removed so as to not restrict plant growth or reduce efficiency. Swales could be implemented along some of the streets that run towards the Lake. This would provide some treatment of runoff from roads before it enters the receiving environment. However, this would require further investigation as to the suitability of particular streets within the catchment.

For riparian vegetation, dead plant matter also needs to be removed so that material does not enter and possibly block the stormwater system. This finds its way into the Lake, adding to the nutrient loading which in turn decreases water quality.

Filtration systems are more complex and require more frequent and expensive maintenance than a vegetated system or a pond type device. They also require a reasonable amount of land. Treatment is through filtration of stormwater and removal of pollutants greater than a specified size. They would be of use for removal of litter and the sediment in the existing stormwater, but do not provide any stormwater retention. Maintenance involves regular removal of sediments from within the filter.

Oil separation is probably not suitable for treatment of the majority of the contaminants in the stormwater at present. These devices would be more appropriate for use at specific sites where oils, grease and fats are the primary contaminant of concern. They are not to be used for removal of sediments or litter and would need to be used with another device to achieve the level of treatment required. Oil separators do not provide any flood water retention and should be installed off-line so flood flows are bypassed. Possible areas for installation of these devices would be close to the source, such as the large carparks which discharge stormwater to Lake Pupuke.

The concerns of residents regarding foulwater overflows both within as well as outside the catchment, appears to dominate the issue of stormwater quality. As this issue is not included in the scope of this study, it has not been addressed in depth. However, it is recommended that NSCC investigate the incidence of foulwater overflows into the Lake Pupuke stormwater system. Removal of overflows will involve liaison with Water Services, and / or temporary treatment of target areas (e.g. using screens) to improve stormwater quality.

It is recommended that:

- ***A pond-type device (refer Figure 6.1) be constructed at the location shown in Figure 8.1 (refer Project 5.0).***
- ***Provision is made for screens at known regular overflow points (Project Care).***

7 Erosion Control

7.1 Streambank and Coastal Erosion

Erosion and scouring of stream banks and coastal areas is a particularly sensitive issue. The naturally occurring process of erosion is accelerated by human activities such as clearance of vegetation and land development. Lake foreshore retreat due to wave and wind action is also a natural process of erosion and is of particular concern within Lake Pupuke catchment. However, there are no existing instability hazards identified in the North Shore City Council Mapping Report (May 1999).

7.2 Streambank Stability

There are no streams discharging to Lake Pupuke , however, localised erosion is of concern along the southern boundary of property No 27 Sylvan Park Avenue. Photo 4 shows evidence of scouring due to high flow from a stormwater outlet pipe, and the foundations of the fence have been exposed in places. If remediation work is not carried out in the short-term, it is possible that the fence may become unstable and topple over

It is recommended that works be carried out to extend the pipe system down to the Lake with an appropriate energy dissipation device at the outlet (Project No.6.0).

7.3 Lake Foreshore Stability

The foreshore area of Lake Pupuke catchment has approximately 30 stormwater outlets. Wave action and fluctuating Lake levels at the outfalls tends to result in localised erosion and undermining. Increasing development generally results in increased flow and velocities at stormwater outlets and associated scouring and sediment deposition. At the time of the catchment walkover, Lake levels were sufficiently high to preclude an inspection / assessment of any erosion at the outlets. The Lake foreshore / banks in some areas appeared to be collapsing into the Lake (refer Photo 5).

It is recommended that:

- ***Council conducts a survey of all outfalls to assess the level of erosion and to decide on the appropriate management of each site (refer Table 8.1).***
- ***The establishment of flaxes around foreshore lake area (identified in Photo 6 and in Figure 8.1) and other areas where required, to prevent further slumping of banks (refer Project 7.0).***

8 Catchment Management Strategy

8.1 Recommended Works

Figure 8.1 identifies specific areas requiring water quality, flood and erosion alleviation works. The projects described below in Table 8.1 have been assigned indicative rankings as shown in Appendix F (refer project sheets). It must be noted that project numbers are not related to rankings. An assessment of the impact of the works on the environment is included in Table 8.2.

Table 8.1 Recommended Works

Project No.	***Works Description***	***Rough Order Cost***
	Stormwater Quality Works	
1.0	Implementation of splaypits outside No. 40 Killarney Street	$10,000
2.0	Reticulation of unserviced areas	$1,500,000-2,000,000
3.0	Install catchpit inserts within the carpark at Carmel College	$2,500
4.0	Install catchpit inserts within both carparks at Killarney Park	$5,000
5.0	Pond type device approx. 3000m^3	$86,000
6.0	Piping (375mm diameter) flow from Sylvan park outlet to Lake edge (50m) for erosion purposes	$16,000
7.0	Planting of Lake bank (approx. 1000m^2) north of Hospital subcatchment outlet pipe (refer Figure 8.1 for specific location), and other areas where required.	$50,000
-	***Investigations and Maintenance***	-
-	Current pipe outfall conditions should be investigated and where erosion is severe, energy dissipaters are placed to prevent scouring.	-

Table 8.2 Environmental Impact Assessment of Works					
Project No.	***Assessment of Effects***				
	Impact on Community	***Effect on Development Layout***	***Effects During Construction***	***Effects on d/s Receiving Environment***	***Comments***
1.0	Limited as devices underground.	Limited as highly modified environment already.	Some dust, noise and traffic issues, but of short duration.	No change.	Same land use.
Mitigation Measures	Council to specify construction requirements / controls in Contract Conditions. Contractors to carry out work during low flow periods to minimise sediment transport.				
2.0	Limited as devices underground.	Limited as highly modified environment already.	Some dust, noise and traffic issues, but of short duration.	No change.	Signage to inform public of works.
Mitigation Measures	Council to specify construction requirements / controls in Contract Conditions. Contractors to carry out work during low flow periods to minimise sediment transport.				
3.0	Limited as devices underground.	Limited as highly modified environment already.	Some dust, noise and traffic issues, but of short duration.	Positive benefits for local catchment and Lake water quality.	Ongoing maintenance issue – disposal to controlled landfill.
Mitigation Measures	Council to specify construction requirements / controls in Contract Conditions.				
4.0	Limited as devices underground.	Limited as highly modified environment already.	Some dust, noise and traffic issues, but of short duration.	Positive benefits for local catchment and Lake water quality.	Ongoing maintenance issue – disposal to controlled landfill.
Mitigation Measures	Council to specify construction requirements / controls in Contract Conditions.				
5.0	Has benefits for education of public on water quality issues. Improved aesthetics.	Limited as area is effectively in floodplain.	Some dust, noise and traffic issues, but of short duration.	Positive benefits for Lake water quality.	Signage to warn public of stormwater discharges during flood events.
Mitigation Measures	Council to specify construction requirements / controls in Contract Conditions. Contractors to carry out work during low flow periods to minimise sediment transport.				
6.0	Improved landscape and stability.	Improved stability of property boundary.	Some dust and noise, but minor and of short duration.	Reduced erosion & sedimentation of d / s Lake environment.	Stabilised environment.
Mitigation Measures	Council to specify construction requirements / controls in Contract Conditions. Contractors to carry out work during low flow periods to minimise sediment transport.				

Table 8.2 Environmental Impact Assessment of Works					
7.0	Improved aesthetics.	Beautification and stabilisation of Lake foreshore.	No effect, planting only.	Reduced erosion & sedimentation of d/s Lake environment.	Stabilised environment.
Mitigation Measures	N/A				

8.2 Strategies

8.2.1 Public Education

In conjunction with ARC, NSCC should engage in a programme of public education. The programme should be designed to

- Encourage public participation.
- Develop public awareness of stormwater related issues.

8.2.2 Health and Safety

NSCC to adopt health and safety issues as discussed in Section 2.8.

8.2.3 Flood Control

The following policies should be applied to all development within the catchment:

- Habitable floor levels should be a minimum of 500mm above the 1% AEP flood level, or above any secondary flowpath.
- No habitable buildings should be permitted within the 1% AEP floodplain.
- No building, structure or dense planting which will impede flood flows should be permitted in the floodplain or secondary flowpath areas.
- Source controls (including reduced impervious areas and/or detention) should be implemented to mitigate downstream flooding.

8.2.4 Stormwater Quality

The following policies should be applied to all development within the catchment:

- Site usage involving risk of contaminants (e.g. hydrocarbons or hazardous substances) should have on-site treatment of runoff.
- High-use roads and carpark areas should use on-site treatment devices such as swales, sand filters, catchpit filters, or equivalent to reduce discharge of sediment (and attached contaminants) and litter.
- New developments should mitigate the effects of site erosion and sedimentation and typical site contaminants through use of source controls and low-impact design techniques.

8.2.5 Erosion Control

The following strategies can assist in minimising catchment erosion:

- Source controls for new developments (including reduced impervious areas and / or detention) should be implemented to mitigate downstream erosion.
- Provide rock and concrete outfall structures for energy dissipation to pipe outlets.
- Provide appropriate planting and (in severe cases) flume lining or piping on steep open drains in soil prone to scouring.
- Require the retention of bush on steep slopes where possible.
- All earthworks and construction within the catchment must be carried out in accordance with ARC TP90.

8.2.6 Maintenance Considerations

The following items require special maintenance consideration:

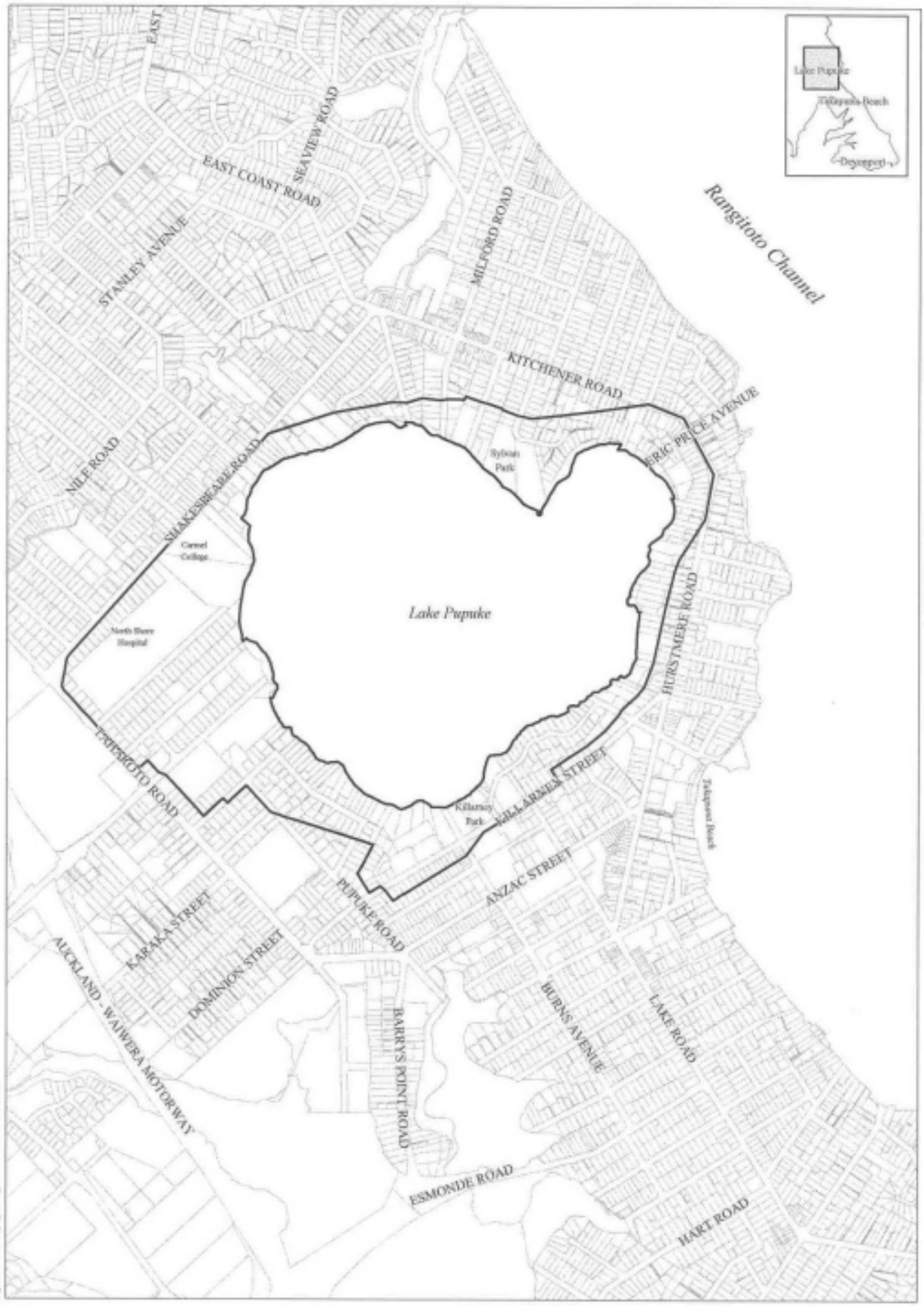
- As development progresses, the primary flowpath, whether a stormwater pipe or natural channel, must be maintained to prevent flooding of nearby properties. Grilles over stormwater inlets and culverts must be cleaned to prevent blockages and the risk of flooding. Major culverts should be checked for blockages every 1-3 months or following significant storm events as required.
- Bank slumping or excessive vegetation growth should be checked at least twice a year. Any such problems should be remedied as soon as possible.

8.2.7 Habitat Enhancement

In the management of stormwater, NSCC should endeavour where possible to enhance existing stream habitats including:

- Provision for fish passage.
- A programme of riparian planting.
- The preservation and where practicable restoration of natural streams.

Figures



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Lake Pupuke
Catchment Management Plan

Figure 3.1
Catchment Location

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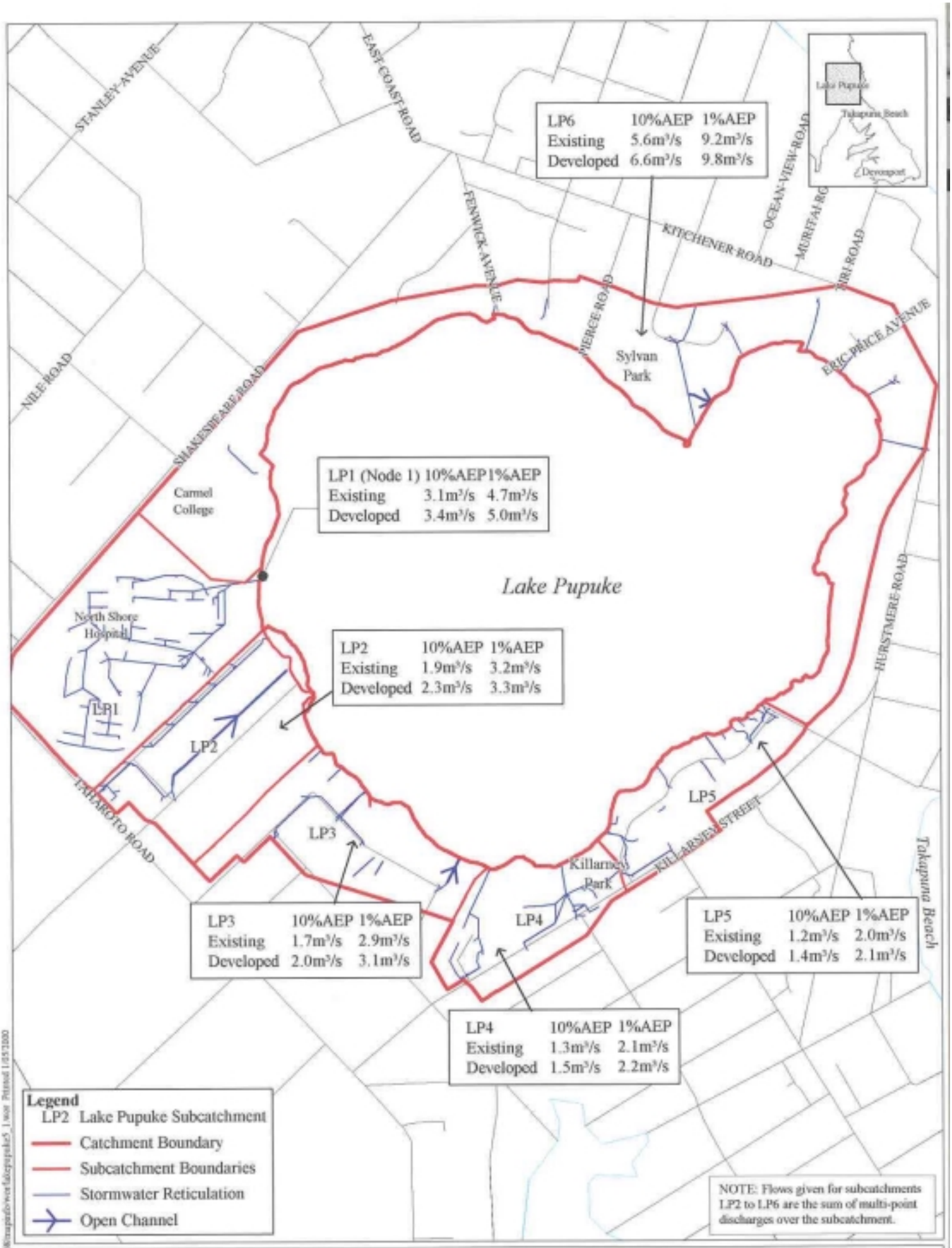
Metres

Lake Pupuke
Catchment Management Plan

Figure 3.2
Land Use Zoning



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Lake Pupuke
Catchment Management Plan

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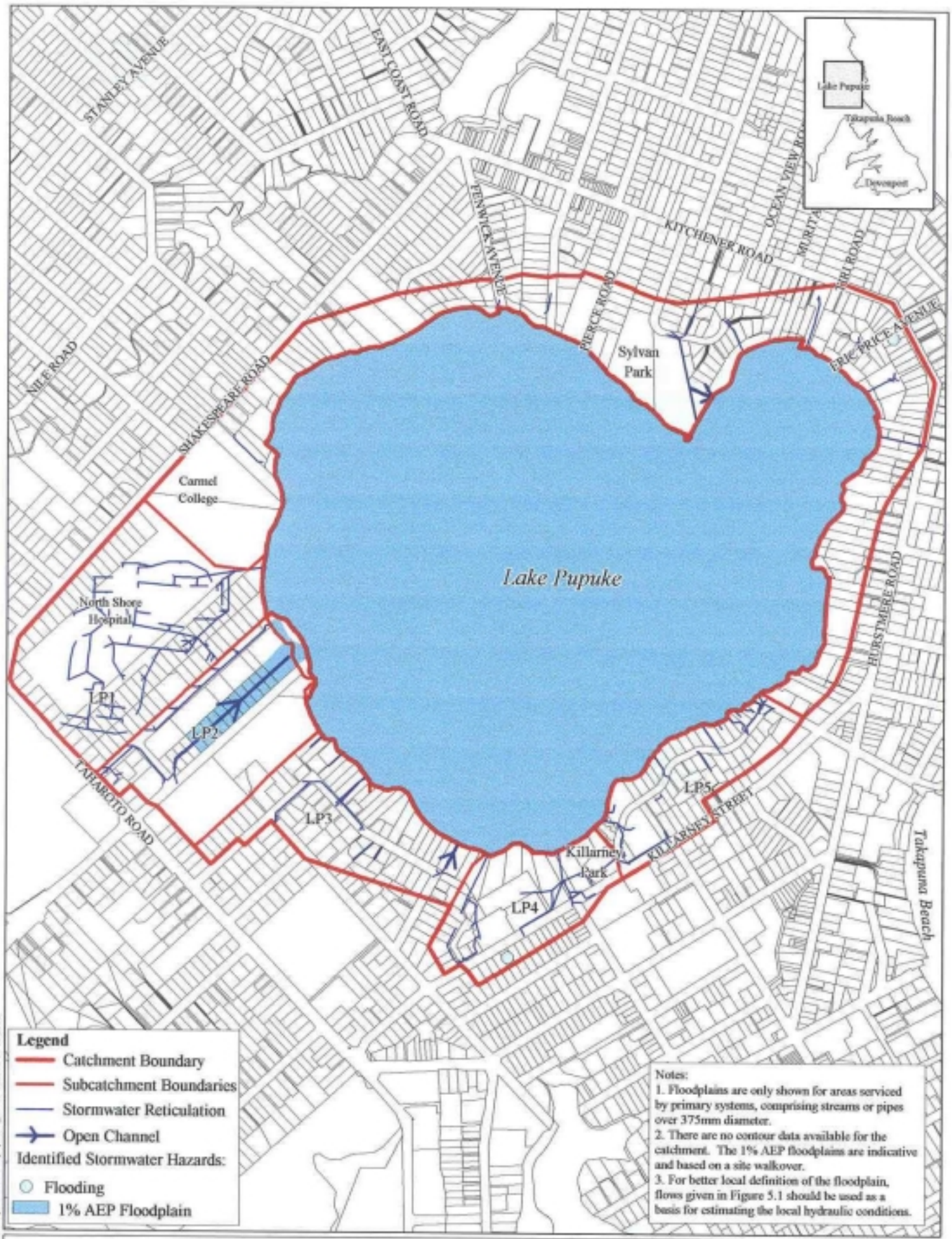
Figure 5.1
Stormwater Drainage System


Lake Pupuke
Takapuna Beach
Sylvan Park
Carmel College
North Shore Hospital
Killarney Park
LP1
LP2
LP3
LP4
LP5
STANLEY AVENUE
EAST COAST ROAD
TENNYSON AVENUE
KITCHENER ROAD
PIERCE ROAD
ERIC PRICE AVENUE
HURSTMERE ROAD
NILE ROAD
SHAKESPEARE ROAD
TAHAROTO ROAD
KILLARNEY STREET
Legend
Catchment Boundary
Subcatchment Boundaries
Stormwater Reticulation
Open Channel
Identified Stormwater Hazards:
Flooding
1% AEP Floodplain
Notes:
1. Floodplains are only shown for areas serviced by primary systems, comprising streams or pipes over 375mm diameter.
2. There are no contour data available for the catchment. The 1% AEP floodplains are indicative and based on a site walkover.
3. For better local definition of the floodplain, flows given in Figure 5.1 should be used as a basis for estimating the local hydraulic conditions.
Scale: 1:10,000 at A4
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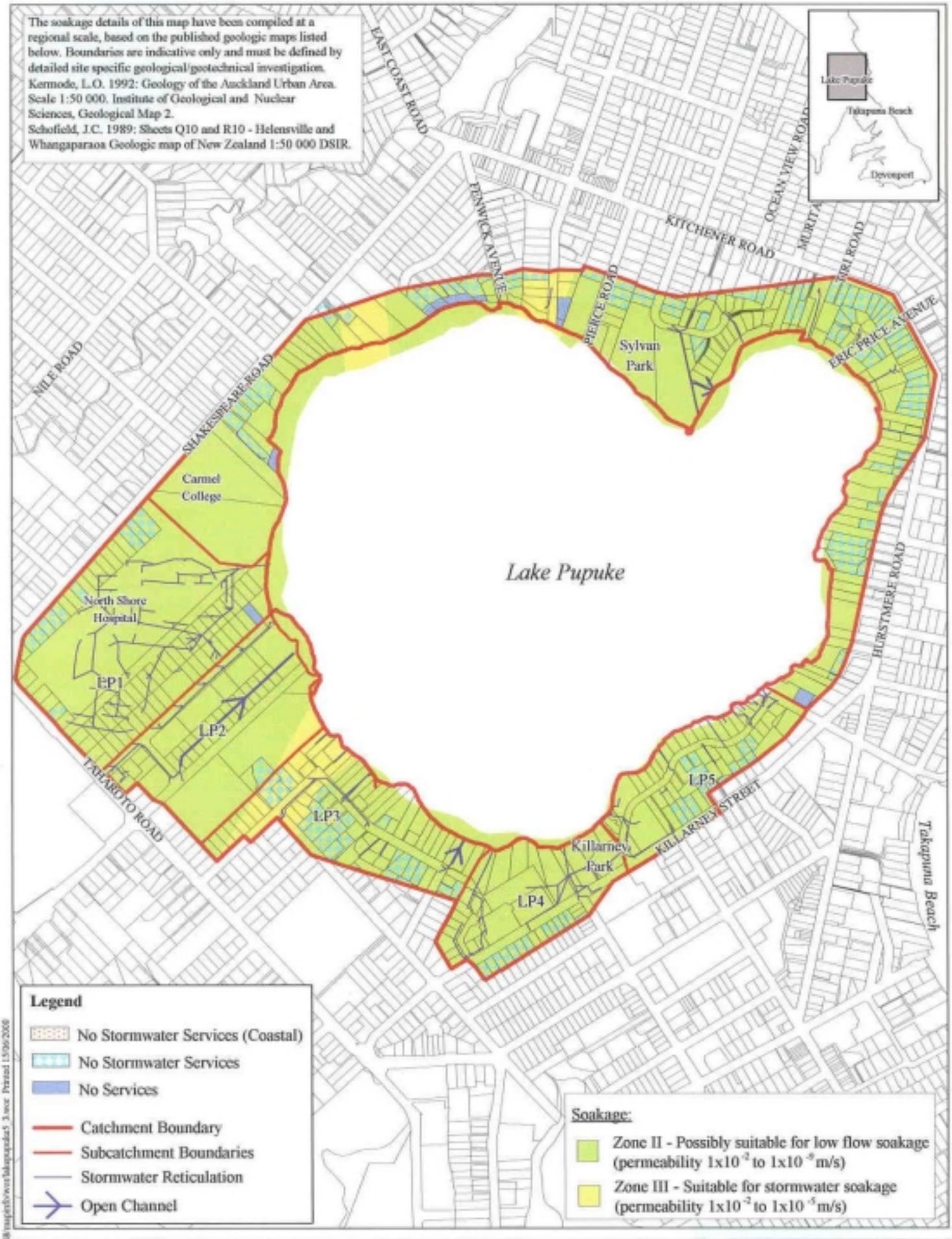
Metres
BECA
2506168/10
Lake Pupuke
Catchment Management Plan
Figure 5.2
Indicative 1% AEP Floodplain
& Indentified Hazards



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Metres

Lake Pupuke
Catchment Management Plan

Figure 5.3
Unserviced Areas and Soakage Potential

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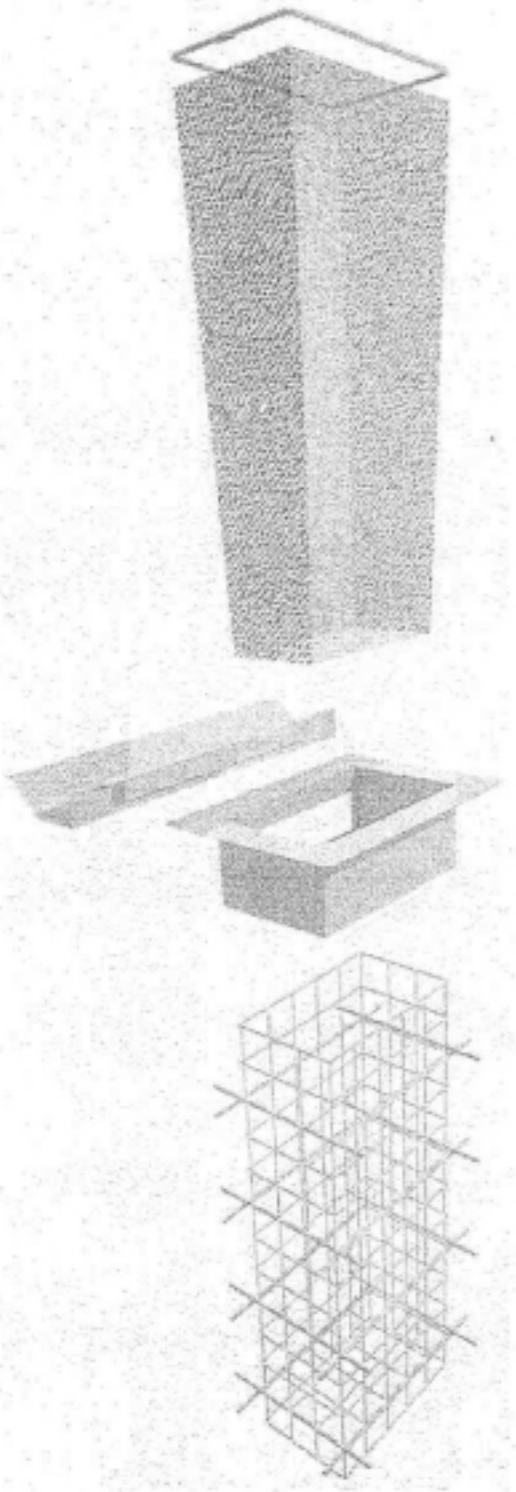
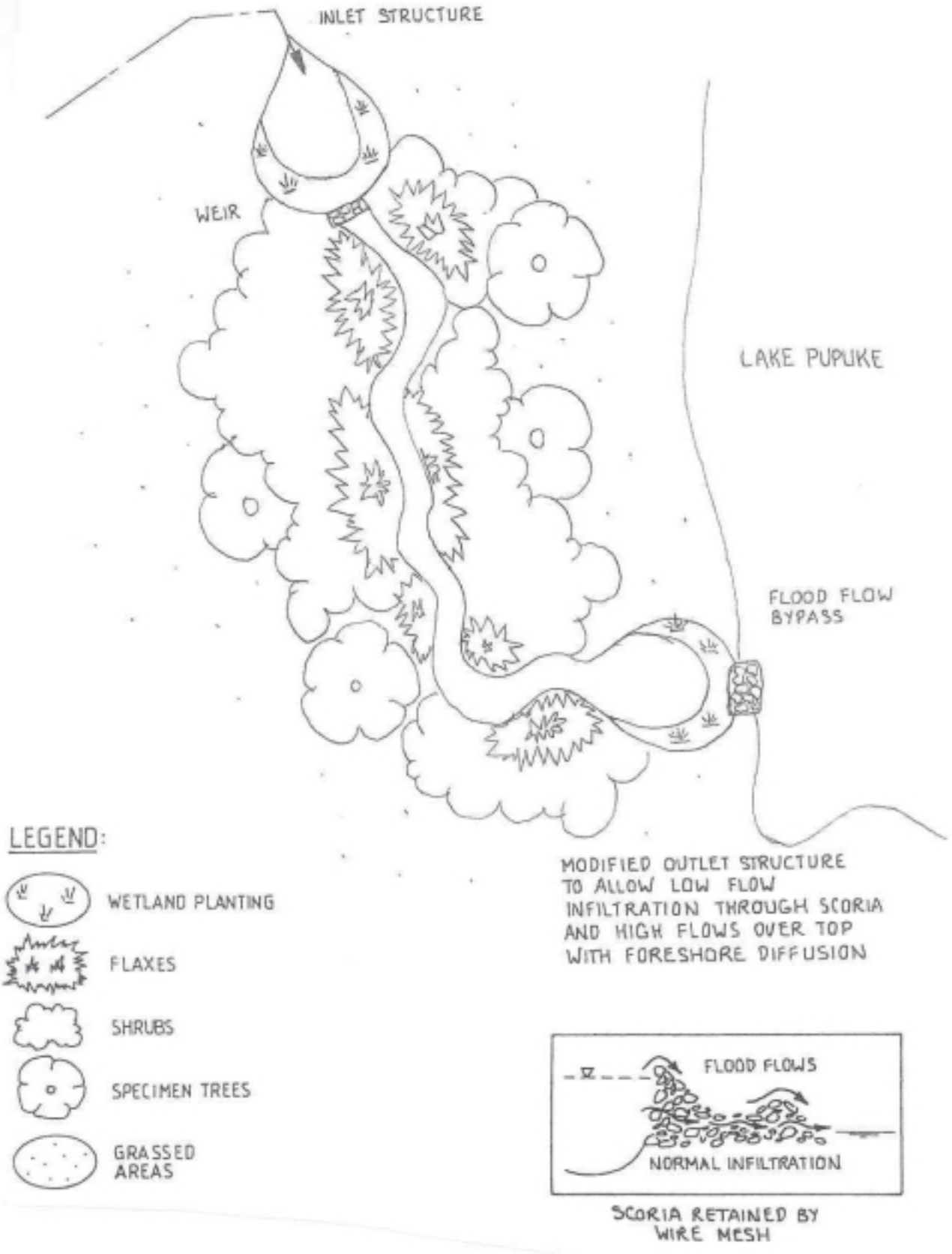
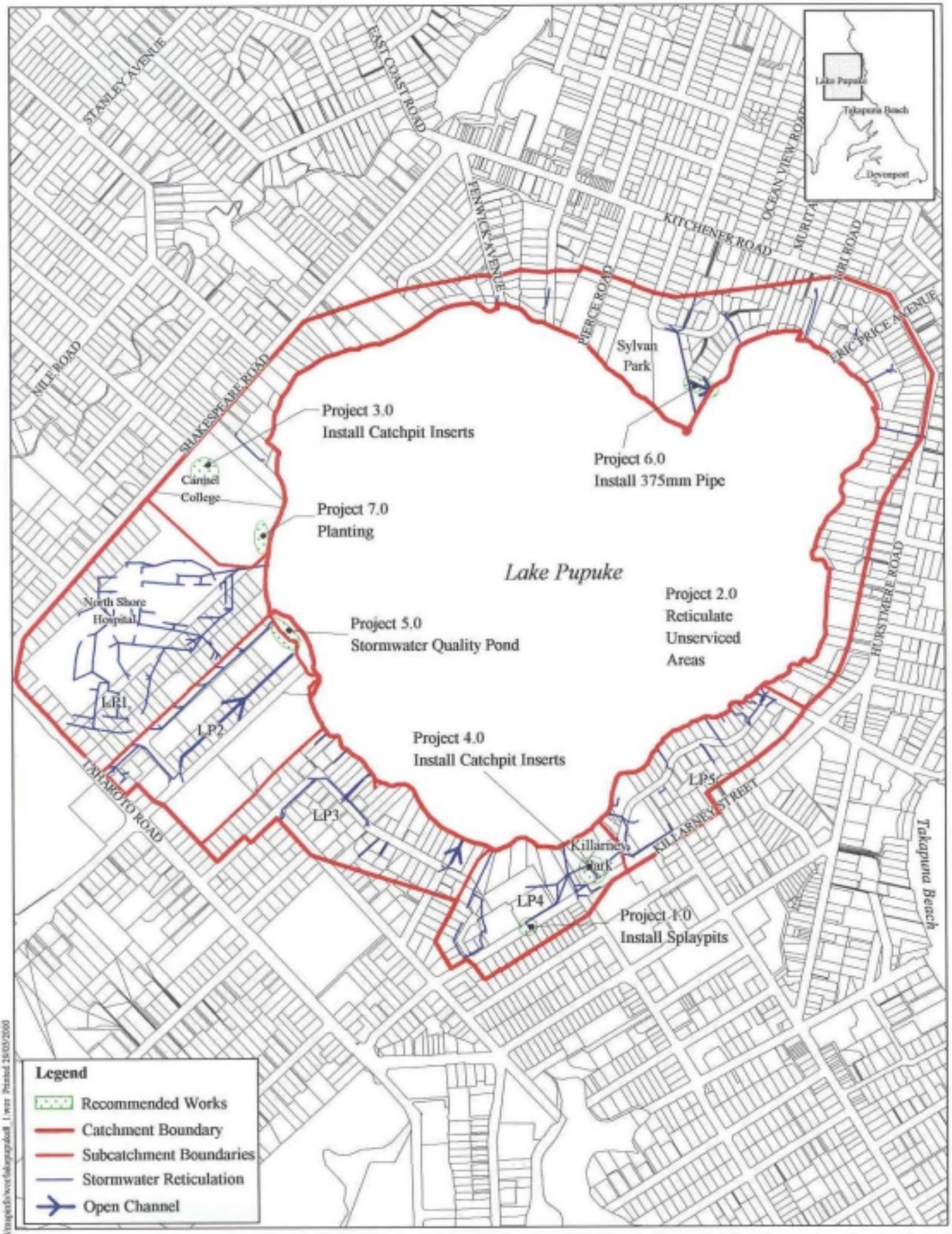


Figure 6.1 Enviropod – A Catchpit Insert



BECA STEVEN

Figure 6.2 Concept Plan of Pond-Type Device



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Scale: 1:10,000 at A4
0 125 250
Metres

Lake Pupuke
Catchment Management Plan

Figure 8.1
Recommended Works

Photos

PHOTO 1: Quarry stormwater quality pond

View looking southeast from Northcote Road East

PHOTO 2: Shea Terrace catchpit showing deposition of organics, litter and metal
View from the bottom of Shea Terrace, looking northeast towards Lake Pupuke

PHOTO 3: Carmel College carpark facilities, with catchpit in foreground

View looking Northwest towards Shakespeare Road

Photo 4: Scouring as a result of stormwater discharging from a pipe approx. 10m back upstream

View looking northwest up hill towards Sylvan Park

Photo 5: Lakeside erosion requiring more intensive planting (Project No. 5.0)

View on the northern side of the stormwater outlet form the hospital grounds, looking north towards the back of Carmel College

Appendix A

NSCC Policy Regarding Open Water Courses and Piped Drains

NORTH SHORE CITY COUNCIL

Open Watercourses Policy

(Adopted 28 June 1998)

1. (a) That the maintenance of private stormwater discharges to a beach, cliff or reserve is the responsibility of the owner of the drain.

1. (b) That the maintenance of the public stormwater discharges to a beach, cliff or reserve is the responsibility of the Council.

1. (c) That the stormwater services manager prepare suitable criteria for the consideration of Council to be incorporated into maintenance standards for these discharges.

2. That responsibility for the maintenance of open drains and natural watercourses be:

Private Responsibility

- Clearance of obstructions under the property owner's control.
- Problems contributed towards by the property owner's activities within the 1 in 10 AEP flow path.
- Problems caused by the property owner's method of maintenance of the drain.
- Minor erosion of the drain floor and banks.

Public Responsibility

- Maintenance of lined drains where the lining was approved or constructed by the Council.
- Serious erosion due to upstream development approved or carried out by the Council that can be mitigated by maintenance works.

NORTH SHORE CITY COUNCIL

Piped Drains Policy

(Adopted May 1998)

1. That Council only maintain drains which serve more than one freehold lot.

2. That Council maintain any other drain which can be demonstrated to have been under the control of the Council for a period of not less than twenty years, or which has been declared as a public drain.

3. That any other drain remains the responsibility of the owner/s of the lot which it serves, through to the point of its connection on the public drain or through to the boundary of the legal road reserve, whichever is encountered first.

4. That the following guidelines be used to assist in interpreting the policy as outlined in recommendations 1, 2 and 3:

    - Owners are responsible for all maintenance of the drain serving a freehold lot, through to its connection point on the public sewer or through to the boundary of the legal road, whichever is encountered first. Usually 100 mm diameter for wastewater and 100 mm or 150 mm diameter for stormwater.

    - Any drain which serves more than one freehold lot will be taken over by the Council and maintained as a public drain. This parallels the policy relating to common private drains.

    - A drain serving more than one dwelling on a single lot is regarded as a private drain through to the road reserve. A single lot is taken to not only include the traditional freehold lot but also the situation where two or more dwellings are on a cross-lease or unit titles type subdivision. The parent lot for this purpose is taken to be one lot even though it may contain more than one flat or unit, provided that they are served by a common drain (usually 100 mm diameter for wastewater and 100 mm or 150 mm diameter for stormwater).

    - In some parts of the reticulation (which tend to be on more recent subdivisions), a 150 mm diameter pipe has been provided up to and near to the boundary. Because such pipes have been constructed to a public drain standard, they are considered to be public drains and are maintained by Council.

Appendix B

Questionnaire Responses and Other Consultation

1. **Please state your street address.**

a) _____ _____
Street Number — Street Name (please write the address to which this questionnaire was delivered, not a post office box nor your home address if it is different from above)

b) _____ _____
Name (optional) — Contact phone number (optional)

c) How long have you lived / worked at this address?

please specify number of years _____

2. **Stormwater flooding on section.**

a) Have you experienced any stormwater flooding on this section due to a major rainfall event, during the last 10 years?

☐ Yes, if so please specify month and year _____ ☐ No (please go to 4.) ☐ Don't know (go to 4.)

b) Please indicate where you believe stormwater overflowed from:

☐ a manhole ☐ a roadway ☐ a creek or stream ☐ a neighbouring property ☐ don't know

c) What part of your property has flooded over the last 10 years?

☐ living area ☐ garage ☐ other, please specify _____

d) How often has stormwater flooded/ponded on this section over the last 10 years?

☐ 1 - 2 times ☐ 3 - 5 times ☐ 6 - 10 times ☐ more than 10 times

e) To what extent has stormwater affected the main dwelling on this section over the past 10 yrs?

☐ not affected ☐ under dwelling ☐ inside dwelling

How often in the past 10 years?

☐ 1 - 2 times ☐ 3 - 5 times ☐ 6 - 10 times ☐ more than 10 times

f) Please estimate the greatest depth of water on the section, under or inside the main dwelling?
(please tick one box only for the most severe effect; note that 10cm = 4 inches)

☐ less than 5 cm ☐ 5 cm to 10 cm ☐ 10 cm to 50 cm ☐ greater than 50 cm

g) Please rate how inconvenient you regard the stormwater flooding of your property.

☐ not inconvenient ☐ slightly ☐ moderately ☐ seriously

3. In remedying the flooding in the catchment and on your property what do you perceive as the most desirable solution?

☐ do nothing ☐ upgrade open drains ☐ provide designated ponding areas
☐ upgrade pipework ☐ raise houses above floodplain ☐ other _____

4. If your property borders a stream, has there been any erosion of your property along the stream?

(a) ☐ Yes ☐ No (please go to 5.) ☐ Don't know (please go to 5.)

if yes, please specify _____

5. **Stormwater Quality**

a) In your opinion how much of an issue is quality (cleanliness) of the water in the stream in this catchment or in the Harbour? *(Rainwater falling on our streets, roofs and industrial areas washes contaminants into our streams and eventually into our harbours. These contaminants include sediment, sewage overflows, animal waste, leaves, heavy metals, garden sprays all of which can affect the health of plants and small marine animals in the natural environment. There are a number of possible options to reduce the effect of these contaminants, most of which are very costly to the city and its ratepayers.)*

We believe reducing stormwater contaminants is:

☐ not an issue ☐ low importance ☐ moderate importance ☐ high importance

b) This is because we are most concerned about:

☐ effects on health ☐ protection of property ☐ protection of harbour and environment ☐ penalising people who pollute

6. If you have any comments, please add them to this form, or you can attach a separate piece of paper to this questionnaire.

_____

_____

_____

TO THE PROPERTY OWNER / OCCUPIER:

THIS IS NOT A CIRCULAR - YOUR HELP IS NEEDED

Over the next few months North Shore City Council (NSCC) and its consultant, Beca Steven, will be investigating how well the present stormwater systems in the Takapuna/Devonport areas are working and how they might be improved. The information is primarily required for long term planning and stormwater management in the catchment. For serious flooding problems that require urgent investigation, residents should contact Action Line on Ph 486-8600.

Your response to this questionnaire will help us to identify flooding within the study areas. It will also help us to assess the management of the stormwater system, and to identify any remaining problems. So we need you to tell us what is happening around your house, business and yard.

Do you have photographs which you would be prepared to lend us showing flooding and flood damage? If so please put your name and address on the back of the photograph so that we can return them to you. The more information you can provide the better.

Please complete the questionnaire on the other side of this sheet, refold it again (with the return address on the outside), seal with sellotape and drop it in the post before 15 February 1999

THERE IS NO POSTAGE REQUIRED. IT HAS BEEN PRE-PAID.

For further information please phone:

Maree Watson or Graham Levy at Beca Stevens 300 9000

Thank you very much for your cooperation.

NORTH SHORE CITY

Private Bag 93500 Takapuna
Telephone 4868400

North Shore City Council

Stormwater Questionnaire

City Services Contract No.300

in partnership with

BECA STEVEN

P O Box 6345
Wellesley St, Auckland
Telephone 300 9000

Beca Steven

a division of
Beca Carter Hollings & Ferner Ltd
Consulting Engineers

Postage paid if posted
in New Zealand

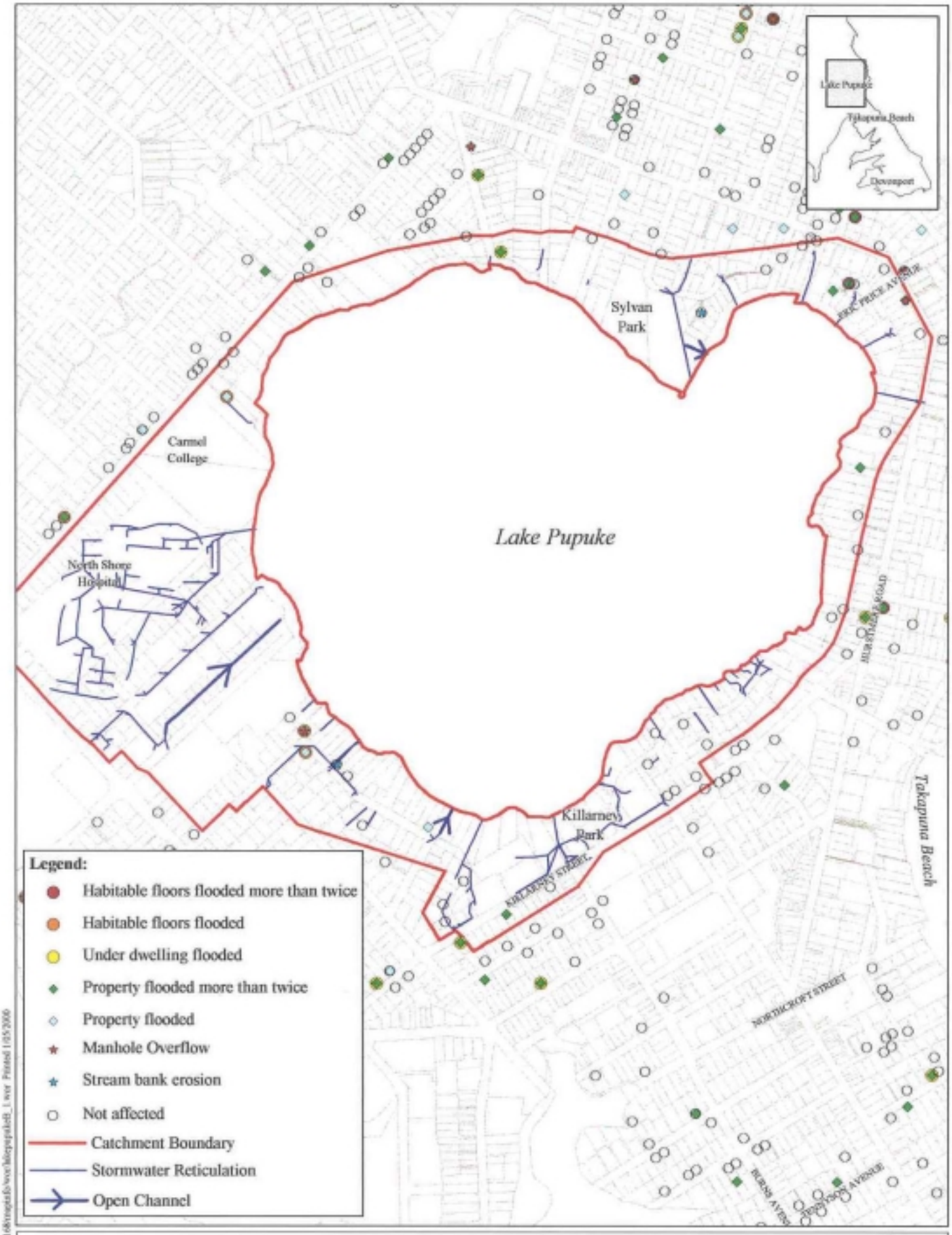
Authority No. 92786 North Shore NZ
Takapuna/Devonport Catchments

North Shore City Council
Private Bag 6345
Auckland

Takapuna/Devonport Stormwater Questionnaire

				WHOLE PROPERTY												OUTDOOR				MAIN DWELLING								EROSION			SUMMARY							
Qu. No.	No.	Street	No. of Years Occupied by Respond-ent	Flooding in last 10 years?		Stormwater overflowed from					Flooded location					Frequency of outdoor flooding over last 10 yrs				Main dwelling area affected			Frequency of main dwelling flooding over last 10 yrs				Depth under or inside main dwelling				Erosion of property along stream?			Habitable Floors Flooded More Than Twice	Habitable Floors Flooded	Under Dwelling Flooded	Property Flooded More Than Twice	Property Flooded	Not affected	Manhole Overflow	Stream Bank Erosion	Problem likely to be attributed to:
				Yes	No	Manhole	Roadway	Stream	Neighbouring property	Unknown	living	garage	Other	Comment	1-2 times	3-5 times	6-10 times	>10 times	not affected	under dwelling	inside dwelling	1-2 times	3-5 times	6-10 times	>10 times	<5cm	5cm - 10cm	10cm - 50cm	>50cm	yes	no	comment							
1457	3	Eric Price Ave	15	1					1			1				1					1		1								1			1	1				Overland flow from unserviced properties
1689	4	Eric Price Ave	5	1					1		1							1			1			1		1			1			1		1	1				Overland flow from unserviced properties
1339	5	Eric Price Ave	3	1					1				1	garden			1		1								1							1	1				Overland flow from unserviced properties
1661	10	Fenwick Ave	14	1					1				1	driveway			1			1				1							N/A			1	1	1				Overland flow from unserviced properties
943	26	Fenwick Ave	4	1					1				1	under			1			1				1										1	1	1				Overland flow from unserviced properties
249	278	Hurstmere Rd	63	1									1	lawn area by lake		1			1																1	1				Lake level
1323	1/40	Killarney St	20	1			1						1	lawn& drive				1	1							1									1	1				Secondary Flow (refer Project 1.0)
1361	2/42	Killarney St	10																																				Secondary Flow (refer Project 1.0)
1169	44	Killarney St	20	1					1				1	garden				1	1								1								1	1				Secondary Flow (refer Project 1.0)
282	12	Kitchener Rd	34	1		1	1		1				1	lower lawn area				1	1						1										1	1		1		Overland flow from unserviced properties
528	3/74	Kitchener Rd	5	1									1	drive	1				1								1									1				Overland flow from unserviced properties
1176	48	Kitchener Rd	16	1			1		1			1							1													no stream								Overland flow from unserviced properties
369	37	Lakeview Rd	39		1																											lake front erosion, council responsibility						1		1	Instability of lakefront (refer Project 7.0)

WHOLE PROPERTY																OUTDOOR				MAIN DWELLING										EROSION			SUMMARY							
Qu. No.	No.	Street	No. of Years Occupied by Respond-ant	Flooding in last 10 years?		Stormwater overflowed from						Flooded location					Frequency of outdoor flooding over last 10 yrs				Main dwelling area affected			Frequency of main dwelling flooding over last 10 yrs				Depth under or inside main dwelling				Erosion of property along stream?			Habitable Floors Flooded	Habitable Floors Flooded More Than Twice	Under Dwelling Flooded	Property Flooded More Than Twice	Property Flooded	Not affected	Manhole Overflow	Stream Bank Erosion	Problem likely to be attributed to:
				Yes	No	Manhole	Roadway	Stream	Neighbouring property	Unknown	living	garage	Other	Comment	1-2 times	3-5 times	6-10 times	>10 times	not affected	under dwelling	inside dwelling	1-2 times	3-5 times	6-10 times	>10 times	<5cm	5cm - 10cm	10cm - 50cm	>50cm	yes	no	comment								
863	498	Lakeview Rd	20	1		1					1				1						1	1				1													Driveway sloping towards garage(refer section 5.4.5)
592	9	Lakeview Rd	35	1									1	frontage on lake Pupuke	1				1				1																High Lake level
1363	1/17	Rangitira Ave	27	1					1		1				1						1	1				1													Overland flow from unserviced properties
601	98	Shakespeare Rd	7	1					1				1	whole house	1						1	1				1													Overland flow from unserviced properties
1404	33	Sylvan Park Ave	20		1																											walkway round Lake Pupuke, lake level higher						1		1	High Lake level
																																	2	3	2	9	14	2	2	2	



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Lake Pupuke
Catchment Management Plan

Figure B.1
Response to Stormwater Questionnaire (Appendix B)

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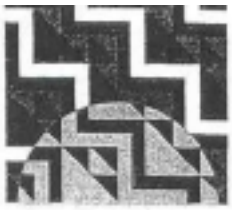
THE NGATI PAOA
WHANAU
TRUST BOARD



363 DON BUCKS ROAD,
MASSEY, AUCKLAND
TEL/FAX 0-9-832 1860

BECA STEVEN
P O Box 6345
AUCKLAND

Attention : Graham Levy, Project Manager

15 November 1999

Tena koe,

RE : NORTH SHORE CATCHMENT MANAGEMENT PLANS

Thank you for your correspondence advising that North Shore City Council is updating or preparing new Catchment Management Plans for a number of areas on the North Shore.

In terms of those matters to be assessed within the plans, the Trust wishes to comment on specific items.

1. Environmental Impact Assessment of proposed works.

   No new piping, culverts or fill from subdivisions and earthworks be permitted in natural waterways or wetlands as the environmental impact on the flora and fauna on the surface and in the waterways, extinguishes the inherent features of the natural landforms and landscapes.

2. Water Quality.

   Ensuring water quality in the various catchments may require constant monitoring, ongoing performance indicators of existing systems and where necessary immediate replacement or closure of substandard water systems.
   Sewage and wastewater outlets into coastal waters should be closed and relocated under strict treatment procedures and processes for disposal to designated high density natural bush areas. Consideration be given to wastewater for irrigation purposes such as sports fields, golf courses and revegetation programmes in public parks and reserves.

3. Erosion Control.

   Where possible sloping walls of packed natural rock be built (not cemented), two or three metres out from the effected area and backfilled with a preferred base of sand or heavy clay fill, topped with suitable topsoil for replanting of pohutukawa or similar coastal vegetation.

In some instances where coastal erosion has occurred, it has also been the cause of ancient human remains surfacing as a tradition of the ancestors of Ngati Paoa were to bury the deceased either on the land edge of the coastline and/or on the nearest beaches to a village .

We are aware that these are comments based on Ngati Paoa values and may not be appropriate or may require some modification.

Kia ora,
Ngati Paoa Whanau Trust

Hariata Gordon
Principal

Meeting at Three Streams (QE Trust Reserve) in Wayside 27/1/00

Present

- Paul Mitchell and Kate Medlicott (Beca Steven)
- Jim Lewis (Forest and Bird)
- John Hogan (Three Streams)

Stormwater Management concerns of Jim Lewis and John Hogan (23 catchments):

- The importance of vegetation control outside of the riparian zones, in particular upper catchment areas. Support community participation in replanting of these areas and streambanks. Follow up needed for educational material developed by Parks and Reserves on streamside planting – "The magic of Streams"
- The high percent impervious allowed for in the District Plan for new development. Some development of residential lots is occurring after maximum impervious areas have been exceeded e.g. paving, carports etc being built after Council have approved maximum impervious areas for lot.
- Streambank erosion, particularly at stormwater outfalls (both existing and new). Design of outfalls from subdivisions adjacent to watercourses, still efficient engineering solutions to collect runoff but not manage it afterwards.
- Question adequacy of sediment removal from detention tanks both roadside and streamside
- Clearfelling of vegetation for new building footprints in bush areas, these are often issued as non-notified consents.
- Utility services are impacting on vegetation e.g. new wastewater sewer lines.
- Not enough attention given to cumulative effects on main streams or coastal degradation from the development of specific sites in tributary catchments.
- Implications of development adjacent to Sites of Special Wildlife Interest (SSWI) and Lake Pupuke, quality of water for aquatic species. Note research by Stormwater Dept. on Life in 6 Streams.
- Runoff in rural catchments – effects of fertilisers, farm animal nutrients and septic tanks
- Agree with TP10 approach and can see benefits from retaining / creating greenfields and wetland ponds, though concerned about location of stormwater management (devices) especially wetlands within esplanade reserves, and acceptance of low efficiency of some designs (50-60%). Retrofit erosion and sediment control ponds to wetland ponds following construction of subdivision.

Appendix C
Catchment Modelling and Summary of Results

Technical Description of Catchment Models

Guideline for Stormwater Runoff Modelling in the Auckland Region

A study has recently been undertaken for the ARC to prepare guidelines for a standard rainfall-runoff model for the Auckland Region. The study included a review of available stormwater modelling packages and analysis methodologies, an evaluation study in which three selected models were calibrated against data from gauged catchments in the Region, and the development of a recommended model for the Region.

The study was driven by the Regional Council's desire for consistency and accuracy in stormwater analysis across the Region. In addition there was a desire to include calculation of storm runoff volume and timing, and the effects of development. Results from the evaluation study highlighted the range of model results (and hence capital works outcomes) that is obtained with the range of available methodologies. On the basis of agreement between modelled and recorded catchment flows and other features of the model, the US Soil Conservation Service model was selected to form the basis of the standard Auckland Region stormwater model.

The outcome of the study will be a set of guidelines produced by the Auckland Regional Council providing a standard methodology for the application of the US Soil Conservation Service (SCS) model to the Region. This will include a standard Auckland design rainfall storm, guidelines for selecting rainfall loss parameters for typical Auckland soils, a regionally calibrated equation for estimating catchment times of concentration, and a standard unit hydrograph.

Table C.1: Summary of Catchment Characteristics				
Subcatchment Number	***Area (ha)***	***Slope[#] (m/m)***	***% Impervious***	
			Existing Use	***Future Use***
LP1	17.1	0.04	70	100
LP2	11.3	0.04	43	70
LP3	10.18	0.04	43	70
LP4	7.4	0.04	43	70
LP5	7.16	0.04	43	70
LP6	32.82	0.04	43	70

[#] Indicative

Table C2: Summary of Nodal Flows							
Node	***D/S Pipe Diameter (mm)***	***Pipe Slope * (m/m)***	***Existing Pipe Capacity (m^3/s)***	***Nodal Flows (m^3/s)***			
				Existing Use		***Future Use***	
				10% AEP	***1% AEP***	***10% AEP***	***1% AEP***
Node 1	1200	0.01	4.23	3.1	4.7	3.4	5.0

*****There are no invert data available for this catchment. Pipe slopes have been estimated from inclinometer readings.

Appendix D

Stormwater Liaison Group – Technical Report 3

Extract from ARC Technical Report 3

Prioritisation of Receiving Environments and Catchments; (Stormwater LIAISON Group)

- The environmental values of the stormwater receiving environments, both marine and freshwater, along with the magnitude of catchment threats such as flooding and erosion should be the key factors for determining the catchment priorities for stormwater management, and priority being given to high value : high threat catchments.
- Environmental values include ecological and community values, but primary importance should be given to the ecological values of the receiving environments when determining the priorities for stormwater management. A healthy ecology has the additional benefits of enhancing the community's safe enjoyment of natural resources.
- Priority should be given to protecting and preserving highly valued receiving environments. Preserving high receiving environment values generally more cost efficient than remediating degraded environments.
- Priority should be given to stormwater quality management with depositional receiving environments. Contaminants are less likely to persist and accumulate in non-depositional marine environments (and hence present a lower priority), but may result in higher suspended sediment levels reducing aesthetic appeal, and other short to medium term effects.

Where opportunities for the efficient enhancement of stormwater quality or quantity issues exists, such as where development is occurring and can address these issues

Appendix E
Stormwater Quality Management Techniques

Stormwater Quality Management Techniques

Stormwater quality management techniques may be implemented by Council and by individual landowners or occupiers.

1.0 Council Stormwater Quality Management Techniques

Stormwater quality techniques that could be implemented by Council include:

- Pumping station overflow storage / treatment.
- Refining road sweeping and catchpit cleaning programmes.
- Provision of rubbish bins within reserves.
- Provision of 'dog boxes' within reserve areas.
- Education.
- Enforcement of regulations.
- Checks upon drainage connections.
- Review of maintenance procedures.
- Site development controls.

Pumping Station Overflow Storage

Council could investigate the installation of overflow holding tanks adjacent to pumping stations. The size of the tanks will depend on the flows through the pumping station and the duration of the overflows captured (eg 12 hours / 24 hours depending on Council policy).

Another means of limiting contaminants released during pumping station overflows would be to partially treat the discharge by installing a device such as a screen followed by a weir at, and activated by, the discharge. This however is normally not viewed as a long-term solution and containment of the overflow would be preferable.

Alarms should be installed on all pumping stations, if they are not already, and the number, frequency and volume of the overflows monitored. This information should be forwarded to the Regional Council as part of the stormwater discharge consent conditions.

Road sweeping and catchpit maintenance

In areas where there are catchpits and curbing, Council could increase the frequency of catchpit cleaning to maximise the potential to intercept sediment:

Increasing the frequency of sump cleaning is likely to improve the efficiency of the sumps to trap sediment.

Council could investigate the time it takes for sumps around the catchment to fill with sediment and adjust the catchment-wide sump cleaning programme accordingly. Some areas of the catchment may require a more intensive cleaning programme to ensure the catchpits maintain optimum efficiency; some a decreased frequency.

Provision of Rubbish Bins Within Reserves

Council could ensure that adequate rubbish bins are provided in reserves within the catchment and that they are regularly emptied. This would help to ensure that litter and debris were retained within the bins and did not enter the stormwater system. The provision of rubbish bins next to stream crossing typically warrants particular attention and priority.

Provision of 'Dog Boxes' within reserve areas.

'Dog boxes' could be placed within reserve areas as have already been done in some North Shore reserves. The boxes encourage dog owners to act responsibly. This would help to control the release of nutrients and improve the amenity value of reserve areas.

Education

Council, in association with the ARC, could develop a community wide education programme. This could involve the production of sector specific information pamphlets, i.e. for industry, commerce, or residents. This could be followed up with public forums to discuss stormwater issues in general.

Another useful mechanism is ongoing education of secondary school pupils from nearby secondary schools. By making the students aware of the significance of contaminants entering the stormwater system, this would have an effect on the community in the short term. This is an activity that could be picked up by the Regional Council.

Helping people visualise where the stormwater system discharges to may also prove beneficial. Symbols of fish either painted or attached on small plates next to stormwater grates may prove a useful preventative tool in areas draining to stormwater; both in public areas and in commercial and industrial areas for staff awareness.

Enforcement

Enforcement of aims and district / regional policies would help to ensure that the sites or areas within the catchment with the potential for individually significant releases of contaminants to stormwater / soakage are regularly checked and are thus accountable.

During licensing inspections under the Dangerous Goods Regulations (now transitional under the Hazardous Substances and New Organisms Act), the inspector should check for potential spillage to the stormwater system. This is, in fact, required in Sections 31 m and 33 d (iii) in that: *"all reasonable precautions shall be taken for ... the prevention of the escape of dangerous goods into any sewer or drain or natural water, ..."*.

Another means of regulating the discharge of contaminants to stormwater is to incorporate into any future Council strategic policies a statement that requires anyone discharging stormwater to the Council stormwater system to be responsible for ensuring that the discharges from their site do not compromise or breach the conditions imposed on Council for the overall discharge consent. This

would then encourage Council to enforce the quality of stormwater being discharged into the Council stormwater system.

Checks Upon Drainage Connections

Illegal connections of stormwater into the foulwater system may result in overflow of foulwater during storm events. Conversely, foulwater and tradewaste connections into the stormwater system would result in contaminants being an almost continuous component of the stormwater discharge.

Council could conduct an audit of the existing stormwater system (this includes open watercourses) to identify potential or actual illegal connections. Works to separate any illegal connections should then be prioritised with existing works to separate illegal connections; foulwater connections to the stormwater system should be preferentially separated.

Review of Maintenance Procedures

Maintenance procedures throughout the catchment should be critically examined from the perspective of preventing contaminants from entering the stormwater system. Maintenance of grassed areas, especially road berms could avoid the use of herbicides where practicable.

Site Development Controls

Any development within the catchment has the potential to generate significant quantities of silt over a short term period. Council could ensure all such development, including that which is Council instigated (such as road maintenance), is subject to the appropriate level of silt control. Controls upon site development may include requirements that:

- Painting contractors should not discharge wastes into the stormwater system.
- Concrete pumping contractors should not allow the discharge of waste concrete into gutters or catchpits. Waste concrete should be disposed of on site or as clean fill as appropriate.
- Bricklaying / paving contractors (eg during curbing construction) should not mix mortar in gutters or any other situation which will drain to the stormwater system.
- All earthworks and material stockpiles should be stored appropriately.
- All individual and subdivisional development and / or building applications must be accompanied by a site management plan including stormwater control plans. Controls may include:
  - Silt curtains.
  - Regular catchpit clearance / road sweeping.
  - Use of cut-off drains.
  - Installation of sedimentation tanks.
  - Regular (self and Council) auditing of controls.

  The range of controls / requirements should be appropriate to the development.

- Where sandblasting and paint stripping are proposed, adequate screening should be provided to trap all airborne material. Sweeping and vacuuming should be utilised to collect the waste for disposal in an appropriate manner.
- No materials should be deposited on Council's roadways as a result of vehicles leaving the building site.
- Council could check the site prior to issuing of the occupancy certificate to ensure that all catchpits / treatment devices have been cleaned out, and that the site has been satisfactorily cleaned up to minimise any significant adverse environmental effects.

2.0 PRIVATE SECTOR POLLUTION PREVENTION

Individual pollution prevention is largely either enforced by Council or is reliant upon the individual to be proactive and / or informed. Council initiated education and enforcement initiatives would directly affect the effectiveness of contaminant removal and / or containment prior to release into the main stormwater system.

There are a number of ways by which contaminants may be controlled at the source:

Installation of Pretreatment Devices

Pretreatment devices may include oil separators, grit and grease traps. Pretreatment may occur on general drainage, or from wash down areas.

Staff Education

Education of staff would help in avoiding incorrect disposal of liquid wastes down stormwater grates. A fish symbol could also be placed on all stormwater grates as a reminder of the end point of the drain.

Spill Contingency Planning

Companies should be encouraged to develop contingencies for spills of substances into the stormwater system. Adsorbent / containment equipment should be available, and a register of events (together with the response) should be established.

Waste Management

Sites should ensure waste bins are covered and do not include liquid wastes that could drain to ground / stormwater. Waste chemical containers should be stored under cover and in a contained area. Particulate material should be secured so that it does not disperse (such as plastic packing chips).

'Chemical' Storage

Storage of dangerous and hazardous goods oils, paints, and chemicals should be such that runoff / spillage to stormwater is avoided. This should include loading and unloading activities together with transfer of these substances within the operation.

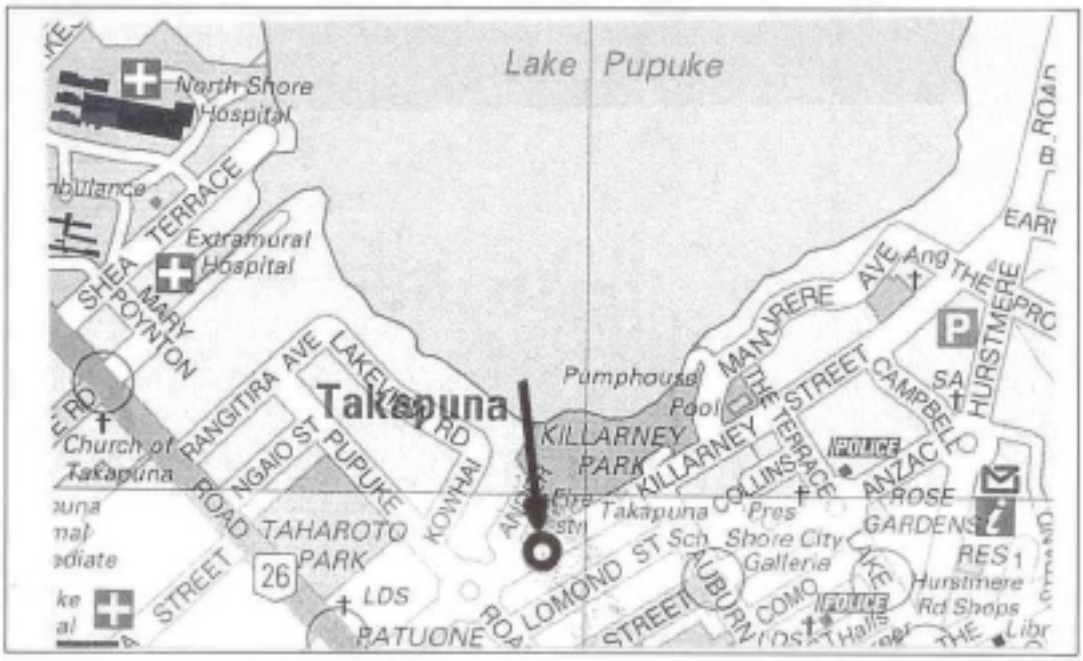
Environmental Management Systems

Establishment of management systems on sites would aid in the prevention of erroneous environmental practices and may provide mitigation against the release of contaminants to stormwater. Other benefits may include cleaner production techniques and increased cost efficiency.

Appendix F
Project Sheets

Project Summary Sheet

Date: 18 October 1999	***Catchment:*** Lake Pupuke	***Ward:***	Takapuna
Project Address:	No. 40 Killarney Street		
Project Description:	1		



Problem Description:	Secondary flow occurs along Killarney Street and surrounding properties as a result of the damaged catchpit outside No.40 blocking.
Solution Required:	Installation of Splaypits to improve the flow from road into the stormwater system.

CMP Y/N:	Y	***Budget Category:***	FP
CMP Project No:	1.0	***Effect / Threat:***	F
Capital Estimate	$10,000	***Frequency:***	4
		Other Factors 1:	CMP
Maintenance Estimate		***Other Factors 2:***	
Estimate Accuracy:	Conceptual	***Other Factors 3:***	
Project Confidence:	Reliable	***Other Factors 4:***	
Solution Confidence:	Limited	***TOTAL RANK:***	4.9
Comments:			

Project Summary Sheet

Date: 18 October 1999	*Catchment:* Lake Pupuke	*Ward:*	Takapuna
Project Address:	Lake Pupuke Catchment		
Project Description:	E		

Refer Figure 5.3

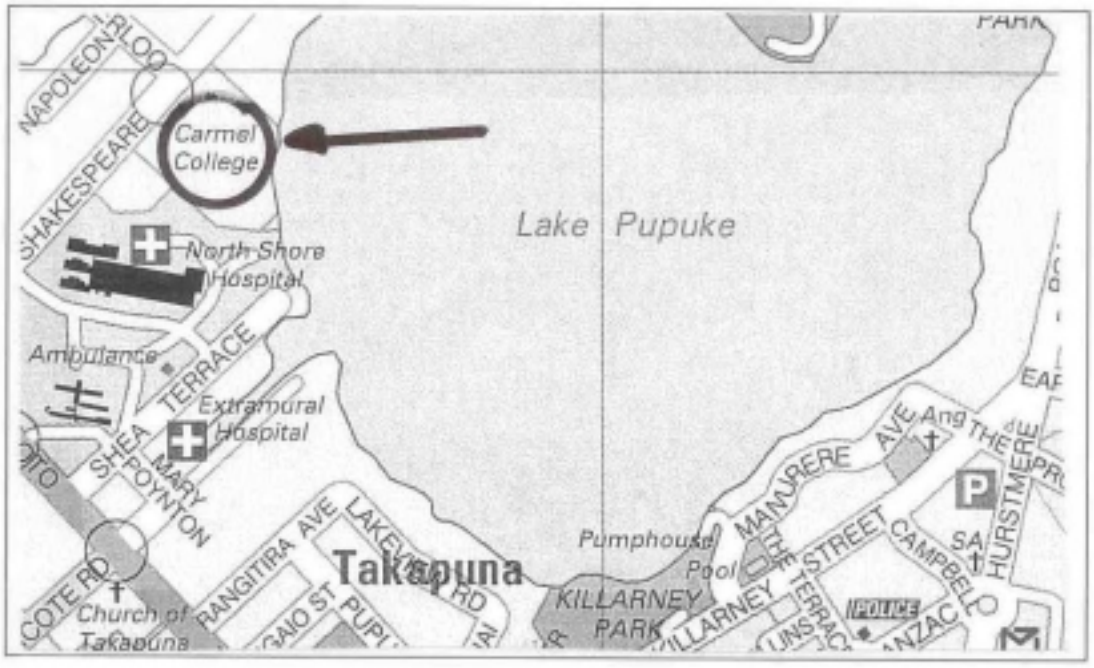
Problem Description: Overland flow from unserviced properties causes localised flooding.

Solution Required: Reticulation of unserviced properties.

CMP Y/N:	Y	*Budget Category:*	UA
CMP Project No:	2.0	*Effect / Threat:*	G
Capital Estimate	$1,500,000-2,000,000	*Frequency:*	5
		Other Factors 1:	CMP
Maintenance Estimate		*Other Factors 2:*	
Estimate Accuracy:	Conceptual	*Other Factors 3:*	
Project Confidence:	Uncertain	*Other Factors 4:*	
Solution Confidence:	Limited	*TOTAL RANK:*	4.6
Comments:			

Project Summary Sheet

Date: 18 October 1999	***Catchment:*** Lake Pupuke	***Ward:***	Takapuna
Project Address:	Carmel College, 114 Shakespeare Road, Milford		
Project Description:	Q		

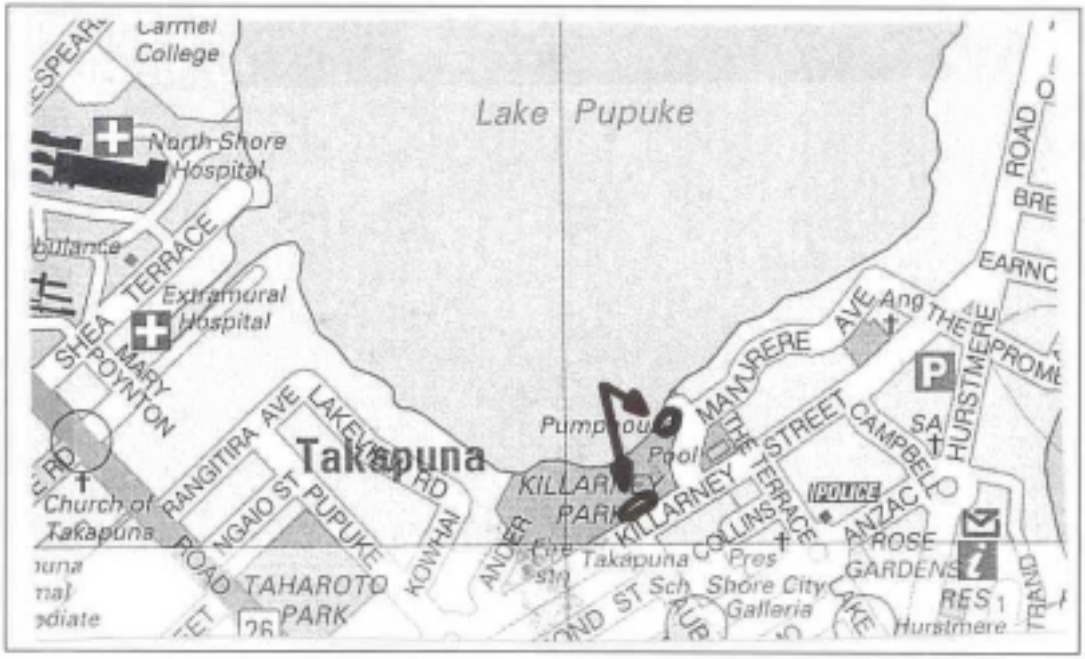


Problem Description:	Contaminants from car parking facilities are transported via runoff into Lake Pupuke
Solution Required:	Install an enviropod to trap litter and associated sediments from the carpark area.

CMP Y/N:	Y	***Budget Category:***	SQ
CMP Project No:	3.0	***Effect / Threat:***	H
Capital Estimate	$2,500	***Frequency:***	7
		Other Factors 1:	CMP
Maintenance Estimate		***Other Factors 2:***	LOC
Estimate Accuracy:	Conceptual	***Other Factors 3:***	PCC
Project Confidence:	Reliable	***Other Factors 4:***	
Solution Confidence:	Limited	***TOTAL RANK:***	4.2
Comments:	An opportunity may exist to combine this project with the Water Watch and Schools Scheme		

Project Summary Sheet

Date: 18 October 1999	***Catchment:*** Lake Pupuke	***Ward:***	Takapuna
Project Address:	Killarney Park, Killarney Road, Takapuna		
Project Description:	Q		

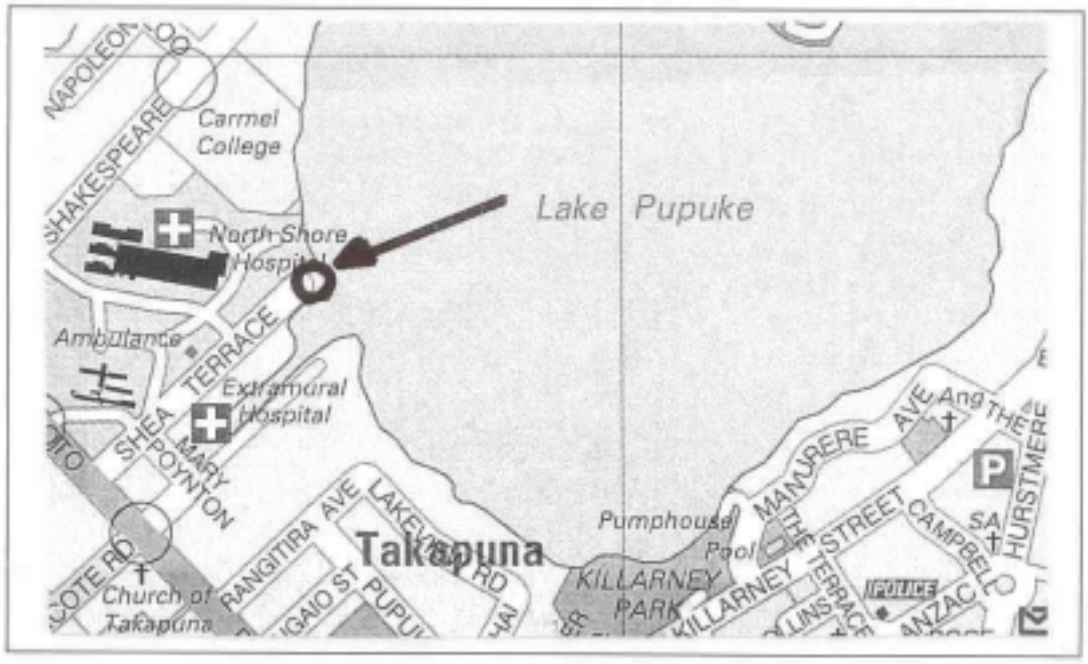


Problem Description:	Contaminants from car parking facilities are transported via runoff into Lake Pupuke
Solution Required:	Installation of 2 enviropods to trap litter and associated sediments from the carpark areas.

CMP Y/N:	Y	***Budget Category:***	SQ
CMP Project No:	4.0	***Effect / Threat:***	H
Capital Estimate	$5,000	***Frequency:***	7
		Other Factors 1:	CMP
Maintenance Estimate		***Other Factors 2:***	LOC
Estimate Accuracy:	Conceptual	***Other Factors 3:***	
Project Confidence:	Reliable	***Other Factors 4:***	
Solution Confidence:	Limited	***TOTAL RANK:***	4.2
Comments:			

Project Summary Sheet

Date: 18 October 1999	***Catchment:*** Lake Pupuke	***Ward:***	Takapuna
Project Address:	Eastern end of Shea Terrace		
Project Description:	Q		

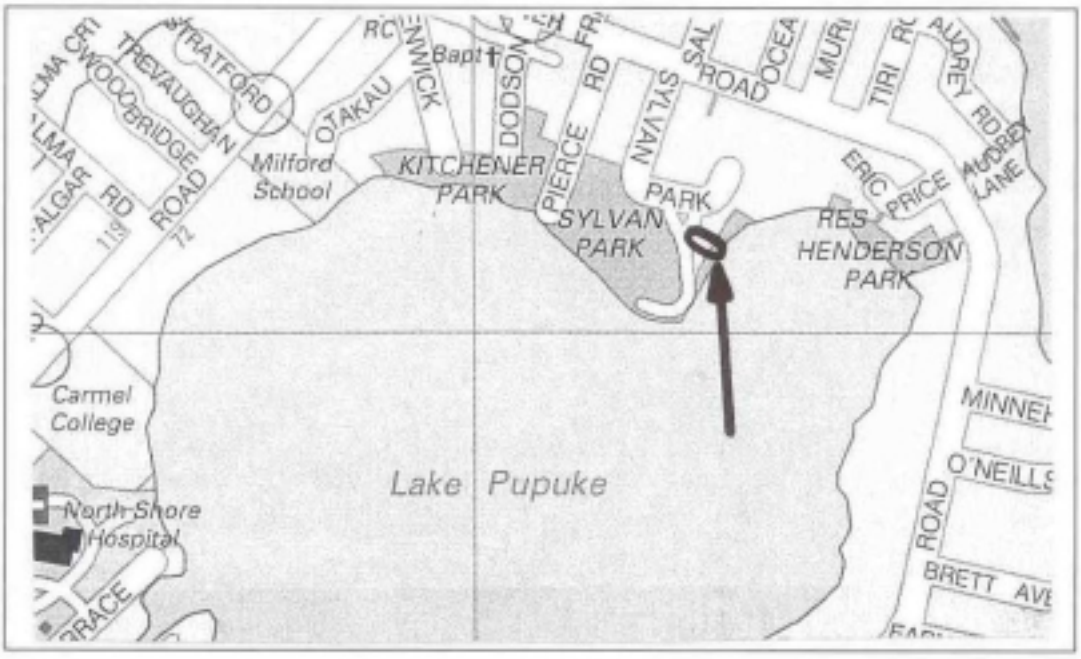


Problem Description:	Contaminants from the North Shore City Hospital and Ambulance car parking facilities are transported via runoff into Lake Pupuke
Solution Required:	Construct a pond to settle out contaminated sediments before the stormwater enters the lake.

CMP Y/N:	Y	***Budget Category:***	SQ
CMP Project No:	5.0	***Effect / Threat:***	H
Capital Estimate	$86,000	***Frequency:***	7
		Other Factors 1:	CMP
Maintenance Estimate		***Other Factors 2:***	LOC
Estimate Accuracy:	Conceptual	***Other Factors 3:***	PCC
Project Confidence:	Reliable	***Other Factors 4:***	
Solution Confidence:	Limited	***TOTAL RANK:***	4.2
Comments:			

Project Summary Sheet

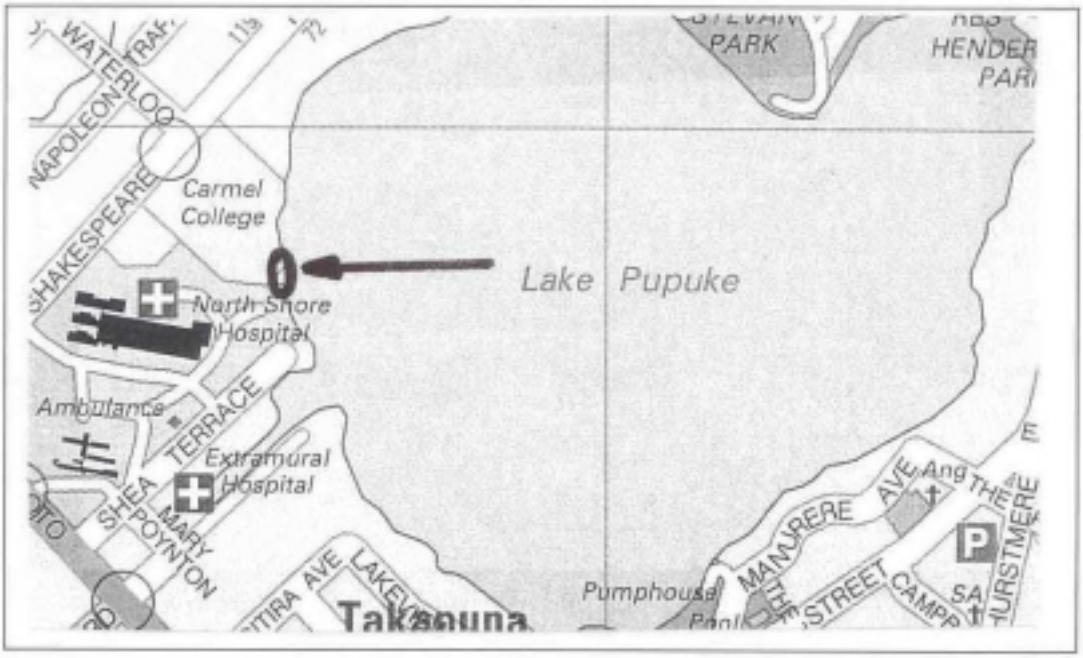
Date: 18 October 1999	***Catchment:*** Lake Pupuke	***Ward:***	Takapuna
Project Address:	Sylvan Park, Milford		
Project Description:	S		



Problem Description:	A stormwater pipe discharges at the top of a bush covered slope, eroding away the ground to form a trench, and also exposing the adjacent fence foundations		
Solution Required:	Piping (375mm diameter) the stormwater to the Lake's edge (50m) with an appropriate outlet		
CMP Y/N:	Y	***Budget Category:***	EP
CMP Project No:	6.0	***Effect / Threat:***	G
Capital Estimate	$16,000	***Frequency:***	4
		Other Factors 1:	CMP
Maintenance Estimate		***Other Factors 2:***	
Estimate Accuracy:	Conceptual	***Other Factors 3:***	
Project Confidence:	Reliable	***Other Factors 4:***	
Solution Confidence:	Limited	***TOTAL RANK:***	4.8
Comments:			

Project Summary Sheet

Date: 18 October 1999	***Catchment:*** Lake Pupuke	***Ward:***	Takapuna
Project Address:	West end of lake (refer location plan below)		
Project Description:	S		



Problem Description:	Lake side erosion
Solution Required:	Stabilise approximately 1000m² through intensive planting

CMP Y/N:	Y	***Budget Category:***	EP
CMP Project No:	7.0	***Effect / Threat:***	H
Capital Estimate	$35,000	***Frequency:***	7
		Other Factors 1:	CMP
Maintenance Estimate		***Other Factors 2:***	
Estimate Accuracy:	Conceptual	***Other Factors 3:***	
Project Confidence:	Reliable	***Other Factors 4:***	
Solution Confidence:	Limited	***TOTAL RANK:***	4.2
Comments:			