Appendix 11.2 Central

Appendix 11.2.1 St Heliers

St Heliers character statement

1. **St Heliers character overlay approach**

The St Heliers Character Overlay utilises controls that seek to retain and enhance the character of St Heliers. Based on an understanding of the historic development and analysis of the urban character of St Heliers village, the elements which contribute to character of the different street environments have been identified.

Surviving early buildings in the centre are an important asset. Sympathetic development will provide a high quality, authentic identity by reinforcing the village's unique qualities in each of the character dimensions. The intention is not to 'freeze' the built environment. It is proposed that having defined the elements that give particular character to the area that change can be managed to protect the distinctive character of the village. Innovative and congruent development likely to add to the attributes of St Heliers village will be encouraged under such a regime.

Traffic and Parking

Tamaki Drive is part of the scenic route that extends eastwards from Auckland's central business district. It is a popular tourist route and is used extensively by cyclists, joggers, roller-bladers and other recreational users. The demand for parking generally falls into three broad categories: residential, commuter and visitor (comprising shoppers, tourists, visiting business people etc). Each group has unique parking requirements. Consequently, traffic and parking conditions vary considerably throughout the year depending on the season, the time of day and weather conditions.

As with other traditional commercial areas throughout Auckland, much of St Heliers was developed before cars were widely used, so many established commercial premises do not provide on-site car parking. This places pressure on the available on-street parking. Feedback from the community indicates that parking is considered a problem in St Heliers, because most of the available parking spaces in the commercial area are often occupied. This inconvenience may deter shoppers and others from visiting the area and prevent local businesses from achieving their full potential. At times there is difficulty when delivery vehicles double-park to deliver goods and prevent vehicles from travelling freely through the village area.
Pedestrian access to and around the village is currently functional with footpaths of reasonable width and condition. However, there is conflict between the location of pedestrian crossings on both Tamaki Drive and St Heliers Bay Road and vehicular traffic. Feedback from the community also raised concerns regarding the location of bus stops adjacent to café/restaurant establishments with outdoor dining.
To address these concerns a parking plan is being developed for St Heliers. This will develop short and long term strategies to address the traffic and carparking concerns for St Heliers.
The character overlay provides for an exemption from the required parking spaces in certain circumstances to retain and encourage the continuity of retail frontages.

Open Space

Open space is an important part of the fabric of St Heliers. It has many layers - parks, reserves, streets, beaches and trees. While these controls seek to maintain and enhance the character of St Heliers village, it is acknowledged that the design and appearance of works within open space will affect its character. Therefore, the council will promote works within the open space, both adjacent to and within the character overlay area, that are sympathetic to the aim of the St Heliers local centre.

2. Description – Character Definition

History

Te Pani-o-Horoiwi (Achilles Point) and Karaka Bay are of historic significance to Auckland. The headland around the present Glover Park was fortified and formed part of a network of fortified pa that protected the navigable passages within the Hauraki Gulf. Karaka Bay was one of the locations around the country chosen for the signing of the Treaty of Waitangi.

The first auction of large blocks of land from the recently surveyed Ngati Paoa Tamaki Block took place in 1842 and St Heliers began as a number of settler farms. In the early 1880s farmland was subdivided in order to develop a 'model' seaside suburb of Auckland. With the completion of the wharf in 1882 St Heliers was initially popular as a holiday destination. Improved bus services affected the ferry services profitability and contributed to the wharf being demolished in 1930. With the opening of Tamaki Drive in 1931 the rate of growth accelerated further, and the village centre provided most services, supplies and entertainment for the surrounding community.

The urban structure and street pattern of St Heliers was based on a planned seaside settlement which has resulted in the existing grid with streets running perpendicular to Tamaki Drive and the waterfront and is a distinctive feature of this centre. The centre retains a range of building types from different periods which provide evidence of the historic development of the centre and how it has changed over time.

Landscape

St Heliers Bay is the eastern-most bay of a repeated pattern of small beaches separated by headlands and cliffs, forming a scalloped profile along Tamaki Drive. The bay lies between the prominent Waitemata Sandstone cliffs at Ladies Bay to the east, and the headland to the west at Kohimarama. The town centre forms the seafront focus of St Heliers Bay and is orientated towards its coastal setting. It is located on flat land set at the base of a small topographic amphitheatre, surrounded by residential development on the land sloping upwards to the south. The surrounding residential development has views of the village, the Waitemata Harbour and beyond. The large expanse of Vellenoweth Green, two large Moreton Bay Fig trees and the beach reserve along Tamaki Drive define the western entrance to the centre. Beyond Turua the land rises towards Achilles Point marking the eastern end of the centre.

Urban Structure

The urban structure of St Heliers is based on the intersection of Tamaki Drive and St Heliers Bay Road at the waterfront and the fact that only these two roads connect continuously with the centre's hinterland. This explains the existing structure of primary and secondary commercial frontages and differentiation of character within St Heliers.

The grid street network in its amphitheatre setting, adjacent to a large open space and foreshore, defines the seaside village character of the town centre. The grid is modified and distorted inland as the topography becomes more elevated. Tamaki Drive stretches along the coastline, and the open space, harbour views form an important component of the character of the scenic entrance to the centre from the west. The retail precinct has a suburban character and is a compact, mixed use, pedestrian orientated centre. There is a wide variety of commercial, retail, restaurant/café premises as well as community facilities such as the St Heliers Community Library, the War Memorial Hall and police station. There is generally an integrated relationship between the village centre and the residential neighbourhood and the village has developed as an integral feature of the area.

Streetscape

The streetscape is the public realm from which we experience the character and amenity of a place. It is considered that there is generally a good relationship between the public and private realms on St Heliers Bay Road. With adequate sidewalks and continuous building frontages where windows, doors and verandahs are orientated towards the sidewalk forming a continuous street wall. The public realm on adjacent streets contrasts with the core area due to the lack of continuous frontage, set back of residential buildings and increased vehicle crossings for residential uses. The public realm along Tamaki Drive is defined by the relationship between the urban and coastal edges of the street. The distinctive Moreton Bay fig trees, Vellenoweth Green and residential and commercial development on the southern side of Tamaki Drive complement the seaside character along the water's edge. The point at which St Heliers Bay Road and Tamaki Drive intersect creates a focal point for the village.

Built Environment

St Heliers Bay Road and Tamaki Drive are streets characterised by continuity of retail frontages, while others are characterised by a greater mix of use and building typology. Both these areas combine to establish the overall character of the centre, while each has different and distinctive character elements.

The built environment at St Heliers is characterised by a diverse range of building types and styles. The pattern of commercial development has been strongly influenced by the transport patterns to and from the bay. Early buildings were of small-scale domestic type construction. The 1920's and 1930's established the pattern of development and architectural form and it is this basic configuration that remains today, although some key buildings have been demolished and others altered. The scale of buildings is generally small, with one or two storeyed buildings on smaller lots. A few taller buildings exist, which are noticeably higher than the predominantly one and two storey buildings. Some of the single story buildings have feature parapets that strengthen the streets vertical element. Where larger development has occurred in the 1920's and 1930's the facades have been articulated to give the appearance of individual smaller scale buildings. The majority of older buildings have pitched roofs and this contributes to the character of the built environment, especially when viewed from the surrounding residential properties. The character and scale of the surviving early buildings establish a seaside character that is a primary asset of St Heliers.

The seaside location and lifestyle has resulted in an overall built pattern that connects the public and private realms. An important built feature is the way public streets and private development meet at the common boundary to create "in-between" spaces, such as porches, verandahs, terraces and courtyards that support the seaside lifestyle.

The Proposed Auckland Unitary Plan (notified 30 September 2013)

Appendix 11.2.2 Sylvia Park

Mt Wellington - Southdown (WEL-STH) Catchment Management Plan
Click here for PDF

Geotechnical completion report for earthworks
Click here for PDF

CITY DESIGN

MT WELLINGTON - SOUTHDOWN (WEL-STH) CATCHMENT MANAGEMENT PLAN

Prepared for
Metro Water Ltd
P O Box 27 060
Mt Roskill

Prepared by
Environmental Management Division
***CITY* DESIGN**
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Released by

John Herald, Manager Environmental Management

January 1998

ISSUE B
File No: D9511523.26
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CMP / WLS 008

CONTENTS

EXECUTIVE SUMMARY

1 BACKGROUND

This Catchment Management Plan (CMP) has been prepared for the Mt Wellington-Southdown (WEL-STH) catchment **(Plan 101)** within Auckland, on behalf of Metrowater. It recommends options for improving and managing stormwater flooding, water quality and foulwater collection over the next two to three decades.

The CMP has been initiated in response to:

- a history of stormwater flooding within many parts of the catchment **(Plan 102)**
- poor water quality within the catchment's receiving waters (Manukau Harbour and Tamaki Estuary)
- the requirements of the Resource Management Act 1991 (RMA).
- the requirements of Auckland City's Strategic Plan (*Outstanding Auckland* 1996), and
- the international trend toward holistic or integrated catchment management

The CMP will be used to support applications to the Auckland Regional Council (ARC) for the necessary resource consents.

2 STUDY OBJECTIVES

The objectives of the study were to:

1) Perform hydrologic and hydraulic analyses of the stormwater and foulwater disposal systems.

2) Identify the extent of flooding, and elements of the stormwater and foulwater systems that are under-capacity.

3) Take account of the South Eastern Arterial (SEART) roading project and its impact on the drainage systems.

4) Recommend remedial works for identified drainage problems, incorporating water quality and environmental principles, and demonstrating a sensitivity for community values.

5) Consult with local Community Boards, Iwi, the public, and interest groups, to enable them to contribute to catchment management.

6) Produce a comprehensive CMP and apply for a resource consent under the RMA.

3 STUDY AREA

The WEL-STH catchment is located in the eastern half of the Auckland isthmus and is bisected by the proposed SEART road link **(Plan 101)**. Catchment geology includes basaltic lava flows, Waitemata formation sandstones and alluvial deposits. The study area comprises two topographical stormwater catchments. The analysis was therefore divided accordingly into two sub-areas referred to as Area 1 and Area 2 respectively **(Plans 101 and 104)**.

Stormwater drainage within Area 1 (580ha) comprises:

- stormwater discharge to ground soakage in upper reaches (50%) **(Plan 104)**
- stormwater discharge to a piped system in the middle and lower catchment (35%)
- several enclosed sub-catchments in the upper reaches
- a well developed pipe and channel system in the lower reaches
- discharge to the Manukau Harbour through two outfalls near Southdown.

Stormwater drainage in Area 2 (290ha) comprises:

- steep upper catchments
- flat lower catchments
- a rudimentary pipe system in the upper reaches
- a well developed pipe and channel system in the lower reaches
- discharge to the Tamaki Estuary approximately 500m south of Pakuranga Bridge.

The foulwater catchment has a total area of 780ha **(Plan 104)**, coinciding approximately with the boundary of the Area 1 stormwater catchment. The remainder of the WEL-STH catchment was considered as part of a previous study.

4 THIS REPORT

This report follows three preliminary reports referred to as Volumes I, II and the Local Flooding Problems Report respectively. Volume I describes the technical methodology that was proposed for the study (*WEL-STH Catchment Management Plan, Methods* 1996). Volume II (Issues Report) supported preliminary consultation by documenting identified issues, along with a range of potential remedial options that could be considered further. It was based on:

- information gathered through a questionnaire leaflet distributed to all residents and industries
- computer modelling
- site visits
- discussion with groups and individuals with local knowledge
- appraisal of past reports, plans and drainage works, and
- application of local and regional policy and design standards.

Localised stormwater disposal problems identified through the questionnaire leaflet, along with site management issues and remedial options are described in the Local Flooding Problems Report.

5 ISSUES AND OPTIONS

The main issues relating to management of the WEL-STH catchment are:

- community involvement
- impact on aquatic fauna
- impact on groundwater availability and quality
- stormwater disposal and surface flooding
- foulwater disposal, and
- planning for and managing future development.

These have been grouped into the following three key issues:

- stormwater flooding
- water quality
- foulwater collection.

Options for dealing with these three key issues are presented in this CMP. A recommended order for implementing them is shown on **Plan 300**. These particular options recognise that the catchment is highly developed and that it already has extensive private and public stormwater infrastructure.

5.1 Stormwater Flooding

The options proposed for mitigating stormwater flooding are intended to meet Auckland City's Watercourse Guidelines. They are based on extensive hydrological and hydraulic modelling which is described in detail in the Methods Report. Upgrading of the primary system is recommended for many parts of Area 1 (Lower) and Area 2, as detailed in this CMP. The total capital cost is estimated to equal $7.04M, including a 15% contingency and a 10% allowance for design and supervision.

Flooding within the Area 1 (Upper) catchment appears to be largely due to the poor performance of both private and Auckland City stormwater soakage systems. Although opportunities exist for better use of soakage, there are virtually no viable hydraulic alternatives. Because of the lack of information on the Mt Wellington aquifer and the performance of existing soakholes, further studies are recommended.

There is a need to look at different approaches to soakage on a catchment-wide basis, for example discharge to the aquifer at many points versus discharge at selected points. However, due to limited information it is not yet possible to evaluate and compare different approaches. By identifying areas with high soakage potential and fully utilising these areas it may be possible to overcome flooding problems in areas with poor soakage potential.

5.2 Water Quality

As shown on **Plan 104**, stormwater from the WEL-STH catchment discharges to the Manukau Harbour (two locations, Area 1 - Lower), Tamaki Estuary (Area 2) and the Mt Wellington aquifer (Area 1 - Upper). The protection of the valuable groundwater resource in the underlying aquifer(s) from the adverse effects of soakage water is of paramount importance. An assessment of water quality which is reported separately has concluded that:

- stormwater sediments are contaminated and may affect local biota in terms of high concentrations of zinc and elevated levels of copper and lead;
- stormwater contains high levels of pathogens and copper which may impact the marine environment;
- groundwater quality is good but exhibits some possible signs of stormwater contamination in terms of the low levels of *faecal coliform*;

- marine biota have been impacted by contaminated stormwater as evidenced by the high concentrations of zinc, lead and copper found in oysters and fish and also possibly by the elevated concentrations of Polychlorinated biphenyls (PCBs) and DDE.

The main sources of contaminants are stormwater runoff from the Auckland-Hamilton Motorway and roads, and the spillage of chemicals within the industrial areas. The following mitigation measures are therefore recommended:

- construct water quality ponds at Ann's Creek and Southdown Reserve
- revise the existing street sweeping and cesspit cleaning programme to take account of site-specific conditions such as the rate of sediment generation and traffic density
- prepare and implement a spill contingency plan
- contribute to Regional public education programmes on stormwater and foulwater disposal
- monitor compliance with regulations on Trade Waste Disposal.
- install adequate filters within all the private and public soakholes.

5.3 Foulwater Collection

The existing foulwater system within Area 1 has the capacity for greater foulwater flows than can be expected at Maximum Probable Development. No remedial works are required with respect to pipe capacity, but could be required due the age (condition) of the asset.

Approximately one-third of the foulwater system within Area 1 appears to have a self-cleansing problem. Periodic flushing of parts of the system is recommended, with a provisional cost estimate of $109,400 per annum.

The three Water Care Services sewers within Area 1 do not appear to have any detrimental effect on the operation of Auckland City's foulwater network.

Inflow and infiltration are occurring, however the system appears to have sufficient capacity to accommodate this. There is sufficient capacity to allow further development, provided inflow and infiltration are reduced commensurately.

1 INTRODUCTION

1.1 Background

This Catchment Management Plan (CMP) has been prepared for the Mt Wellington-Southdown (WEL-STH) catchment **(Plan 101)** within Auckland on behalf of Metrowater. It recommends options for improving and managing stormwater flooding, water quality and foulwater collection over the next two to three decades.

The CMP has been initiated in response to:

- a history of stormwater flooding within many parts of the catchment **(Plan 102)**
- poor water quality within the catchment's receiving waters (Manukau Harbour and Tamaki Estuary)
- the requirements of the Resource Management Act 1991 (RMA).
- the requirements of Auckland City's Strategic Plan (*Outstanding Auckland* 1996), and
- the international trend toward holistic or integrated catchment management

The CMP will be used to support applications to the Auckland Regional Council (ARC) for the necessary resource consents.

1.2 Study Objectives

The objectives of the study were to:

1) Perform hydrologic and hydraulic analyses of the stormwater and foulwater disposal systems.

2) Identify the extent of flooding, and elements of the stormwater and foulwater systems that are under-capacity.

3) Take account of the South Eastern Arterial (SEART) roading project and its impact on the drainage systems.

4) Recommend remedial works for identified drainage problems, incorporating water quality and environmental principles, and demonstrating a sensitivity for community values.

5) Consult with local Community Boards, Iwi, the public, and interest groups, to enable them to contribute to catchment management.

6) Produce a comprehensive CMP and apply for a resource consent under the RMA.

The study which supports this CMP has been conducted in four phases as follows (Figure 1):

1) Preliminary
2) Data Collection
3) Consultative
4) Technical.

Phase 1 established the scope of the study, forward planning and preliminary investigation. It included the preparation of the Issues report which helped identify the study objectives. Although community consultation is a key component of Phase 3, it is fundamental to the CMP and has therefore occurred throughout the entire study. Phase 4 included the computation of flood levels and the analysis and costing of remedial options. It was based on the data collected in Phase 2.

1.3 Study Area

The WEL-STH catchment is located in the eastern half of the Auckland isthmus and is bisected by the proposed SEART road link **(Plan 101)**.

Catchment geology includes basaltic lava flows, Waitemata formation sandstones and alluvial deposits **(Plan 103)**.

The study area comprises two topographical stormwater catchments. The analysis was therefore divided accordingly into two sub-areas referred to as Area 1 and Area 2 respectively **(Plans 101 and 104)**.

Stormwater drainage within Area 1 (580ha) comprises:

- stormwater discharge to ground soakage in upper reaches (50%) **(Plan 104)**
- stormwater discharge to a piped system in the middle and lower catchment (35%)
- several enclosed sub-catchments in the upper reaches
- a well developed pipe and channel system in the lower reaches
- discharge to the Manukau Harbour through two outfalls near Southdown.

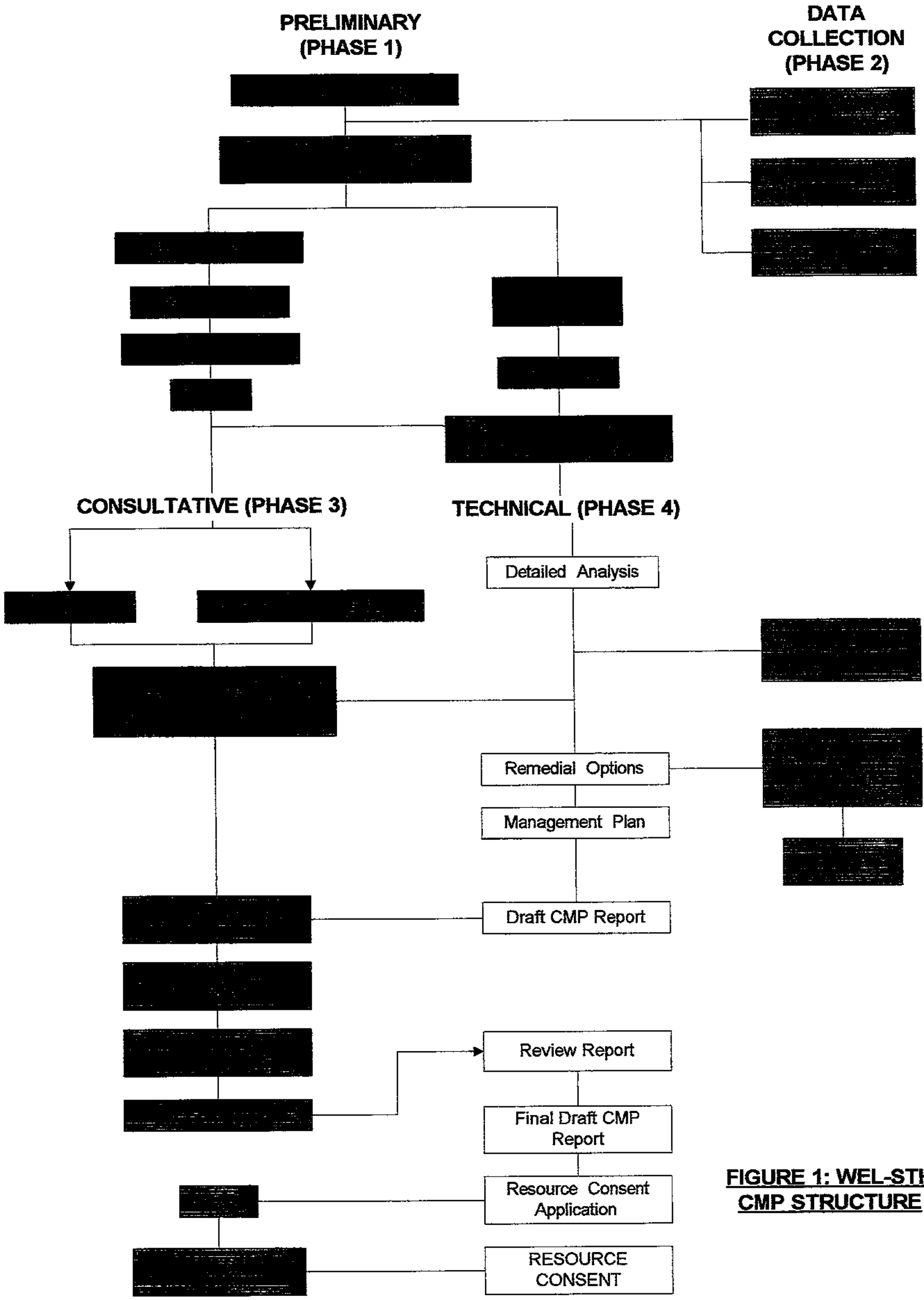

FIGURE 1: WEL-STH CMP STRUCTURE

Stormwater drainage in Area 2 (290ha) comprises:

- steep upper catchments
- flat lower catchments
- a rudimentary pipe system in the upper reaches
- a well developed pipe and channel system in the lower reaches
- discharge to the Tamaki Estuary approximately 500m south of Pakuranga Bridge.

The foulwater catchment has a total area of 780ha **(Plan 104)**, coinciding approximately with the boundary of the Area 1 stormwater catchment. The Carbine Road foulwater catchment was not part of this study because it already has a management plan (*Carbine Road Sewer Investigation* 1996).

1.4 This Report

This report follows three preliminary reports referred to as Volumes I, II and the Local Flooding Problems Report respectively. Volume I describes the technical methodology that was proposed for the study (*WEL-STH Catchment Management Plan, Methods* 1996). Volume II *(Issues Report)* supported preliminary consultation by documenting identified issues, along with a range of potential remedial options that could be considered further. It was based on:

- information gathered through a questionnaire leaflet distributed to all residents and industries
- computer modelling
- site visits
- discussion with groups and individuals with local knowledge
- appraisal of past reports, plans and drainage works, and
- application of local and regional policy and design standards.

Catchment management issues and options are presented and discussed in Section 2 of this report. The recommended options and their respective costs are summarised in Section 3. A recommended order for implementing these options is shown on **Plan 300.**

Plans of the study area showing details of the foulwater and stormwater models, the predicted flood hazard and recommended management and remedial works options are presented in a separate document.

Localised stormwater disposal problems identified through the questionnaire leaflet, along with site management issues and remedial options are described in the Local Flooding Problems Report.

The findings of a water quality assessment are summarised in this CMP and are reported in full separately (*Mt Wellington-Southdown (WEL-STH) Water Quality Assessment*, 1997).

2 CATCHMENT MANAGEMENT ISSUES AND OPTIONS

Catchment management issues were identified during Phase 1 of the study and were described in the Issues Report. The report concluded that the main issues for the WEL-STH catchment are:

- community involvement
- impact on aquatic fauna
- impact on groundwater availability and quality
- stormwater disposal and surface flooding
- foulwater disposal, and
- planning for and managing future development.

Following further analysis, these were grouped into the following three key issues:

- stormwater flooding
- water quality
- foulwater collection

Options for dealing with these three key issues are described below.

2.1 Stormwater Flooding

Issues associated with stormwater flooding are discussed below and various management options presented. These particular options recognise that the catchment is highly developed **(Plan 105)** and that it already has extensive private and public stormwater disposal infrastructure in place. The options proposed are intended to meet Auckland City's Watercourse Guidelines (Appendix A). The work is based on extensive hydrological and hydraulic modelling which is described in detail in the Methods Report.

2.1.1 Area 1 - Lower Catchment

2.1.1.1 Ann's Creek Line

The Ann's Creek Line drains the sub-catchment located on the eastern side of Great South Road. It stretches from Penrose Road and Commissariat Road in the north, across the Auckland-Hamilton Motorway to the intersection of Sylvia Park Road and Great South Road in the south **(Plan 250)**. It then discharges to the Manukau Harbour via Ann's Creek.

The main stormwater system consists of two sub-systems, the first from the Penrose Road area and the second from near Commissariat Road. Both sub-systems pass beneath the Auckland-Hamilton Motorway and the proposed SEART before converging to form a single pipeline near Sims Road **(Plan 250).**

Discussions with local residents and land owners, site investigations and computer modelling revealed that the stormwater drainage system does not satisfy Auckland City requirements at some locations. **Plans 240 and 241** show the predicted extent of flooding for the 10, 50 and 100 year Average Recurrence Interval (ARI) rainstorms. The main areas at risk are:

- Wilkie Place
- Great South Road
- Penrose Road to Holloway Place
- Holloway Place to Sims Road
- 1012 Great South Road, and
- Sylvia Park Road/Great South Road.

Each of these areas is discussed in more detail below.

Wilkie Place

Computer modelling predicts ponding and high water levels within properties adjacent to the inlet of the culvert in 14 Wilkie Place, and within properties adjacent to the open channel upstream of the culvert. However, no habitable floors would be inundated during the 100 year ARI rainstorm. The main identified inadequacies with the stormwater system are as follows:

- The existing culvert beneath the Auckland-Hamilton Motorway does not have sufficient capacity to discharge flows from large rainstorms without raising water levels at the inlet.
- The watercourse is obstructed by several fences, producing backwater effects and higher water levels. Several of these fences were broken by flows from a heavy rainstorm on 24 May 1997.

- Blockage of the culvert inlet by flood debris is another potential risk that would worsen the situation.

Owners of the properties along the watercourse also complained about:

- Child safety in relation to the watercourse
- Erosion of the bank due to shrinking and cracking during summer
- Health issues related to stagnant water in the watercourse during summer
- Debris blockage contributing to high water levels through properties.

It is recommended that a second culvert be installed beneath the motorway to reduce the risk of flooding. This would involve installing a 1200mm diameter culvert alongside the existing 1050mm culvert to the 1600mm diameter pipe installed as a part of SEART **(Plan 300)**. Appropriately designed grilles should be installed at the culvert inlet to reduce blockage and improve safety. A cost estimate for these works is presented below:

Table 2.1 Wilkie Place Remedial Works

Item	Rate ($/m)	Length (m)	Cost ($)
1200 mm pipe	1,700	106	180,200
1600 mm pipe	2,220	23	51,060
Inlet Structure	$45,000 (each)		45,000
Design (10%)			27,600
Contingency (15%)			41,400
Total			**345,300**

An appropriate maintenance regime would resolve the residents' concerns relating to stagnant water, erosion and culvert blockage.

Great South Road

A formal piped stormwater drainage system does not exist for the section of Great South Road within the Area 1 catchment. Because the road overlies the lower part of the Mt Wellington aquifer, which is mostly basalt and includes sections which are fractured, stormwater drainage is mostly by localised soakage. During winter months and particularly at times of heavy rainfall, ponding occurs regularly at low points in the road, along with flooding of some adjoining low-lying properties. The main causes of this are:

- Existing soakholes are not able to completely dispose of flows from the road.

- Successive re-surfacing of Great South Road without corresponding increases in kerb and driveway levels has significantly reduced gutter capacity and the overall ability of the road to effectively convey stormwater flows to disposal points.
- The number of cesspits on the road does not allow for complete disposal of stormwater during heavy rainstorms.
- Poor drainage from some adjoining properties results in additional stormwater flows being discharged to the road.

There are two potential options for reducing the flooding risk. The first would involve installing a new stormwater pipe and additional catch pits along most of Gt South Road to collect road runoff only. The second option would involve the following:

- Improve road drainage capacity by raising kerb and driveway levels, or lowering the road surface
- Install additional cesspits and soakholes (this would require additional investigative work to determine the best locations for soakholes). Soakholes would also reduce overall stormwater volmes, thereby improving receiving water quality.
- Also pipe some sections of the road to the existing Ann's Creek line and Industry Road line where possible.

It is recommended that the second option be adopted because it would be more cost-effective. A cost estimate for this option is presented below.

Table 2.2 Great South Road Remedial Works

Item	Quantity	Rate	Cost ($)
Cesspits	6	1,000 ea	6,000
Soakholes	TBD	60,000 (lump)	60,000
225 mm dia. pipe	200 m	380 ($/m)	76,000
375 mm dia. pipe	560 m	450 ($/m)	252,000
Design & Supervision (10%)			39,400
Contingency (15%)			59,100
Total			**492,500**

Penrose Road to Holloway Place

Computer modelling indicates that the existing pipe system does not meet Auckland City discharge capacity standards (10 year ARI), and for some reaches does not have sufficient capacity to convey the 5 year ARI flow. Flooding of Penrose Road occurs regularly at this location during periods of heavy rainfall (Local Flooding Problems Report). Furthermore, the potential exists for flooding of the Auckland-Hamilton Motorway in the event of a severe rainstorm (ARI greater than 10 years). It is recommended that the existing pipeline be upgraded to accommodate flows for rainstorms with an ARI of 10 years.

Holloway Place to Sims Road

The upstream reach is an open channel, whilst the remainder consists of a 1050 mm diameter pipe of variable gradient. Computer modelling indicates that the existing system does not have sufficient capacity to accept flows from rainstorms with an ARI greater than 5 years, and therefore does not meet the requirements of the Watercourse Guidelines. Discussions with local residents and landowners suggest that flooding of this area has occurred in the past. Furthermore, additional development of the area is likely to require a higher level of service in terms of flood protection than is presently offered **(Plan 240)**. It is therefore recommended that the following works be undertaken:

- Pipe the existing section of open channel with a 1600 mm diameter pipe (as required for development).
- Upgrade the existing 1050 mm diameter pipeline by installing a new 1200 mm diameter pipe parallel with this existing pipeline to Sims Road, and then connect to a new 1950 mm diameter pipeline beneath SEART, which was recently installed as a part of the SEART project.

A cost estimate for the works between Penrose and Sims Road is presented below.

Table 2.3 Penrose Road to Sims Road Remedial Works

Item	Quantity	Rate	Cost ($)
750 mm dia. pipe	50 m	940 ($/m)	47,000
1350 mm dia. pipe	110 m	1920 ($/m)	211,200
1500 mm dia. pipe	130 m	2200 ($/m)	286,000
1600 mm dia. pipe	340 m	2400 ($/m)	816,000
1200 mm dia. pipe	390 m	1700 ($/m)	663,000
Design & Supervision (10%)			202,300
Contingency (15%)			303,500
Total			**2,529,000**

1012 Gt South Road

Reports by members of the public on previous rainstorms indicate that properties downstream of the inlet structure at the downstream end of the open channel (994 to 1012 Gt South Road) overtops during heavy rainstorms. A flood report for an event which occurred in May 1997 states that flooding of the basement and some adjacent low areas occurred at 1012 Gt South Road. There is evidence suggesting this was caused by overtopping of the bank at the inlet structure immediately upstream. Computer modelling of the system and Auckland City flood gauge readings support this conclusion.

One remedial option would be to increase the capacity of the system by installing a new pipe to complement the existing pipe. A previous project undertaken by *CITY* DESIGN included the design of a 1950 mm diameter pipeline from this point to Ann's Creek beneath Gt South Road. This design could therefore be utilised if necessary.

A second option would be to increase the level of the earth embankment above the inlet structure to eliminate the risk of overtopping and consequently protect downstream properties from flooding.

It is recommended that this second option be adopted because it would be more cost-effective and also easier to implement. A cost estimate for this option is presented below.

Table 2.4 1012 Gt South Road Remedial Works

Item	Quantity	Rate	Cost ($)
Preparation			10,000
Increase bank high by 1 m with 6 m width along 25 m (import fill and compact)	150 m^3	45 ($/$m^3$)	6,750
Design & Supervision (10%)			1,700
Contingency (15%)			2,550
Total			**21,000**

Sylvia Park Road/Gt South Road

Computer modelling indicates that the three adjacent 1000 mm diameter pipelines beneath Gt South Road do not have sufficient capacity to convey flows from rainstorms with ARI's greater than 10 years without causing ponding across Sylvia Park Road. The situation is worse when rainstorms coincide with high tides. It is recommended that the three pipes be replaced with a single arch culvert (3m wide, 1.75m high). A design and costing for an arch culvert at this location was prepared in 1994/95. A revised cost estimate for this option is presented below.

Table 2.5 Sylvia Park Road/Gt South Road

Item	Quantity	Rate ($)	Cost ($)
Arch Culvert 3 m width by 1.75 m height (Cost as per the Gt South Road/ Sylvia Park Road Intersection upgrade project including 12% adjustment for inflation)	1	221,00	221,000
Design & Supervision (10%)			22,100
Contingency (15%)			33,150
Total			**276,250**

2.1.1.2 Hugo Johnston/Industry Road Lines

The western part of the Area 1 stormwater catchment is drained by a series of stormwater pipelines which converge at Southdown Reserve prior to discharging to the Manukau Harbour **(Plan 250)**.

Site investigations, discussions with local residents and land owners, and computer modelling have identified discharge capacity problems with the existing stormwater drainage system. These could contribute to flooding of industrial and commercial buildings. As shown on **Plans 240 and 241**, the main areas at risk are:

- Fletcher Pond to SEART
- SEART to Church Street
- Southdown Lane to Southdown Reserve

Fletcher Pond to SEART

A major problem with this line occurs at the Fletcher Pond, a small detention pond located at 635-643 Gt South Road. The existing 600 mm diameter outlet pipe from the pond does not have sufficient capacity to completely convey flows from the pond. This results in overflows and consequent flooding of downstream buildings and properties. According to computer modelling, the flooding would be relatively shallow and widespread. It would eventually inundate the intersection of Gt South Road and the proposed SEART, which is located some distance downstream. This finding is supported by occupants of these properties who have reported flooding in the past. In particular, the car wrecking yard at 645 Gt South Road has reported ongoing flooding problems. In addition, some properties adjacent to SEART which still rely on soakage for stormwater disposal regularly experience flooding from local runoff.

The following remedial works are therefore recommended **(Plans 300)**:

- Upgrade the 600 mm diameter outlet pipe from the Fletcher Pond to a 900 mm diameter pipeline to eliminate overflows from the pond for rainstorms with an ARI less than 10 years.
- Connect any remaining properties on soakage to the stormwater reticulation system.

It should be noted that spare capacity exists in the pipeline downstream of the pond's existing outlet (600mm diameter pipe), therefore upgrading the outlet alone will be sufficient to increase the capacity of the whole system.

A cost estimate for this work is presented below.

Table 2.6 Fletcher Pond to SEART

Items	Quantities	Rate	Cost ($)
900 mm dia. pipe	80 m	1170 ($/m)	93,600
Design & Supervision (10%)			9,360
Contingency (15%)			14,040
Total			**117,000**

SEART to Church Street

The Penrose Tavern and 926 Great South Road reported flooding on 24 May 1997. Computer modelling indicates that in the event of a severe rainstorm (ARI greater than 10 years), flooding of the intersection of SEART and Great South Road will occur. This is a result of local flows, overflows from the Fletcher Pond and overflows from the Ann's Creek stormwater line at Sims Road. It is likely that the implementation of the recommended remedial works for the Fletcher Pond (see above) and upgrading of the Ann's Creek line will eliminate most of this flooding. However, these measures would not take care of local flows from Gt South Road and SEART which are not collected by the existing drainage system. There is also a problem with local property stormwater draining directly on to Gt South Road rather than being collected by local on-site drains.

It is recommended that all of the following measures be implemented to mitigate the flooding shown on **Plans 240 and 241**:

- install additional catch pits on Great South Road downstream of SEART. These could be connected to the Industry Road stormwater line
- As an additional safeguard, and to ensure that flooding of properties on the southern side of Church Street does not occur, install additional cesspits adjacent to 431- 433 Church Street

- Improve private drainage systems along Gt South Road by upgrading soakage or direct connection to the existing stormwater system.

A cost estimate for these works is presented below.

Table 2.7 SEART to Church Street

Items	Quantities	Rate ($)	Cost ($)
Cesspits	10	1200 ea	12,000
1200 mm dia. pipe	20 m	1600/m	32,000
1350 mm dia. pipe	300 m	1920/m	576,000
Oneway valve	1	1,000 ea	1,000
Design & Supervision (10%)			62,100
Contingency (15%)			93,200
Total			**776,300**

Southdown Lane to Southdown Reserve

Flooding of parts of Southdown Lane regularly occurs during periods of heavy rainfall. Stormwater overflows from cesspits on Southdown Lane result in the flooding of some properties when the capacity of the main stormwater system is exceeded. In a particularly heavy rainstorm which occurred in May 1997, Mainfreight Ltd (12 Southdown Lane) reported serious flooding. Whilst no damage was reported, access to their premises was restricted and the potential for additional damage was identified by them. Number 5 Southdown Lane was also affected during the same rainstorm, resulting in damage to some of their electric motors.

The following problems with the stormwater system in this locality have been identified:

- *backwater effects*: due to the low-lying (relative to mean sea level) and flat nature of this area, the capacity of the stormwater system tends to be affected by high tidal levels at the outfall and the shallow grades of the main stormwater pipes. This, in part, results in the overflows at Southdown Lane.
- *pipe sizes:* computer modelling of the main stormwater line beneath Southdown Lane indicates that a reduction in effective pipe diameter occurs at Southdown Lane. This constricts the flow and reduces the capacity of the system as a whole, resulting in flooding of Southdown Lane.
- *overland flow:* stormwater not entering the main system at Church Street and Industry Road will eventually flow to Southdown Lane
- *system capacity*: overall the capacity of the system downstream of the main railway line is insufficient to accept flows from upstream pipelines.

Two potential remedial options have been identified. The first involves the following works:

- Upgrade the twin 600 mm diameter pipes beneath Southdown Lane to a single 1200 mm diameter pipe.
- Disconnect the eastern Industry Road stormwater line from the main line and divert to Ann's Creek via a new 1350 mm diameter stormwater line.

The second option is to upgrade the entire system through to Southdown Reserve. This would require new box culverts beneath the railway line and Hugo Johnston Drive.

It is recommended that the first option be adopted. Upgrading the existing pipes will increase the capacity of this sub-line as a whole, and disconnection from the main system will reduce total flows through the latter. A cost estimate for this option is presented below.

Table 2.8 Southdown Lane to Southdown Reserve Remedial Works

Items	Quantities	Rate ($)	Cost ($)
Excavation and Filling	5000 m^3	30/ m^3	150,000
Landscaping	1	25,000	25,000
Pollutec (see Section 2.2)	2	220,000 ea	440,000
Diversion pipe (1200 mm dia.)	100 m	1570/m	157,000
Design & Supervision (10%)			77,200
Contingency (15%)			115,800
Total (with Pollutec)			**965,000**
Total (without Pollutec)			**415,000**

2.1.2 Area 1 - Upper Catchment

Flooding occurs in many parts of this area as shown on **Plans 200 to 215**. Further details are included in the Local Flooding Problems Report. Most of these problems appear to have occurred as a result of poor performance of both private and Auckland City stormwater soakage systems. The following issues have been identified:

- Conventional approaches to catchment management which consider only surface flow with some allowance for infiltration are not appropriate in cases where disposal by soakage is significant
- Soakage potential and soakage performance vary considerably in this area. No clear trends in soakage potential were identified in this study.

- the Mount Wellington aquifer is a valuable resource and any comprehensive remedial works relating to soakage should take account of the aquifer as a whole.
- Lavas Place is the only area known for flooding as a result of a high water table. Similar situations may exist in other parts of the catchment, but have not been identified during this study.

Although opportunities exist for better use of soakage for stormwater disposal, there are virtually no viable hydraulic alternatives to soakage within some of this area. Remedial works for this area will be identified and prioritised upon completion of current studies of the Mt Wellington aquifer and the performance of existing soakholes.

There is a need to look at different approaches to soakage on a catchment-wide basis, for example discharge to the aquifer at many points versus discharge at selected points. However, due to limited information it is not yet possible to evaluate and compare different approaches. By identifying areas with high soakage potential and fully utilising these areas it may be possible to overcome flooding problems in areas with poor soakage potential. Some of the alternative approaches that were identified in the present study are presented in Table 2.9.

As a result of the provisional information for soakage rates, the flood levels provided in this study should be regarded as provisional. In general, flood levels for the Area 1 - Upper Catchment have a lower level of accuracy than those provided for other parts of the WEL-STH study area. An assessment of the effect of assumed soakage rate on flood levels is presented in Appendix B.

Table 2.9 outlines issues, options and recommendations for each of the main sub-catchments and includes both hydraulic and non-hydraulic options. Catchment numbers as given in the table refer to numbers on **Plans 201 to 215**, which give the catchment locations, model details and predicted extent of flooding.

Whilst the overall lack of identified trends with respect to soakage makes it difficult to propose definite remedial options, an effort has been made to include both non-hydraulic and short-term options. These will address the short-term situation until such time as more reliable soakage-related options are proposed.

In order to estimate flood levels within soakage areas the following assumptions were made:

- an average section size of 800 m^2 was used for residential areas;

- a soakage rate of either 5 l/s or 10 l/s was assumed for private soakage based on an 800 m^2 section - flood levels for 5 l/s are shown on the plans (see note below);
- for Council soakholes on roads and in reserves a soakage rate of 15 l/s was assumed - this was based on soakage test data for Council soakholes;
- in order to simplify the analysis private soakage was modelled as a 'blanket' infiltration loss over the entire catchment.

While data on private soakage was obtained, this was of limited use . Data from building consent applications was considered to be unrealistic for a number of reasons as follows:

- recorded soakage rates tend not to be realistic for long term soakage. Field experience indicates that soakage rates decrease over the course of a long duration storm;
- poor maintenance of soakholes means that initial soakage rates are not appropriate for older soakholes;
- the method used for obtaining soakage rates (ie. one hole at a time) does not take into account the interaction of soakholes located near each other (within 10 m of each other).

For this reason soakage rates of either 5 l/s or 10 l/s per 800 m^2 property were used. Flood levels for 5 l/s are shown on Plans 200-215. However, flood levels for 2 soakage rates were determined merely to demonstrate the sensitivity of soakage rates of flood levels. It has been assumed that as more accurate soakage data becomes available in the future, a more realistic estimate of flood levels will be possible.

However, based on the information available at the present time, it is considered that an accurate estimate of flood levels is not possible.

Table 2.9 Stormwater Flooding Issues and Options For Area 1 (Upper) Sub-Catchments

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
1	Panorama Road/ Leonard Road/ Reliable Road	12 .0	Low-lying area at intersection of Reliable Way / Leonard Road subject to regular flooding. Modelling indicates that water depths of up to 0.5m could occur for 10 year ARI event.	(1) Upgrade existing soakage (2) Divert Stormwater to quarry at Fulton Hogan Ltd. through new Stormwater pipe.	• Inspect soakage structures to determine whether existing Structures are adequate • Undertake more detailed soakage investigation to determine suitability of Option 1. • Adopt either Option 1 or 2 based on investigation results
2	Gavin Street/ Sophia Street/ Leonard Road	-	No significant problems identified	-	-
3	Penrose Road/ Gunson Road/ Commissariat Road	17.5	Flooding of low-lying properties, particularly 1/213 Penrose Road for two main reasons: • under capacity pipe system • inadequate soakage	(1) Upgrade soakage field at Vic Cowan Park and catchment reticulation system. (2) Purchase 1/213 Penrose Road and allow property to flood. Raise garage floor levels for 2/213, 3/213 and 4/213 as required. (3) Divert western part of catchment to main Area 1 pipe system (to achieve up to 30% reduction in total volume of runoff) (4) Do nothing and accept flooding	• Undertake more detailed soakage investigation to determine viability of Option 1. ie. determine whether Vic Cowan Park has capacity for flows from entire catchment • Upgrading of the pipe system is not recommended if soakage capacity is inadequate. In this case, a cost benefit analysis between Option 2 and Option 3 is recommended. Based on information gained in the present Study, Option 2 appears to be more favourable.

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
4	Ellerslie-Panmure Highway / Clare Place / Banks Road	15.5	• Habitable floor levels at No. 33 Banks Road meet Auckland City's freeboard requirements. • Section flooding of some of the properties at the end of Clare Place is likely. • Fences obstruct the main overland flow path for this sub-catchment. • Modelling indicates that No. 404 E/P Highway could be flooded. • Flooding of the Ellerslie Panmure Highway in places	(1) Upgrade both private and Council soakage. (2) Construct a formal detention pond at the site of the existing pond (33/37 Banks Road). (3) Implement a public education programme. Improve and extend existing road soakage systems.	Adoption of Options 1-3 is recommended.
5	Banks Road / Boakes Road / Harwood Road	7.7	• Likely flooding above habitable floor levels at 46 Banks Road. • Property flooding of 34 Banks Road (Mercury Energy Ltd.).	(1) Upgrading of on-site soakage (2) Raising of floor level at 46 Banks Road. (3) Flood proofing of 46 Banks Road. (4) Installation of additional soakage higher up in the catchment to reduce flows at final discharge point.	• Adoption of Options 1 and 4 is recommended
6	Ferndale Road / Motu Place / Ellerslie Panmure Highway This is by far the largest local catchment in the Upper Catchment.	34.7	• 10 year ARI: Likely flooding above habitable floor levels at 9, 10 & 12 Ferndale Rd. • 100 year ARI: Likely flooding above habitable floor levels at 7-12 Ferndale Rd and 88/3, 94 Banks Road. • This is a large catchment (for a single soakage field), and therefore a large soakage capacity is required at the Ferndale Rd/Motu Place soakage field.	(1) Adopt a source control approach i.e. dispose of stormwater runoff before it reaches the main soakage field at Ferndale Rd/Motu Place. This could be achieved by focusing on the development of soakage along Ferndale Rd, Stanhope Rd and the Ellerslie-Panmure Highway.	• Adoption of Option 1

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
7	Cebalo Place / Panorama Road / Ferndale Road / Leonard Road	8.5	• Modelling indicates flooding of 90 Ferndale Road, 11 and 12 Cebalo Place may occur in the event of the 10 year ARI Rainstorm.	(1) Do nothing (2) Upgrade both private and Council soakage	In the short term it is recommended that Option 1 be adopted as flooding was not found to be a major issue in this sub-catchment. However, upgrading of soakage will be required in the long term.
8	Harrison Road / Ellerslie Panmure Highway / Ballarat Street. Note: Modeling of this catchment was based primarily on Aeroplan information supplied by the Client. This information did not provide details of new development in this area. Limited information of new development and associated drainage was subsequently obtained; however, this information was not sufficient to construct an accurate model of the post-development scenario.	12.3	• Modelling indicates flooding of: 2/7, 3/7 Ballarat Street.; 286 E-P Hwy. could occur in the event of the 10 year ARI Rainstorm. • Modelling also indicates that the newly constructed overland flow path and detention area at the end of Harrison Road could flood in the event of the 10 year ARI Rainstorm. This could cause flooding of Harrison Road and properties on the southern side of this road.	(1) Upgrading of private soakage at affected Ballarat Street and E-P Hwy. properties. Options for the area south of E-P Road can not be proposed with certainty. It appears however that enlargement of the detention area at the end of Harrison Road could eliminate potential flooding in this area.	• For flooding problems north of the E-P Hwy., adoption of Option 1 is recommended. • For the Harrison Road area, it is recommended that additional information on soakage and proposed drainage be gathered to determine any potential flood risk in this area. Note: It is believed that soakage in the Harrison Road area tends to be better than average for the Upper Catchment as a whole. However, in the absence of actual data, a private soakage rate of 5 l/s per 800 m^2 property was assumed as for the rest of the catchment. Soakage data and specific drainage details for the area would allow for a better estimate of potential flood risk.

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
9	Lavas Place	9.0	flooding of the Lavas Place reserve area and adjacent properties occurs on a regular basis during winter months. This problem appears to be the result of a rise in water table levels and a consequent reduction in performance of soakage. Groundwater investigations in the area indicate that this is a localised phenomenon with rises in groundwater level being more normal in surrounding areas. A 1996 investigation by City Design of this problem suggested that drainage of the pond via a new pipe to a new soakage system at Vic Cowan Park would be a possible option. This option, with others, has been considered in the present Study.	(1) Divert north-east part of catchment (2.2 ha) to reserve at end of Allcock Street. and north of Lavas Place. (2) install pipe from Lavas Place pond to new soakage field at Vic Cowan Park. (3) Provide more detention storage by enlarging Lavas Place pond. (4) Raise affected houses (5) Flood proof affected houses. (6) install one-way valves on properties flooded via catch pits. (7) Convert flooded habitable floors to non-habitable.	• It is recommended that consideration of Options 1 and 2 be postponed until a detailed soakage investigation of Vic Cowan Park has been completed. • Option 3 is dependent on enlargement of the existing Lavas Place Reserve pond. Due to the previous use of this site as a landfill, enlargement of the pond would require investigation of the likely impacts of the landfill on the pond. • As the affected houses are of brick construction, this option would be an expensive exercise. Therefore this is not recommended. • It is considered that Options 6 and 7 are not permanent solutions: however, it is recommended that these be undertaken as a short-term solution to the present flooding problems.
10	Ellerslie Panmure Highway / Eaglehurst Road / Reliable Way	16.2	Based on model output from this catchment , the absence of reported drainage problems, and information gathered during site visits, no major issues were identified in this catchment	(1) Do nothing. It should be noted that it appears that soakage in the old quarry site which is now the premises of Fulton Hogan Ltd, appears to be significantly higher than other areas. It is therefore considered that this site may be a good location for a soakage system should the need for this arise.	It is not necessary to undertake any work in this area at present. However, it would be useful to know the reason behind the high soakage values that have been obtained at this site (29 l/s for a recently installed soakhole). This sort of information would clearly be useful in a catchment-wide investigation of soakage.

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
11	Stanhope Road / Marua Road / Rutland Road	13.8	• Flooding of Marua Road and properties along the southern side of the road occurs regularly during heavy rainfall. The bulk of this flood water appears to come from properties along the northern side of the road with poor soakage systems. • The lowest point in this catchment is the area at 43 and 45 Stanhope Road. Modelling of the catchment indicates that flooding of more than one of these properties is likely to occur in the event of a severe Rainstorm.	(1) Pipe properties north of Marua Road into the Ellerslie -Waiatarua Catchment. (2) *Improve soakage along* Marua Road and for properties south of the road. Without pipe tunnelling, diversion of this area to another catchment does not seem to be a viable option.	It is recommended that both Options 1 and 2 be undertaken.
12	Lunn Ave / Marua Road Due to the extremely flat and 'localised' nature of the topography between these two roads, it was considered that a model would not be appropriate.	-	There are a number of localised flooding problems in this area that were identified and addressed in the *Local Flooding Problems Report.*	(1) For most of this area the only viable remedial option is the improvement of soakage. (2) For the area roughly west of 176 Marua Road, design of a piped Stormwater system is planned.	• It is recommended that improvement of soakage be made a high priority for this area. • For the *area west of 176 Marua Road*, it is recommended that serious consideration be given to the proposed piped Stormwater system for this area.

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
13	Stanhope Road / Ellerslie Panmure Highway	12.9	• Modelling indicates that the four *local depressions within this* catchment could flood in the event of the 10 year ARI Rainstorm **(Plan 204 & 205)**. • This includes flooding of: 8, 9, 15 (B)[1], 16 (B), 17(B), 18(B) McDonald Cres; 2/320, E-P Hwy.[2].	(1) Do nothing (2) Upgrade existing soakage (3) Purchase affected properties (4) Raise affected houses (5) Flood proof affected houses	• It is recommended that Option 2 be adopted as a first priority. Existing road soakage at McDonald Crescent, Dinglebank Place and the E-P Hwy. opp. No. 320 appears to be inadequate. Ideally this work would only be *carried out after a detailed* soakage investigation of the catchment to determine the feasibility of additional soakage. • Option 3 is unlikely to be cost-effective due to the number of properties involved. • Options 4 and 5 are realistic possibilities, but it is recommended that consideration of these only be made *in the event of Option 2 not being possible.*
14	Ballarat Street / Vause Street / Peek Street	6.8	• Modelling indicates that flooding of several properties could occur for the 10 and 100 year ARI events **(Plan 201 & 204).**	(1) Upgrade private and *Council soakage* Due to the topography of this catchment and neighbouring catchments, diversion of Stormwater out of the catchment is not considered a viable option.	• It is recommended that improvement of soakage (Option 1) be adopted for remedial work in this catchment.
15	Carrs Place / Ballarat Street. / Vause Street. / Whites Way / Marua Road	6.2	• Modelling indicates potential *flooding* above floor levels for 9A, 10, 1/11 (basement), 12, 1/14 (basement) Carrs Place for the 10 year ARI event.	(1) Upgrade both private and Council soakage	Adopt Option 1

[1] Basement
[2] Ellerslie-Panmure Highway

No.	Sub-Catchment	Area (ha)	Issues	Possible Remedial Options	Recommended Remedial Option
16	Dryden Place / Ballarat Street. / Marua Road	4.1	• Modelling indicates potential flooding of properties at the corner of Marua Road and Ballarat Street. • Flood history indicates that properties at the end of Dryden Place experience flooding due to inadequate soakage.	(1) install additional soakage at the low lying road area adjacent to No. 69 Ballarat Street. (2) Upgrade soakage at Dryden Place. (3) Pipe Stormwater from Dryden Place out of catchment.	Adopt Options 1 and 2. Option 3 is unlikely to be cost effective and is therefore not recommended.

2.1.3 Area 2

2.1.3.1 Main System

Approximately 70% of this catchment is drained by five main pipe branches. These converge into a single channel upstream of Carbine Road before discharging to the Tamaki Estuary. Together they cover a large area which extends roughly from Hamlin's Hill in the West, Panama Road in the south, Commissariat Road and Penrose Road in the north and Carbine Road in the east. The remainder of the catchment, which covers most of the area east of Carbine Road, is drained by small localised stormwater systems that discharge directly to the Tamaki Estuary.

Aranui Road/Mt Wellington Highway to Eastern Suburbs Railway Line

Computer modelling indicates that there are a number of inadequacies in the stormwater drainage system in this area which will cause widespread flooding further downstream during rainstorms with ARI's greater than 10 years. These findings are supported by observations by members of the public. For example the capacity of the 1500 mm diameter culvert beneath Mt Wellington Highway was exceeded during a heavy rainstorm in January 1995, resulting in flooding of the Highway. In addition:

- the existing culvert beneath the Mt Wellington Highway does not have sufficient capacity to carry flows from the 10 year ARI event.
- The Aranui Road open channel experiences backwater effects due to capacity problems and the hydraulic inefficiency of the downstream culvert during the 10 year ARI event.
- The poor inlet conditions that exist at the entrance to the main culvert from the open channel reduce the capacity of the system as a whole, and exacerbate the effects of the problems upstream at the Mt Wellington Highway.
- The existing pipe system through the Sylvia Park Industrial area does not have sufficient capacity to convey flows from the 10 year ARI event. There is no overland flow path through this area to safely convey overland flows without causing widespread flooding. Upgrading of the system is somewhat limited by the existence of a syphon in the stormwater line due to a nearby Watercare Services Trunk Sewer.
- The lower part of the B Branch stormwater line **(Plan 251)** which lies parallel with Longford Street does not have sufficient capacity to convey flows from rainstorms with an ARI greater than 10 years. There is presently no safe overland flow path to convey water back into the main system without causing flooding. In addition, inlet conditions for the B Branch pipe at the Longford Street reserve are poor, reducing the overall capacity of the system.

- Auckland City has requested that the Mt Wellington Highway be protected from the 20 year ARI event due to its importance as a major arterial route.

A number of potential remedial measures have been investigated. It was found that the buildings within the Sylvia Park industrial area are due for demolition and that the site will be redeveloped. The opportunity therefore exists to set requirements such as minimum floor levels for this new development.

The recommended option includes the following works **(Plan 300)**:

- Regrade reserve between Longford Street and Aranui Road to allow for temporary ponding of the excess flow
- Relocate the existing 1500 mm diameter culvert under Mt Wellington Highway to make way for new 3m wide by 2m high box culvert and construct new inlet channel.
- Construct new 3m wide by 2m high box culvert from the Aranui Road open channel to the existing 'railway line' open channel.
- Lower the surfaces of the new access roads along the South Eastern Arterial Viaduct and utilise them as overland (secondary) flowpaths.
- Abandon existing stormwater pipe from junction of B Branch and new box culvert to inlet at main system open channel, to divert B Branch flows to box culvert.
- Improve inlet conditions at entrance to main system open channel.

The other potential options that were identified but which are not recommended are outlined below, along with the reasons for not considering them further:

(1) *Construction of detention pond upstream of Mt Wellington Highway* - not considered further due to the lack of available space at this site.

(2) *Upgrade existing pipe system to accommodate flows from the 1% ARI event* - not considered further due to the prohibitive cost.

(3) *Set minimum floor levels for new development at Sylvia Park Industrial Area* - as the Sylvia Park industrial area is due for redevelopment, flooding of this area could be addressed by setting minimum floor levels on the basis of modelled flood levels. In discussions with the client and the property owner, it was agreed that it would be preferable to resolve the flooding issue rather than resort to this action. This option would also not resolve the flooding of Mt Wellington Highway.

(4) *Diversion of B Branch to Aranui Road at Longford Street Reserve* - not considered further when it was found that water levels in the Aranui Road open channel are above water levels at the reserve, and would therefore result in water flowing into the reserve rather than out of it.

Cost estimates for the recommended option are presented below.

Table 2.10 Aranui Road/Mt Wellington Highway to Eastern Suburbs Railway Line Remedial Works

Item	Quantities	Rate ($)	Cost ($)
Box culvert (3 m wide, 2 m high)	350 m	2,400/m	840,000
Relocation of existing 1500 mm dia. pipe	40 m	2,200/m	88,000
Inlet Structure	1	45,000 ea	45,000
Outlet Structure	1	12,500 ea	12,500
Overland Flow path along SEART Viaduct (20 m by 0.5 m)	350 m	500/m	175,000
Channel widening excavation by 1m	520 m^3	30/m^3	15,600
Channel Lining	480 m	400/m	192,000
Inlet improvement works	1	45,000 ea	45,000
Connection between 1200mm pipe and new box culvert	1	5,000 ea	5,000
Design & Supervision (10%)			141,810
Contingency (15%)			212,715
Total			**1,772,625**

Table 2.11 Temporary Ponding in Longford Reserve Remedial Works

Items	Quantities	Rate ($)	Cost ($)
Excavation and Filling	2,400 m^3	30/ m^3	72,000
Inlet Structure	1	10,000 ea	10,000
Wall	150 m by 0.5 m	100/m	15,000
Design & Supervision (10%)			9,700
Contingency (15%)			14,550
Total			**121,250**

2.1.3.2 Upper Catchment

A large part of the existing pipe system for the upper catchment of Area 2 does not have sufficient capacity to accept flows from the 10 year ARI event. These particular pipes are shown in red on **Plan 251**. However, it should be pointed out that the upper part of Area 2 is relatively steep. There are few potential ponding areas and there would only be a cause for concern if the overland flow paths are blocked. The issue of minimum floor levels in these areas is therefore generally not a problem. Prioritisation of any proposed remedial work in this area should be undertaken on the basis of the existing capacity of these pipes relative to the required 10 year ARI flow. **Plan 243** shows the main overland flow paths in the upper catchment part of Area 2. The extents of these overland flow paths are approximate and therefore should not be used for the setting of building controls.

2.2 Water Quality

As shown on **Plan 104**, stormwater from the WEL-STH catchment discharges to the Manukau Harbour (two locations, Area 1 - Lower), Tamaki Estuary (Area 2) and the Mt Wellington aquifer (Area 1 - Upper). An assessment of water quality has been conducted as part of this study and is reported in full separately (*Mt Wellington-Southdown (WEL-STH) Water Quality Assessment*, 1997). This assessment concluded that:

- stormwater sediments are contaminated and may affect local biota in terms of high concentrations of zinc and elevated levels of copper and lead;
- stormwater contains high levels of pathogens and copper which may impact the marine environment;
- groundwater quality is good but exhibits some possible signs of stormwater contamination in terms of the low levels of *faecal coliform*;
- marine biota have been impacted by contaminated stormwater as evidenced by the high concentrations of zinc, lead and copper found in

oysters and fish and also possibly by the elevated concentrations of Polychlorinated biphenyls (PCBs) and DDE.

The main sources of contaminants are stormwater runoff from the Auckland-Hamilton Motorway and roads, and the spillage of chemicals within the industrial areas.

2.2.1 Remedial Options

The options for mitigating water quality effects generally fall into one of the following three categories:

1) control potential contaminants at source
2) treat contaminants within the reticulation system (eg water quality ponds)
3) allow contaminants to accumulate within the receiving environment and then periodically remove and dispose of appropriately (eg to controlled landfill).

For highly developed catchments like WEL-STH, a combination of methods is considered appropriate, so as to arrive at the "Best Practicable Option" (BPO). This approach is used here, with an emphasis on methods which fall into the first two categories above.

The following measures are recommended:

1) revise the existing street sweeping and cesspit cleaning programme to take account of site-specific conditions such as the rate of sediment generation and traffic density
2) prepare and implement a spill contingency plan
3) contribute to Regional public education programmes on stormwater and foulwater disposal
4) monitor compliance with regulations on Trade Waste Disposal.
5) continue using oil absorbers and booms as part of the ongoing watercourse maintenance programme, especially in creek areas where oil has been previously detected
6) incorporate trash screens and grilles (if feasible) into recommended remedial works for flood protection

The other potential options that were identified but which are not recommended are outlined below, along with reasons for not considering them further.

A potential arrangement for utilising treatment units such as oil/water or centrifical separators in conjunction with the ponds is shown on **Plans 300,** 302 and 303. However the use of centrifical continuous deflection (swirl) separators is not recommended at present because:

(a) they have limited effectiveness in removing fine particles that will not settle within ponds.

(b) no other suitable locations have been identified in the highly developed WEL-STH catchment.

and c) the improvement in water quality is not consistent with their capital and maintenance costs. Capital costs of these separators are estimated to be $440,000 if installed at the pond areas (Area 1).

Oil/water separators are also not recommended at present because:

(a) they are effective for bulk oil removal but not emulsified oil removal

(b) aside from the pond area, no suitable locations have been identified

(c) during high flows the treatment unit would have to be bypassed

(d) they are not cost effective given their limited improvement in water quality.

A cesspit filter system (CFS), which consists of installing filter bags and/or oil absorbing media in cesspits could be used to control stormwater sediment along roadways. A preliminary assessment of the requirements for the WEL-STH catchment is presented in Appendix G. Based on the relatively high annual operations and maintenance costs and lack of long term performance and cost data, this option is not recommended. However, CFS may be appropriate for use in limited areas or on a pilot study basis.

Specific measures for each sub-catchment are described below.

2.2.2 Manukau Harbour (Area 1 - Lower Catchment)

Water Quality Ponds

Ann's Creek, Onehunga, is relatively shallow with a maximum depth of 0.3m below sea level. It is a site of sediment deposition because it is sheltered from the effects of strong tidal currents and high energy wave action. Stormwater, groundwater and sewer overflows enter this inlet. Previous studies note that impact of these discharges is considerable. Since the Manukau Sewage Purification Works have come into operation, it has been observed that levels of contaminants are decreasing.

The existing water quality management measures include oil booms near the intersection of Sylvia Park Road and Gt South Road, and at Southdown Reserve adjacent to Hugo Johnston Drive. In addition, there are ponds at the Southdown Reserve where the stormwater pipelines from the western part of the catchment converge prior to discharging to the Manukau Harbour. These ponds do not fully meet present water quality pond design criteria. Despite this, monitoring by the ARC indicates that they do improve water quality.

The Auckland City Strategic Plan (*Outstanding Auckland* 1996) states that Auckland City will *establish wetlands for stormwater treatment where possible.* Fully effective treatment ponds may require areas of land up to 1% of the contributing catchment area, therefore finding suitably large, vacant areas can be problematic within a developed catchment. Despite this, opportunities for utilising water quality ponds to improve the quality of runoff to the Manukau Harbour have been identified as described below.

Southdown Reserve
These ponds are administered by the ARC and treat the flow from only one of the four inlets. Upgrading these ponds and rearranging them to include the other three inlets is recommended. The pond will have a volume of 5000 cubic metres and will be restricted to the reserve land, because the adjacent property will be redeveloped shortly and is therefore unavailable.

Ann's Creek
The undeveloped land adjacent to the tidal part of Ann's Creek is an ideal location for a water quality pond because it is located at the outlet of the stormwater system. It's efficiency will however be limited because of its size in comparison to the size of the contributing catchment. The design should allow the pond to be used for contingent spillage control purposes.

Other Water Quality Improvements

Other water quality improvements in this area may be realised by implementing maintenance and management measures as described in Section 2.2.1. Installing a grille at the Wilkie Place inlet may also reduce trash and rubbish entering the watercourse. Improving soakage at Great South Road will reduce stormwater volumes, thereby improving receiving water quality.

2.2.3 Tamaki Estuary (Area 2)

Water Quality Ponds

The Tamaki Estuary catchment is considered to be a relatively degraded environment compared to other parts of the Auckland Region.

Three water quality ponds are being constructed as part of the SEART project. These will treat runoff parts of SEART, the Auckland-Hamilton Motorway and Commissariat/Aranui Roads. In addition, an oil boom is located at Bowden Road.

There is no vacant land suitable for treatment ponds between Mt Wellington Highway and the Tamaki estuary outfall.

Other Water Quality Improvements

Other water quality improvements in this area may be realised by implementing the maintenance and management measures as described in Section 2.2.1. Additionally trash grilles should be incorporated as practical into the design of inlets under the Mt Wellington Highway and at Aranui Road.

Using the reserve between Longford Street and Aranui Road for temporary ponding of excess flow will allow for settlement of the sediment in that discharge.

2.2.4 Mt Wellington Aquifer (Area 1 - Upper Catchment)

In reviewing the potential impact on receiving water arising from the discharge of urban stormwater, the protection of the valuable groundwater resource in the underlying aquifer(s) from the adverse effects of soakage water is of paramount importance. It is recommended that adequate filters be installed at all private and public soakholes.

2.3 Foulwater Collection

Key issues associated with the collection of foulwater from the Area 1 Upper and Lower catchments are discussed below. A description of the modelling used to support this work is presented in Appendix E. Issues relating to Area 2 were outside the scope of this study, having been examined as part of the Carbine Road Study.

2.3.1 Self-Cleansing Velocities

The Auckland City Sanitary Sewer Design Manual (SSDM) recommends a minimum self-cleansing velocity of 0.65 m/s, with 0.75 m/s desirable in the upper reaches. Computed minimum and maximum peak velocities for each main foulwater pipe within Area 1 are presented in Appendix F and shown on **Plans 610 and 611**. These results are for the Existing Development (ED) and Ultimate Development (UD) scenarios as defined in Appendix E. The velocities have been categorised into the following three; greater than 0.65m/s, between 0.4 and 0.65 m/s and below 0.4 m/s. This gives a relative assessment of the potential for self-cleansing.

Out of a total of 365 reaches modelled in the ED scenario, 41% had a velocity between 0.4 and 0.65 m/s and 44% had a velocity below 0.4 m/s. From a total of 480 reaches modelled in the UD scenario, 34% had a velocity between 0.4 and 0.65 m/s and 32% had a velocity below 0.4 m/s. This indicates that under the UD scenario, approximately one-third of the foulwater system within Area 1 has a potential self-cleansing problem.

The velocities for the ED scenario are of a similar order of magnitude to those for the UD scenario. The extent of the self-cleansing areas presented in **Plans 610 and 611** are therefore similar for both scenarios. The main difference is the extent of non self-cleansing toward the downstream part of the system, which is due to the lower input volumes generated under the ED scenario. This applies mostly to the pipelines labelled AA*** (STREETHPF), AW*** (WELAF), AA*** (WELFF), AA*** (WELTF) and AA*** (WELXF).

It is recommended that the areas highlighted in **Plans 610 and 611** be inspected to verify the model results with regard to self-cleansing. If it is found that self-cleansing is not occurring then the extent of the problem should be traced through the pipe system. In any case the whole of the foulwater pipe network should be inspected on a regular basis as part of the maintenance programme.

The following was found during the site inspection programme **(Plans 610 and 611)**:

- At Alana Place there was confirmation that self-cleansing was not occurring.
- At Ferndale Road it was found that self-cleansing was occurring but there was evidence of ingress of tree roots to the pipework.
- At Leonard Road there was evidence of self-cleansing problems within the AT*** branchline.
- The inspection of Prescott Road found evidence of self-cleansing problems within the AC*** branchline.
- The inspection of Hugo Johnston Drive revealed self-cleansing was occurring at this point.
- At Autumn Place it was found that there was a considerable amount of large debris in the manhole indicating a significant breach in the integrity of the pipework upstream from this point.
- At Southdown Lane there was evidence that self-cleansing is not occurring in the AC*** branch line.
- The manhole within Industry Road had evidence that self-cleansing was occurring.
- The manhole at Harwood Road had evidence of the foulwater rising above the channel onto the benching of the manhole. This correlated with the results of the modelling in that rapid flow and turbulence is occurring due to a sudden change of grade at the manhole. As this manhole is located within private property close to the backdoor of a house the odour problem is conspicuous. A new manhole cover could be installed and sealed in place to overcome the odour problem.

Table 2.12 Provisional Costing for Foulwater System Flushing

Foulwater Catchments	Number of Branches to be Flushed*	Rate ($ ea)	Estimated Cost by Flushing	Total Yearly Cost at 4 Times per Year
WELAF	17	380	$ 6,460	$ 25,840
WELBF	1	380	$ 380	$ 1,520
WELCF	2	380	$ 760	$ 3,040
WELDF	2	380	$ 760	$ 3,040
WELFF	14	380	$ 5,320	$ 21,280
WELGF	1	380	$ 380	$ 1,520
WELHF	4	380	$ 1,520	$ 6,080
WELRF	3	380	$ 1,140	$ 4,560
WELSF	1	380	$ 380	$ 1,520
WELTF	8	380	$ 3,040	$ 12,160
WEAAF	1	380	$ 380	$ 1,520
WEABF	1	380	$ 380	$ 1,520
STHAF	1	380	$ 380	$ 1,520
STHBF	0	380	$ -	$ -
STHCF	0	380	$ -	$ -
STHDF	0	380	$ -	$ -
STHEF	0	380	$ -	$ -
STHPF	3	380	$ 1,140	$ 4,560
STHPF01 + STHPF02	2	380	$ 760	$ 3,040
STHPF03	0	380	$ -	$ -
STHPF04	0	380	$ -	$ -
STHPF05	2	380	$ 760	$ 3,040
STHPF06	1	380	$ 380	$ 1,520
STHPF07	3	380	$ 1,140	$ 4,560
STHPF08	5	380	$ 1,900	$ 7,600
Total			**$ 27,360**	**$ 109,440**

* To be verified during routine inspections, prior to performing flushing.

The options for dealing with self-cleansing problems include regrading the relevant section of pipeline or to clean the pipeline by hydrojetting or flushing. The flushing can either be performed manually, by tanker, on a regular basis or can be setup permanently with an installed tank and timer system. The optimum method would be determined once the extent and magnitude of the self-cleansing problem has been accurately defined. A provisional costing for flushing is presented in Table 2.12.

Table 2.13 gives the recommended implementation priority order for flushing of sewers with self-cleansing problems. The priority order was prepared by ranking catchments on the basis of the number of sewer reaches with self-cleaning problems.

Table 2.13 Implementation Priority

PRIORITY	CATCHMENT
1	WELAF, WELBE WELDF, WELCF
2	WELFF, WELPF, WELHF, WELRF
3	WELTF, SEAAF, STHAF, STHPF, STHP07, SHPF06, STHPF05, STHPF08, STHPF01

2.3.2 Capacity Of Existing Pipe System

The modelled pipe capacities for the UD scenario are presented in Appendix F. A factor is included that relates the maximum daily discharge to the full pipe discharge. These results indicate that the present foulwater system has the capacity for greater flows than occur for the UD scenario. No remedial pipework or pipe upgrading is therefore required with respect to pipe capacity.

The highest foulwater levels simulated in the UD scenario, over the peak of the daily flow, were located at Ferndale Road (AW150 to AW140 and AW040 to AW030), Great South Road (MH27 to MH26) and Sylvia Park Road (AA030 to PS15). The foulwater depths were greater than two-thirds of the respective pipe diameters.

During the development of the foulwater model, information became available regarding a proposed real estate development at Heritage Park next to the Ellerslie-Panmure Highway. This development is relatively intensive, consequently the UD scenario foulwater loading is quite high. As a result, the capacity factor for the AW*** pipe system has a maximum value of 0.85. This is within the full capacity potential of the respective pipe reaches.

The Water Care Services Sewer on Great South Road between MH26 and MH27 has a slight negative grade (0.01%). This distorts the pipe capacity factor and so it has been omitted from Appendix F. Despite this, the lateral inflow pipes connecting to MH26 and MH27 do not experience backwater effects as their invert levels are sufficiently above the respective Water Care Services Sewer foulwater levels.

2.3.3 Inflow And Infiltration

The foulwater modelling for Area 2 (Carbine Road) was a more detailed study than has been performed for Area 1. Amongst other things the Carbine Road study included an inflow/infiltration assessment. The results of the analysis indicated an increase in the foulwater Peak Dry Weather Flow by up to 250% depending on the particular pipe reach and rainfall event.

The assessment of Area 1 performed as part of this WEL-STH study did not specifically include an analysis of infiltration and inflow. However the UD scenario was based on a foulwater loading rate, as per the SSDM, which included a factor for infiltration equal to twice the Peak Dry Weather Flow. Consequently the assessment of the existing foulwater network within Area 1 included an allowance for inflow and infiltration.

The approach taken to assess infiltration for Area 1 is consistent with that for the Area 2 (Carbine Road) assessment. This is reasonable given that the foulwater networks for both Area 1 and Area 2 are of similar age (circa 1950's).

2.3.4 Asset Condition

As noted above, the foulwater infrastructure within Area 1 is of a similar age as that for Area 2 (Carbine Road). The more detailed investigation of Area 2 highlighted the need for a range of remedial works because of the deteriorated asset condition.

The limited site inspections conducted to verify the modelling results for Area 1 revealed some problems with the pipework. These included root ingress, the presence of rocks up to 100mm in diameter and odour issues **(Plan 102)**. It is therefore recommended that inspections of the foulwater system be undertaken as part of a preventative maintenance programme. This should occur at regular intervals and target different areas of the system on a rotational basis. It may be necessary to undertake video inspections of selected pipes. The information obtained will enable the construction of a data base of problem areas and will also assist in optimising remediation works. The site inspections will verify problem areas, the extent of self-cleansing and the locations for injection of flushing water.

2.3.5 Summary

The existing foulwater pipe network has the capacity for greater foulwater flows than can be expected at Maximum Probable Development. No remedial pipework or pipe upgrading is required with respect to pipe capacity.

The three Water Care Services sewers within Area 1 do not appear to have any detrimental effect on the operation of Auckland City's foulwater network.

There is inflow and infiltration occurring within the existing Area 1 foulwater network. The modelling shows that the system has sufficient capacity to accommodate some inflow and infiltration. The inflow and infiltration increases the flow velocity, promoting self-cleansing. There is capacity within the existing foulwater network to allow further development, as long as the inflow and infiltration are reduced commensurately.

The approach taken to assess infiltration for Area 1 is consistent with that for the Area 2 (Carbine Road) assessment. This is reasonable given that the two networks are of similar age.

The more detailed investigation of Area 2 performed as part of the Carbine Road study highlighted the need for a range of remedial works because of the deteriorated asset condition. It is probable that similar remedial works will be required within Area 1. This will become evident during future inspections.

3 SUMMARY OF RECOMMENDED OPTIONS

For convenience the various options recommended in Section 2 for sustainable management of the WEL-STH catchment are summarised below. These options are grouped here according to the three key catchment management issues (stormwater flooding, water quality and foulwater collection).

The recommended order of implementing the works is shown on **Plan 300.**

3.1 Stormwater Flooding

Indicative capital costs for the stormwater remedial works are shown bracketed. The total cost is estimated to equal $7.04M, including a 15% contingency and a 10% allowance for design and supervision.

3.1.1 Area 1 - Lower Catchment

Wilkie Place ($345,300)

- Install second culvert beneath the Auckland-Hamilton Motorway (1200mm diameter pipe with 1600mm diameter pipe immediately downstream).
- Install grilles at inlets of culverts.
- Periodic maintenance of the watercourse.

Great South Road ($492,500)
Install additional cesspits, soakholes and associated pipelines (225/375mm diameter) along most of Gt South Road for road drainage only.

Penrose Road to Sims Road ($2,529,000)

- Upgrade existing pipeline (Penrose Rd to Holloway Place) to accommodate flows for rainstorms up to the 10 year ARI event.
- Pipe the existing section of open channel with a 1600 mm diameter pipe.
- Upgrade the 1050 mm diameter pipeline (Holloway Place to Sims Rd) by installing a new 1200 mm diameter pipe parallel with the existing pipeline as far as Sims Road and connect to new 1950 mm diameter pipeline beneath SEART.

1010-1012 Great South Road ($21,000)
Raise the crest of the earth embankment to a level higher than the inlet structure to reduce the risk of overtopping.

Corner Sylvia Park and Great South Roads ($277,000)
Replace the three existing 1000 mm diameter pipes with a single arch culvert (3m wide, 1.75m high).

Fletcher Pond ($117,000)

- Upgrade the existing 600 mm diameter outlet pipe to a 900 mm diameter pipeline.
- Connect any remaining properties on soakage to the stormwater reticulation system.

SEART to Church Street ($777,000)

- install additional cesspits on Great South Road downstream of SEART (consider connection to the Industry Road stormwater line).
- install additional cesspits adjacent to 431- 433 Church Street.
- Improve private drainage systems along Gt South Road by upgrading soakage or direct connection to the existing stormwater system.

Southdown Lane to Southdown Reserve ($415,000)

- Upgrade twin 600 mm diameter pipes beneath Southdown Lane to a single 1200 mm diameter pipe.
- Disconnect the eastern Industry Road stormwater line from main line and divert to Ann's Creek via a new 1350 mm diameter pipe.

3.1.2 Area 1 - Upper Catchment

- Collect and review information on the characteristics of the Mt Wellington aquifer, the performance of existing soakage systems and the adequacy of soakage systems in specific areas.
- Frequent maintenance of both Auckland City and private soakholes.
- Revise the design of the Auckland City standard road soakhole.

3.1.3 Area 2

Longford Reserve/Aranui Road to the Eastern Suburbs Railway Line ($1,772,625 plus $121,300)

- Regrade reserve between Longford Street and Aranui Road to allow for temporary ponding of the excess flow.
- Relocate existing 1500 mm diameter culvert beneath Mt Wellington Highway to make way for new box culvert (3m wide, 2m high) and construct inlet channel.
- Construct new box culvert (3m wide, 2m high) from the Aranui Road open channel to the existing 'railway line' open channel.
- Lower the surfaces of the new access roads along the South Eastern Arterial Viaduct and utilise them as overland (secondary) flowpaths.

- Abandon existing Stormwater pipe from junction of B Branch and new box culvert to inlet at main system open channel, to divert B Branch flows to box culvert.
- Improve inlet conditions at entrance to main system open channel.

Upper Catchment

- Control development within overland flow paths **(Plan 243).**

3.2 Water Quality

For the entire catchment:

- revise the existing street sweeping and cesspit cleaning programme to take account of site-specific conditions such as the rate of sediment generation and traffic density.
- prepare and implement a spill contingency plan.
- contribute to Regional public education programmes on stormwater and foulwater disposal.
- monitor compliance with regulations on Trade Waste Disposal.
- continue using oil absorbers and booms as part of the ongoing watercourse maintenance programme, especially in creek areas where oil has been previously detected.
- incorporate trash screens (if feasible) into recommended remedial works for flood protection such as those at Wilkie Place (Area 1), Aranui Road (Area 2) and under Mt Wellington Highway (Area 2).

3.2.1 Area 1 - Lower Catchment

Construct and landscape water quality ponds at :

- Ann's Creek **(Plan 304)**
- Southdown Reserve **(Plan 303).**

3.2.2 Area 1 - Upper Catchment

Install and maintain adequate filters on private and public soakholes

3.2.3 Tamaki Estuary (Area 2)

Three water quality ponds are being constructed as part of the SEART project. Additionally, the reserve between Longford Street and Aranui Road should be regraded to allow for settlement of sediment in that temporary pond.

3.3 Foulwater Collection

- Field inspection of pipe reaches with potential self-cleansing problems **(Plans 610 and 611)**
- Periodic flushing of pipes with identified self-cleansing problems (provisional cost estimate of $109,400 per annum).

4 REFERENCES AND BIBLIOGRAPHY

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APPENDIX A Recommended Levels of Flood Protection

Asset Protected	Acceptable Average Recurrence Interval (ARI) for Flooding (Years)	Minimum Freeboard - Flood Prone Area[2] (mm)	Minimum Freeboard - Other Areas (mm)
Parks, reserves, private yards	1-5	-	-
Non-habitable residential buildings, garage floors	10	-	200
Commercial and industrial buildings	50	200	300
Dwellings	100	300	500
Major facilities (eg. power supply, detention dams, telephone, water and sewage facilities)	100	300	500

1 Source: *Auckland City Watercourse Guidelines*, Auckland City Drainage investigations Team, 1991.

2 Flood Prone Area - Defined as the area between the 100 year ARI flood plain and the extent of flooding in a predicted 100 year ARI rainstorm with the primary flowpath partially blocked.

APPENDIX B Effect of Assumed Soakage Rate on Predicted Flood Levels - Area 1 (Upper Catchment)

Location		Computed Flood Level (m)			
Sub-catchment	Node	10 Year ARI[1]		100 Year ARI	
		5 l/s	10 l/s	5 l/s	10 l/s
Ballarat	DC1	33.02	32.58	33.20	33.08
	D4	31.17	30.73	31.52	31.30
Banks 1	AB1	34.32	33.97	34.60	34.40
	AC1	34.31	33.49	35.00	34.50
	AD1	33.07	32.79	33.53	33.29
	A 4	31.38	30.41	32.07	31.60
Banks 2	T2	34.02	33.01	33.41	33.59
	S6	33.39	33.19	33.35	33.38
	T5	30.65	29.35	30.25	30.59
	S8	31.27	29.02	30.35	30.59
Carrs	1D3	32.21	31.81	32.61	32.32
Cebalo	1B1	34.30	34.06	34.69	34.41
	1A2	31.01	30.40	31.91	31.25
Dryden	C4	32.40	32.04	33.02	32.60
	2E1	29.44	28.56	30.19	29.68
	2E4	26.03	23.82	26.14	26.06
Fulton	2E1	29.44	28.56	30.19	29.68
	2E4	26.03	23.82	26.14	26.06
Harrison	2C1	34.12	33.94	34.34	34.18
	2C2	33.77	33.67	34.01	33.86
	2C6	34.42	32.81	34.58	34.54
	2C8	35.04	34.35	35.35	35.12
Lavas	ZB11	30.55		31.19	
Marua	B3	35.41	34.65	36.15	35.64
Mercury	3B2	30.30	30.06	30.77	30.41
Penrose	F10	30.01		30.26	
	FK1	31.77		32.08	
	F16	31.55		31.57	
Reliable	AK1	30.21	29.90	30.53	30.29
	AKA1	29.17	28.43	29.27	29.23
	AK3	28.15	27.64	28.26	28.21
Stanhope	2BA1	32.21	32.03	32.51	32.23
	2A2	36.86	36.27	36.96	36.91
	2A3	34.36	34.03	34.72	34.55
	2B2	32.03	31.75	32.51	32.07

1 ARI = Average Recurrence Interval.

NOTE: For catchments in shaded rows private soakage was assumed to be negligible. For this reason a single flood level has been provided for these catchments.

APPENDIX C Computed Discharges for Area 1 (Lower) Stormwater System

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
L 1	375	0.19	0.49	0.62	0.85	0.98
L 2	375	0.12	0.55	0.69	0.94	1.09
L 3	300	0.05	0.63	0.78	1.07	1.24
L 4	450	0.24	0.05	0.05	0.05	0.05
L 5	525	0.57	0.05	0.05	0.05	0.05
L 6	525	0.70	0.26	0.31	0.41	0.46
L 7	525	0.59	1.06	1.32	1.79	2.06
L 8	525	0.50	1.33	1.64	2.23	2.57
AK 9	o/c	n/a	1.15	1.36	1.89	2.15
LA 1	300	0.19	1.27	1.51	2.10	2.39
LA 2	450	0.17	1.27	1.50	2.09	2.38
LA 3	450	0.20	0.17	0.17	0.17	0.17
LA 4	450	0.19	1.27	1.50	2.09	2.38
LA 5	450	0.14	1.28	1.52	2.12	2.41
L 9	525	0.27	2.39	2.94	4.07	4.66
LB 1	300	0.25	0.12	0.15	0.20	0.24
L 10	525	0.45	2.47	3.05	4.21	4.83
L 11	525	0.45	0.52	0.53	0.57	0.58
L 12	525	0.24	0.52	0.53	0.56	0.58
LCA 2	o/c	n/a	1.41	1.64	2.28	2.58
LC 1	o/c	n/a	3.27	4.13	5.95	6.86
LC 102	300	0.08	3.25	4.11	5.93	6.84
LC 2	450	0.34	3.25	4.07	5.92	6.83
LC 3	450	0.52	3.24	4.06	5.86	6.76
LC 4	450	0.20	3.24	4.01	5.83	6.75
L 13	375	0.24	3.70	4.48	6.31	7.22
L 14	375	0.16	3.75	4.56	6.42	7.36
L 15	610	0.67	0.37	0.42	0.52	0.57
L 16	750	0.99	0.37	0.42	0.52	0.57
LZA 1	o/c	0.02	0.63	0.74	1.02	1.16
LZA 102	234	2.33	0.62	0.72	1.01	1.14
L 17	750	0.99	1.68	2.02	2.77	3.12
LD 1	300	0.32	0.11	0.14	0.19	0.22
LD 2	300	0.28	0.24	0.30	0.41	0.47
LD 3	650	0.96	3.61	4.41	6.28	7.24
L 18	860	1.52	4.17	5.15	7.26	8.32
L 19	900	1.08	4.60	5.71	7.93	9.08

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
L 20	558	52.45	4.97	6.22	8.64	9.90
L 20A	558	52.45	4.97	6.21	8.63	9.88
L 21	o/c	n/a	5.23	6.55	9.11	10.42
L 102	1050	2.05	5.21	6.54	9.09	10.41
LE 4	600	2.50	0.15	0.18	0.25	0.29
LE 5	600	1.39	0.15	0.18	0.25	0.29
L 22	o/c	n/a	2.74	2.87	3.18	3.34
L 103	o/c	n/a	3.18	4.50	7.05	8.37
L 104	1000	1.31	2.72	2.85	3.17	3.32
L 23	1050	1.83	2.71	2.84	3.16	3.31
L 24	1065	2.04	3.32	3.61	4.21	4.52
L 25	1065	2.10	3.56	3.92	4.65	5.02
L 26	1215	4.00	3.93	4.36	5.25	5.69
L 27	1950	4.20	4.20	4.20	4.20	4.20
LW 1	1215	1.35	2.56	2.72	2.74	2.74
LW 2	1215	2.89	2.56	1.35	1.35	1.35
LF 1	150	0.03	0.10	0.13	0.17	0.20
LF 2	300	0.21	0.12	0.16	0.21	0.25
LF 3	300	0.26	0.12	0.16	0.21	0.24
LF 4	300	0.30	0.27	0.34	0.46	0.53
LF 5	300	0.21	0.27	0.34	0.46	0.53
LF 6	300	0.17	0.47	0.58	0.80	0.91
LF 7	300	0.15	0.49	0.60	0.83	0.95
LF 8	375	0.38	0.85	1.05	1.44	1.66
LF 9	450	0.64	1.00	1.24	1.70	1.96
LFA 1	225	0.09	0.03	0.04	0.06	0.06
LFA 2	225	0.15	0.07	0.09	0.13	0.15
LFB 1	300	0.22	0.20	0.24	0.34	0.39
LFA 3	300	0.31	0.27	0.33	0.46	0.53
LFC 1	300	0.35	0.22	0.27	0.37	0.43
LFC 2	300	0.32	0.27	0.34	0.46	0.53
LFC 3	300	0.16	0.36	0.45	0.61	0.71
LFC 4	300	0.21	0.38	0.47	0.65	0.74
LFD 1	300	0.19	0.24	0.29	0.41	0.47
LFD 2	300	0.21	0.34	0.42	0.58	0.67
LFD 3	300	0.32	0.21	0.21	0.21	0.21
LFD 4	300	0.19	0.24	0.24	0.26	0.27

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
LFC 5	375	0.30	0.67	0.79	1.00	1.12
LFC 6	375	0.35	0.85	0.99	1.28	1.45
LFC 7	375	0.33	0.92	1.09	1.41	1.60
LF 10	1060	0.77	2.40	2.91	3.80	4.30
LF 11	o/c	n/a	2.52	3.10	4.25	4.89
LFE 1	225	0.09	0.08	0.09	0.13	0.15
LFE 2	225	0.04	0.08	0.09	0.09	0.09
LFE 3	225	0.06	0.04	0.04	0.04	0.04
LFK 1	150	0.04	0.01	0.02	0.02	0.02
LFK 2	150	0.06	0.03	0.04	0.06	0.06
LFG 1	225	0.07	0.03	0.04	0.05	0.06
LFE 4	225	0.12	0.14	0.17	0.20	0.21
LFE 5	225	0.13	0.24	0.29	0.37	0.41
LF 12	o/c	18.40	2.78	3.42	4.70	5.42
LFM 2	225	0.08	0.09	0.11	0.15	0.17
LFP 1	225	0.05	0.04	0.05	0.07	0.08
LFN 1	300	0.29	0.03	0.03	0.04	0.05
LFN 2	225	0.08	0.03	0.03	0.04	0.05
LFN 3	300	0.11	0.24	0.29	0.41	0.47
LFN 4	300	0.29	0.24	0.29	0.40	0.45
LF 14	1065	3.21	3.23	4.01	5.53	6.40
LF 15	1065	2.16	3.57	3.78	4.01	4.13
LF 16	1600	2.30	3.57	3.78	4.00	4.11
LW 3	1950	25.21	6.26	6.67	6.91	7.02
LV 1	300	0.04	0.02	0.03	0.04	0.04
LV 2	300	0.08	0.04	0.05	0.07	0.08
LV 3	300	0.15	0.04	0.05	0.07	0.08
L 28	1500	4.75	7.39	7.82	8.08	8.20
L 29	1500	6.63	6.21	6.47	7.14	7.47
L 30	1500	4.59	6.53	6.88	7.21	7.29
L 31	1500	6.03	4.59	4.59	4.59	4.59
L 32	1500	14.39	4.59	4.59	4.59	4.59
LG 2	1215	3.20	0.40	0.48	1.17	1.59
LG 3	900	1.46	2.31	2.74	3.70	4.18
LG 4	900	1.51	3.08	3.71	5.14	5.85
LG 5	900	1.64	3.07	3.69	5.09	5.78
LG 6	900	1.45	3.53	4.31	6.03	6.94

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
LG 7	900	0.94	3.55	4.36	6.07	7.02
LG 8	750	2.33	3.69	4.57	6.36	7.35
LG 9	750	1.87	3.77	4.68	6.52	7.52
LG 10	914	3.86	3.77	4.68	6.52	7.52
L 33	1800	1.00	8.35	9.27	11.10	12.10
L 34	1832	21.94	8.43	9.42	11.28	12.31
L 35A	1500	0.00	8.89	10.75	12.96	14.34
L 35	1800	6.30	7.21	7.28	9.67	11.34
L 36	1600	3.57	7.21	7.28	9.65	11.32
L 37	1600	2.82	3.57	3.57	3.57	3.57
L 38	1450	2.44	2.82	2.82	2.82	2.82
LH 1	1200	1.07	4.40	4.47	6.83	8.51
LH 2	1200	0.83	4.40	4.47	6.83	8.49
LH 3	1200	0.83	4.42	4.74	6.82	8.49
L 39	1800	13.03	7.24	7.55	9.64	11.31
LK 2	300	0.03	0.23	0.30	0.41	0.48
LK 3	300	0.10	0.23	0.30	0.41	0.48
LK 4	300	0.03	0.23	0.30	0.40	0.48
LK 5	300	0.08	0.47	0.59	0.81	0.94
LK 6	300	0.11	0.47	0.59	0.81	0.94
P 1	300	0.05	0.05	0.05	0.07	0.08
PA 1	225	0.07	0.03	0.04	0.05	0.06
PB 1	450	0.51	0.36	0.45	0.62	0.72
PB 2	500	0.65	0.63	0.81	1.08	1.26
P 2	680	0.49	0.71	0.89	1.20	1.39
P 3	680	1.94	0.81	0.99	1.35	1.56
P 4	680	0.84	0.80	0.99	1.35	1.56
P 5	680	1.37	0.90	1.10	1.50	1.73
P 6	680	1.43	1.06	1.29	1.75	2.02
PC 1	450	0.16	0.11	0.13	0.18	0.20
PCA 1	300	0.05	0.23	0.28	0.39	0.45
PC 2	450	0.16	0.34	0.41	0.56	0.64
PC 3	600	0.38	0.38	0.45	0.62	0.71
P 7	830	1.32	1.51	1.83	2.47	2.84
P 8	910	2.25	1.51	1.81	2.45	2.80
P 9	910	1.50	1.65	1.97	2.59	2.96
PD 1	300	0.34	0.06	0.08	0.11	0.13

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
PD 2	300	0.50	0.06	0.08	0.11	0.13
PD 3	300	0.19	0.06	0.08	0.11	0.13
PDB 1	350	0.47	0.83	1.10	1.49	1.77
PD 4	525	0.75	0.89	1.18	1.59	1.89
PDA 1	525	0.66	0.09	0.11	0.15	0.17
PD 5	525	1.00	0.97	1.27	1.72	2.04
PD 6	525	0.67	0.97	1.26	1.71	2.02
P 10	1050	2.02	2.54	3.16	4.15	4.67
P 11	1050	2.47	2.02	2.02	2.02	2.02
P 12	1200	1.07	2.02	2.02	2.02	2.02
PE 1	375	0.08	0.17	0.20	0.28	0.32
PE 2	375	0.09	0.47	0.58	0.80	0.91
PE 3	600	0.16	0.62	0.75	1.04	1.19
PE 4	700	0.61	0.71	0.87	1.20	1.37
PE 5	600	0.94	1.21	1.98	3.30	3.98
PE 6	525	0.80	0.94	0.94	0.94	0.94
PE 7	525	0.54	0.80	0.80	0.80	0.80
PH 1	450	0.11	0.08	0.10	0.14	0.16
PH 2	450	0.35	0.17	0.20	0.26	0.29
PE 8	450	1.27	0.98	1.01	1.03	1.05
PH 3	1200	2.70	1.14	1.20	1.29	1.32
P 13	1200	1.07	3.16	3.22	3.31	3.35
P 13A	700	51.06	3.16	3.22	3.31	3.34
P 14	1200	3.54	4.09	4.56	5.24	5.55
P 15	1200	4.30	4.21	4.79	5.61	5.98
P 16	1200	2.64	4.80	6.19	8.37	9.61
P 17	600	1.84	4.80	6.19	8.37	9.61
P 18	o/c	20.86	4.80	6.16	8.36	9.58
* L 40	1000	3.94	11.56	14.11	16.71	18.21
L 41	o/c	39.65	11.56	14.08	16.64	18.17
AW 1	285	0.07	0.66	0.76	1.06	1.20
AW 102	64.2	35.75	0.59	0.69	0.99	1.13
AX 5	475	0.29	1.72	2.09	2.95	3.36
AX 107	o/c	n/a	0.29	0.29	0.29	0.29
AX 108	o/c	19.27	1.43	1.80	2.67	3.07
A 1	225	0.05	1.60	1.98	3.00	3.44
AB 1	300	0.06	0.09	0.11	0.15	0.17

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
A 2	385	0.16	1.64	2.03	3.05	3.53
A 101	o/c	n/a	0.16	0.16	0.16	0.16
A 102	300	0.05	1.48	1.87	2.89	3.37
A 3	375	0.07	1.48	1.85	2.87	3.32
A 4	375	0.10	1.51	1.89	2.93	3.38
A 5	675	0.46	1.53	1.91	2.97	3.43
A 6	675	0.56	1.52	1.89	2.95	3.41
AC 1	300	0.10	0.11	0.12	0.17	0.20
A 7	525	0.46	1.55	1.94	2.97	3.45
A 8	525	0.41	1.57	1.96	3.05	3.53
AD 1	300	0.05	0.12	0.14	0.19	0.22
AD 2	300	0.06	0.12	0.14	0.19	0.21
AD 3	450	0.21	0.17	0.20	0.28	0.31
ADA 1	450	0.16	0.12	0.14	0.19	0.21
AD 4	450	0.22	0.28	0.33	0.46	0.52
AD 5	450	0.27	0.43	0.51	0.70	0.79
A 9	o/c	n/a	1.71	2.17	3.37	3.90
A 104	450	0.98	1.69	2.15	3.35	3.88
A 11	170	0.02	1.75	2.26	3.47	4.03
A 106	600	0.67	1.74	2.24	3.45	4.01
A 12	1400	2.28	0.70	0.71	0.73	0.73
dum 13	1320	5.25	0.20	0.23	0.32	0.36
A 13	1320	5.25	1.84	2.37	3.60	4.15
DUM 14	1350	5.47	0.63	0.73	1.01	1.14
A 14	1350	5.47	2.11	2.80	4.20	4.82
DUM 15	1350	5.47	0.68	0.79	1.10	1.24
A 15	1350	5.47	2.38	3.32	5.08	5.81
DUM 16	o/c	n/a	0.78	0.90	1.26	1.42
A 16	o/c	n/a	2.40	3.34	5.05	5.73
A 108	1600	6.18	2.70	3.95	6.10	6.77
AR 1	177	81.15	0.71	0.82	1.14	1.29
AR 2	220	81.15	1.01	1.19	1.66	1.88
AR 3	255	81.15	1.29	1.59	2.26	2.56
AR 4	308	81.15	1.77	2.19	3.15	3.59
AR 5	600	0.38	1.84	2.28	3.28	3.73
AR 6	600	0.38	1.99	2.43	3.49	3.97
AR 7	600	0.56	2.05	2.49	3.58	4.07

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 In 5 year (m3/s)	1 In 10 year (m3/s)	1 In 50 year (m3/s)	1 In 100 year (m3/s)
AR 8	600	1.53	2.08	2.53	3.63	4.13
AS 1	375	0.15	0.16	0.19	0.27	0.30
AS 2	600	0.56	0.37	0.44	0.61	0.69
AR 9	600	0.56	1.90	1.96	2.09	2.09
AVV 1	300	0.05	0.07	0.08	0.11	0.13
AVV 2	o/c	n/a	0.13	0.16	0.22	0.25
AVV 102	300	0.08	0.12	0.14	0.20	0.23
ASA 2	300	0.25	0.07	0.08	0.11	0.13
DUM 17	o/c	n/a	0.89	1.03	1.44	1.62
A 17	o/c	n/a	5.03	6.86	10.16	10.94
A 110	1600	11.23	5.67	7.53	11.35	12.16
A 18	1600	9.49	5.76	7.61	11.45	12.28
A 20	1450	10.77	5.76	7.60	11.42	12.26
DUM 21	1650	4.18	0.22	0.26	0.36	0.41
A 21	1650	4.18	5.95	7.81	11.69	12.58
DUM 22	1650	4.18	0.38	0.44	0.62	0.70
A 22	1650	4.18	6.23	8.07	12.09	13.04
DUM 23	1650	4.18	0.30	0.35	0.49	0.55
A 23	1650	4.18	6.43	8.23	12.33	13.38
B 1	375	0.10	0.11	0.13	0.18	0.20
B 2	375	0.11	0.24	0.29	0.40	0.45
B 3	375	0.08	0.24	0.28	0.39	0.44
B 4	375	0.15	0.24	0.28	0.39	0.44
B 5	375	0.18	0.29	0.33	0.46	0.52
BA 1	300	0.06	0.19	0.22	0.31	0.35
AE 1A	o/c	n/a	0.01	0.01	0.01	0.01
AE 2	525	0.13	2.25	4.03	8.15	9.19
A 24	1800	6.46	6.49	8.26	12.40	13.44
A 25	1800	6.30	6.58	6.66	6.99	7.08
AF 1	600	0.53	0.45	0.52	0.73	0.82
AF 2	600	0.41	0.44	0.52	0.73	0.82
DUM 26	1800	6.14	0.25	0.29	0.40	0.45
A 26	1800	6.14	6.56	6.80	7.39	7.53
AL 1	375	0.17	0.29	0.38	0.80	0.91
AL 2	600	0.33	0.30	0.46	1.00	1.19
AL 3	600	0.38	0.39	0.48	1.08	1.33
A 27	2000	4.17	6.83	7.19	8.53	8.98

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
A 28	1950	8.09	6.77	7.18	8.49	8.93
AK 2	225	0.04	0.10	0.12	0.16	0.18
AK 3	375	0.15	0.23	0.27	0.38	0.43
AK 4	600	0.47	0.36	0.44	0.61	0.68
AK 5	675	0.45	0.52	0.63	0.75	0.79
AM 1	375	0.20	0.08	0.09	0.13	0.15
AK 6	900	1.08	0.78	2.00	6.34	7.53
AK 7	1050	0.82	0.89	1.99	6.33	7.52
AK 8	1050	1.55	1.01	1.98	6.30	7.53
AK 9	1050	1.50	1.42	1.95	6.24	7.51
AK 10	1050	2.08	1.52	1.62	1.67	1.69
AK 11	o/c	n/a	1.52	1.91	6.23	7.45
AK 12	1050	2.67	1.52	1.91	6.16	7.44
AK 13	o/c	n/a	1.51	1.91	6.16	7.42
AK 14	1050	1.34	1.51	1.86	6.14	7.37
AP 2	900	1.45	1.01	1.17	1.64	1.85
APA 1	600	0.48	0.96	1.11	1.55	1.75
APA 2	o/c	n/a	0.94	1.10	1.54	1.74
AP 3	o/c	n/a	2.23	2.69	3.77	4.27
AP 4	o/c	n/a	2.46	2.98	4.16	4.70
APB 1	o/c	n/a	0.64	0.74	1.04	1.17
B 6	600	0.13	0.52	0.60	0.81	0.91
B 7	600	0.39	0.52	0.60	0.81	0.91
B 8	900	1.04	0.67	0.79	1.07	1.20
B 9	900	0.80	0.75	0.89	1.18	1.32
B 10	1050	1.27	0.86	0.98	1.33	1.46
D 1	225	0.02	0.07	0.08	0.11	0.12
D 2	225	0.03	0.11	0.13	0.18	0.20
D 3	225	0.04	0.28	0.33	0.46	0.52
D 4	300	0.05	0.28	0.33	0.46	0.52
D 5	300	0.06	0.31	0.37	0.52	0.58
D 6	300	0.06	0.06	0.06	0.06	0.06
D 7	300	0.07	0.06	0.06	0.06	0.06
CV 1	300	0.18	0.03	0.04	0.05	0.06
CV 2	300	0.21	0.08	0.09	0.13	0.14
CV 3	300	0.12	0.08	0.09	0.12	0.14
CV 4	300	0.30	0.08	0.09	0.12	0.14

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
C 1	600	0.38	0.15	0.18	0.25	0.28
C 2	600	0.17	0.15	0.18	0.25	0.28
C 3	675	0.42	0.49	0.57	0.79	0.90
CAB 1	300	0.09	0.03	0.03	0.05	0.05
CAB 2	300	0.17	2.67	3.10	3.37	3.51
CAD 1	285	0.07	0.23	0.49	1.44	1.91
CAD 102	300	0.11	0.16	0.42	1.37	1.84
CAB 3	o/c	n/a	2.82	3.69	5.02	5.65
CAB 102	300	0.14	2.80	3.68	5.00	5.63
CAB 4	300	0.14	2.78	3.67	4.98	5.62
CAB 5	375	0.15	2.78	3.66	4.96	5.60
CAC 1	300	0.11	0.23	0.26	0.37	0.42
CAC 2	375	0.17	0.23	0.26	0.37	0.41
CAC 3	375	0.17	0.22	0.26	0.36	0.41
CAC 4	375	0.19	0.27	0.32	0.44	0.50
CAA 1	300	0.12	0.03	0.04	0.06	0.06
CAA 2	300	0.11	0.07	0.08	0.11	0.13
CAB 6	450	0.54	2.90	3.86	5.32	6.01
CAA 3	600	0.46	2.93	3.89	5.39	6.08
CA 1	675	0.90	3.03	4.01	5.62	6.35
CA 2	675	0.56	3.02	4.00	5.61	6.33
C 4	900	0.89	3.19	4.26	6.21	7.03
DUM C4	900	0.89	0.14	0.16	0.23	0.26
DUM C5	900	1.39	0.25	0.30	0.42	0.47
C 5	900	1.39	3.26	4.37	6.39	7.24
C 6	1143	3.40	3.26	4.36	6.37	7.24
C 7	810	0.39	3.26	4.36	6.36	7.23
E 0	600	0.45	2.86	3.96	5.97	6.84
DUM C8	810	0.89	0.11	0.13	0.18	0.21
C 8	810	0.89	2.81	3.90	5.88	7.13
E 1	600	0.42	0.57	0.59	0.65	0.67
E 2	600	0.15	0.57	0.59	0.65	0.67
C 9	800	0.36	2.81	3.89	5.86	7.10
C 10	800	0.41	2.80	3.88	5.83	7.05
DUM C11	800	0.83	0.22	0.26	0.37	0.41
C 11	800	0.83	2.80	3.88	5.83	7.05
C 12	900	1.38	2.80	3.88	5.82	7.03

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
DUM C13	900	1.11	0.25	0.29	0.41	0.46
C 13	900	1.11	3.10	4.19	6.17	7.41
DUM C14	900	0.98	0.43	0.51	0.71	0.80
C 14	900	0.98	3.09	4.19	6.17	7.40
DUM C15	900	0.94	0.55	0.65	0.91	1.03
C 15	900	0.94	3.09	4.18	6.16	7.44
C 16	900	0.86	3.09	4.18	6.15	7.42
C 17	900	0.50	3.06	4.18	6.15	7.42
B 11	1200	1.69	3.05	4.17	6.14	7.42
B1 1	1050	0.85	1.36	2.48	4.45	5.73
B1 2	1200	1.55	1.03	2.47	4.44	5.72
E 3	680	0.24	0.15	0.15	0.15	0.15
DUE E4	680	0.52	0.11	0.13	0.18	0.21
E 4	680	0.52	0.15	0.15	0.15	0.15
DUE E5	750	0.55	0.26	0.30	0.42	0.47
E 5	750	0.55	0.15	0.15	0.15	0.15
DUE E6	750	0.37	0.34	0.40	0.56	0.64
E 6	750	0.37	0.15	0.15	0.15	0.15
DUE E7	750	0.31	0.59	0.69	0.96	1.08
E 7	750	0.31	0.15	0.15	0.15	0.15
EA 1	300	0.10	0.10	0.12	0.16	0.18
EA 2	300	0.33	0.10	0.11	0.16	0.18
E 7A	750	0.31	0.25	0.27	0.31	0.33
DUE E8	750	0.70	0.80	0.94	1.29	1.46
E 8	750	0.70	0.25	0.27	0.31	0.33
DUE E9	750	0.70	0.91	1.07	1.47	1.66
E 9	750	0.70	0.94	0.96	1.00	1.02
DUE E10	750	0.70	0.24	0.28	0.39	0.44
E 10	750	0.70	1.14	1.31	1.76	1.97
EC 1	300	0.03	0.35	0.43	0.63	0.71
DUE E11	750	0.98	0.31	0.37	0.51	0.58
E 11	686	1.93	1.49	1.74	2.37	2.66
EB 1	300	0.24	0.12	0.14	0.19	0.22
EB 2	300	0.27	0.28	0.33	0.46	0.52
EB 3	300	0.04	0.41	0.47	0.66	0.75
EB 4	300	0.03	0.43	0.49	0.69	0.78
DUE 12	1200	1.35	0.48	0.57	0.79	0.90

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA1-PIPED FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 50 year (m3/s)	1 in 100 year (m3/s)
E 12	1200	1.35	1.75	2.05	2.80	3.14
DUE E13	1200	1.62	0.57	0.66	0.93	1.05
E 13	1200	1.62	1.75	2.05	2.80	3.14
DUE E14	1200	1.72	0.73	0.86	1.19	1.36
E 14	1200	1.72	1.75	2.04	2.78	3.12
B1 3	1200	2.14	1.06	2.43	4.42	5.68
DUE E15	1350	4.77	0.93	1.10	1.53	1.73
E 15	o/c	n/a	3.28	3.88	5.20	6.31
B 12	1200	1.69	1.69	1.69	1.69	1.69
E 16	1500	7.79	4.97	5.56	6.89	7.98
E 18	1800	4.11	4.97	5.56	6.88	7.91
E 19	1800	4.11	4.96	5.54	6.88	7.89
E 20	o/c	n/a	4.96	5.54	6.86	7.88
E 21	1200	4.56	5.26	5.91	7.22	7.87
AN 1	525	0.33	0.76	0.88	1.22	1.38
AN 2	525	0.18	0.78	0.91	1.27	1.43
ANA 1	525	0.35	0.60	0.69	0.96	1.09
AN 3	900	0.89	1.34	1.59	2.21	2.49
E 22	1106	19.28	6.22	6.70	8.90	9.70
AP 5	1050	1.30	3.16	3.80	5.34	6.04
A 29	1950	4.27	7.13	9.03	14.25	15.91
E 24	1676	18.42	14.80	16.55	21.60	23.70

APPENDIX D Computed Discharges for Area 2 Stormwater System

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
A 1	300	0.193	0.096	0.116	0.182
A 2	300	0.184	0.143	0.174	0.276
A 3	300	0.189	0.17	0.207	0.325
A 4	300	0.08	0.199	0.236	0.362
A 5	300	0.174	0.141	0.154	0.2
A 6	300	0.155	0.362	0.45	0.688
A 7	300	0.145	0.441	0.554	0.875
A 8	300	0.157	0.46	0.575	0.912
A 9	300	0.205	0.469	0.588	0.94
AA 1	300	0.233	0.119	0.144	0.23
AA 2	300	0.198	0.251	0.307	0.493
AA 3	300	0.198	0.378	0.464	0.746
AA 4	300	0.197	0.286	0.306	0.372
A 10	400	0.228	0.667	0.811	1.217
A 11	400	0.361	0.93	1.129	1.824
A 12	450	0.494	0.98	1.199	1.94
A 13	600	1.01	0.991	1.218	1.978
A 14	600	0.981	1.02	1.215	1.978
AB 1	300	0.29	0.098	0.12	0.193
AB 2	300	0.244	0.32	0.392	0.634
AB 3	300	0.215	0.449	0.552	0.889
AB 4	300	0.172	0.613	0.706	1.134
A 15	600	0.789	1.544	1.774	2.779
A 16	600	0.476	1.614	1.886	2.841
A 17	750	1.1	1.73	2.178	3.118
A 18	750	1.1	1.961	2.504	3.747
A 19	760	1.183	2.259	2.756	4.332
AC 1	300	0.168	0.334	0.41	0.661
ACA 1	225	0.087	0.081	0.1	0.161
AC 2	300	0.148	0.388	0.476	0.742
AC 3	450	0.428	0.497	0.601	0.998
AC 4	450	0.135	0.652	0.759	1.253

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
A 20	760	1.095	3.209	3.776	5.943
A 21	760	1	3.235	3.802	5.988
A 22	910	1.445	3.237	3.809	5.998
AC1 1	1050	3.742	3.495	4.365	7.053
AC1 2	1050	3.175	4.299	4.805	8.02
AD 1	300	0.127	0.122	0.15	0.242
AD 2	300	0.197	0.136	0.166	0.269
AD 3	300	0.193	0.231	0.282	0.455
AD 4	450	0.737	0.267	0.325	0.522
AD 5	900	1.569	0.302	0.369	0.59
AD 6	900	1.109	0.496	0.606	0.969
A 23	1360	2.984	7.661	9.072	3.501
AD1 5	450	0	0	0	0
AE 1	300	0.246	0.063	0.077	0.125
AE 2	375	0.259	0.159	0.195	0.316
AE 2D	404	19.314	0.49	0.602	0.924
AF 1	300	0.237	0.077	0.095	0.153
AF 2	300	0.207	0.076	0.094	0.151
AF 3	300	0.088	0.076	0.094	0.151
AF 4	300	0.109	0.076	0.088	0.134
AF 5	475	0.383	0.076	0.088	0.134
AF 5D	354	17.882	0.358	0.44	0.66
AG 1	225	0.056	0.576	0.707	1.141
AG 2	300	0.121	0.607	0.745	1.202
AH 1	375	0.166	0.114	0.144	0.242
AH 2	525	0.527	0.302	0.376	0.553
AG 2D	1520	4.488	1.574	1.933	3.116
A 24	1512	16.324	5.393	5.938	7.638
AT 1	300	0.084	1.176	1.443	2.33
AT 2	1200	3.379	4.099	5.034	8.112
ATB 0	300	0	0	0	0
AT 3	1000	2.713	4.152	5.099	8.228

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
ATA 1	300	0.084	0.697	0.842	1.326
AT 4	900	1.569	4.111	4.402	5.371
ATB 1	1200	3.379	3.831	5.041	9.025
AT 5	900	1.569	5.109	5.267	5.451
AU 1	400	0.18	0.091	0.11	0.173
AU 2	600	0.532	0.171	0.206	0.325
AU 3	300	0.084	0.171	0.206	0.325
AT 6	300	0	6.804	9.482	6.749
AV 1	300	0.084	0.162	0.195	0.308
AV 2	450	0.247	0.162	0.195	0.308
AV 3	600	0.532	0.351	0.424	0.632
AV 4	600	0	0.587	0.721	1.101
A 241	1879	19.314	10.21	11.127	2.929
AV 5	900	1.569	0.224	0.271	0.384
A 25	1963	17.882	10.403	11.361	3.31
AW 1	300	0.084	0.066	0.08	0.126
AW 2	300	0.084	0.066	0.08	0.126
AW 3	450	0.247	0.13	0.16	0.261
AH 4	600	1.166	0.384	0.476	0.692
A 26	1520	4.488	10.447	11.441	3.31
B 1	300	0.219	0.126	0.155	0.25
B 2	300	0.155	0.125	0.153	0.248
B 3	300	0.159	0.244	0.3	0.485
B 4	375	0.488	0.292	0.359	0.58
B 5	450	0.482	0.365	0.448	0.721
B 6	525	1.118	0.487	0.598	0.8
B 7	525	1.202	0.747	0.918	1.26
BA 1	300	0.219	0.085	0.105	0.169
BA 2	300	0.189	0.113	0.138	0.223
BA 3	300	0.21	0.144	0.177	0.285
BA1 1	300	0.148	0.234	0.287	0.463
BA1 2	300	0.148	0.278	0.341	0.549

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
BA1 3	375	0.268	0.286	0.351	0.566
BA 4	375	0.381	0.396	0.456	0.726
B 8	525	0.527	1.19	1.402	1.793
BB 1	300	0.119	0.059	0.072	0.117
BB 2	300	0.29	0.189	0.232	0.374
BB 3	300	0.152	0.235	0.288	0.457
B 9	760	1.548	1.489	1.782	2.367
BD 1	225	0.048	0.244	0.3	0.484
BD 2	225	0.048	0.357	0.438	0.706
B 10	760	1.548	1.844	1.986	2.254
B 11	760	1.642	1.844	2.264	3.408
BE 1	225	0.114	0.033	0.04	0.064
BE 2	225	0.098	0.099	0.122	0.196
BDM 13D	1050	1.296	0.224	0.275	0.443
B 12	open ~~759~~ channel	~~8.83~~	1.969	2.477	3.746
B 13	1050	1.296	1.969	2.477	3.732
A 26P	1050	0	10.423	11.437	3.289
A 27	1380	1.551	6.124	8.794	9.302
A 28	1350	3.271	6.124	8.794	9.302
A 29	1350	7.314	3.271	3.271	3.271
A 30	1350	1.463	3.271	3.271	3.271
A 31	1520	2.007	1.463	1.463	1.463
ADM 27D	1380	1.551	0.114	0.138	0.22
ADM 28D	1350	3.271	0.168	0.204	0.323
ADM 29D	1350	7.314	0.226	0.274	0.435
ADM 30D	1350	1.463	0.226	0.274	0.435
AH 4D	600	1.166	0.627	0.771	1.167
ADM 311	911	4.426	0.852	1.044	1.601
A 311	1455	4.426	2.221	2.498	3.064
A 32	1520	2.15	2.219	2.494	3.055
A 33	1263	14.451	3.271	3.271	3.86
A 34	1544	8.829	3.271	3.271	3.834

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
ADM 32D	1520	2.15	0.239	0.29	0.46
ADM 33D	628	14.451	0.821	0.995	1.578
ADM 34D	832	8.829	1.011	1.225	1.942
ADM 35D	1520	1.36	1.226	1.487	2.357
A 35	1520	1.36	6.124	8.794	9.302
B 14	1050	1.296	1.969	2.477	3.732
B 15	1050	1.058	1.969	2.444	3.732
B 16	1050	1.058	1.969	2.204	3.709
B 17	1050	1.058	1.969	2.18	3.709
B 18	1220	2.954	1.909	2.18	3.678
C 1	225	0.136	0.077	0.095	0.153
C 2	225	0.138	0.077	0.095	0.153
C 3	225	0.094	0.119	0.146	0.224
C 4	300	0.202	0.119	0.146	0.221
C 5	300	0.182	0.368	0.446	0.72
C 6	450	0.53	0.487	0.556	0.786
CA 1	225	0.094	0.061	0.075	0.121
CA 2	300	0.225	0.147	0.181	0.267
CA 3	300	0.205	0.328	0.403	0.59
CA 4	375	0.372	0.506	0.622	0.939
CA 5	450	0.59	0.676	0.874	1.474
CA 6	450	0.383	0.783	0.923	1.624
C 7	450	0.332	1.357	1.532	2.299
CB 1	300	0.119	0.328	0.402	0.649
CB 2	300	0.195	0.373	0.458	0.738
CB 3	375	0.288	0.387	0.476	0.769
C 8	450	0.303	1.699	1.925	3.088
CC 1	300	0.103	0.151	0.188	0.308
CC 2	300	0.239	0.186	0.231	0.381
CC 3	300	0.198	0.217	0.27	0.427
C 9	760	1.87	1.915	2.296	3.376
C 10	760	1.414	1.911	2.307	3.372

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
C 11	900	1.569	1.91	2.267	3.363
CD 1	300	0.223	0.784	0.974	1.605
CD 2	300	0.308	0.935	1.162	1.913
C 12	375	0.173	2.517	2.778	3.945
CE 1	300	0.135	0.126	0.155	0.306
CE 2	300	0.135	0.246	0.299	0.52
C 13	600	1.024	2.799	3.123	4.531
C 14	760	1.264	2.791	3.116	4.527
C 15	1215	2.209	2.966	3.33	4.811
C 16	1036	17.77	2.536	2.641	2.906
CF 1	300	0.202	0.651	0.799	1.29
CF 1D	134	31.613	0.304	0.327	0.403
C 17	1581	9.28	3.275	3.548	4.37
CG 1	300	0.202	0.468	0.574	0.927
CG 1D	122	31.613	0.259	0.272	0.315
C 18	636	31.613	3.775	4.167	5.374
CDM 19D	738	11.784	0.722	0.887	1.431
C 19	1642	11.784	4.318	4.917	6.584
CDM 20D	480	11.784	0.297	0.361	0.572
C 20	1671	11.784	4.499	5.182	7.014
CDM 21D	881	11.784	1.056	1.28	2.029
C 21	1758	11.784	5.065	6.086	8.539
CDM 22D	768	11.784	0.786	0.954	1.512
C 22	1804	11.784	5.386	6.724	9.685
C 221	1000	4.397	5.384	6.702	9.666
BDM 18D	1200	0	0	0	0
BF 1	300	0.059	0.26	0.32	0.516
BF 1D	300	0.059	0.347	0.426	0.688
BG 1	300	0.059	0.265	0.325	0.524
BG 1D	300	0.059	0.327	0.402	0.648
BH 1	300	0.059	0.051	0.062	0.101
BH 1D	300	0.059	0.1	0.12	0.19

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
BDM 17D	1050	1.058	0.263	0.296	0.405
BDM 18D	1220	2.954	0.711	0.845	1.291
BI 1	225	0.035	0.772	1.14	2.626
BI 2	300	0.065	0.737	1.14	2.626
BI 2D	300	0.065	0.707	1.132	2.625
BJ 1	225	0.062	0.084	0.102	0.163
BJ 1D	1215	2.209	0.084	0.102	0.162
BDM 19D	1200	3.022	1.322	1.654	2.691
B 19	1200	3.022	2.44	2.857	5.616
B 20	1215	2.209	2.437	2.856	5.6
BDM 21D	1000	1.408	0.776	0.941	1.491
B 21	1000	1.408	8.091	9.839	4.294
B 21D	1000	1.408	1.408	1.408	1.408
A 36	1900	43.095	11.056	13.527	6.975
D 1	300	0.084	0.235	0.283	0.446
D 2	300	0.133	0.198	0.221	0.3
D 3	375	0.215	0.412	0.48	0.707
D 4	525	0.391	0.63	0.762	1.197
D 5	525	0.391	0.678	0.83	1.305
DA 1	375	0.068	0.046	0.055	0.087
DA 2	375	0.048	0.153	0.185	0.28
DA 3	375	0.526	0.135	0.153	0.213
D 6	600	0.376	0.767	0.917	1.414
D 8	680	0.407	0.767	0.917	1.414
D 13	910	1.252	1.077	1.254	1.825
D 17	910	1.533	1.705	1.982	2.932
DB 1	450	0.221	0.199	0.25	0.421
DB 4	525	0.373	0.333	0.389	0.522
D 19	910	1.143	2.227	2.585	3.646
DDM 20D	910	2.168	0.585	0.707	1.114
D 20	910	2.168	2.607	3.045	4.302
DDM 21D	1650	2.676	0.319	0.385	0.607

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
D 21	1650	2.676	2.77	3.206	4.555
DDM 22D	89	37.404	0.182	0.22	0.347
D 22	479	37.404	2.845	3.29	4.676
D 22D	441	42.748	2.845	3.287	4.676
F 1	450	0.247	0.241	0.292	0.459
F 2	450	0.358	0.318	0.349	0.551
F 3	450	0.737	0.364	0.405	0.578
FA1 1	300	0.092	0.084	0.102	0.16
FA1 2	300	0.17	0.206	0.243	0.351
FA1 3	450	0.322	0.206	0.243	0.351
FA1 4	525	0.773	0.495	0.566	0.873
FA1 5	300	0.138	0.683	0.792	1.141
FA1 6	300	0.18	0.74	0.861	1.249
FA1 7	300	0.17	0.815	0.952	1.403
FA1 8	300	0.119	0.827	0.966	1.448
FA1 9	300	0.138	0.827	0.966	1.448
F 4	800	0.725	1.042	1.258	1.89
F 5	800	0.81	1.34	1.524	2.291
FA 1	600	0.753	0.171	0.206	0.325
FA 2	700	0.672	0.347	0.42	0.663
F 6	1015	0.684	2.242	2.558	3.889
F 6A	1669	5.892	2.242	2.558	3.889
F 7	1162	17.676	2.922	3.42	5.062
F 8	910	2.19	3.027	3.59	5.254
FB 1	225	0.035	0.171	0.206	0.325
FB 2	450	0.313	0.238	0.287	0.453
FB 3	450	0.506	0.237	0.286	0.453
FB 4	910	0.723	0.316	0.382	0.584
FB 5	910	1.252	0.575	0.695	1.019
FB 6	910	1.695	0.825	0.997	1.496
F 10	2500	2.731	3.772	4.541	6.925
F 11	1060	3.678	3.859	4.646	7.091

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
FC 3	300	0.182	0.057	0.069	0.108
FC 2	300	0.182	0.113	0.136	0.215
FC 1	300	0.124	0.259	0.313	0.463
FC 1	300	0.075	0.712	0.86	1.354
FC 2	300	0.096	1.17	1.416	2.222
FC 3	375	0.152	1.188	1.438	2.257
FCA 1	300	0.119	0.221	0.267	0.42
FCB 1	300	0.084	0.155	0.187	0.295
FCB 2	450	0.341	0.306	0.37	0.582
FC 4	600	0.694	1.547	1.87	3.068
FCC 1	225	0.055	0.158	0.196	0.321
FCC 2	375	0.136	0.055	0.055	0.055
FC 5	600	0.476	1.621	1.968	3.182
FC 6	841	20.202	1.635	1.986	3.195
FC 7	901	17.816	1.676	2.002	3.191
FE 1	375	0.369	0.194	0.234	0.368
FE 2	450	0.421	0.267	0.323	0.509
FE 3	450	0.449	0.336	0.406	0.586
FE 4	525	0.553	1.036	1.252	1.792
FE 5	525	0.167	0.553	0.553	0.553
FE 6	600	0.841	0.194	0.2	0.219
FEA 1	525	0.833	0.547	0.66	1.04
FEA 2	600	0.996	0.621	0.751	1.168
FEA 3	600	0.476	1.473	1.815	2.832
FEA 4	600	0.673	1.531	1.885	2.944
FE 7	1050	1.833	0.939	0.96	1.029
FE 8	1050	1.4	1.733	2.095	3.178
FE 9	1050	3.086	1.711	2.108	3.199
FE 10	1050	1.296	1.71	2.107	3.086
Feb-01	300	0.084	0.875	1.056	1.664
Feb-02	300	0.241	0.084	0.084	0.084
Feb-03	300	0.08	0.234	0.265	0.37

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
Feb-04	300	0.046	0.264	0.301	0.426
Feb-05	950	11.784	1.246	1.506	2.368
FE 11	720	1.311	2.922	3.262	5.088
F 12	1780	18.632	8.249	9.768	4.994
F 121	1580	20.231	8.237	9.741	4.965
FF 1	491	24.998	0.661	0.798	1.257
FF 2	360	0.131	1.132	1.373	2.177
FF 3	360	0.339	1.072	1.316	2.104
F 13	1568	27.636	9.085	10.799	6.593
FDM 14D	341	16.665	0.216	0.261	0.412
F 14	1950	16.665	9.159	10.875	6.716
FDM 15D	1800	8.268	0.421	0.509	0.802
F 15	1800	8.268	9.298	10.997	6.931
FDM 16D	310	5.892	0.064	0.077	0.121
F 16	2500	5.892	9.352	11	6.998
F 16D	2500	5.892	9.352	11	6.998
A 37	1289	42.249	22.738	26.728	8.437
G 1	255	0.038	0.039	0.047	0.074
G 4	450	0.135	0.122	0.143	0.22
GA 1	300	0.065	0.148	0.179	0.282
G 5	450	0.156	0.323	0.395	0.57
G 6	600	0.291	0.243	0.261	0.321
G 7	910	0.885	0.365	0.409	0.534
G 8	910	1.022	0.365	0.409	0.529
G 8D	910	1.022	0.644	0.746	1.079
ADM 38D	2000	0	0	0	0
A 38	1288	42.249	22.703	26.697	8.42
A 39	1288	42.249	22.701	26.696	8.418
H 1	300	0.088	0.013	0.015	0.024
H 2	600	0.445	0.047	0.056	0.089
H 3	600	0.607	0.102	0.123	0.194
H 3D	600	0.607	0.636	0.768	1.21

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
A 40	1287	42.249	22.68	26.672	8.4
J 1	300	0.103	0.087	0.105	0.165
J 2	375	0.118	0.147	0.176	0.224
J 3	375	0.068	0.168	0.207	0.278
J 4	400	0.18	0.195	0.222	0.319
J 5	450	0.5	0.397	0.46	0.678
J 6	600	0.291	0.669	0.788	1.02
J 7	600	0.291	0.827	0.979	1.496
JA 1	300	0.092	0.036	0.044	0.069
J 8	600	0.412	0.874	1.036	1.587
J 9	600	0.291	0.933	1.107	1.7
JB 1	200	0.049	0.013	0.015	0.024
J 10	600	0.291	0.937	1.112	1.708
J 10D	600	0.291	0.966	1.167	1.79
A 41	2000	35.746	22.827	26.883	8.754
L 1	225	0.041	0.219	0.264	0.416
L 2	300	0.046	0.295	0.357	0.562
LA 1	225	0.033	0.064	0.077	0.121
L 3	300	0.053	0.404	0.488	0.767
L 4	300	0.065	0.434	0.524	0.824
L 4D	300	0.065	0.434	0.524	0.824
N 1	300	0.13	0.435	0.525	0.828
N 2	375	0.263	0.752	0.909	1.431
N 3	375	0.144	1.159	1.4	2.203
N 4	600	1.103	1.582	1.912	3.005
NA 1	600	0.476	0.333	0.402	0.633
NA 2	600	0.532	0.475	0.574	0.823
NB 1	300	0.037	0.011	0.014	0.022
NB 2	300	0.084	0.033	0.04	0.064
NA 3	600	0.476	0.644	0.747	0.994
N 5	1015	0.684	2.3	2.68	3.94
K 1	450	0.271	0.148	0.179	0.282

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
K 2	450	0.175	0.146	0.176	0.271
K 3	600	0.168	0.287	0.345	0.452
K 4	600	0.238	0.294	0.32	0.463
K 5	600	0.412	0.311	0.348	0.494
KA 1	300	0.088	0.046	0.055	0.087
KA 2	300	0.096	0.094	0.114	0.18
K 6	600	0.376	0.44	0.481	0.651
K 7	600	0.445	1.933	2.501	4.364
K 7D	600	0.445	1.964	2.543	4.393
ADM 39D	2000	31.262	1.908	2.072	2.557
ADM 42D	376	48.852	3.952	4.908	7.75
A 42	1312	48.852	26.771	31.747	6.438
M 1	300	0.127	0.048	0.058	0.091
M 4	300	0.08	0.129	0.155	0.245
M 4D	300	0.08	0.228	0.274	0.431
ADM 43D	2500	0	0	0	0
A 43	1312	48.852	26.766	31.729	6.434
ADM 44D	2000	20.261	0.3	0.362	0.57
A 44	2000	20.261	26.886	31.903	6.734
ADM 45D	2500	0	0	0	0
N 6	1015	1.367	0.77	0.788	0.848
N 7	888	4.12	1.169	1.27	1.608
N 8	1215	1.104	1.255	1.373	1.765
N 9	1215	5.844	1.174	1.331	1.813
N 10	830	1.484	1.173	1.331	1.812
N 10D	830	1.484	1.568	1.664	2.131
A 45	2000	20.261	26.875	31.876	6.731
P 4	300	0.116	0.2	0.242	0.381
P 4D	300	0.116	0.147	0.154	0.176
A 46	2000	20.261	26.875	31.876	6.731
ADM 47D	2000	35.746	1.649	1.66	1.695
A 47	1316	48.852	26.875	31.876	6.771

WEL-STH CATCHMENT MANAGEMENT PLAN

AREA2 FLOW DETAILS					
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m3/s)	1 in 10 year (m3/s)	1 in 100 year (m3/s)
Q 1	300	0.096	0.278	0.336	0.529
Q 2	300	0.174	0.355	0.429	0.674
Q 2D	2500	49.694	0.412	0.497	0.783
ADM 48D	2500	49.694	2.125	2.311	3.083
A 48	2500	49.694	28.019	33.248	8.732
A 49	1354	66.429	28.015	33.245	8.729

APPENDIX E Hydraulic Modelling of Area 1 Foulwater System

1. INTRODUCTION

This appendix describes the modelling process used to assess the performance of the existing foulwater network in Area 1 of the WEL-STH foulwater catchment (Plans 104, 600 and 601). Area 2 (Carbine Road) has been assessed previously and is the subject of a separate report (*Carbine Road Sewer Investigation*, 1996). The Carbine Road study was more detailed than that for Area 1 and included an inflow/infiltration assessment. Reference is made here to the Carbine Road study where appropriate.

The purpose of modelling Area 1 was to assess the performance of the existing pipe network for the existing development (ED), as well as Maximum Probable Development (MPD) and Ultimate Development (UD). The MPD model is based on maximum residential and industrial development as per the current Auckland District Plan. The UD model was created from the MPD residential parameters along with maximum loadings for industrial flows as per the Auckland City Sanitary Sewer Design Manual (SSDM). The performance parameters assessed were the capacity of each pipe element and their potential for self-cleansing.

2. APPROACH

The foulwater system was modelled using the MOUSE (Version 3.2) software package. This product of the Danish Hydraulic Institute is widely utilised internationally for this type of application.

The modelling included sections of the Water Care Services (WCS) Sewers, where appropriate, so that their effect on the WEL-STH foulwater system could be accounted for. Also, the two temporary flow monitors were located on the WCS sewers (Mount Wellington and Penrose Sewers respectively). The models therefore implicitly accounted for backwater effects from the WCS Sewers.

The flow monitoring data was utilised to construct and calibrate a model with parameters which equate to the ED foulwater loading. The parameters were then modified to give a model with which to assess the system for MPD. Then, in order to stress the system further, another model was created using maximum input parameters for industrial flows and the MPD parameters for the residential zones. The latter model is referred to here as the UD model.

3. DESCRIPTION

3.1 Pipe Network

The foulwater catchment was modelled as three sub-systems (Mount Wellington, Penrose and Sylvia Park Road) which relate to the three WCS Sewers within the study area (Plans 600 and 601). The Mount Wellington and Penrose sub-systems are both located at the upstream end of the respective WCS Sewers. The Sylvia Park Road system is relatively small and drains to a pump station which discharges to the WCS Sewer near Great South Road.

The WEL-STH Methods Report used a particular naming system for the subcatchments within the study area. The revised subcatchment naming is presented in Table E.1.

The modelled network was based on the plans supplied by Metrowater. Manhole and pipe details for the relevant WCS Sewers were supplied by Water Care Services. The WCS manhole numbering system was retained for the respective trunk sewers.

The location and naming of the subcatchments along with the model structure is presented in Plans 600 and 601.

Not all of the pipes and manholes have been included in the model since there needs to be a minimum area for a node (particularly the first node on a lateral line) to generate sufficient flow. If the flow is too small then the errors in the model algorithms are greater than the simulated foulwater volume, leading to model instability. Some manholes have been excluded because they are close together and the short pipe length would require unrealistically small time steps to remove the associated velocity errors.

The MOUSE models for the Mount Wellington and Penrose catchments have been constructed in sections. This optimised the operation of MOUSE since the recommended maximum number of nodes is 200, with smaller models being more efficient with regards to run time and debugging. The models were overlapped to account for the interaction between adjoining systems.

The Mount Wellington area was modelled in two sections. The first section included the network that drains to MH18 at the head of the Mount Wellington WCS Sewer. The second section had as an input the results obtained at MH18 and included the Auckland City and WCS pipework from MH18 to MH11. Flow monitoring was conducted at MH11 as this is the sole outlet for this part of the network.

The Penrose study area was modelled in six sections. Five of the sections were for Auckland City networks that drain to WCS manholes. The sixth section combined these five smaller sections with the WCS Sewer and other relatively small peripheral systems. The flow monitoring site was MH06.

3.2 Pipe Roughness

The Manning's 'n' value was assessed on site with a dye test between two manholes located on Autumn Place (AA160 to AA150), conducted on 15 May 1997. The results of the test gave a Manning's 'n' of 0.0133 for a 225mm diameter ceramic pipe. This is consistent with the expected value of 0.0143 for ceramic pipe and was utilised for the entire model. Consequently there will be an averaging effect on the modelled velocities as compared to actual local variations in roughness.

3.3 Pumping Stations

There are nine pumping stations within Area 1. They are all located within the Mount Wellington model area except for one which is located in the Sylvia Park Road catchment. The pumping station labels have been prefixed PS, with the locations shown on Plans 600 and 601. A list of the pumping stations and their respective labels is presented in Table E.2.

Table E.2 Pumping Stations

Label	Pumping Station
PS1	Ballarat Street
PS2	McDonald Crescent
PS3	Stanhope Road
PS4	Harris Road
PS5	Motu Place
PS6	Ferndale Road
PS7	Banks Road
PS15	Sylvia Park Road
PS16	Penrose Road

Details of the construction of the pumping stations were obtained from Metrowater and Auckland City records. The operation of all Auckland City pumping stations is monitored and recorded in a database via a telemetry system.

All of the pump stations within the study area have emergency storage. This storage has been included only at PS3, where the pipe gradients were such that the storage contributed to the operation of the pump as well as local backwater effects.

3.4 Boundary Conditions

A selection of the monitored discharge data for MH11 (Mount Wellington) and MH06 (Penrose), which did not include rainfall inflow, was analysed using a moving average technique to produce a representative daily Average Dry Weather Flow profile. This was input as a boundary condition for the relevant model.

For residential areas the number of dwellings per model node were counted and the Population Equivalent (PE) calculated based on Auckland City SSDM parameters of 2.8 PE/house and 2.4 PE/unit. The number of dwellings were determined from aerial photographs flown in 1993. For the model runs for MPD and UD, a rate of 2.8 PE/dwelling was used. The maximum PE/ha for residential areas was based on the zoning and the Auckland District Plan, with 56 PE/ha used for Residential 5 and 64 PE/ha for Residential 6a. These same values were utilised in the Carbine Road Foulwater Study.

Water consumption data, Trade Waste Consent data and Auckland City SSDM parameters were utilised in the first instance to obtain the equivalent PE/ha figures to assess industrial flows. The order of preference was Trade Waste, water consumption then Auckland City SSDM parameters (initially using 17,500 l/s/ha) where no other data was available. For trade waste Consent data (dated November 1995) there are two figures available (m3/day and l/s), with the larger of the two values utilised here. The water consumption data (up to February 1995) was averaged to give an equivalent daily volumetric flow rate.

In the Carbine Road Foulwater Study a figure of 17,500 l/s/ha was used to give a PE/ha of 88, which incorporates a factor of 200 l/PE/day (residential foulwater discharge). For the WEL-STH study, a figure of 105 l/PE/day has been utilised as per the SSDM, which is the average of 80 and 130 l/PE/day. These values relate to non-residential loadings for an "industrial day worker".

The above calculation using 5000 l/s/ha and 105 l/PE/day gives an ED and MPD factor of 48 PE/ha. Using a value of 17,500 l/s/ha equates to 167 PE/ha which was quite often higher than when the Trade Waste and water consumption data was used. The latter data were assessed individually and sometimes reduced proportionally but generally retained at the higher (conservative) value. The UD model utilised 17,500 l/s/ha for the majority of industrial flows.

The foulwater modelling for Area 2 (Carbine Road) was a relatively more detailed study than has been performed for Area 1. Amongst other things it included an infiltration assessment. The results of the analysis indicated an increase in the foulwater baseflow by up to 2.5 times depending on the particular pipe reach and rainstorm.

The modelling performed for Area 1 did not specifically include inflow nor infiltration. The model was however run at higher flows than the monitored rate to stress the system (UD scenario) to a level that simulated the effects of inflow and infiltration. The increase in flow attributed to infiltration (detailed below) was consistent with the results found in the Carbine Road Study. This is a reasonable approach to this issue given that the age of the foulwater network is similar for both Area 1 and Area 2.

The variation of flow follows a daily cycle which is based on the Average Dry Weather Flow (ADWF) with a Peaking Factor (2.5) to give the Peak Dry Weather Flow (PDWF). The PDWF has an Infiltration Factor which is specified in the SSDM as 2 times the PDWF, giving the Peak Wet Weather Flow (PWWF). This in turn gives a combined factoring of 5 times the ADWF to account for both the diurnal peak and rainfall infiltration.

In this analysis of Area 1 the daily DWF profile used for the input to the models was based on the monitoring data, consequently the daily Peaking Factor was incorporated as a model input. From the monitoring data the daily Peaking Factor for the Mount Wellington and Penrose Branches of 2.4 and 1.6 times the average flow respectively. The output data from the UD model gives a PWWF for the Mount Wellington Branch, equivalent to 2.4 times the PDWF. For the Penrose Branch the PWWF is 2.6 times the PDWF in the UD model. These factors equate, for the Mount Wellington Branch, as a total factor of 5.8 and for the Penrose Branch of 4.2 times the ADWF. These values are within the order of magnitude of those recommended in the SSDM, consequently the UD model results were used to assess the system capacity including inflow and infiltration.

4. CALIBRATION

4.1 Methodology

The flow monitoring site for the Mount Wellington model was located at MH11 on the Mount Wellington WCS Sewer. Two weeks of monitoring data, from 22 November 1996 to 5 December 1996 inclusive, was available in which there were several rainfall events. The monitoring data that did not include evidence of inflow and infiltration was analysed to give the DWF parameters for input as a boundary condition for the modelling.

For the Penrose study area the monitoring site was located at MH06 on the Penrose Watercare Services Sewer. The monitoring period was from 7 May to 21 May 1996 inclusive.

The variables that affect the volume generated by the model are node area (ha), population density (PE/ha) and foulwater loading (m3/day/PE). The catchment area is fixed for each node, consequently the other two variables are available for the calibration of daily foulwater volumes. The peak daily flow rate is influenced by the diurnal curve which is input as a model boundary condition.

When the models were run initially the output volume was approximately eight times the monitored flow. This was using the initial industrial flow factor of 17500 l/s/ha. The calibration to fit the monitoring data required significant reduction in the input flows.

Several different model scenarios were run in order to assess model sensitivity to PE/ha and m3/day/ha. These model scenarios were important because a change in the latter parameter gives an even increase of daily volume across the whole model area, with the distribution in proportion to the individual nodal PE/ha values. A change in the PE/ha at individual nodes gives a change in the location within the model where the flow is generated. This therefore influences the distribution of flow within the pipework. Consequently some pipes in a residential area may be sufficient as it appears that a 150mm diameter pipe can accommodate most residential flows. Within the industrial areas where the significant inflow is occurring the pipe dimensions may be more critical.

It was found that the volume generated by the model is more sensitive to population density (PE/ha) than the foulwater loading (m3/day/PE). During the calibration process for the ED scenario the 17,500 l/s/ha rate was reduced where relevant to 5000 l/s/ha, resulting in a corresponding decrease in the nodal PE/ha value. This value is reasonable given that the majority of industry within the study area is "dry" and the monitoring data was for average dry weather flow conditions.

4.2 Results

The calibration results for the Mount Wellington MH11 manhole are presented in Figure E.1. The plot presents the averaged monitoring data, the average of dry weather flow for the monitoring period, two sets of daily monitoring data and the output of the calibrated ED model.

The oscillation of the model output is due to the operation of pumping stations. This effect was apparent in the monitoring data but was smoothed in the analysis to obtain the Dry Weather Flow. The ADWF is the average of the smoothed monitoring data.

There is a good correlation between the model output for the ED scenario and the monitoring data for both the peak flow and total daily volume. The model output is within the range of recorded data from 7 hours onwards. The difference during the early data (up to 7 hours) is due to numerical instabilities within the model attributable to the low flow input. During this initial period the low volume generated is greater than the errors within the model algorithms and the base flow which the model automatically allocates to all pipes within the modelled system. The early time anomaly is not relevant to this study as the peak daily flow is the parameter used here to assess the capacity of the system.

The plot of monitoring data and ED model output for MH06 (Penrose Model) is presented in Figure E.2. The plot shows a good correlation between the monitored discharge data and the modelled discharge output for both peak flow and daily volume. The modelled velocity and foulwater level at MH06 also correlated well with these monitored parameters. The success of the correlation is related to the averaging that was performed on the monitoring data to give the daily DWF input for the model.

For the Mount Wellington model the final calibrated foulwater loading (m3/day/ha) had an average value of 0.073 m3/day/ha. For the Penrose model the average value equalled 0.095 m3/day/ha. These values compare favourably with the Auckland City SSDM range from 12 l/person/day (Entertainment Facility) to 780 l/bed/day (Hospitals). The difference in values reflects the influence of the population density (PE/ha). The values obtained during calibration are within an acceptable range.

The Sylvia Park Road model was constructed utilising parameters obtained from the Mount Wellington and Penrose models. The output from the model was compared to the Sylvia Park Road pumping station flow data obtained from the telemetry database. There was a good correlation between the two sets of data.

4.3 Verification

In the drainage questionnaire (November 1995) there were reports of odour problems associated with the drainage system near 29 Harwood Road, 3 Southdown Lane and 6 Pacific Rise (Plan 102). The sites at Harwood Road and Southdown Lane were inspected after modelling, confirming the possibility of self-cleansing problems.

The other sites that were inspected (Plans 610 and 611) to verify the model results for possible self-cleansing problems were located in Alana Place (CE100), Harwood Road (AB020), Ferndale Road (AA360 and AA370), Leonard Road (AS010), Prescott Road (AA080), Hugo Johnston Drive (AA180 and AA190), Autumn Place (AA150 and AA160), Southdown Lane (AA040) and Industry Road (AA040).

4.4 Summary

Based on the calibration and verification of the ED model it is considered that the model parameters are realistic and that the model is fit for the purpose of simulating the performance of the system. A summary of the adopted foulwater loadings (m3/day/ha) is presented in Table E.3.

Table E.3 Adopted Foulwater Loadings

Model	Volumetric Flow Rate (m3/day/ha)
Mount Wellington	0.073
Penrose	0.095
Sylvia Park Road	0.090

5. SIMULATIONS

After successfully calibrating the models, simulations were then performed for the MPD (Maximum Probable Development) and UD (Ultimate Development) scenarios.

During the calibration phase some initial model runs generated significantly more output volume (up to eight times) than the monitored flow. This was due to the conservative approach initially adopted when assessing the industrial flow input parameters. This calibration process was effectively a sensitivity analysis of the existing network for flows greater than would normally be expected. It is worth noting that at these high flow rates the system performed well with only a few places where pressurising and surcharging occurred. Also, the velocity of flow was only slightly greater than that for the UD scenario.

Table E.4 presents a summary of the input and output parameters utilised for the model simulations.

The output data for the UD model gives a maximum daily flow of 32 l/s for the Mount Wellington Branch, which is 2.4 times the PDWF. For the Penrose Branch the maximum daily flow is 68 l/s, which is 2.6 times the PDWF. With the Sylvia Park UD model the maximum daily flow is 55 l/s which is 2.6 times the PDWF. The UD model results have been utilised here to assess system performance.

With the ED and MPD model scenarios the discharges in some lateral pipes are relatively low, giving correspondingly low velocities. This effect is also seen in the UD model, in that a low daily flow (such as during the morning phase of the diurnal curve) the velocity curve has a flatline response until the discharge accumulates sufficiently to allow an output from the computation. The pumping peaks are also evident over the base velocity.

The SSDM recommends a minimum self-cleansing velocity of 0.65 m/s, with 0.75 m/s desirable in the upper reaches. The velocity results from the ED and UD model scenarios are presented in Appendix F, with the latter also presented on Plans 610 and 611. The maximum velocity has been divided into two groups, the first between 0.4 and 0.65 m/s and the second below 0.4 m/s. This gives a relative assessment of the potential for self-cleansing.

The UD model results have also been utilised to assess capacity issues. The maximum daily discharge has been expressed as a proportion of the full pipe discharge. This data is presented in Appendix F.

6. MODEL FILES

The computer files utilised for the MOUSE modelling are presented in Table E.5.

Due to the manner in which the Mount Wellington and Penrose models have been constructed it is necessary when running either model to transfer output hydrographs from the relevant submodels to the respective boundary file for the main model.

7. RECOMMENDATIONS FOR FURTHER WORK

As an additional verification of the ED model output, the telemetry data from the pumping stations could be correlated with the model pumping station outputs.

TABLE E.1 SUB-CATCHMENT NOMENCLATURE

Mount Wellington		Otahuhu		Southdown	
Methods Report	Modelling Status	Methods Report	Modelling Status	Methods Report	Modelling Status
WELAF	WELAF	OTHUF	STHPF	STHAF	STHAF
WELBF	WELBF			STHBF	Lateral pipe data not supplied - input directly to WCS Manhole
WELCF	WELCF			STHCF	Lateral pipe data not supplied - input directly to WCS Manhole
WELDF	WELDF			STHDF	STHDF
WELFF	WELFF			STHEF	Lateral pipe data not supplied - input directly to WCS Manhole
WELGF	WELGF			STHFF	WELTF
WELHF	WELHF			STHGF	WELTF
WELOF	Not included			STHHF	STHPF01 & STHPF02
WELQF	Not included			STHIF	STHPF05
WELRF	WELRF			STHJF	STHPF04
WELSF	WELSF			STHKF	STHPF03
WELTF	WELTF			STHLF	STHPF05
WELVF	Not included			STHMF	STHPF07
WELWF	Not included			STHNF	STHPF06
WELXF	STHPF08				
WEAAF	WEAAF				
WEABF	WEABF				

Figure E.1 Calibration of Mt Wellington Mainline at MH11

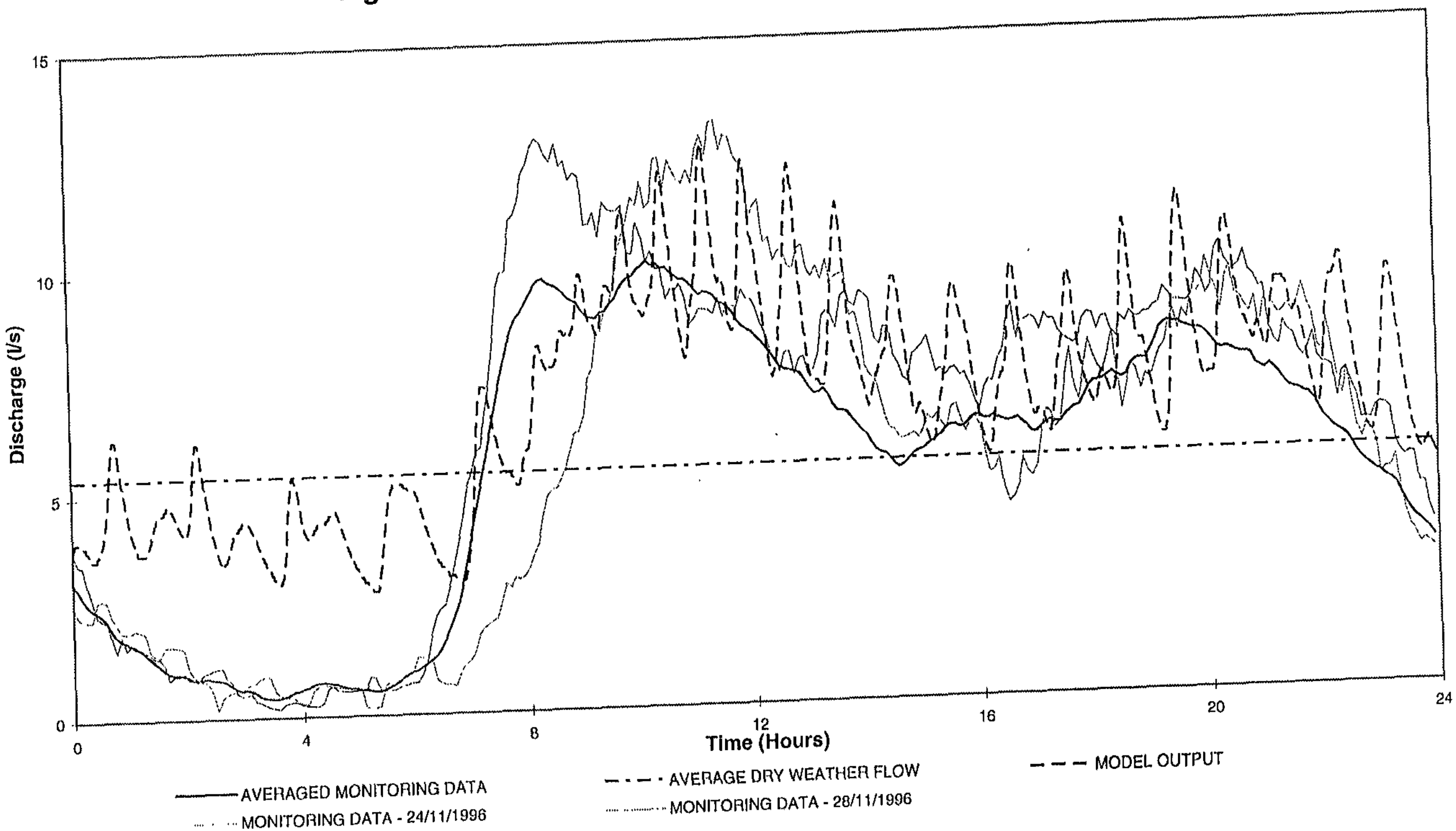

Figure E.2 Calibration of Penrose Mainline at MH06

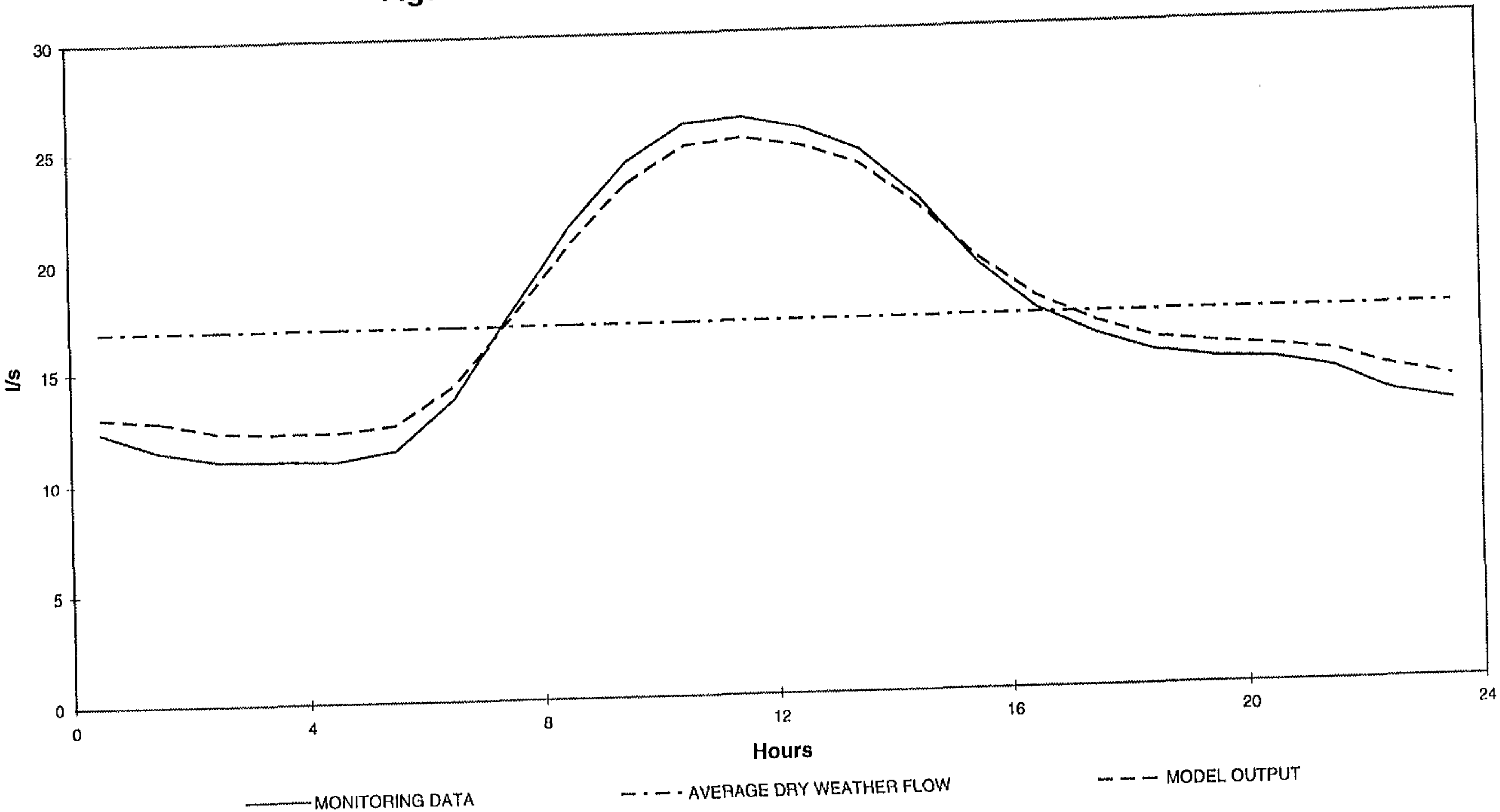

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TABLE E.4 MOUSE MODEL OUTPUT SUMMARY

	MT WELLINGTON BRANCH	PENROSE BRANCH	SYLVIA PARK BRANCH
			Based on pump rate of
ANALYSED MONITORING DATA			108 l/s from 2 pumps
Average Dry Weather Flow (l/s)	5.4	16.8	Range 267 - 1308 m^3/d
Peak flow rate (l/s)	13.2	26.1	Average 751 m^3/d
Total daily volume (m^3/day)	**468**	**1455**	
EXISTING MODEL			
Run number	EX-W2	EX-P6	EX-S
Typical l/s/Ha	5000	5000	5000
Typical PE/Ha	20 - 40	20 - 40	50 - 6500
Model m^3/d/PE	0.073	0.09	0.09
Peak flow rate (l/s)	13	25	21
Daily volume (m^3/day)	**465**	**1448**	**1191**
MPD MODEL			
Run number	MP-W2	MP-P6	MP-S
Typical l/s/Ha	5000	5000	17500
Typical PE/Ha	50 - 60	50 - 70	130 - 6500
Model m^3/d/PE	0.073	0.09	0.09
Peak flow rate (l/s)	16	29	25
Daily Volume (m^3/day)	**698**	**1647**	**1379**
UD MODEL			
Run number	UD-W2	UD-P6	UD-S
Typical l/s/Ha	17500	17500	17500
Typical PE/Ha	90	170	130 - 6500
Model m^3/d/PE	0.073	0.09	0.2
Peak flow rate (l/s)	29	68	55
Daily Volume (m^3/day)	**1311**	**3907**	**3064**

TABLE E.5 MOUSE MODEL FILES

RUN NUMBER	DATA FILE (SWF)	HOTSTART: BOUNDARY FILE (BSF)	HOTSTART: SIMULATION PARAMETERS RUN TIME (min)	HOTSTART: SIMULATION PARAMETERS TIME STEP (sec)	HOTSTART: RESULT FILE (PRF)	MODEL: BOUNDARY FILE (BSF)	MODEL: SIMULATION PARAMETERS RUN TIME (min)	MODEL: SIMULATION PARAMETERS TIME STEP (sec)	MODEL: RESULTS FILE (PRF)	MODEL: RESULTS OUTPUT VOLUME (m^3)	COMMENTS
EX-W1	WWAFE	WWAFEH	360	3	WWAFEH	WWAFE	1440	3	WWAFE	302	Output hydrograph (Model & Hotstart) MH18 from WWAF*.PRF copied to WWALLE*.BSF
EX-W2	WALLE	WWALLEH	360	3	WWALLEH	WWALLE	1440	3	WWALLE	465	Mt Wellington Existing Model
MP-W1	WWAFU	WWAFEH	360	3	WWAFUH	WWAFE	1440	3	WWAFU	464	Output hydrograph (Model & Hotstart) MH18 from WWAF*.PRF copied to WWALLU*.BSF
MP-W2	WALLU	WWALLUH	360	3	WWALLUH	WWALLU	1440	3	WWALLU	698	Mt Wellington MPD Model
UD-W1	WWAFW1	WWAFEH	360	3	WWAFE2H	WWAFE	1440	3	WWAFE2	985	Output hydrograph (Model & Hotstart) MH18 from WWAF*.PRF copied to WWALLW*.BSF
UD-W2	WALLW1	WWALLWH	360	3	WWALLW2H	WWALLW	1440	3	WWALLW2	1311	Mt Wellington UD Model
EX-P1	PWFFE	PWFFEH	300	3	PWFFEH	PWFFE	1440	3	PWFFE	239	Output hydrograph (Model & Hotstart) MH32 from PWFF*.PRF copied to PALLE*.BSF
EX-P2	PWRFE	PWRFEH	300	3	PWRFEH	PWRFE	1440	3	PWRFE	118	Output hydrograph (Model & Hotstart) MH30 from PWRF*.PRF copied to PALLE*.BSF
EX-P3	PWTFE	PWTFEH	300	3	PWTFEH	PWTFE	1440	3	PWTFE	160	Output hydrograph (Model & Hotstart) MH18 from PWTF*.PRF copied to PALLE*.BSF
EX-P4	POTHE	POTHEH	300	3	POTHEH	POTHE	1440	3	POTHE	121	Output hydrograph (Model & Hotstart) MH17 from POTH*.PRF copied to PALLE*.BSF
EX-P5	PSMFE	PSMFEH	300	3	PSMFEH	PSMFE	1440	3	PSMFE	145	Output hydrograph (Model & Hotstart) MH08 from PSMF*.PRF copied to PALLE*.BSF
EX-P6	PALLE	PALLEH	300	3	PALLEH	PALLE	1440	3	PALLE	1448	Penrose Existing Model
MP-P1	PWFFU	PWFFUH	300	3	PWFFUH	PWFFE	1440	3	PWFFU	376	Output hydrograph (Model & Hotstart) MH32 from PWFF*.PRF copied to PALLU*.BSF
MP-P2	PWRFE	PWRFEH	300	3	PWRFEH	PWRFE	1440	3	PWRFE	118	Output hydrograph (Model & Hotstart) MH30 from PWRF*.PRF copied to PALLU*.BSF
MP-P3	PWTFU	PWTFUH	300	3	PWTFUH	PWTFE	1440	3	PWTFU	233	Output hydrograph (Model & Hotstart) MH18 from PWTF*.PRF copied to PALLU*.BSF
MP-P4	POTHE	POTHEH	300	3	POTHEH	POTHE	1440	3	POTHE	121	Output hydrograph (Model & Hotstart) MH17 from POTH*.PRF copied to PALLU*.BSF
MP-P5	PSMFU	PSMFUH	300	3	PSMFUH	PSMFE	1440	3	PSMFU	136	Output hydrograph (Model & Hotstart) MH08 from PSMF*.PRF copied to PALLU*.BSF
MP-P6	PALLU	PALLUH	300	3	PALLUH	PALLU	1440	3	PALLU	1647	Penrose MDP Model
UD-P1	PWFFW1	PWFFEH	300	3	PWFFW1H	PWFFE	1440	3	PWFFW1	851	Output hydrograph (Model & Hotstart) MH32 from PWFF*.PRF copied to PALLW*.BSF
UD-P2	PWRFW1	PWRFEH	300	3	PWRFW1H	PWRFE	1440	3	PWRFW1	222	Output hydrograph (Model & Hotstart) MH30 from PWRF*.PRF copied to PALLW*.BSF
UD-P3	PWTFW1	PWTFEH	300	3	PWTFW1H	PWTFE	1440	3	PWTFW1	402	Output hydrograph (Model & Hotstart) MH18 from PWTF*.PRF copied to PALLW*.BSF
UD-P4	POTHW1	POTHEH	300	3	POTHW1H	POTHE	1440	3	POTHW1	393	Output hydrograph (Model & Hotstart) MH17 from POTH*.PRF copied to PALLW*.BSF
UD-P5	PSMFW1	PSMFEH	300	3	PSMFW1H	PSMFE	1440	3	PSMFW1	425	Output hydrograph (Model & Hotstart) MH08 from PSMF*.PRF copied to PALLW*.BSF
UD-P6	PALLW1	PALLW1H	300	3	PALLW2H	PALLW1	1440	3	PALLW2	3907	Penrose UD Model
EX-S	SYLEXT	SYLEXTH	300	30	SYLEXTH	SYLEXT	1440	30	SYLEXT	1191	Sylvia Park Existing Model
MP-S	SYLMPD	SYLMPDH	300	30	SYLMPDH	SYLMPD	1440	30	SYLMPD	1379	Sylvia Park MPD Model
UD-S	SYLMPD	SYLMPDH	300	30	SYLULDH	SYLMPD	1440	30	SYLULD	3064	Sylvia Park UD Model

APPENDIX F Computed Peak Velocities and Discharges for Area 1 Foulwater System

CATCHMENT STHPF06
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AA210	–	AA190	0.25	0.6	0.04	0.2	0.3
AA190	–	AA180	0.34	0.82	0.07	0.2	0.3
AA180	–	AA170	0.48	1.1	0.11	0.3	0.4
AA170	–	AA160	0.48	1.1	0.11	0.3	0.4
AA160	–	AA150	0.65	1.5	0.09	0.4	0.6
AA150	–	AA140	0.88	2.1	0.05	0.3	0.4
AF030	–	AF020	0.1	0.25	0.02	0.2	0.3
AF020	–	AF010	0.1	0.25	0.01	0.3	0.3
AF010	–	AA150	0.1	0.25	0.02	0.1	0.1
AE050	–	AE010	0.11	0.24	0.01	0.2	0.3
AE010	–	AA140	0.11	0.24	0.02	0.1	0.1
AA140	–	AA130	1	2.3	0.07	0.3	0.3
AA130	–	AA120	1	2.3	0.09	0.3	0.3
AA120	–	AA110	1.6	3.7	0.08	0.3	0.4
AA110	–	AA100	2.1	5	0.15	0.3	0.4
AA100	–	AA080	2.7	6.4	0.19	0.4	0.5
AA080	–	AA070	2.7	6.4	0.12	0.5	0.6
AB010	–	AA070	0.31	0.75	0.03	0.6	0.8
AA070	–	AA060	3	7.1	0.23	0.4	0.5
AA060	–	AA050	3	7.1	0.29	0.4	0.5
AA050	–	AA040	3	7.1	0.21	0.4	0.5
AA040	–	AA030	3.2	7.6	0.2	0.6	0.7
AA030	–	AA020	3.2	7.6	0.04	1.3	1.6
AA020	–	MH08	3.2	7.6	0.01	0.7	0.9

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

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CATCHMENT STHPF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AA250	–	AA240	0.3	0.72	0.03	0.3	0.3
AA240	–	AA230	0.77	1.8	0.08	0.4	0.5
AA230	–	AA210	0.77	1.8	0.17	0.4	0.5
AA210	–	AA200	0.77	1.8	0.14	0.5	0.6
AA200	–	AA190	0.77	1.8	0.12	0.4	0.6
AA190	–	AA180	1.3	3	0.14	0.6	0.8
AF010	–	AA180	0.28	0.67	0.02	0.2	0.3
AE010	–	AA180	0.22	0.53	0.03	0.1	0.2
AA180	–	AA170	1.8	4.2	0.13	0.7	0.9
AA170	–	AA160	1.9	4.5	0.2	0.8	1
AA160	–	AA150	1.9	4.5	0.22	0.7	0.8
AA150	–	AA140	2.1	5.1	0.36	0.7	0.9
AA140	–	AA130	2.1	5.1	0.12	0.5	0.7
AA130	–	AA110	2.4	5.7	0.24	0.3	0.4
AA110	–	AA080	2.7	6.5	0.24	0.5	0.6
AA080	–	AA070	2.7	6.5	0.12	0.7	0.9
AA070	–	AA060	2.7	6.5	0.21	0.7	0.9
AA060	–	AA030	2.7	6.5	0.32	0.7	0.9
AA030	–	AA020	2.7	6.5	0.28	1.2	1.5
AA020	–	MH17	2.9	7	0.12	2.4	3

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

16/01/98

CATCHMENT WELFF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AA380	–	AA370	0.08	0.13	0.01	0.2	0.2
AA370	–	AA360	0.08	0.13	0.01	0.2	0.2
AA360	–	AA350	0.1	0.13	0.01	0.1	0.2
AA350	–	AA340	0.19	0.34	0.03	0.3	0.4
AA340	–	AA330	0.4	0.42	0.01	0.3	0.4
AA330	–	AA320	0.76	0.89	0.09	0.4	0.4
AA320	–	AA310	0.76	0.89	0.06	0.4	0.5
AA310	–	AA300	0.76	0.89	0.07	0.4	0.4
BN020	–	BN010	0.28	0.28	0.01	0.6	0.6
BN010	–	AA330	0.26	0.27	0.01	0.2	0.2
BK020	–	AA330	0.08	0.14	0.01	0.1	0.1
AA300	–	AA290	0.89	1.1	0.09	0.4	0.4
AA290	–	AA280	0.89	1.1	0.12	0.4	0.4
AA280	–	AA270	0.89	1.1	0.11	0.3	0.3
BJ020	–	BJ010	0.11	0.14	0.01	0.2	0.3
BJ010	–	AA300	0.1	0.14	0.01	0.1	0.1
BF010	–	AA270	0.14	0.14	0.01	0.1	0.1
AA270	–	AA260	1.1	1.4	0.15	0.3	0.3
AA260	–	AA250	1.1	1.4	0.27	0.3	0.3
AA250	–	AA240	1.1	1.4	0.15	0.5	0.5
AA240	–	AA230	1.3	1.7	0.06	0.6	0.7
AA210	–	AA190	1.3	1.7	0.09	0.4	0.5
BE020	–	BE010	0.19	0.19	0.01	0.4	0.4
BE010	–	AA240	0.18	0.19	0.01	0.1	0.2
AA230	–	AA220	1.3	1.7	0.15	0.4	0.5
AA220	–	AA210	1.3	1.7	0.11	0.6	0.7
AA190	–	AA180	1.7	2.7	0.13	0.3	0.3
AY040	–	AY030	0.31	0.74	0.03	0.4	0.6
AY030	–	AY020	0.31	0.74	0.03	0.3	0.3
AY020	–	AY010	1.1	2.6	0.13	0.3	0.4
AY010	–	AA180	1.2	2.7		0.1	0.2
AA180	–	AA160	2.9	5.4	0.13	0.4	0.5
AA160	–	AA140	3.1	6	0.16	0.4	0.5
AA140	–	AA130	3.1	6	0.15	0.4	0.4
AW030	–	AA130	0.51	1.2	0.03	0.2	0.2
AA130	–	AA120	4.4	9.1	0.17	0.5	0.6
AA120	–	AA110	4.4	9.1	0.14	0.6	0.8
AA110	–	AA100	4.5	9.2	0.1	0.5	0.6
AT020	–	AT010	0.12	0.28	0.02	0.2	0.2
AT010	–	AS010	0.3	0.71	0.04	0.2	0.3
AS010	–	AA100	1.1	2.3	0.03	0.2	0.3
AA100	–	AA090	5.7	12	0.16	0.6	0.7
AS140	–	AS130	0.08	0.11	0.01	0.1	0.1
AS130	–	AS120	0.37	0.82	0.06	0.4	0.6
AS120	–	AS110	0.37	0.82	0.03	0.5	0.6
AS110	–	AS100	0.37	0.82	0.04	0.4	0.5
AS100	–	AS080	0.43	0.95	0.04	0.3	0.3
AS080	–	AS060	0.46	1	0.03	0.3	0.3
AS060	–	AS040	0.55	1.2	0.03	0.3	0.4
AS040	–	AS030	0.55	1.2	0.02	0.5	0.6
AS030	–	AS020	0.74	1.2	0	2.1	2.5
AS020	–	AS010	0.83	1.6	0.03	0.4	0.5

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

16/01/98

CATCHMENT WELFF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AB100	–	AB090	0.08	0.17	0.02	0.2	0.3
AB090	–	AB080	0.11	0.17	0.01	0.3	0.4
AB080	–	AB070	0.15	0.17	0.01	0.3	0.3
AB070	–	AB060	0.18	0.25	0.02	0.3	0.3
AB060	–	AB050	0.18	0.25	0.01	0.4	0.4
AB050	–	AB040	0.23	0.36	0.02	0.5	0.5
AB040	–	AB030	0.33	0.6	0.02	0.3	0.4
AB030	–	AB020	0.37	0.69	0.06	0.3	0.4
AB020	–	AB010	0.37	0.69	0.03	0.7	0.9
AB010	–	AA030	0.58	1.2	0.01	0.7	1.5
AC040	–	AC010	0.22	0.52	0.04	0.3	0.4
AC010	–	AB010	0.22	0.52	0.03	0.4	0.5
AQ020	–	AQ010	0.34	0.82	0.01	0.2	0.3
AQ010	–	AA090	0.39	0.94	0.01	0.1	0.1
AA090	–	AA080	6.3	13	0.21	0.6	0.8
AA080	–	AA070	6.3	13	0.18	0.7	0.9
AA070	–	AA060	6.3	13	0.16	0.6	0.7
AM060	–	AM040	0.09	0.15	0	0.1	0.1
AM040	–	AM030	0.17	0.33	0	0.1	0.2
AM030	–	AM020	0.26	0.55	0.01	0.2	0.2
AM020	–	AA060	0.35	0.76	0.01	0.1	0.1
AA060	–	AA050	6.8	14	0.18	0.7	0.9
AA050	–	AA040	6.8	14	0.19	0.8	1
AA040	–	AA030	6.8	14	0.1	1.1	1.4
AA030	–	AA020	7.4	15	0.1	1.5	1.8
AA020	–	MH32	7.4	15	0.02	5.2	6.5

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

16/01/98

CATCHMENT WELRF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AA100	–	AA090	0.82	2	0.08	0.3	0.3
AD010	–	AA090	0.09	0.1	0.01	0	0.1
AA090	–	AA080	1	2.4	0.08	0.2	0.2
AC020	–	AC010	0.11	0.13	0.01	0.2	0.3
AC010	–	AA080	0.14	0.2	0.01	0.1	0.4
AA080	–	AA070	1.3	2.8		0.2	0.3
AA070	–	AA060	1.4	3.1	0.09	0.3	0.4
AA060	–	AA050	1.7	3.7	0.19	0.3	0.4
AA050	–	AA040	1.7	3.7	0.14	0.3	0.4
AA040	–	AA020	1.7	3.7	0.15	0.4	0.5
AA020	–	MH30	1.8	4	0.02	2.5	3.2

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

CATCHMENT WELTF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AA370	--	AA360	0.09	0.11	0.01	0.2	0.2
AA360	--	AA350	0.09	0.11	0.01	0.2	0.3
AA350	--	AA340	0.1	0.11	0.01	0.1	0.1
AA340	--	AA330	0.17	0.28	0.04	0.2	0.2
AA330	--	AA320	0.17	0.28	0.02	0.2	0.3
AA320	--	AA310	0.17	0.28	0.03	0.2	0.2
AA310	--	AA300	0.17	0.28	0.02	0.2	0.3
AA300	--	AA290	0.17	0.28	0.03	0.2	0.2
AA290	--	AA280	0.24	0.44	0.04	0.3	0.3
AA280	--	AA270	0.24	0.44	0.04	0.3	0.4
AA270	--	AA260	0.38	0.44	0.01	0.4	0.4
AR040	--	AR030	0.28	0.28	0.01	0.3	0.3
AR040	--	AR030	0.28	0.28	0.01	0.3	0.3
AR030	--	AR020	0.55	0.59	0.05	0.4	0.4
AR020	--	AR010	0.76	0.83	0.02	1.4	1.5
AR010	--	AA260	0.76	0.83	0.01	0.7	0.7
AT020	--	AT010	0.08	0.14	0.01	0.2	0.3
AT010	--	AR020	0.2	0.2	0.01	0.4	0.4
AA260	--	AA250	1.2	1.4	0.05	0.9	0.9
AA250	--	AA240	1.2	1.4	0.05	0.9	0.9
AA240	--	AA230	1.2	1.4	0.05	0.5	0.5
AM030	--	AM020	0.25	0.25	0.01	0.7	0.7
AM020	--	AM010	0.24	0.24	0.01	0.3	0.4
AM010	--	AA230	0.57	0.62	0.01	0.3	0.3
AN020	--	AN010	0.34	0.34	0.01	1	1
AN010	--	AM010	0.31	0.31	0.01	1.1	1.1
AQ010	--	AA230	0.21	0.21	0.01	0.1	0.1
AA230	--	AA220	2	2.3	0.12	0.9	1
AA220	--	AA210	2	2.3	0.08	0.8	0.8
AA210	--	AA200	2	2.4	0.18	0.5	0.5
AK030	--	AK020	0.14	0.14	0.01	0.3	0.3
AK020	--	AK010	0.23	0.23	0.01	0.7	0.7
AK010	--	AA200	0.25	0.27	0.01	0.1	0.1
AA200	--	AA190	2.3	2.6	0.24	0.6	0.6
AG020	--	AG010	0.12	0.12	0.01	0.2	0.3
AG010	--	AA160	0.16	0.21	0.01	0.1	0.1
AA170	--	AA160	2.3	2.6	0.14	0.8	0.9
AA190	--	AA170	2.3	2.6	0.08	0.8	0.9
AA160	--	AA120	2.5	2.9	0.17	0.6	0.6
AA120	--	AA110	2.5	2.9	0.21	0.7	0.7
AA110	--	AA100	2.5	2.9	0.09	0.8	0.8
AA100	--	AA080	2.8	3.8	0.26	0.8	0.8
AA080	--	AA070	2.8	3.8	0.13	0.8	0.8
AC140	--	AC110	0.3	0.71	0.04	0.3	0.4
AC110	--	AC090	0.3	0.71	0.07	0.3	0.3
AC090	--	AC070	0.3	0.71	0.05	0.2	0.3
AC070	--	AC050	0.71	1.7	0.1	0.5	0.6
AC050	--	AC020	0.84	2	0.03	0.5	0.6
AC020	--	AC010	0.98	2.3	0.04	0.5	0.6
AC010	--	AA070	0.98	2.3	0.04	0.8	1
AA070	--	AA060	4.1	6.8	0.06	0.9	1
AA060	--	AA050	4.1	6.8	0.06	0.8	0.9

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

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CATCHMENT WELTF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AA050	--	AA040	4.1	6.8	0.07	0.8	0.9
AA040	--	AA030	4.1	6.8	0.05	0.9	1
AA030	--	AA020	4.1	6.8	0.05	0.7	0.8
AA020	--	AA010	4.4	7.4	0.09	0.7	0.7
AB020	--	AB010	0.23	0.48	0.01	0.9	1.1
AB010	--	AA010	0.23	0.48	0.01	0.8	1
AA010	--	MH18	4.6	7.9		0.5	0.6

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

CATCHMENT WELAF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
CE100	--	CE090	0.08	0.19	0.02	0.2	0.2
CE090	--	CE070	0.08	0.19	0.02	0.2	0.2
CE070	--	CE060	0.1	0.19	0.01	0.2	0.3
CE060	--	CE050	0.09	0.19	0.02	0.2	0.2
CE050	--	CE040	0.13	0.4	0.02	0.1	0.2
CJ040	--	CJ030	0.09	0.4	0.03	0.2	0.3
CJ030	--	CJ020	0.1	0.4	0.03	0.2	0.3
CJ020	--	CJ010	0.12	0.73	0.06	0.2	0.4
CJ010	--	CE040	0.12	0.73	0.07	0.1	0.3
CE040	--	PS1	0.25	1.1	0.17	0.2	0.4
CC070	--	CC050	0.14	2.4	0.1	0.4	1.2
CC050	--	CC040	0.31	2.3	0.04	0.8	1.5
CC040	--	CC030	0.3	2.3	0.06	0.5	0.9
CC030	--	CC020	0.3	2.2	0.15	0.3	0.5
CC020	--	CC010	0.3	2	0.4	0.2	0.4
CC010	--	BT050	0.3	2	0.13	0.1	0.3
BT050	--	BT040	2	5	0.5	0.5	0.6
BT040	--	BT030	2	4.5	0.45	0.5	0.7
BW020	--	BT030	0.22	1.4	0.03	0.8	1.4
BT160	--	BT150	0.09	0.38	0.03	0.2	0.3
BT150	--	BT130	0.1	0.46	0.05	0.2	0.3
BT130	--	BT120	0.1	0.58	0.05	0.2	0.3
BT120	--	BT110	0.1	0.58	0.04	0.3	0.5
BT110	--	BT100	0.18	0.58	0.02	0.1	0.3
BT100	--	BT080	1.4	1.8	0.15	0.5	0.5
BT080	--	BT070	1.4	1.8	0.19	0.5	0.5
BT070	--	BT060	1.7	2.9	0.11	0.7	0.9
BT060	--	BT050	1.7	2.9	0.17	0.8	0.9
CW010	--	BT100	1.2	1.3	0	0.2	0.2
CT050	--	CT040	0.08	0.77	0.07	0.2	0.4
CT040	--	CT030	0.08	0.77	0.07	0.2	0.4
CT030	--	CT020	0.11	0.77	0.04	0.3	0.7
CT020	--	CT010	0.29	0.77	0.02	0.6	0.8
CT010	--	BT070	0.29	0.87	0.03	0.2	0.4
DC040	--	DC030	0.1	0.35	0.02	0.2	0.3
DC030	--	PS3	0.1	0.35	0.03	0.2	0.3
DD020	--	DD010	0.11	0.17	0.01	0.2	0.2
DD010	--	PS3	0.11	0.16	0.03	0.2	0.2
BT030	--	PS2	2.3	5.8	0.37	0.4	0.6
AA330	--	AA320	0.08	0.9	0.09	0.2	0.4
AA320	--	AA310	0.11	0.9	0.02	0.2	0.3
AA310	--	AA300	0.13	1.3	0.04	0.2	0.4
AA300	--	AA290	0.13	1.3	0.03	0.2	0.5
AA290	--	AA280	0.13	1.3	0.1	0.3	0.6
DK020	--	AA280	0.11	0.58	0.03	0.2	0.4
AA280	--	AA260	0.24	1.8	0.06	0.4	0.7
AA260	--	AA230	0.25	2	0.16	0.2	0.4
AA230	--	AA210	0.27	2.4	0.2	0.3	0.5
AA210	--	AA190	0.27	2.4	0.21	0.2	0.5
AA190	--	AA170	0.3	2.9	0.06	0.1	0.3
DB040	--	DB020	0.09	1.2	0.11	0.2	0.4

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

CATCHMENT WELAF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
DB020	–	AA170	0.14	1.3	0.03	0.1	0.3
AA170	–	AA160	0.46	4.2	0.14	0.2	0.3
AA160	–	AA150	0.46	4.2	0.12	0.2	0.4
AA150	–	AA140	0.46	4.1	0.07	0.2	0.5
AA140	–	AA120	0.47	4.2	0.1	0.2	0.3
AA120	–	AA110	0.47	4.2	0.18	0.2	0.4
AA110	–	AA100	0.47	4.2	0.05	0.4	0.8
AA100	–	AA080	0.47	4.2	0.03	0.7	1.3
BR060	–	BR040	0.08	0.09	0.01	0.2	0.2
BR040	–	BR030	0.1	0.1	0.01	0	0.1
BR030	–	BR010	0.79	10	0.14	0.2	0.6
BR010	–	AA080	0.88	9.6	0.4	0.3	0.6
AA080	–	AA070	1.4	13	0.24	0.3	0.7
AA070	–	AA060	1.4	13	0.17	0.3	0.9
AA060	–	AA050	2.3	23	0.17	0.7	1.4
AA050	–	AA040	2.4	23	0.25	0.5	1
AA040	–	AA020	2.5	21	0.37	0.4	0.8
AM060	–	AM040	0.19	0.62	0.02	0.5	0.7
AM040	–	AM030	0.19	0.62	0.02	0.3	0.4
AM030	–	PS4	0.19	0.62	0.02	0.4	0.5
AD210	–	AD200	0.13	0.45	0.01	0.2	0.3
AD200	–	AD190	0.13	0.45	0.03	0.3	0.4
AD190	–	AD180	0.13	0.45	0.02	0.3	0.6
AD180	–	AD150	0.17	0.45	0.01	0.3	0.4
AD150	–	AD140	0.19	0.84	0.04	0.4	0.6
AS060	–	AS040	0.11	0.26	0.02	0.2	0.3
AS040	–	AS030	0.11	0.26	0.01	0.2	0.2
AS030	–	AD140	0.13	0.53	0.01	0.2	0.3
AR010	–	AD130	0.15	0.42	0.02	0.1	0.2
AD140	–	AD130	0.32	1.5	0.01	0.5	0.8
AD130	–	AD120	0.48	2	0.04	0.3	0.4
AD120	–	AD110	0.48	2	0.02	0.4	0.6
AD110	–	AD100	0.48	2	0.02	0.4	0.6
AD100	–	AD090	0.48	2.1	0.01	0.7	1.1
AD090	–	AD080	0.48	2.1	0.04	0.3	0.5
AD080	–	AD070	0.48	2.1	0.04	0.3	0.5
AD070	–	AD060	0.48	2.1	0.03	0.3	0.4
AD060	–	AD050	0.48	2.1	0.04	0.2	0.4
AL010	–	AJ050	0.08	1.5	0.05	0.1	0.4
AJ050	–	AJ040	0.12	1.3	0.03	0.1	0.4
AJ040	–	AJ030	0.1	1.3	0.04	0.2	0.4
AJ030	–	AJ020	0.12	1.2	0.03	0.2	0.5
AJ020	–	AJ010	0.12	1.2	0.02	0.2	0.6
AJ010	–	AD050	0.21	1.3	0.01	0.1	0.4
AD050	–	AD040	0.71	3.7	0.03	0.6	1
AD040	–	AD020	0.72	3.9	0.02	0.5	0.7
AD020	–	AD010	0.72	3.8	0.2	0.5	0.8
AD010	–	AA020	0.72	3.9	0.34	0.2	0.5
AA020	–	MH18	3.3	25	0.12	1.5	2.6
AB030	–	AB020	0.1	0.49	0.04	0.3	0.4
AB020	–	AB010	0.18	0.49	0.02	0.6	0.9

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

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CATCHMENT WELAF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AB010	–	MH18	0.17	0.49	0.02	0.6	0.8
MH18	–	MH17	3.5	25	0.33	0.5	0.8
AW160	–	AW150	0.31	5.8	0.51	0.3	0.6
AW150	–	AW140	0.32	5.9	0.81	0.3	0.7
AW140	–	AW130	0.32	5.9	0.51	0.3	0.7
AW130	–	AW120	0.32	5.9	0.48	0.4	0.9
AW120	–	AW110	0.37	5.9	0.09	1.4	3.2
AW110	–	AW100	0.37	5.9	0.18	0.8	1.9
AW100	–	AW090	0.37	5.9	0.36	0.4	0.9
AW090	–	AW080	0.37	5.9	0.42	0.3	0.7
BL020	–	BL010	0.3	0.3	0.01	1.1	1.1
BL010	–	AW080	0.28	0.28	0.01	0.8	0.8
AW080	–	AW070	0.64	6.2	0.36	0.5	0.9
AW070	–	AW060	0.65	6.3	0.22	0.5	1.1
BH030	–	BH020	0.1	0.11	0.01	0.3	0.3
BH020	–	BH010	0.39	0.39	0.01	1.5	1.5
BH010	–	AW060	0.38	0.38	0.01	1.2	1.2
AW060	–	AW050	1	6.7	0.41	0.5	0.8
BE050	–	BE040	0.14	0.14	0.01	0.3	0.3
BE040	–	BE030	0.13	0.14	0.01	0.3	0.3
BE030	–	BE020	0.13	0.14	0.01	0.5	0.5
BE020	–	BE010	0.15	0.15	0.01	0.5	0.5
BE010	–	AW050	0.16	0.16	0.01	0	0.1
AW050	–	AW040	1.2	6.9	0.61	0.3	0.6
AW040	–	AW030	1.2	6.9	0.85	0.4	0.7
AW030	–	PS5	1.2	6.9	0.28	1	1.6
AX020	–	PS5	0.16	0.16	0.01	0.6	0.6

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

16/01/98

CATCHMENTS WELHF, WELBF, WELGF, WELDF AND WELCF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
CATCHMENT WELHF							
AB03012	–	AB02012	0.12	0.12	0.01	0.3	0.3
AB02012	–	AB01012	0.12	0.12	0.01	0.3	0.3
AB01012	–	MH12	1.10	1.10	0.01	5.8	5.8
AA07012	–	AA06012	0.21	4.10	0.22	0.5	1.2
AA06012	–	AA05012	0.26	4.00	0.09	1	2
AA04012	–	AA03012	0.29	4.00	0.12	0.2	0.5
AA05012	–	AA04012	0.27	3.90	0.11	0.2	0.5
AA03012	–	AA02012	0.32	4.40	0.13	0.2	0.5
AA02012	–	MH12	0.33	4.40	0.14	0.3	0.6
AA17012	–	AA16012	0.13	0.14	0.01	0.3	0.3
AA16012	–	AA15012	0.13	0.14	0.02	0.2	0.2
AA15012	–	AA14012	0.13	0.14	0.01	0.2	0.2
AA14012	–	AA12012	0.14	0.24	0.02	0.2	0.3
AA12012	–	AA10012	0.14	0.24	0.01	0.3	0.3
AA10012	–	AA09012	0.14	0.24	0.01	0.3	0.3
AA09012	–	AA08012	0.14	0.24	0.03	0.2	0.2
AA08012	–	AA07012	0.15	0.44	0.03	0.1	0.3
AV15012	–	AV14012	0.11	1.40	0.08	0.2	0.5
AV14012	–	AV12012	0.11	1.50	0.1	0.2	0.5
AV12012	–	AV11012	0.12	1.50	0.07	0.3	0.5
AV11012	–	AV10012	0.13	1.60	0.16	0.2	0.5
AV10012	–	AV08012	0.13	1.60	0.13	0.2	0.4
AV08012	–	AV07012	0.13	1.80	0.13	0.3	0.6
AV07012	–	AV05012	0.13	1.80	0.12	0.3	0.6
AV05012	–	AV04012	0.13	1.80	0.12	0.3	0.7
AV04012	–	AV03012	0.14	1.80	0.07	0.5	1.1
AV03012	–	AV02012	0.15	1.90	0.15	0.3	0.6
AV02012	–	PS16	0.15	1.90	0.14	0.3	0.7
AW02012	–	PS16	0.16	0.22	0.01	0	0
CATCHMENT WELBF							
AF01014	–	PS6	0.09	0.12	0.01	0.2	0.3
AF02014	–	AF01014	0.09	0.12	0.01	0.2	0.2
AA07014	–	AA06014	0.13	0.81	0.04	0.2	0.8
AA06014	–	AA05014	0.13	0.80	0.07	0.2	0.4
AA05014	–	AA04014	0.13	0.77	0.06	0.2	0.5
AA04014	–	AA03014	0.14	0.85	0.07	0.2	0.4
AA03014	–	AA02014	0.14	0.83	0.07	0.3	0.5
AA02014	–	MH14	0.78	0.83	0.01	0.5	3
CATCHMENT WELGF							
AA07013	–	AA05013	0.09	0.22	0.02	0.2	0.3
AA05013	–	AA04013	0.10	0.22	0.01	0.3	0.3
AA04013	–	AA02013	0.10	0.22	0.02	0.3	0.3
AA02013	–	MH13	0.25	0.28	0.01	0.1	1.1
CATCHMENT WELDF							
AB14017	–	AB13017	0.13	0.15	0.01	0.2	0.2
AB13017	–	AB12017	0.12	0.15	0.02	0.2	0.2
AB12017	–	AB11017	0.13	0.30	0.01	0.2	0.3
AB11017	–	AB10017	0.13	0.30	0.03	0.2	0.2
AL02017	–	AB10017	0.11	0.20	0.01	0.1	0.2
AB10017	–	AB09017	0.25	0.68	0.05	0.2	0.3
AB09017	–	AB08017	0.26	0.85	0.09	0.3	0.4

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

CATCHMENTS WELHF, WELBF, WELGF, WELDF AND WELCF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601)			Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
US		DS					
AB08017	--	AB07017	0.26	0.85	0.04	0.3	0.5
AB07017	--	AB06017	0.26	0.85	0.11	0.2	0.3
AB06017	--	AB04017	0.29	1.40	0.14	0.2	0.4
AB04017	--	AB03017	0.29	1.40	0.13	0.2	0.4
AB03017	--	AB02017	0.29	1.40	0.18	0.3	0.4
AC01017	--	AB02017	0.09	0.14	0.01	0.2	0.3
AD01017	--	AB02017	0.05	0.05	0	0.2	0.3
AB02017	--	PS7	0.46	1.80	0.13	0.4	0.6
AA02017	--	MH17	0.18	4.00	0.12	0.7	1.6
CATCHMENT WELCF							
AB03015	--	AB02015	0.41	0.42	0.01	0.6	0.6
AB02015	--	AB01015	0.33	0.35	0.03	0.3	0.3
AB01015	--	AA02015	0.33	0.37	0.03	0.3	0.3
AA05015	--	AA04015	0.09	0.09	0.01	0.2	0.2
AA04015	--	AA03015	0.10	0.13	0.01	0.2	0.2
AA03015	--	AA02015	0.10	0.15	0.01	0.2	0.3
AA02015	--	MH15	0.77	0.92	0.01	3	3.7
WCS MOUNT WELLINGTON SEWER							
MH18	--	MH17	3.50	25.00	0.23	0.4	0.8
MH17	--	MH16	3.80	27.00	0.24	0.4	0.7
MH16	--	MH15	3.80	27.00	0.25	0.4	0.7
MH15	--	MH14	4.60	27.00	0.26	0.4	0.7
MH14	--	MH13	5.30	27.00	0.26	0.4	0.7
MH13	--	MH12	5.60	27.00	0.23	0.5	0.7
MH12	--	MH11	7.10	32.00	0.22	0.7	1
MH11	--	MH10	7.20	32.00	0.31	0.6	1

Note: 1. Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

CATCHMENT WELXF
ULTIMATE DEVELOPMENT MODEL RESULTS

MODEL NODE (Plans 600/601) US		DS	Minimum Discharge (l/sec)	Maximum Discharge (l/sec)	Qmax/Qf	Minimum Velocity (m/sec)	Maximum Velocity (m/sec)
AB180	–	AB160	0.32	0.78	0.02	0.1	0.1
AB160	–	AB140	2.4	5.7	0.08	0.4	0.5
AB140	–	AB130	2.7	6.7	0.1	0.2	0.3
AB130	–	AB120	16	37	0.34	1	1.2
AB120	–	AB110	16	37	0.55	0.9	1.2
AB110	–	AB080	16	37	0.37	0.8	1
AB080	–	AB070	17	40	0.46	1.2	1.4
AB070	–	AB040	16	40	0.3	0.8	1.1
AB040	–	AB020	19	46	0.59	0.8	1
AB020	–	AB010	19	46	0.51	1.1	1.3
AB010	–	AA030	19	46	0.43	0.9	1.1
AA240	–	AA230	0.62	1.5	0.08	0.4	0.5
AG010	–	AA230	0.55	1.3	0.04	1	1.3
AA230	–	AA220	1.2	2.8	0.16	0.6	0.7
AA220	–	AA190	1.4	3.4	0.19	0.6	0.8
AA190	–	AA180	1.4	3.4	0.09	0.7	0.9
AE020	–	AE010	0.16	0.37	0.02	0.2	0.2
AE010	–	AA180	0.52	1.2	0.03	0.2	0.3
AA180	–	AA160	2	4.9	0.13	0.6	0.7
AA160	–	AA150	2.1	4.9	0.07	0.6	0.8
AA150	–	AA140	2.4	5.7	0.15	0.5	0.7
AA140	–	AA130	2.4	5.7	0.15	0.7	0.9
AA130	–	AA120	2.5	6	0.14	0.7	0.9
AA120	–	AA110	2.5	6	0.18	0.8	0.9
AA110	–	AA100	2.5	6	0.16	0.6	0.8
AA100	–	AA080	2.5	6	0.09	0.5	0.6
AD010	–	AA080	0.55	1.3	0.06	0.3	0.4
AA080	–	AA070	3.1	7.4	0.36	0.5	0.6
AA070	–	AA060	3.1	7.4	0.23	0.5	0.6
AA060	–	AA050	3.1	7.4	0.12	0.4	0.4
AA050	–	AA040	3.1	7.4	0.19	0.2	0.3
AA040	–	AA030	3.6	8.5	0.26	0.3	0.4
AA030	–	PS15	23	55	0.77	1	1.3

Note: 1.Qmax is Maximum Discharge
2. Qf is Full Pipe Discharge
3. Data relates to one daily cycle

16/01/98

APPENDIX G Preliminary Assessment of Catchment Filter System (CFS) Requirements

Road Name	Average Daily Traffic Count (Number of Vehicles) [1]	Length (km)	Estimated Number of CFS Bags[2]
Auckland Hamilton Motorway (Mt Wellington)	121000 (65000 each direction approx.)	3.9	98
Great South Road	22293	2.7	33
Mt Wellington Hway	23136	2.2	27
Penrose Road (cnr Great South Road)	19208	2.1	27
Ellerslie-Panmure Hway (East Harris Road)	13951	1.8	22
Carbine Road	12154	1.6	20
Marua Road	3311	1.7	21
Sylvia Park Road	-	0.9	11
Lunn Avenue	15973	0.8	10
TOTAL	-	**17.7**	**269**
Esimated Annual Cost[2]			**$50-100,000**

1 Source: Auckland City Traffic Count - to October 1997.
2 Based on preliminary results of pilot study within Auckland City (Viaduct Basin). Further site-specific trials would be required before exact number of bags, frequency of replacement and efficiency rates could be determined with confidence.

APPENDIX H Computed Discharges for Area 1 (Upper) Stormwater System

WEL-STH CATCHMENT MANAGEMENT PLAN

ALLCOK AREA1-SOAKAGE FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
Y 1	o/c	n/a	0.175	0.216	0.298	0.333
Y 101	o/c	n/a	0.032	0.032	0.032	0.032
Y 102	o/c	n/a	0.143	0.184	0.265	0.3
Y 2	o/c	n/a	0.469	0.624	0.875	0.984
Y 2A	o/c	n/a	0.002	0.002	0.003	0.003
Y 3	o/c	n/a	0.002	0.002	0.003	0.003
Y 103	o/c	n/a	0.002	0.002	0.003	0.003
Y 104	o/c	n/a	0	0	0	0
YB 2	o/c	n/a	0.045	0.056	0.077	0.086
YB 101	o/c	n/a	0.016	0.016	0.016	0.016
YB 102	o/c	n/a	0.029	0.04	0.061	0.07
YC 1	o/c	n/a	0.043	0.052	0.07	0.078
YC 101	o/c	n/a	0.016	0.016	0.016	0.016
YC 102	o/c	n/a	0.027	0.036	0.055	0.063
Y 4	o/c	n/a	0.408	0.507	0.73	0.835
Y 105	o/c	n/a	0.016	0.016	0.016	0.016
Y 106	o/c	n/a	0.392	0.491	0.715	0.819
Y 4A	o/c	n/a	0	0	0.001	0.001

BALLARAT AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
D 1	o/c	n/a	0.076	0.093	0.129	0.145
D 102	o/c	n/a	0.058	0.075	0.111	0.126
D 2	o/c	n/a	0.17	0.214	0.307	0.347
D 104	o/c	n/a	0.151	0.195	0.289	0.329
D 3	o/c	n/a	0.151	0.193	0.282	0.322
DB 1	o/c	n/a	0.024	0.03	0.042	0.047
DA 1	o/c	n/a	0.124	0.152	0.212	0.237
DA 2	o/c	n/a	0.321	0.406	0.607	0.687
DA 102	o/c	n/a	0.248	0.333	0.534	0.614

BANK1 AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
A 1	o/c	n/a	0.069	0.111	0.153	0.171
AA 1	o/c	n/a	0.125	0.085	0.117	0.131
AA 2	o/c	n/a	0.123	0.161	0.223	0.25
AA 3	o/c	n/a	0.005	0.158	0.221	0.248
AB 1A	o/c	n/a	0.126	0.006	0.008	0.008
AA 4	o/c	n/a	0.359	0.162	0.225	0.253
A 2	o/c	n/a	0.032	0.466	0.65	0.732
A 101	o/c	n/a	0.327	0.032	0.032	0.032
A 102	o/c	n/a	0.355	0.434	0.618	0.7
AC 1	o/c	n/a	0.032	0.439	0.604	0.675
AC 101	o/c	n/a	0.001	0.032	0.032	0.032
AC 1A	o/c	n/a	0.001	0.001	0.002	0.002
AC 2	o/c	n/a	0.149	0.001	0.002	0.002
AA 5	240	0.046	0.046	0.198	0.284	0.322
AA 101	o/c	n/a	0.103	0.046	0.046	0.046
AA 102	o/c	n/a	0.172	0.152	0.238	0.276
AA 6	o/c	n/a	0.693	0.24	0.368	0.432
A 3	o/c	n/a	0.11	0.933	1.333	1.528
AD 1A	225	0.113	0.11	0.11	0.11	0.111
AD 2	375	0.198	0.002	0.11	0.11	0.111
A 4A	o/c	n/a	0.001	0.002	0.003	0.003

BANK2 AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
T 1	210	0.032	0.184	0.227	0.313	0.349
T 101	o/c	n/a	0.032	0.032	0.032	0.032
T 102	o/c	n/a	0.152	0.195	0.28	0.317
T 2	160	0.016	0.312	0.448	0.652	0.749
T 103	o/c	n/a	0.016	0.016	0.016	0.016
T 104	o/c	n/a	0.297	0.432	0.636	0.733
T 2A	o/c	n/a	0.001	0.001	0.002	0.002
TF 1	o/c	n/a	0.26	0.321	0.443	0.495
T 3	o/c	n/a	0.376	0.489	0.675	0.754
TB 1	o/c	n/a	0.144	0.178	0.245	0.273
TBA 1	160	0.016	0.188	0.232	0.319	0.357
TBA 101	o/c	n/a	0.016	0.016	0.016	0.016
TBA 102	o/c	n/a	0.172	0.216	0.303	0.341
TB 2	160	0.016	0.323	0.432	0.635	0.726
TB 101	o/c	n/a	0.016	0.016	0.016	0.016
TB 102	o/c	n/a	0.307	0.416	0.619	0.71
TE 1	160	0.016	0.094	0.116	0.16	0.178
TE 101	o/c	n/a	0.016	0.016	0.016	0.016
TE 102	o/c	n/a	0.078	0.1	0.144	0.163
TB 3	160	0.016	0.573	0.777	1.116	1.31
TB 103	o/c	n/a	0.016	0.016	0.016	0.016
TB 104	o/c	n/a	0.557	0.761	1.1	1.295
TB 4	o/c	n/a	0.647	0.887	1.269	1.482
TD 1	290	0.077	0.138	0.17	0.234	0.262
TD 101	o/c	n/a	0.077	0.077	0.077	0.077
TD 102	o/c	n/a	0.061	0.093	0.157	0.185
TD 2	o/c	n/a	0.095	0.146	0.244	0.287
T 4	o/c	n/a	1.256	1.708	2.456	2.832
S 1	290	0.077	0.091	0.112	0.154	0.172
S 101	o/c	n/a	0.077	0.077	0.077	0.077
S 102	o/c	n/a	0.014	0.035	0.077	0.095
S 2	o/c	n/a	0.106	0.154	0.254	0.294

BANK2 AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
S 3	o/c	n/a	0.295	0.403	0.585	0.69
S 4	210	0.032	0.287	0.392	0.57	0.682
S 103	o/c	n/a	0.032	0.032	0.032	0.032
S 104	o/c	n/a	0.255	0.36	0.538	0.65
SB 1	160	0.016	0.169	0.208	0.287	0.321
SB 101	o/c	n/a	0.016	0.016	0.016	0.016
SB 102	o/c	n/a	0.153	0.193	0.272	0.305
SB 2	210	0.032	0.342	0.451	0.63	0.707
SB 103	o/c	n/a	0.032	0.032	0.032	0.032
SB 104	o/c	n/a	0.31	0.419	0.597	0.675
S 5	o/c	n/a	0.558	0.843	1.325	1.448
S 6	210	0.032	0.604	0.899	1.418	1.55
S 105	o/c	n/a	0.032	0.032	0.032	0.032
S 106	o/c	n/a	0.571	0.866	1.385	1.518
S 6A	o/c	n/a	0.446	0.823	1.342	1.484
S 7	o/c	n/a	0.442	0.821	1.342	1.483
SC 1	o/c	n/a	0.053	0.065	0.089	0.1
SCA 1	o/c	n/a	0.175	0.214	0.298	0.335
SC 2	o/c	n/a	0.186	0.236	0.339	0.389
T 5	240	0.046	1.328	1.825	2.63	2.98
T 105	o/c	n/a	0.046	0.046	0.046	0.046
T 106	o/c	n/a	1.282	1.779	2.584	2.934
T 4A	o/c	n/a	0.02	0.025	1.195	1.68
S 8	o/c	n/a	0.688	1.017	2.974	3.909
S 8A	o/c	n/a	0.032	0.037	0.052	0.055

CARR AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
1D 1	210	0.032	0.144	0.178	0.245	0.273
1D 101	o/c	n/a	0.032	0.032	0.032	0.032
1D 102	o/c	n/a	0.112	0.145	0.212	0.241
1D 2	160	0.016	0.23	0.325	0.468	0.53
1D 104	o/c	n/a	0.214	0.309	0.453	0.514
1DD 1	160	0.016	0.234	0.289	0.398	0.445
1DD 102	o/c	n/a	0.218	0.273	0.382	0.429
1D 3	o/c	n/a	0.636	0.868	1.235	1.395

CEBALA AREA1-SOAKAGE FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
1A 1	o/c	n/a	0.144	0.178	0.245	0.273
1B 1	160	0.016	0.138	0.17	0.234	0.262
1B 101	o/c	n/a	0.016	0.016	0.016	0.016
1B 1A	o/c	n/a	0.001	0.001	0.002	0.002
1B 2	o/c	n/a	0.001	0.001	0.002	0.002
1B 3	210	0.032	0.109	0.134	0.185	0.207
1B 103	o/c	n/a	0.032	0.032	0.032	0.032
1B 104	o/c	n/a	0.076	0.102	0.153	0.174
1B 4	o/c	n/a	0.254	0.326	0.461	0.519
1A 2	160	0.016	0.443	0.601	0.851	0.973
1A 101	o/c	n/a	0.016	0.016	0.016	0.016
1A 102	o/c	n/a	0.766	1.043	1.486	1.684
1A 3	o/c	n/a	0	0	0.001	0.001

DRYDEN AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
C 1	290	0.077	0.179	0.221	0.304	0.34
C 101	o/c	n/a	0.077	0.077	0.077	0.077
C 102	o/c	n/a	0.102	0.144	0.228	0.263
C 2	o/c	n/a	0.147	0.207	0.315	0.365
C 3	210	0.032	0.184	0.265	0.4	0.465
C 103	o/c	n/a	0.032	0.032	0.032	0.032
C 104	o/c	n/a	0.152	0.233	0.368	0.433
C 4a	o/c	n/a	0.001	0.001	0.002	0.002

FULTON AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
2E 1	160	0.016	0.208	0.256	0.353	0.395
2E 101	o/c	n/a	0.016	0.016	0.016	0.016
2E 102	o/c	n/a	0.192	0.241	0.337	0.379
2E 1A	o/c	n/a	0.001	0.001	0.002	0.002
2E 2	o/c	n/a	0.432	0.533	0.734	0.82
2E 3	o/c	n/a	0.575	0.702	1.149	1.216
2EA 1	o/c	n/a	0.263	0.324	0.447	0.499
2E 4	240	0.046	1.073	1.405	2.231	2.604
2E 103	o/c	n/a	0.046	0.046	0.046	0.046
2E 104	o/c	n/a	1.027	1.359	2.185	2.558
2E 4A	o/c	n/a	0.037	0.04	0.041	0.041

LAVAS PLACE AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 In 50 year (m^3/s)	1 in 100 year (m^3/s)
ZB 1	300	0.115	0.024	0.029	0.04	0.044
ZB 2	300	0.255	0.1	0.122	0.168	0.187
ZB 3	450	0.392	0.1	0.122	0.168	0.187
ZB 4	450	0.248	0.29	0.353	0.485	0.541
ZH 1	225	0.112	0.052	0.063	0.087	0.097
ZH 2	225	0.161	0.052	0.063	0.087	0.097
ZH 3	450	0.455	0.052	0.063	0.087	0.097
ZB 5	450	0.215	0.341	0.415	0.571	0.638
ZB 6	450	0.554	0.339	0.412	0.568	0.635
ZF 1	375	0.206	0.283	0.345	0.474	0.53
ZF 2	375	0.24	0.337	0.411	0.566	0.632
ZF 3	375	0.048	0.336	0.409	0.563	0.63
ZB 7	500	0.093	0.748	0.911	1.261	1.409
ZB 8	600	0.505	0.739	0.899	1.244	1.391
ZD 1	600	0.798	0.021	0.026	0.035	0.039
ZB 9	600	1.025	0.751	0.914	1.257	1.405
ZB 10	290	0.077	1.025	1.241	1.714	1.918
ZB 12	o/c	n/a	0.471	0.471	0.472	0.472

MARUA ROAD AREA1-SOAKAGE FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
B 2	210	0.032	0.314	0.388	0.534	0.597
B 101	o/c	n/a	0.032	0.032	0.032	0.032
B 102	o/c	n/a	0.282	0.355	0.502	0.564
BA 1	260	0.057	0.314	0.388	0.534	0.597
BA 101	o/c	n/a	0.057	0.057	0.057	0.057
BA 102	o/c	n/a	0.657	0.824	1.158	1.3
BB 1	o/c	n/a	0.213	0.263	0.362	0.404
B 3	240	0.046	1.342	1.823	2.616	2.956
B 103	o/c	n/a	0.046	0.046	0.046	0.046
B 104	o/c	n/a	1.296	1.777	2.57	2.91
B 3a	o/c	n/a	0.001	0.001	0.002	0.002

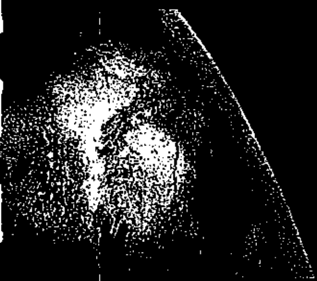
MERCURY ENERGY AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
3B 1	o/c	n/a	0.1	0.124	0.17	0.19
3BA 1	o/c	n/a	0.05	0.062	0.085	0.095
3B 2	325	0.104	0.934	1.188	1.65	1.862
3B 101	o/c	n/a	0.104	0.104	0.104	0.104
3B 2A	o/c	n/a	0.001	0.002	0.002	0.003

RELIABLE WAY AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
AK 1	o/c	n/a	0.175	0.216	0.298	0.333
AK 1A	o/c	n/a	0.001	0.001	0.002	0.002
AK 2	160	0.016	0.15	0.185	0.255	0.286
AK 101	o/c	n/a	0.016	0.016	0.016	0.016
AK 102	o/c	n/a	0.134	0.17	0.24	0.27
AKA 1	o/c	n/a	0.195	0.241	0.332	0.371
AKA 1A	o/c	n/a	0.001	0.002	0.296	0.36
AK 3	375	0.152	0.236	0.328	0.578	0.758
AK 103	o/c	n/a	0.152	0.152	0.152	0.152
AK 104	o/c	n/a	0.958	1.26	1.815	2.124
AK 3A	o/c	n/a	0.001	0.381	1.438	1.703

STANHOPE ROAD AREA1-SOAKAGE FLOW DETAILS						
ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
2B 1	o/c	n/a	0.256	0.309	0.421	0.469
2BA 1	o/c	n/a	0.231	0.286	0.394	0.44
2BA 1A	o/c	n/a	0.002	0.06	0.249	0.304
2A 1	o/c	n/a	0.317	0.387	0.529	0.591
2A 2	o/c	n/a	0.574	0.747	1.051	1.185
2A 2A	o/c	n/a	0.002	0.218	0.875	1.028
2A 3	o/c	n/a	0.521	0.64	1.403	1.73
2A 3A	o/c	n/a	0.001	0.002	0.65	0.977
2B 2	o/c	n/a	0.257	0.311	0.924	1.364

PENROSE ROAD AREA1-SOAKAGE FLOW DETAILS

ILSAX Models' Nodes	Pipe Diameter (mm)	Pipe Capacity (m3/s)	1 in 5 year (m^3/s)	1 in 10 year (m^3/s)	1 in 50 year (m^3/s)	1 in 100 year (m^3/s)
F 1	300	0.064	0.333	0.408	0.56	0.625
F 2	375	0.166	0.401	0.507	0.696	0.777
FA 1	150	0.014	0.016	0.02	0.028	0.031
FAA 1	300	0.254	0.03	0.037	0.051	0.057
FAA 2	300	0.099	0.065	0.08	0.111	0.124
FA 2	300	0.232	0.104	0.131	0.181	0.202
F 3	375	0.132	0.497	0.635	0.872	0.975
F 4	375	0.163	0.163	0.17	0.185	0.191
F 5	375	0.145	0.558	0.711	0.978	1.097
F 6	375	0.285	0.577	0.734	1.008	1.127
FB 1	375	0.068	0.275	0.34	0.468	0.523
F 7	600	0.13	0.552	0.625	0.753	0.808
F 8	600	0.409	0.616	0.712	0.874	0.944
F 9	600	0.353	0.95	1.141	1.466	1.609
FC 1	225	0.043	0.073	0.09	0.123	0.138
FC 2	225	0.177	0.1	0.127	0.174	0.195
FC 3	225	0.027	0.361	0.448	0.617	0.689
F 10	900	1.386	1.279	1.575	2.065	2.283
F 11	900	0.543	1.579	2.035	2.809	3.173
FK 1A	o/c	n/a	0.002	0.002	0.003	0.003
FK 2	o/c	n/a	0.133	0.164	0.226	0.252
F 12	900	0.496	1.716	2.222	3.063	3.458
F 13	910	0.511	1.763	2.288	3.153	3.525
F 14	910	2.21	1.756	2.282	3.146	3.517
F 15	240	0.046	1.82	2.357	3.246	3.63
F 101	o/c	n/a	0.046	0.046	0.046	0.046
F 102	o/c	n/a	1.774	2.31	3.2	3.584
F 16	o/c	n/a	1.752	2.297	3.18	3.562



Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

REPORT

SINCLAIR KNIGHT MERTZ

Sylvia Park Business Centre, Mt Wellington
Geotechnical Completion Report for Earthworks

Report prepared for:

SINCLAIR KNIGHT MERTZ

Report prepared by:

TONKIN & TAYLOR LTD

Distribution:

SYLVIA PARK BUSINESS CENTRE LTD	1 copy
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May 2006

Job no: 21432.100

Table of contents

Executive summary

Tonkin & Taylor Ltd were engaged by Sinclair Knight Mertz Ltd on behalf of their client Sylvia Park Business Centre Ltd to monitor and provide earthworks certification for the commercial development at the Sylvia Park Business Centre, Mt Wellington Highway, Mt Wellington, Auckland.

This report contains information required for Completion Reporting, as well as outlining design issues that need to be considered for subsequent building design and construction.

Previous geotechnical investigation work was undertaken by several consultants and most recently by Tonkin & Taylor Ltd in November 2004, our Ref 21432. Multiplex are the managing Contractor for the enabling and building works. Civil / survey design was undertaken by Sinclair Knight Mertz and structural design by Murray Jacobs Ltd, Buller George Ltd, Stiffe Hooker Ltd and Holmes Consulting Ltd.

Current works commenced on the site in November 2004 with the majority of cut and fill completed by April 2005. Ground improvement works consisted of demolition of a number of one storey buildings, cut and fill earthworks and the placing of pavement materials.

The Business Centre site is considered to have building platform areas suitable for commercial and retail development in accordance with this report.

1 Introduction

Tonkin & Taylor Ltd (T&T) were engaged by Sinclair Knight Mertz (SKM) for their client Sylvia Park Business Centre Ltd (SPBL) to undertake earthworks compaction control and provide geotechnical earthworks certification for the Sylvia Park Business Centre, Mt Wellington Highway, Mt Wellington.

Sylvia Park Business Centre is a multipurpose shopping centre proposed to contain reinforced concrete buildings consisting of shopping malls, supermarkets and entertainment venues with at grade and underground carparks.

Our proposal letter dated 29 October 2004 sets out our conditions of engagement and scope of works. Confirmation was received in a Letter of Engagement, dated 2 November 2004. The scope of work covered by this report includes:

i. review of geotechnical investigation reporting for the site prepared in August 2004 by T&T along with review of aerial photographs and our geotechnical database for the area,
ii. observation, inspection and testing for the earthworks,
iii. additional post earthworks investigation of some areas of ground to determine foundation design conditions for piled foundations, and
iv. certification for commercial development are in terms of this report.

Tonkin & Taylor Ltd has also undertaken observation of foundations for the project.

1.1 Description of site

This report is applicable to the Sylvia Park Business and Shopping Centre.

The Sylvia Park Business Centre covers over 20Ha and is bounded by Mt Wellington Highway to the west, residential properties on Lynton Road to the north, North Island Trunk Railway to the east and State Highway 1 to the south. An access road links to Carbine Road to the east.

Stage 1 of the development is located in the southern half of the site while Stage 2 is north of the south eastern Highway which runs through the centre of the site.

It involves the development of 1 commercial building with associated roads and underground services.

As can be seen on the Earthworks As-Built plan (SKM AN00667-OA-CB-230, SK-247 and 248 attached in Appendix A), all of this stage has been affected by earthworks. The depth of cut was generally less than 1 m (apart from the underground carpark, services excavations and excavation of the toe of the Mt Wellington Interchange on-ramp) and the maximum depth of fill was approximately 1.5 m.

The footprints of the buildings occupy a strip running north south across the site while carparking covers the rest. The current level is essentially flat with only minor variation for the drainage and for the roading, carparking and landscaping as shown on the SKM As-Built drawings in Appendix A.

2 Related reports

Previous geotechnical investigation reporting has been carried out for the site by Tonkin & Taylor Ltd in August 2004, ref 21432.

Other relevant investigation reports include:

Stormwater Trench Retention Investigations	18 April 2005
Proof Drilling of Foundations, Stage 1	3 May 2005
Rail Over Bridge Pile Length Drilling Investigations	27 May 2005
Foodtown Pile Capacity Investigations	27 June 2005
Northern Precinct Supplementary Investigations	4 July 2005

The T&T geotechnical investigation report outlines development recommendations including subsurface drainage, compaction criteria, roading and services installation and building foundation criteria. These have been incorporated into the bulk earthworks specifications prepared by SKM.

Minor previous earthworks were undertaken as part of a previous development during the 1940's (World War 2) for the U S Armed Forces. Some underground services were installed during and after this development.

A general specification for the earthworks as included in the geotechnical report, and provided initial guidelines for the control of the earthworks.

A series of building specific investigation boreholes have been carried out as part of detailed design of the buildings, as well as some proof drilling during construction. These have been reported in a series of letter reports.

The recommendations contained in the above reports have been incorporated into our control of the works and, where applicable, incorporated into this completion reporting for this Stage. In particular, T&T handauger borelogs and proof drilling have been used to help set foundation design criteria.

3 Earthworks operations

3.1 Plant

Earthworks (Bulk / final) were contracted to Ross Reid Contractors Ltd for all / the majority of earthworks on all stages. The main items of plant used were a tractor drawn scraper, several excavators and one self propelled compactor. This plant generally carried out all construction works, roading and earthworks. Specialist roading plant was brought on site for pavement construction.

3.2 Earthworks sequence / programme

Earthworks operations for the site commenced in November 2004. They consisted of the removal of old pavements, organic material stockpiles of fill and the rubble from demolition of numerous one storey light weight timber framed buildings. The concrete slabs forming the foundations and floors were removed to stockpile for crushing and reuse on site.

Initial operations were to remove soft / weak / disturbed material generally from below the foundations slabs. These areas were backfilled to the original level and the site tested. Initially trafficking by the plant was determined to be causing excessive remoulding of the materials and operations were modified to limit this effect. The strength of the existing ground required some undercutting and backfilling with improved material, approximately 50% of the area. The site was then filled with 0.3 m to 1.2 m material generally to the level of the underside of the floor slab. To aid construction, a temporary coating of seal was applied. The fill consisted principally of material cut from the eastern side of the site but some imported material was required during the later stages of the works. At May 2005, the majority of the earthworks operations for the overall site was complete.

Installation of services and drainage as shown on the current As-Built drawings took place in conjunction with the earthworks operations. Roading and parking for Stage 2A was also largely completed.

The maximum depth of fill was 1.2 m and the maximum depth of cut was 3.0 m as shown on the earthwork drawings in Appendix A.

The approximate volume of earthworks to July 2005 is 59,000 cubic metres cut and 38,000 m^3 fill principally using material from on site.

The compaction requirements for engineered fill material has been recommended as follows:

i Cohesive material such as bulk fill:

- a Average vane strength over 10 consecutive readings shall not be less than 125 kPa with no individual reading less than 110 kPa
- b The air voids shall not exceed 10%.

ii Cohesion material within 500 mm of finished subgrade under pavements or buildings:

- a Average vane strength over 10 consecutive readings shall not be less than 150 kPa with no individual reading less than 130 kPa
- b The air voids shall not exceed 8%.

iii Cohesionless material such as hard fill shall be placed in uniform layers not greater than 150 mm loose thickness.

Compaction on each layer of fill materials so placed shall be sufficient to obtain the following standards:

a The in-situ dry density shall be not less than 75% of the maximum relative density, as determined by Test 4.2, NZS 4402

b The number of blows to drive the Scala penetrometer from a depth of 50 to 200 mm below the fill surface shall be not less than 11.

4 Compaction

4.1 Control criteria

The majority of the bulk earthworks was cut to fill from within the site. However, there was also a range of other materials including crushed concrete for hardfill as well as imported granular fill.

Road and paved area design was provided by SKM with geotechnical testing during construction provided by others under their instruction. Review and acceptance of the results were provided by SKM. The criteria for acceptance was based on recommendations provided by T&T in their specification Ref No. 21432.100 dated 11 August 2004, copy attached in Appendix C.

The main method used for the clay and silt type fill materials was the maximum allowable air voids and minimum allowable shear strength method.

Insitu density, strength and water content tests were carried out on the filling at or in excess of the frequency recommended by NZS 4431:1989. Testing results are contained in Appendix C.

After some initial issues associated with excessive working of the material, control tests showed that the results were consistently meeting the required shear strength and air void criteria, demonstrating that the water content of placed fill was consistently at or close to optimum. To the best of our knowledge, any problems encountered were rectified by close monitoring of the selection of borrow materials, discing and remixing of the available soil types and minor reworking where required.

5 Project evaluation / building design considerations

5.1 Bearing capacity for building foundations

A combination of shallow footings and piled foundations have been utilised for the new development. All filled and natural ground within the influence of the shallow and pad type foundations as shown on the drawings in Appendix A generally has a geotechnical ultimate bearing capacity of 300 kPa. This corresponds to a factored (ultimate limit state) bearing capacity of 150 kPa and working bearing capacity of 100 kPa. For deeper foundations site specific reports have been prepared.

Where a working bearing capacity greater than 100 kPa was required, further specific site investigation and design of foundations have been undertaken.

Limits for distributed floor loadings have been provided. These are generally 15 kPa but for The Warehouse are increased to 20 kPa.

It is concluded that settlements associated with the fill placement would have been largely completed prior to application of building loads. This is based on results of the preload tests report of August 2004.

5.2 Slope stability

The site is generally flat as shown on the As-Built drawings in Appendix A. Local retention works were constructed adjacent to the boundary of the Mt Wellington Interchange on-ramp. Slope stability is not considered an issue for the permanent works.

5.3 Retaining walls

A timber pole retaining wall has been constructed along the base of a cut batter that forms the on-ramp for the Mt Wellington Interchange in the south western sector of the site. T&T provided design review and construction observation of the work.

During construction some slumping of the excavated face occurred but the ground was remediated and the earthworks associated with the final retention works are considered to have been completed in accordance with design. In particular, the soils identified during investigation and the parameters utilised for design are considered to be applicable.

5.4 Settlement

Settlements have been assessed from analyses using assessed parameters for the soil types as well as from results obtained from the pre-loading trials.

Based on this information we consider that settlement of shallow footings of structures designed in accordance with the recommendations in the reports reference previously, should be within normally accepted design tolerances.

5.5 Drainage

Groundwater drainage was installed in the Pak N Save basement carpark. This consisted of 150 mm diameter perforated pipe (Novaflo) within a geotextile sleeve installed within a series of trenches with a graded granular drainage layer below the proposed floor slab level as shown on As-Built drawings in Appendix A. They have outlets to the sump in the proposed adjacent Stage 2B (Basement Carpark). These drains are not expected to require maintenance during the design life of the structure.

5.6 Stormwater controls

Stormwater disposal systems have been designed and constructed by others. These systems serve to collect all runoffs from roofs, decks and paved areas, together with discharges from retaining wall drains and other subsoil drains and should connect into the public stormwater drainage network.

5.7 Road and paved area subgrades

Road and paved area design was provided by SKM with geotechnical testing during construction provided by T&T and others under SKM instruction. Review and acceptance of the results were provided by SKM. The recommended criteria for acceptance for subgrades was provided by T&T in their letter Ref No. 21432.100 dated 11 August 2004, from which the criteria are included in Section 4.1 and have been incorporated into SKM's specifications.

Prior to placing sub-base or basecourse material, the formation was tested as described in section 4.

We are advised by SKM that the final basecourse tests undertaken by others were satisfactory. This will be certified separately by SKM.

6 Statement of Professional Opinion as to the suitability of land for building development

1, Mr P J Millar of Tonkin & Taylor Ltd, P O Box 5271, Wellesley St, Auckland, hereby confirm that:

6.1 I am a Chartered Professional Engineer experienced in the field of geotechnical engineering and was retained by Sylvia Park Business Centre Limited as the Geotechnical Engineer on the Sylvia Park Business Centre, Mt Wellington Highway, Mt Wellington. Inspection and observation of the works have been carried out during construction by either myself or staff acting under my direction.

6.2 The extent of investigations are described in the Tonkin & Taylor Ltd report, Ref No. 21432 dated August 2004 and other referenced reports. The conclusions and recommendations of these documents have been re-evaluated in the preparation of this report. Details of earthworks control tests performed are enclosed.

6.3 The Contractor confirms that the work undertaken has been completed in accordance with the drawings, specifications and any variations issued and is consistent with the inspections and observations carried out by Tonkin & Taylor Ltd. A completion Certificate – Construction is to be provided by the Contractor.

6.4 On the basis of our observations and inspections, together with the information supplied by others, including the Contractor's Completion Certificate, it is my professional opinion, not to be construed as a guarantee that:

6.4.1 The fills shown on the attached SKM drawing No. AN00667-OA SK247 have been generally placed in compliance with NZS 4431:1989.

6.4.2 The completed earthworks give due regard to land slope and foundation stability considerations.

6.5 Foundations

6.5.1 Foundation design

The filled and natural ground within site boundaries is considered generally suitable for the erection thereon of commercial and retail buildings.

6.5.2 Bearing capacity

Shallow footings

Foundation design for all building in this Stage should limit geotechnical ultimate bearing capacity to 300 kPa (factored capacity ULS) 150 kPa, working 100 kPa).

6.5.3 Pile foundations

Pile foundations have been utilised for some structures where high concentrated loadings are applied. These have all been subject to specific reporting and separate certification for the foundations.

6.5.4 Retaining walls

Retaining walls have been constructed on the south western perimeter of the site. Tonkin & Taylor Ltd undertook observation of the ground conditions encountered and installation of the piles. We confirm the soil conditions are consistent with soils exhibiting the parameters recommended by Tonkin & Taylor Ltd and retention works designed in accordance with these parameters should provide adequate performance.

6.5.5 Unexpected ground conditions

Our assessment is based on interpolation between borehole positions, site observations and periodic earthworks control visits. Local variations in ground conditions may occur. Although highly unlikely, unfavourable ground conditions may be encountered during excavation for foundations or site benching. It is important that we be contacted in this eventuality, or in the event that any variation in subsoil conditions from those described in the report are found. Design assistance is available as required to accommodate any unforeseen ground conditions present.

7 Applicability

The professional opinion contained within this report is furnished to Sylvia Park Business Centre Ltd, Multiplex Ltd, Sinclair Knight Mertz Ltd and the Auckland City Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

TONKIN & TAYLOR LTD

Environmental and Engineering Consultants

Authorised for Tonkin & Taylor by:

....

P J Millar

Project Co-ordinator

pjm:mcs

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Appendix A: Drawings

SKM Drawings

AN00667 - OA-SK-247 Rev A Bulk Earthworks, Cut and Fill Depths
- OA-SK-248 Rev A Bulk Earthworks Existing Contours
- OA-C8-230 Rev 5 Bulk Earthworks Finished Contours

Appendix B: Test results

Location Plan

Tonkin & Taylor Ltd or Geotechnics

Nukes moisture density

Scala

Pilcon shear vanes

Benkleman Beam

Cleggs

GEOTECHNICS LTD.
Sylvia Park Earthworks
Phone: 021 378 385

NDM
DWB Dan Baker.
TPG - Tanka

Data Input By: TPG Date: 30/03/05

Data Input Checked By: Date:

JOB NO: 21432

FILE/FOLDER: Sylvia Park Earthworks

TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
13/01/2005	1 1		South of SEART- FILL AREA 1				1888	1496	26.2	5.8				001/05	P
13/01/2005	2 2		South of SEART- FILL AREA 1				1887	1496	26.1	5.9				001/05	P
13/01/2005	3 3		South of SEART- FILL AREA 1				1930	1549	24.7	4.9				001/05	P
13/01/2005	4 4		South of SEART- FILL AREA 1				1800	1408	27.8	9.1				001/05	P
13/01/2005	5 5		South of SEART- FILL AREA 1				1936	1509	28.3	1.8				001/05	P
13/01/2005	6 6		South of SEART- FILL AREA 1				1982	1564	26.7	0.7				001/05	P
13/01/2005	7 7		South of SEART- FILL AREA 1				1996	1546	29.1	0				001/05	P
13/01/2005	8 8		South of SEART- FILL AREA 1				1941	1502	29.2	0.9				001/05	P
13/01/2005	9 9		South of SEART- FILL AREA 1				1934	1550	24.8	4.6				001/05	P
13/01/2005	10 10		South of SEART- FILL AREA 1				1969	1572	25.3	2.5				001/05	P
13/01/2005	11 1		South of SEART- FILL AREA 1										180	002/05	P
13/01/2005	12 2		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	13 3		South of SEART- FILL AREA 1										120	002/05	P
13/01/2005	14 4		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	15 5		South of SEART- FILL AREA 1										105	002/05	F
13/01/2005	16 6		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	17 7		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	18 8		South of SEART- FILL AREA 1										120	002/05	P
13/01/2005	19 9		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	20 10		South of SEART- FILL AREA 1										90	002/05	F
13/01/2005	21 11		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	22 12		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	23 13		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	24 14		South of SEART- FILL AREA 1										150	002/05	P
13/01/2005	25 15		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	26 16		South of SEART- FILL AREA 1										90	002/05	F
13/01/2005	27 17		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	28 18		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	29 19		South of SEART- FILL AREA 1										90	002/05	F
13/01/2005	30 20		South of SEART- FILL AREA 1										utp	002/05	P

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Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test				GEO	Average	Hand	Lab	Status
							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
13/01/2005	31 21		South of SEART- FILL AREA 1										120	002/05	F
13/01/2005	32 22		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	33 23		South of SEART- FILL AREA 1										78	002/05	F
13/01/2005	34 24		South of SEART- FILL AREA 1										90	002/05	F
13/01/2005	35 25		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	36 26		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	37 27		South of SEART- FILL AREA 1										utp	002/05	P
13/01/2005	38 28		South of SEART- FILL AREA 1										75	002/05	F
13/01/2005	39 29		South of SEART- FILL AREA 1										90	002/05	F
13/01/2005	40 30		South of SEART- FILL AREA 1										utp	002/05	P
14/01/2005	41 1	0	SOUTHERN CUT AREA -PIT NO 1						37.9					003/05	P
14/01/2005	42 2	0.2	SOUTHERN CUT AREA -PIT NO 1						33.4					003/05	P
14/01/2005	43 3	0.4	SOUTHERN CUT AREA -PIT NO 1						41					003/05	P
14/01/2005	44 4	0.6	SOUTHERN CUT AREA -PIT NO 1						39.8					003/05	P
14/01/2005	45 5	0.8	SOUTHERN CUT AREA -PIT NO 1						38.4					003/05	P
14/01/2005	46 6	1	SOUTHERN CUT AREA -PIT NO 1						41					003/05	P
14/01/2005	47 1	0	SOUTHERN CUT AREA -PIT NO 2						39.8					003/05	P
14/01/2005	48 2	0.2	SOUTHERN CUT AREA -PIT NO 2						24.5					003/05	P
14/01/2005	49 3	0.4	SOUTHERN CUT AREA -PIT NO 2						44.9					003/05	P
14/01/2005	50 4	0.6	SOUTHERN CUT AREA -PIT NO 2						39.4					003/05	P
14/01/2005	51 5	0.8	SOUTHERN CUT AREA -PIT NO 2						45					003/05	P
14/01/2005	52 6	1	SOUTHERN CUT AREA -PIT NO 2						30.9					003/05	P
15/01/2005	53 1		South of SEART- FILL AREA 2				1877	1372	36.8	0				004/05	P
15/01/2005	54 2		South of SEART- FILL AREA 2				1824	1395	30.7	5.5				004/05	P
15/01/2005	55 3		South of SEART- FILL AREA 2				1736	1247	39.2	5				004/05	P
15/01/2005	56 4		South of SEART- FILL AREA 2				1793	1273	40.9	0.9				004/05	P
15/01/2005	57 5		South of SEART- FILL AREA 2				1818	1392	30.6	5.8				004/05	P
15/01/2005	58 6		South of SEART- FILL AREA 2				1760	1415	24.4	13.1				004/05	F
15/01/2005	59 7		South of SEART- FILL AREA 2				1796	1557	15.4	18.4				004/05	F
15/01/2005	60 8		South of SEART- FILL AREA 2				1777	1309	35.7	4.8				004/05	P

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							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
15/01/2005	61 9		South of SEART- FILL AREA 2				1783	1328	34.3	5.3				004/05	P
15/01/2005	62 10		South of SEART- FILL AREA 2				1762	1340	31.5	8.2				004/05	P
15/01/2005	63 1		South of SEART- FILL AREA 2										155	005/05	P
15/01/2005	64 2		South of SEART- FILL AREA 2										113	005/05	F
15/01/2005	65 3		South of SEART- FILL AREA 2										220+	005/05	P
15/01/2005	66 4		South of SEART- FILL AREA 2										82	005/05	F
15/01/2005	67 5		South of SEART- FILL AREA 2										119	005/05	F
15/01/2005	68 6		South of SEART- FILL AREA 2										121	005/05	F
15/01/2005	69 7		South of SEART- FILL AREA 2										168	005/05	P
15/01/2005	70 8		South of SEART- FILL AREA 2										220+	005/05	P
15/01/2005	71 9		South of SEART- FILL AREA 2										utp	005/05	P
15/01/2005	72 10		South of SEART- FILL AREA 2										utp	005/05	P
15/01/2005	73 11		South of SEART- FILL AREA 2										143	005/05	P
15/01/2005	74 12		South of SEART- FILL AREA 2										152	005/05	P
15/01/2005	75 13		South of SEART- FILL AREA 2										201	005/05	P
15/01/2005	76 14		South of SEART- FILL AREA 2										220+	005/05	P
15/01/2005	77 15		South of SEART- FILL AREA 2										217	005/05	P
15/01/2005	78 16		South of SEART- FILL AREA 2										199	005/05	P
15/01/2005	79 17		South of SEART- FILL AREA 2										192	005/05	P
15/01/2005	80 18		South of SEART- FILL AREA 2										144	005/05	P
15/01/2005	81 19		South of SEART- FILL AREA 2										220+	005/05	P
15/01/2005	82 20		South of SEART- FILL AREA 2										214	005/05	P
15/01/2005	83 21		South of SEART- FILL AREA 2										152	005/05	P
15/01/2005	84 22		South of SEART- FILL AREA 2										160	005/05	P
15/01/2005	85 23		South of SEART- FILL AREA 2										185	005/05	P
15/01/2005	86 24		South of SEART- FILL AREA 2										155	005/05	P
15/01/2005	87 25		South of SEART- FILL AREA 2										170	005/05	P
15/01/2005	88 26		South of SEART- FILL AREA 2										190	005/05	P
15/01/2005	89 27		South of SEART- FILL AREA 2										204	005/05	P
15/01/2005	90 28		South of SEART- FILL AREA 2										220+	005/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
15/01/2005	91 29		South of SEART- FILL AREA 2										utp	005/05	P
15/01/2005	92 30		South of SEART- FILL AREA 2										154	005/05	P
20/01/2005	93 1		South of SEART- FILL AREA 1				1830	1541	18.8	14.4				007/05	F
20/01/2005	94 2		South of SEART- FILL AREA 1				1889	1506	25.5	6.3				007/05	P
20/01/2005	95 3		South of SEART- FILL AREA 1				1863	1603	16.3	15				007/05	F
20/01/2005	96 1		RETEST SPE - 002/05 - 4										220+	008/05	RP
20/01/2005	97 2		RETEST SPE - 002/05 - 5										UTP	008/05	RP
20/01/2005	98 3		RETEST SPE - 002/05 - 6										UTP	008/05	RP
20/01/2005	99 4		RETEST SPE - 002/05 - 7										220+	008/05	RP
20/01/2005	100 5		RETEST SPE - 002/05 - 10										220+	008/05	RP
20/01/2005	101 6		RETEST SPE - 002/05 -12										220+	008/05	RP
20/01/2005	102 7		RETEST SPE - 002/05 - 13										220+	008/05	RP
20/01/2005	103 8		RETEST SPE - 002/05 - 16										220+	008/05	RP
20/01/2005	104 9		RETEST SPE - 002/05 - 17										220+	008/05	RP
20/01/2005	105 10		RETEST SPE - 002/05 - 19										188	008/05	RP
20/01/2005	106 11		RETEST SPE - 002/05 - 21										220+	008/05	RP
20/01/2005	107 12		RETEST SPE - 002/05 - 22										UTP	008/05	RP
20/01/2005	108 13		RETEST SPE - 002/05 - 23										220+	008/05	RP
20/01/2005	109 14		RETEST SPE - 002/05 - 24										220+	008/05	RP
20/01/2005	110 15		RETEST SPE - 002/05 - 28										220+	008/05	RP
20/01/2005	111 16		RETEST SPE - 002/05 - 29										220+	008/05	RP
21/01/2005	112 1		South of SEART- FILL AREA 1										145	009/05	P
21/01/2005	113 2		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	114 3		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	115 4		South of SEART- FILL AREA 1										182	009/05	P
21/01/2005	116 5		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	117 6		South of SEART- FILL AREA 1										119	009/05	F
21/01/2005	118 7		South of SEART- FILL AREA 1										219	009/05	P
21/01/2005	119 8		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	120 9		South of SEART- FILL AREA 1										230+	009/05	P

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							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
21/01/2005	121 10		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	122 11		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	123 12		South of SEART- FILL AREA 1										190	009/05	P
21/01/2005	124 13		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	125 14		South of SEART- FILL AREA 1										162	009/05	P
21/01/2005	126 15		South of SEART- FILL AREA 1										191	009/05	P
21/01/2005	127 16		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	128 17		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	129 18		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	130 19		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	131 20		South of SEART- FILL AREA 1										218	009/05	P
21/01/2005	132 21		South of SEART- FILL AREA 1										198	009/05	P
21/01/2005	133 22		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	134 23		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	135 24		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	136 25		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	137 26		South of SEART- FILL AREA 1										230+	009/05	P
21/01/2005	138 27		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	139 28		South of SEART- FILL AREA 1										UTP	009/05	P
21/01/2005	140 29		South of SEART- FILL AREA 1										182	009/05	P
21/01/2005	141 30		South of SEART- FILL AREA 1										162	009/05	P
24/01/2005	142 1		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	143 2		South of SEART- FILL AREA 1										UTP	010/05	P
24/01/2005	144 3		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	145 4		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	146 5		South of SEART- FILL AREA 1										UTP	010/05	P
24/01/2005	147 6		South of SEART- FILL AREA 1										UTP	010/05	P
24/01/2005	148 7		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	149 8		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	150 9		South of SEART- FILL AREA 1										UTP	010/05	P

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Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Nuclear Density Test: Corr. Dry Density (kg/m³)	Nuclear Density Test: Oven Water Content (%)	Nuclear Density Test: Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
24/01/2005	151 10		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	152 11		South of SEART- FILL AREA 1										UTP	010/05	P
24/01/2005	153 12		South of SEART- FILL AREA 1										UTP	010/05	P
24/01/2005	154 13		South of SEART- FILL AREA 1										198	010/05	P
24/01/2005	155 14		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	156 15		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	157 16		South of SEART- FILL AREA 1										230+	010/05	P
24/01/2005	158 1		South of SEART- FILL AREA 2										198	011/05	P
24/01/2005	159 2		South of SEART- FILL AREA 2										222	011/05	P
24/01/2005	160 3		South of SEART- FILL AREA 2										198	011/05	P
24/01/2005	161 4		South of SEART- FILL AREA 2										123	011/05	F
24/01/2005	162 5		South of SEART- FILL AREA 2										230	011/05	P
24/01/2005	163 6		South of SEART- FILL AREA 2										107	011/05	F
24/01/2005	164 7		South of SEART- FILL AREA 2										230+	011/05	P
24/01/2005	165 8		South of SEART- FILL AREA 2										99	011/05	F
24/01/2005	166 9		South of SEART- FILL AREA 2										165	011/05	P
24/01/2005	167 10		South of SEART- FILL AREA 2										230+	011/05	P
24/01/2005	168 11		South of SEART- FILL AREA 2										230+	011/05	P
24/01/2005	169 12		South of SEART- FILL AREA 2										165	011/05	P
24/01/2005	170 13		South of SEART- FILL AREA 2										181	011/05	P
24/01/2005	171 14		South of SEART- FILL AREA 2										230+	011/05	P
24/01/2005	172 15		South of SEART- FILL AREA 2										198	011/05	P
24/01/2005	173 16		South of SEART- FILL AREA 2										165	011/05	P
24/01/2005	174 1		South of SEART- FILL AREA 1				1963	1533	28.1	1.5				012/05	P
24/01/2005	175 2		South of SEART- FILL AREA 1				1960	1489	31.7	0.0				012/05	P
24/01/2005	176 3		South of SEART- FILL AREA 1				1980	1591	24.5	3.4				012/05	P
24/01/2005	177 4		South of SEART- FILL AREA 1				1982	1613	22.9	4.7				012/05	P
24/01/2005	178 5		South of SEART- FILL AREA 1				1913	1539	24.3	6.8				012/05	P
24/01/2005	179 6		South of SEART- FILL AREA 1				1918	1611	19.1	10.9				012/05	P
24/01/2005	180 7		South of SEART- FILL AREA 1				1958	1704	15.0	12.8				012/05	P

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25/01/2005	181 1		South of SEART- TOP OF FILL AREA 2				1913	1505	27.2	4.6				016/05	P
25/01/2005	182 2		South of SEART- TOP OF FILL AREA 2				1904	1490	27.8	4.6				016/05	P
25/01/2005	183 3		South of SEART- TOP OF FILL AREA 2				1840	1487	23.8	10.8				016/05	P
25/01/2005	184 4		South of SEART- TOP OF FILL AREA 2				1809	1439	25.8	10.8				016/05	P
25/01/2005	185 1		South of SEART- FILL AREA 1				1815	1394	30.2	7.4				017/05	P
25/01/2005	186 2		South of SEART- FILL AREA 1				1913	1538	24.5	6.7				017/05	P
25/01/2005	187 3		South of SEART- FILL AREA 1				1840	1463	25.8	9.3				017/05	P
25/01/2005	188 4		South of SEART- FILL AREA 1				1901	1524	24.7	7.1				017/05	P
25/01/2005	189 5		South of SEART- FILL AREA 1				1867	1473	26.7	7.3				017/05	P
25/01/2005	190 1	0.2	South of SEART- FILL AREA 3										157	018/05	P
25/01/2005	191	0.4	South of SEART- FILL AREA 3										157	018/05	P
25/01/2005	192 2	0.2	South of SEART- FILL AREA 3										188	018/05	P
25/01/2005	193	0.4	South of SEART- FILL AREA 3										188	018/05	P
25/01/2005	194 3	0.2	South of SEART- FILL AREA 3										204	018/05	P
25/01/2005	195	0.4	South of SEART- FILL AREA 3										188	018/05	P
25/01/2005	196 4	0.2	South of SEART- FILL AREA 3										173	018/05	P
25/01/2005	197	0.4	South of SEART- FILL AREA 3										204	018/05	P
25/01/2005	198 1		South of SEART- FILL AREA 3										94	019/05	F
25/01/2005	199 2		South of SEART- FILL AREA 3.										110	019/05	F
25/01/2005	200 3		South of SEART- FILL AREA 3										188	019/05	P
25/01/2005	201 4		South of SEART- FILL AREA 3										107	019/05	F
25/01/2005	202 5		South of SEART- FILL AREA 3										71	019/05	F
25/01/2005	203 6		South of SEART- FILL AREA 3										63	019/05	F
25/01/2005	204 7		South of SEART- FILL AREA 3										86	019/05	F
25/01/2005	205 8		South of SEART- FILL AREA 3										86	019/05	F
25/01/2005	206 9		South of SEART- FILL AREA 3										102	019/05	F
25/01/2005	207 10		South of SEART- FILL AREA 3										71	019/05	F
25/01/2005	208 11		South of SEART- FILL AREA 3										110	019/05	F
26/01/2005	209 1		RETEST OF SPE - 011/05-4										230+	021/05	RP
26/01/2005	210 2		RETEST OF SPE - 011/05-8										230+	021/05	RP

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26/01/2005	211 3		RETEST OF SPE - 011/05-6										181	021/05	RP
26/01/2005	212 4		RETEST OF SPE - 009/05 - 6										198	021/05	RP
26/01/2005	213 5		RETEST OF SPE - 005/05 - 2										UTP	021/05	RP
26/01/2005	214 6		RETEST OF SPE - 005/05 - 4										UTP	021/05	RP
26/01/2005	215 7		RETEST OF SPE - 005/05 - 5										230+	021/05	RP
26/01/2005	216 8		RETEST OF SPE - 005/05 - 6										230+	021/05	RP
26/01/2005	217 1		RETEST OF SPE - 007/05 - 1				1896	1441	31.6	2.3				022/05	RP
26/01/2005	218 2		RETEST OF SPE - 007/05 - 3				1873	1463	28	6				022/05	RP
26/01/2005	219 3		RETEST OF SPE - 004/05 - 6				1956	1548	26.4	3.1				022/05	RP
26/01/2005	220 4		RETEST OF SPE - 004/05 - 7				1961	1538	27.4	2.1				022/05	RP
27/01/2005	221 1		South of SEART- FILL AREA 2				1987	1556	27.7	0.5				023/05	P
27/01/2005	222 2		South of SEART- FILL AREA 2				1912	1529	25	6.3				023/05	P
27/01/2005	223 1		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	224 2		South of SEART- FILL AREA 2										UTP	024/05	P
27/01/2005	225 3		South of SEART- FILL AREA 2										204	024/05	P
27/01/2005	226 4		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	227 5		South of SEART- FILL AREA 2										UTP	024/05	P
27/01/2005	228 6		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	229 7		South of SEART- FILL AREA 2										188	024/05	P
27/01/2005	230 8		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	231 9		South of SEART- FILL AREA 2										UTP	024/05	P
27/01/2005	232 10		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	233 11		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	234 12		South of SEART- FILL AREA 2										188	024/05	P
27/01/2005	235 13		South of SEART- FILL AREA 2										UTP	024/05	P
27/01/2005	236 14		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	237 15		South of SEART- FILL AREA 2										220+	024/05	P
27/01/2005	238 1	0.2	South of SEART- FILL AREA 2										220+	025/05	P
27/01/2005	239	0.4	South of SEART- FILL AREA 2										220+	025/05	P
27/01/2005	240 2	0.2	South of SEART- FILL AREA 2										220+	025/05	P

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27/01/2005	241	0.4	South of SEART- FILL AREA 2										220+	025/05	P
27/01/2005	242 3	0.2	South of SEART- FILL AREA 2										220+	025/05	P
27/01/2005	243	0.4	South of SEART- FILL AREA 2										204	025/05	P
27/01/2005	244 4	0.2	South of SEART- FILL AREA 2										220+	025/05	P
27/01/2005	245	0.4	South of SEART- FILL AREA 2										173	025/05	P
28/01/2005	246 1		South of SEART- FILL AREA 1				1940	1519	27.8	2.8				026/05	P
28/01/2005	247 2		South of SEART- FILL AREA 1				1941	1581	22.8	6.7				026/05	P
28/01/2005	248 3		South of SEART- FILL AREA 1				1933	1576	22.6	7.3				026/05	P
28/01/2005	249 1		South of SEART- FILL AREA 1										170	027/05	P
28/01/2005	250 2		South of SEART- FILL AREA 1										148	027/05	P
28/01/2005	251 3		South of SEART- FILL AREA 1										144	027/05	P
28/01/2005	252 4		South of SEART- FILL AREA 1										195	027/05	P
28/01/2005	253 5		South of SEART- FILL AREA 1										155	027/05	P
28/01/2005	254 6		South of SEART- FILL AREA 1										170	027/05	P
28/01/2005	255 7		South of SEART- FILL AREA 1										188	027/05	P
28/01/2005	256 8		South of SEART- FILL AREA 1										UTP	027/05	P
28/01/2005	257 9		South of SEART- FILL AREA 1										140	027/05	P
28/01/2005	258 10		South of SEART- FILL AREA 1										174	027/05	P
28/01/2005	259 11		South of SEART- FILL AREA 1										193	027/05	P
28/01/2005	260 12		South of SEART- FILL AREA 1										157	027/05	P
28/01/2005	261 13		South of SEART- FILL AREA 1										174	027/05	P
28/01/2005	262 14		South of SEART- FILL AREA 1										168	027/05	P
1/02/2005	263 1	0.2	South of SEART- FILL AREA 3										182	032/05	P
1/02/2005	264	0.4	South of SEART- FILL AREA 3										165	032/05	P
1/02/2005	265 2	0.2	South of SEART- FILL AREA 3										190	032/05	P
1/02/2005	266	0.4	South of SEART- FILL AREA 3										182	032/05	P
1/02/2005	267 3	0.2	South of SEART- FILL AREA 3										173	032/05	P
1/02/2005	268	0.4	South of SEART- FILL AREA 3										165	032/05	P
1/02/2005	269 4	0.2	South of SEART- FILL AREA 3										165	032/05	P
1/02/2005	270	0.4	South of SEART- FILL AREA 3										149	032/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test				GEO	Average	Hand	Lab	Status
							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
1/02/2005	271 5	0.2	South of SEART- FILL AREA 3										198	032/05	P
1/02/2005	272	0.4	South of SEART- FILL AREA 3										182	032/05	P
1/02/2005	273 6	0.2	South of SEART- FILL AREA 3										153	032/05	P
1/02/2005	274	0.4	South of SEART- FILL AREA 3										132	032/05	P
1/02/2005	275 7	0.2	South of SEART- FILL AREA 3										206	032/05	P
1/02/2005	276	0.4	South of SEART- FILL AREA 3										173	032/05	P
1/02/2005	277 8	0.2	South of SEART- FILL AREA 3										182	032/05	P
1/02/2005	278	0.4	South of SEART- FILL AREA 3										149	032/05	P
1/02/2005	279 9	0.2	South of SEART- FILL AREA 3										165	032/05	P
1/02/2005	280	0.4	South of SEART- FILL AREA 3										140	032/05	P
4/02/2005	281 1		RETEST SPE 019/05 - 1										UTP	029/05	RP
4/02/2005	282 2		RETEST SPE 019/05 - 2										UTP	029/05	RP
4/02/2005	283 3		RETEST SPE 019/05 - 4										UTP	029/05	RP
4/02/2005	284 4		RETEST SPE 019/05 - 5										UTP	029/05	RP
4/02/2005	285 5		RETEST SPE 019/05 - 6										UTP	029/05	RP
4/02/2005	286 6		RETEST SPE 019/05 - 7										UTP	029/05	RP
4/02/2005	287 7		RETEST SPE 019/05 - 8										UTP	029/05	RP
4/02/2005	288 8		RETEST SPE 019/05 - 9										UTP	029/05	RP
4/02/2005	289 9		RETEST SPE 019/05 - 10										UTP	029/05	RP
4/02/2005	290 10		RETEST SPE 019/05 - 11										198	029/05	RP
4/02/2005	291 1		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	292 2		South of SEART- FILL AREA 2										116	030/05	P
4/02/2005	293 3		South of SEART- FILL AREA 2										175	030/05	P
4/02/2005	294 4		South of SEART- FILL AREA 2										201	030/05	P
4/02/2005	295 5		South of SEART- FILL AREA 2										228	030/05	P
4/02/2005	296 6		South of SEART- FILL AREA 2										198	030/05	P
4/02/2005	297 7		South of SEART- FILL AREA 2										175	030/05	P
4/02/2005	298 8		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	299 9		South of SEART- FILL AREA 2										142	030/05	P
4/02/2005	300 10		South of SEART- FILL AREA 2										215	030/05	P

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Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
4/02/2005	301 11		South of SEART- FILL AREA 2										205	030/05	P
4/02/2005	302 12		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	303 13		South of SEART- FILL AREA 2										201	030/05	P
4/02/2005	304 14		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	305 15		South of SEART- FILL AREA 2										195	030/05	P
4/02/2005	306 16		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	307 17		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	308 18		South of SEART- FILL AREA 2										230+	030/05	P
4/02/2005	309 19		South of SEART- FILL AREA 2										205	030/05	P
4/02/2005	310 20		South of SEART- FILL AREA 2										185	030/05	P
4/02/2005	311 21		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	312 22		South of SEART- FILL AREA 2										215	030/05	P
4/02/2005	313 23		South of SEART- FILL AREA 2										162	030/05	P
4/02/2005	314 24		South of SEART- FILL AREA 2										175	030/05	P
4/02/2005	315 25		South of SEART- FILL AREA 2										UTP	030/05	P
4/02/2005	316 26		South of SEART- FILL AREA 2										188	030/05	P
4/02/2005	317 27		South of SEART- FILL AREA 2										188	030/05	P
4/02/2005	318 1		South of SEART- FILL AREA 2				1879	1449	29.6	4.6				031/05	P
4/02/2005	319 2		South of SEART- FILL AREA 2				1938	1547	25.3	4.8				031/05	P
4/02/2005	320 3		South of SEART- FILL AREA 2				1904	1625	17.2	13.2				031/05	F
4/02/2005	321 4		South of SEART- FILL AREA 2				1889	1686	12	18.7				031/05	F
8/02/2005	322 1		RETEST SPE 031/05-3				1905	1484	28.4	4.1				034/05	RP
8/02/2005	323 2		RETEST SPE 031/05-4				1892	1490	27	5.8				034/05	RP
8/02/2005	324 3		South of SEART- FILL AREA 2				1861	1475	26.2	7.9				034/05	P
8/02/2005	325 4		South of SEART- FILL AREA 2				1936	1545	25.3	4.9				034/05	P
9/02/2005	326 1		South of SEART- FILL AREA 2				1895	1459	29.9	3.5				035/05	P
9/02/2005	327 2		South of SEART- FILL AREA 2				1909	1458	31	2				035/05	P
9/02/2005	328 3		South of SEART- FILL AREA 2				1886	1407	34.1	1.1				035/05	P
9/02/2005	329 4		South of SEART- FILL AREA 2				1890	1402	34.8	0.4				035/05	P
9/02/2005	330 1		South of SEART- FILL AREA 2										207	036/05	P

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9/02/2005	331	2		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	332	3		South of SEART- FILL AREA 2										188	036/05	P
9/02/2005	333	4		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	334	5		South of SEART- FILL AREA 2										157	036/05	P
9/02/2005	335	6		South of SEART- FILL AREA 2										173	036/05	P
9/02/2005	336	7		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	337	8		South of SEART- FILL AREA 2										141	036/05	P
9/02/2005	338	9		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	339	10		South of SEART- FILL AREA 2										204	036/05	P
9/02/2005	340	11		South of SEART- FILL AREA 2										188	036/05	P
9/02/2005	341	12		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	342	13		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	343	14		South of SEART- FILL AREA 2										220+	036/05	P
9/02/2005	344	15		South of SEART- FILL AREA 2										188	036/05	P
9/02/2005	345	16		South of SEART- FILL AREA 2										220+	036/05	P
10/02/2005	346	1		South of SEART- FILL AREA 2										215	039/05	P
10/02/2005	347	2		South of SEART- FILL AREA 2										UTP	039/05	P
10/02/2005	348	3		South of SEART- FILL AREA 2										230+	039/05	P
10/02/2005	349	4		South of SEART- FILL AREA 2										182	039/05	P
10/02/2005	350	5		South of SEART- FILL AREA 2										230+	039/05	P
10/02/2005	351	6		South of SEART- FILL AREA 2										UTP	039/05	P
10/02/2005	352	7		South of SEART- FILL AREA 2										230+	039/05	P
10/02/2005	353	8		South of SEART- FILL AREA 2										190	039/05	P
10/02/2005	354	9		South of SEART- FILL AREA 2										230+	039/05	P
10/02/2005	355	10		South of SEART- FILL AREA 2										230+	039/05	P
10/02/2005	356	11		South of SEART- FILL AREA 2										198	039/05	P
10/02/2005	357	12		South of SEART- FILL AREA 2										UTP	039/05	P
10/02/2005	358	13		South of SEART- FILL AREA 2										UTP	039/05	P
10/02/2005	359	14		South of SEART- FILL AREA 2										230+	039/05	P
10/02/2005	360	15		South of SEART- FILL AREA 2										215	039/05	P

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11/02/2005	361 1		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	362 2		South of SEART- FILL AREA 2										198	037/05	
11/02/2005	363 3		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	364 4		South of SEART- FILL AREA 2										230+	037/05	
11/02/2005	365 5		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	366 6		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	367 7		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	368 8		South of SEART- FILL AREA 2										230+	037/05	
11/02/2005	369 9		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	370 10		South of SEART- FILL AREA 2										155	037/05	
11/02/2005	371 11		South of SEART- FILL AREA 2										198	037/05	
11/02/2005	372 12		South of SEART- FILL AREA 2										UTP	037/05	
11/02/2005	373 13		South of SEART- FILL AREA 2										191	037/05	
11/02/2005	374 14		South of SEART- FILL AREA 2										165	037/05	
11/02/2005	375 15		South of SEART- FILL AREA 2										230+	037/05	
11/02/2005	376 16		South of SEART- FILL AREA 2										230+	037/05	
11/02/2005	377 1		South of SEART- FILL AREA 2				1929	1478	30.5	1.4				038/05	
11/02/2005	378 2		South of SEART- FILL AREA 2				1974	1473	34	0				038/05	
11/02/2005	379 3		South of SEART- FILL AREA 2				1967	1545	27.3	1.9				038/05	
11/02/2005	380 4		South of SEART- FILL AREA 2				1971	1566	25.9	2.8				038/05	
15/02/2005	381 1		South of SEART-TOP FILL AREA 1				1929	1586	21.6	8.3				040/05	
15/02/2005	382 2		South of SEART-TOP FILL AREA 1				1927	1625	18.6	10.9				040/05	
15/02/2005	383 3		South of SEART-TOP FILL AREA 1				1877	1522	23.3	9.4				040/05	
15/02/2005	384 1		South of SEART-TOP FILL AREA 1										230+	042/05	
15/02/2005	385 2		South of SEART-TOP FILL AREA 1										230+	042/05	
15/02/2005	386 3		South of SEART-TOP FILL AREA 1										190	042/05	
15/02/2005	387 4		South of SEART-TOP FILL AREA 1										230+	042/05	
15/02/2005	388 5		South of SEART-TOP FILL AREA 1										230+	042/05	
15/02/2005	389 6		South of SEART-TOP FILL AREA 1										215	042/05	
15/02/2005	390 7		South of SEART-TOP FILL AREA 1										230+	042/05	

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15/02/2005	391	8		South of SEART-TOP FILL AREA 1										230+	042/05	P
15/02/2005	392	9		South of SEART-TOP FILL AREA 1										198	042/05	P
15/02/2005	393	10		South of SEART-TOP FILL AREA 1										230+	042/05	P
15/02/2005	394	11		South of SEART-TOP FILL AREA 1										223	042/05	P
15/02/2005	395	12		South of SEART-TOP FILL AREA 1										165	042/05	P
15/02/2005	396	13		South of SEART-TOP FILL AREA 1										230+	042/05	P
15/02/2005	397	14		South of SEART-TOP FILL AREA 1										198	042/05	P
15/02/2005	398	15		South of SEART-TOP FILL AREA 1										190	042/05	P
15/02/2005	399	16		South of SEART-TOP FILL AREA 1										230+	042/05	P
15/02/2005	400	1	0.2	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	401		0.4	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	402		0.6	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	403	2	0.2	Sth of SEART- PADS TOP FILL AREA 1										230+	046/05	P
15/02/2005	404		0.4	Sth of SEART- PADS TOP FILL AREA 1										230+	046/05	P
15/02/2005	405		0.6	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	406	3	0.2	Sth of SEART- PADS TOP FILL AREA 1										230+	046/05	P
15/02/2005	407		0.4	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	408		0.6	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	409	4	0.2	Sth of SEART- PADS TOP FILL AREA 1										230+	046/05	P
15/02/2005	410		0.4	Sth of SEART- PADS TOP FILL AREA 1										230+	046/05	P
15/02/2005	411		0.6	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	412	5	0.2	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	413		0.4	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
15/02/2005	414		0.6	Sth of SEART- PADS TOP FILL AREA 1										UTP	046/05	P
17/02/2005	415	1	0.2	Sth of SEART- PADS TOP FILL AREA 1										182	045/05	P
17/02/2005	416		0.4	Sth of SEART- PADS TOP FILL AREA 1										165	045/05	P
17/02/2005	417		0.6	Sth of SEART- PADS TOP FILL AREA 1										173	045/05	P
17/02/2005	418	2	0.2	Sth of SEART- PADS TOP FILL AREA 1										165	045/05	P
17/02/2005	419		0.4	Sth of SEART- PADS TOP FILL AREA 1										230+	045/05	P
17/02/2005	420		0.6	Sth of SEART- PADS TOP FILL AREA 1										230+	045/05	P

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17/02/2005	421 3	0.2	Sth of SEART- PADS TOP FILL AREA 1										149	045/05	P
17/02/2005	422	0.4	Sth of SEART- PADS TOP FILL AREA 1										230+	045/05	P
17/02/2005	423	0.6	Sth of SEART- PADS TOP FILL AREA 1										198	045/05	P
17/02/2005	424 4	0.2	Sth of SEART- PADS TOP FILL AREA 1										198	045/05	P
17/02/2005	425	0.4	Sth of SEART- PADS TOP FILL AREA 1										230+	045/05	P
17/02/2005	426	0.6	Sth of SEART- PADS TOP FILL AREA 1										215	045/05	P
17/02/2005	427 5	0.2	Sth of SEART- PADS TOP FILL AREA 1										175	045/05	P
17/02/2005	428	0.4	Sth of SEART- PADS TOP FILL AREA 1										182	045/05	P
17/02/2005	429	0.6	Sth of SEART- PADS TOP FILL AREA 1										215	045/05	P
21/02/2005	430 1		3 SOUTH WAREHOUSE				1920	1564	22.7	7.8				058/05	P
21/02/2005	431 2		3 SOUTH WAREHOUSE				1932	1580	22.3	7.6				058/05	P
21/02/2005	432 3		3 SOUTH WAREHOUSE				1937	1568	23.6	6.3				058/05	P
21/02/2005	433 4		3 SOUTH WAREHOUSE				1983	1574	26	2.1				058/05	P
22/02/2005	434 1		1 North Pad-Carpark Warehouse				2058	1682	22.4	1.5				059/05	P
22/02/2005	435 2		1 North Pad-Carpark Warehouse				2021	1671	21	4.4				059/05	P
22/02/2005	436 3		1 North Pad-Carpark Warehouse				1887	1448	30.3	3.7				059/05	P
22/02/2005	437 4		1 North Pad-Carpark Warehouse				1920	1389	38.3	0				059/05	P
22/02/2005	438 5		1 North Pad-Carpark Warehouse				1866	1283	45.5	0				059/05	P
22/02/2005	439 1		2 Middle Pad-Carpark Warehouse				1936	1496	29.4	1.8				060/05	P
22/02/2005	440 2		2 Middle Pad-Carpark Warehouse				1932	1498	29	2.3				060/05	P
22/02/2005	441 3		2 Middle Pad-Carpark Warehouse				1979	1541	28.4	0.4				060/05	P
22/02/2005	442 4		2 Middle Pad-Carpark Warehouse	NDM data	only		1984	1570	26.4	1.7				060/05	P
22/02/2005	443 5		2 Middle Pad-Carpark Warehouse				1874	1480	26.7	6.9				060/05	P
22/02/2005	444 1		3 South Pad-Carpark Warehouse				1869	1381	35.4	1.1				061/05	P
22/02/2005	445 2		3 South Pad-Carpark Warehouse				1863	1376	35.4	1.5				061/05	P
22/02/2005	446 3		3 South Pad-Carpark Warehouse				1852	1400	32.3	4.1				061/05	P
22/02/2005	447 4		3 South Pad-Carpark Warehouse				1912	1455	31.4	1.6				061/05	P
22/02/2005	448 5		3 South Pad-Carpark Warehouse				1935	1498	29.1	2.1				061/05	P
22/02/2005	449 1		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	450 2		1 North Pad-Carpark Warehouse										201	065/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Nuclear Density Test: Corr. Dry Density (kg/m³)	Nuclear Density Test: Oven Water Content (%)	Nuclear Density Test: Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
22/02/2005	451 3		1 North Pad-Carpark Warehouse										230+	065/05	P
22/02/2005	452 4		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	453 5		1 North Pad-Carpark Warehouse										215	065/05	P
22/02/2005	454 6		1 North Pad-Carpark Warehouse										145	065/05	P
22/02/2005	455 7		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	456 8		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	457 9		1 North Pad-Carpark Warehouse										205	065/05	P
22/02/2005	458 10		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	459 11		1 North Pad-Carpark Warehouse										230+	065/05	P
22/02/2005	460 12		1 North Pad-Carpark Warehouse										182	065/05	P
22/02/2005	461 13		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	462 14		1 North Pad-Carpark Warehouse										172	065/05	P
22/02/2005	463 15		1 North Pad-Carpark Warehouse										UTP	065/05	P
22/02/2005	464 16		1 North Pad-Carpark Warehouse										168	065/05	P
22/02/2005	465 1		2 Middle Pad-Carpark Warehouse										215	066/05	P
22/02/2005	466 2		2 Middle Pad-Carpark Warehouse										185	066/05	P
22/02/2005	467 3		2 Middle Pad-Carpark Warehouse										230+	066/05	P
22/02/2005	468 4		2 Middle Pad-Carpark Warehouse										172	066/05	P
22/02/2005	469 5		2 Middle Pad-Carpark Warehouse										162	066/05	P
22/02/2005	470 6		2 Middle Pad-Carpark Warehouse										UTP	066/05	P
22/02/2005	471 7		2 Middle Pad-Carpark Warehouse										UTP	066/05	P
22/02/2005	472 8		2 Middle Pad-Carpark Warehouse										162	066/05	P
22/02/2005	473 9		2 Middle Pad-Carpark Warehouse										UTP	066/05	P
22/02/2005	474 10		2 Middle Pad-Carpark Warehouse										145	066/05	P
22/02/2005	475 11		2 Middle Pad-Carpark Warehouse										230+	066/05	P
22/02/2005	476 12		2 Middle Pad-Carpark Warehouse										172	066/05	P
22/02/2005	477 13		2 Middle Pad-Carpark Warehouse										UTP	066/05	P
22/02/2005	478 14		2 Middle Pad-Carpark Warehouse										UTP	066/05	P
22/02/2005	479 15		2 Middle Pad-Carpark Warehouse										201	066/05	P
22/02/2005	480 16		2 Middle Pad-Carpark Warehouse										178	066/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.		Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
22/02/2005	481	1		3 South Pad-Carpark Warehouse										230+	067/05	P
22/02/2005	482	2		3 South Pad-Carpark Warehouse										UTP	067/05	P
22/02/2005	483	3		3 South Pad-Carpark Warehouse										UTP	067/05	P
22/02/2005	484	4		3 South Pad-Carpark Warehouse										201	067/05	P
22/02/2005	485	5		3 South Pad-Carpark Warehouse										UTP	067/05	P
22/02/2005	486	6		3 South Pad-Carpark Warehouse										182	067/05	P
22/02/2005	487	7		3 South Pad-Carpark Warehouse										UTP	067/05	P
22/02/2005	488	8		3 South Pad-Carpark Warehouse										158	067/05	P
22/02/2005	489	9		3 South Pad-Carpark Warehouse										230+	067/05	P
22/02/2005	490	10		3 South Pad-Carpark Warehouse										230+	067/05	P
22/02/2005	491	11		3 South Pad-Carpark Warehouse										215	067/05	P
22/02/2005	492	12		3 South Pad-Carpark Warehouse										221	067/05	P
22/02/2005	493	13		3 South Pad-Carpark Warehouse										205	067/05	P
22/02/2005	494	14		3 South Pad-Carpark Warehouse										205	067/05	P
22/02/2005	495	15		3 South Pad-Carpark Warehouse										224	067/05	P
22/02/2005	496	16		3 South Pad-Carpark Warehouse										UTP	067/05	P
1/03/2005	497	1	0.2	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	498		0.4	3 South Pad-Carpark Warehouse										223	064/05	P
1/03/2005	499		0.6	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	500	2	0.2	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	501		0.4	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	502		0.6	3 South Pad-Carpark Warehouse										215	064/05	P
1/03/2005	503	3	0.2	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	504		0.4	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	505		0.6	3 South Pad-Carpark Warehouse										198	064/05	P
1/03/2005	506	4	0.2	3 South Pad-Carpark Warehouse										198	064/05	P
1/03/2005	507		0.4	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	508		0.6	3 South Pad-Carpark Warehouse										223	064/05	P
1/03/2005	509	5	0.2	3 South Pad-Carpark Warehouse										230+	064/05	P
1/03/2005	510		0.4	3 South Pad-Carpark Warehouse										230+	064/05	P

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Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Nuclear Density Test: Corr. Dry Density (kg/m³)	Nuclear Density Test: Oven Water Content (%)	Nuclear Density Test: Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
1/03/2005	511	0.6	3 South Pad-Carpark Warehouse										230+	064/05	P
2/03/2005	512 1		Southern Gully Fill										201	068/05	P
2/03/2005	513 2		Southern Gully Fill										188	068/05	P
2/03/2005	514 3		Southern Gully Fill										215	068/05	P
2/03/2005	515 4		Southern Gully Fill										185	068/05	P
2/03/2005	516 5		Southern Gully Fill										182	068/05	P
2/03/2005	517 6		Southern Gully Fill										162	068/05	P
2/03/2005	518 7		Southern Gully Fill										195	068/05	P
2/03/2005	519 8		Southern Gully Fill										218	068/05	P
2/03/2005	520 9		Southern Gully Fill										223	068/05	P
2/03/2005	521 10		Southern Gully Fill										230+	068/05	P
2/03/2005	522 11		Southern Gully Fill										116	068/05	P
2/03/2005	523 12		Southern Gully Fill										230+	068/05	P
2/03/2005	524 13		Southern Gully Fill										150	068/05	P
2/03/2005	525 14		Southern Gully Fill										125	068/05	P
2/03/2005	526 15		Southern Gully Fill										142	068/05	P
2/03/2005	527 16		Southern Gully Fill										158	068/05	P
2/03/2005	528 1	0.2	Southern Gully Fill										UTP	069/05	P
2/03/2005	529	0.4	Southern Gully Fill										UTP	069/05	P
2/03/2005	530	0.6	Southern Gully Fill										UTP	069/05	P
2/03/2005	531 2	0.2	Southern Gully Fill										230+	069/05	P
2/03/2005	532	0.4	Southern Gully Fill										UTP	069/05	P
2/03/2005	533	0.6	Southern Gully Fill										UTP	069/05	P
2/03/2005	534 3	0.2	Southern Gully Fill										UTP	069/05	P
2/03/2005	535	0.4	Southern Gully Fill										UTP	069/05	P
2/03/2005	536	0.6	Southern Gully Fill										UTP	069/05	P
2/03/2005	537 4	0.2	Southern Gully Fill										125	069/05	P
2/03/2005	538	0.4	Southern Gully Fill										112	069/05	P
2/03/2005	539	0.6	Southern Gully Fill										201	069/05	P
2/03/2005	540 5	0.2	Southern Gully Fill										162	069/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test				GEO	Average	Hand	Lab	Status
							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
2/03/2005	541	0.4	Southern Gully Fill										135	069/05	P
2/03/2005	542	0.6	Southern Gully Fill										119	069/05	P
2/03/2005	543 6	0.2	Southern Gully Fill										230+	069/05	P
2/03/2005	544	0.4	Southern Gully Fill										116	069/05	P
2/03/2005	545	0.6	Southern Gully Fill										145	069/05	P
2/03/2005	546 7	0.2	Southern Gully Fill										UTP	069/05	P
2/03/2005	547	0.4	Southern Gully Fill										UTP	069/05	P
2/03/2005	548	0.6	Southern Gully Fill										UTP	069/05	P
2/03/2005	549 8	0.2	Southern Gully Fill										182	069/05	P
2/03/2005	550	0.4	Southern Gully Fill										120	069/05	P
2/03/2005	551	0.6	Southern Gully Fill										UTP	069/05	P
2/03/2005	552 1		Pad No 20 - South of SEART										205	072/05	P
2/03/2005	553 2		Pad No 20 - South of SEART										178	072/05	P
2/03/2005	554 3		Pad No 20 - South of SEART										185	072/05	P
2/03/2005	555 4		Pad No 20 - South of SEART										188	072/05	P
2/03/2005	556 5		Pad No 20 - South of SEART										155	072/05	P
2/03/2005	557 6		Pad No 20 - South of SEART										230+	072/05	P
2/03/2005	558 7		Pad No 20 - South of SEART										182	072/05	P
2/03/2005	559 8		Pad No 20 - South of SEART										201	072/05	P
2/03/2005	560 9		Pad No 20 - South of SEART										230+	072/05	P
2/03/2005	561 10		Pad No 20 - South of SEART										230+	072/05	P
2/03/2005	562 11		Pad No 20 - South of SEART										172	072/05	P
2/03/2005	563 12		Pad No 20 - South of SEART										230+	072/05	P
2/03/2005	564 13		Pad No 20 - South of SEART										149	072/05	P
2/03/2005	565 14		Pad No 20 - South of SEART										UTP	072/05	P
2/03/2005	566 15		Pad No 20 - South of SEART										215	072/05	P
2/03/2005	567 16		Pad No 20 - South of SEART										201	072/05	P
2/03/2005	568 1	0.2	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	569	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	570	0.6	Pad No 20 - South of SEART										UTP	073/05	P

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2/03/2005	571 2	0.2	Pad No 20 - South of SEART										230+	073/05	P
2/03/2005	572	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	573 3	0.2	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	574	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	575 4	0.2	Pad No 20 - South of SEART										230+	073/05	P
2/03/2005	576	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	577 5	0.2	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	578	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	579 6	0.2	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	580	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	581 7	0.2	Pad No 20 - South of SEART										112	073/05	P
2/03/2005	582	0.4	Pad No 20 - South of SEART										129	073/05	P
2/03/2005	583	0.6	Pad No 20 - South of SEART										155	073/05	P
2/03/2005	584 8	0.2	Pad No 20 - South of SEART										230+	073/05	P
2/03/2005	585	0.4	Pad No 20 - South of SEART										UTP	073/05	P
2/03/2005	586 1		Southern Gully Fill				1941	1549	25.3	4.7				074/05	P
2/03/2005	587 2		Southern Gully Fill				1885	1396	35.1	0.5				074/05	P
2/03/2005	588 3		Southern Gully Fill				1993	1492	33.6	0				074/05	P
2/03/2005	589 4		Southern Gully Fill				1860	1348	38	0				074/05	P
2/03/2005	590 5		Southern Gully Fill				1966	1610	22.1	6.1				074/05	P
2/03/2005	591 1		Pad No 20 - South of SEART				1946	1512	28.7	1.9				075/05	P
2/03/2005	592 2		Pad No 20 - South of SEART				2043	1681	21.6	2.9				075/05	P
2/03/2005	593 3		Pad No 20 - South of SEART				1991	1584	25.7	1.9				075/05	P
2/03/2005	594 4		Pad No 20 - South of SEART				2027	1620	25.2	0.5				075/05	P
2/03/2005	595 5		Pad No 20 - South of SEART				2017	1641	22.9	3				075/05	P
4/03/2005	596 1		Pad A - North of SEART				1831	1436	27.5	8.5				083/05	P
4/03/2005	597 2		Pad A - North of SEART				1900	1436	32.3	1.6				083/05	P
4/03/2005	598 3		Pad A - North of SEART				1989	1569	26.8	1.2				083/05	P
4/03/2005	599 4		Pad A - North of SEART				1980	1505	31.6	0				083/05	P
4/03/2005	600 5		Pad A - North of SEART				1929	1559	23.8	6.5				083/05	P

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4/03/2005	601	1		Pad A - North of SEART										185	084/05	P
4/03/2005	602	2		Pad A - North of SEART										165	084/05	P
4/03/2005	603	3		Pad A - North of SEART										135	084/05	P
4/03/2005	604	4		Pad A - North of SEART										182	084/05	P
4/03/2005	605	5		Pad A - North of SEART										185	084/05	P
4/03/2005	606	6		Pad A - North of SEART										139	084/05	P
4/03/2005	607	7		Pad A - North of SEART										230+	084/05	P
4/03/2005	608	8		Pad A - North of SEART										195	084/05	P
4/03/2005	609	9		Pad A - North of SEART										UTP	084/05	P
4/03/2005	610	10		Pad A - North of SEART										UTP	084/05	P
4/03/2005	611	11		Pad A - North of SEART										UTP	084/05	P
4/03/2005	612	12		Pad A - North of SEART										198	084/05	P
4/03/2005	613	13		Pad A - North of SEART										198	084/05	P
4/03/2005	614	14		Pad A - North of SEART										201	084/05	P
4/03/2005	615	15		Pad A - North of SEART										178	084/05	P
4/03/2005	616	16		Pad A - North of SEART										UTP	084/05	P
4/03/2005	617	17		Pad A - North of SEART										147	084/05	P
4/03/2005	618	18		Pad A - North of SEART										165	084/05	P
4/03/2005	619	19		Pad A - North of SEART										155	084/05	P
4/03/2005	620	20		Pad A - North of SEART										230+	084/05	P
4/03/2005	621	21		Pad A - North of SEART										182	084/05	P
4/03/2005	622	1	0.2	Pad A - North of SEART										UTP	085/05	P
4/03/2005	623		0.4	Pad A - North of SEART										164	085/05	P
4/03/2005	624		0.6	Pad A - North of SEART										138	085/05	P
4/03/2005	625	2	0.2	Pad A - North of SEART										UTP	085/05	P
4/03/2005	626	3	0.2	Pad A - North of SEART										190+	085/05	P
4/03/2005	627		0.4	Pad A - North of SEART										118	085/05	P
4/03/2005	628		0.6	Pad A - North of SEART										138	085/05	P
4/03/2005	629	4	0.2	Pad A - North of SEART										190+	085/05	P
4/03/2005	630		0.4	Pad A - North of SEART										185	085/05	P

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							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
4/03/2005	631	0.6	Pad A - North of SEART										128	085/05	P
4/03/2005	632 5	0.2	Pad A - North of SEART										155	085/05	P
4/03/2005	633	0.4	Pad A - North of SEART										132	085/05	P
4/03/2005	634	0.6	Pad A - North of SEART										178	085/05	P
4/03/2005	635 6	0.2	Pad A - North of SEART										190+	085/05	P
4/03/2005	636	0.4	Pad A - North of SEART										UTP	085/05	P
4/03/2005	637	0.6	Pad A - North of SEART										132	085/05	P
4/03/2005	638 7	0.2	Pad A - North of SEART										190+	085/05	P
4/03/2005	639	0.4	Pad A - North of SEART										155	085/05	P
4/03/2005	640	0.6	Pad A - North of SEART										161	085/05	P
4/03/2005	641 8	0.2	Pad A - North of SEART										171	085/05	P
4/03/2005	642	0.4	Pad A - North of SEART										124	085/05	P
4/03/2005	643	0.6	Pad A - North of SEART										UTP	085/05	P
8/03/2005	644 1		Pad B - North of SEART										165	087/05	P
8/03/2005	645 2		Pad B - North of SEART										205	087/05	P
8/03/2005	646 3		Pad B - North of SEART										UTP	087/05	P
8/03/2005	647 4		Pad B - North of SEART										215	087/05	P
8/03/2005	648 5		Pad B - North of SEART										211	087/05	P
8/03/2005	649 6		Pad B - North of SEART										178	087/05	P
8/03/2005	650 7		Pad B - North of SEART										195	087/05	P
8/03/2005	651 8		Pad B - North of SEART										162	087/05	P
8/03/2005	652 9		Pad B - North of SEART										198	087/05	P
8/03/2005	653 10		Pad B - North of SEART										185	087/05	P
8/03/2005	654 11		Pad B - North of SEART										230+	087/05	P
8/03/2005	655 12		Pad B - North of SEART										230+	087/05	P
8/03/2005	656 13		Pad B - North of SEART										195	087/05	P
8/03/2005	657 14		Pad B - North of SEART										182	087/05	P
8/03/2005	658 15		Pad B - North of SEART										162	087/05	P
8/03/2005	659 16		Pad B - North of SEART										191	087/05	P
8/03/2005	660 1	0.2	Pad B - North of SEART										UTP	088/05	P

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Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m^3)	Corr. Dry Density (kg/m^3)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
8/03/2005	661	0.4	Pad B - North of SEART										218	088/05	P
8/03/2005	662	0.6	Pad B - North of SEART										UTP	088/05	P
8/03/2005	663 2	0.2	Pad B - North of SEART										230+	088/05	P
8/03/2005	664	0.4	Pad B - North of SEART										230+	088/05	P
8/03/2005	665	0.6	Pad B - North of SEART										UTP	088/05	P
8/03/2005	666 3	0.2	Pad B - North of SEART										165	088/05	P
8/03/2005	667	0.4	Pad B - North of SEART										185	088/05	P
8/03/2005	668	0.6	Pad B - North of SEART										UTP	088/05	P
8/03/2005	669 4	0.2	Pad B - North of SEART										218	088/05	P
8/03/2005	670	0.4	Pad B - North of SEART										230+	088/05	P
8/03/2005	671	0.6	Pad B - North of SEART										230+	088/05	P
8/03/2005	672 5	0.2	Pad B - North of SEART										165	088/05	P
8/03/2005	673	0.4	Pad B - North of SEART										UTP	088/05	P
8/03/2005	674	0.6	Pad B - North of SEART										UTP	088/05	P
8/03/2005	675 1	0.2	Pad F - North of SEART										230+	089/05	P
8/03/2005	676	0.4	Pad F - North of SEART										230+	089/05	P
8/03/2005	677	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	678 2	0.2	Pad F - North of SEART										230+	089/05	P
8/03/2005	679	0.4	Pad F - North of SEART										UTP	089/05	P
8/03/2005	680	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	681 3	0.2	Pad F - North of SEART										UTP	089/05	P
8/03/2005	682	0.4	Pad F - North of SEART										UTP	089/05	P
8/03/2005	683	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	684 4	0.2	Pad F - North of SEART										UTP	089/05	P
8/03/2005	685	0.4	Pad F - North of SEART										UTP	089/05	P
8/03/2005	686	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	687 5	0.2	Pad F - North of SEART										UTP	089/05	P
8/03/2005	688	0.4	Pad F - North of SEART										UTP	089/05	P
8/03/2005	689	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	690 6	0.2	Pad F - North of SEART										135	089/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test				GEO	Average	Hand	Lab	Status
							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
8/03/2005	691	0.4	Pad F - North of SEART										230+	089/05	P
8/03/2005	692	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	693 7	0.2	Pad F - North of SEART										UTP	089/05	P
8/03/2005	694	0.4	Pad F - North of SEART										UTP	089/05	P
8/03/2005	695	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	696 8	0.2	Pad F - North of SEART										UTP	089/05	P
8/03/2005	697	0.4	Pad F - North of SEART										149	089/05	P
8/03/2005	698	0.6	Pad F - North of SEART										UTP	089/05	P
8/03/2005	699	1	Pad C - North of SEART				1970	1474	33.7	0				090/05	P
8/03/2005	700	2	Pad C - North of SEART				1951	1665	17.2	11.1				090/05	F
8/03/2005	701	3	RETEST OF TEST NO 2				1941	1548	25.4	4.6				090/05	RP
8/03/2005	702	4	Pad C - North of SEART				2003	1622	23.5	3.1				090/05	P
8/03/2005	703 1	0.2	Pad C - North of SEART										UTP	091/05	P
8/03/2005	704	0.4	Pad C - North of SEART										UTP	091/05	P
8/03/2005	705	0.6	Pad C - North of SEART										230+	091/05	P
8/03/2005	706 2	0.2	Pad C - North of SEART										230+	091/05	P
8/03/2005	707	0.4	Pad C - North of SEART										UTP	091/05	P
8/03/2005	708	0.6	Pad C - North of SEART										UTP	091/05	P
8/03/2005	709 3	0.2	Pad C - North of SEART										UTP	091/05	P
8/03/2005	710	0.4	Pad C - North of SEART										188	091/05	P
8/03/2005	711	0.6	Pad C - North of SEART										168	091/05	P
8/03/2005	712 4	0.2	Pad C - North of SEART										UTP	091/05	P
8/03/2005	713	0.4	Pad C - North of SEART										UTP	091/05	P
8/03/2005	714	0.6	Pad C - North of SEART										UTP	091/05	P
8/03/2005	715 5	0.2	Pad C - North of SEART										UTP	091/05	P
8/03/2005	716 1		PAD F- NORTH OF SEART				2141	1707	25.4	0				092/05	P
8/03/2005	717 2		PAD F- NORTH OF SEART				1870	1367	36.8	0.2				092/05	P
8/03/2005	718 3		PAD F- NORTH OF SEART				1851	1477	25.4	9				092/05	P
8/03/2005	719 4		PAD F- NORTH OF SEART				1814	1416	28.1	8.9				092/05	P
8/03/2005	720 5		PAD F- NORTH OF SEART				1964	1596	23.1	5.3				092/05	P

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
8/03/2005	721 1		PAD B- NORTH OF SEART				1928	1390	38.7	0				093/05	P
8/03/2005	722 2		PAD B- NORTH OF SEART				1910	1495	27.8	4.4				093/05	P
8/03/2005	723 3		PAD B- NORTH OF SEART				1884	1441	30.8	3.4				093/05	P
8/03/2005	724 4		PAD B- NORTH OF SEART				1939	1517	27.8	2.8				093/05	P
8/03/2005	725 5		PAD B- NORTH OF SEART				1894	1395	35.8	0				093/05	P
8/03/2005	726 1		NORTH OF SEART				2059	1648	25	0				100/05	P
8/03/2005	727 2		NORTH OF SEART				1964	1569	25.2	3.7				100/05	P
8/03/2005	728 3		NORTH OF SEART				2025	1632	24.1	1.6				100/05	P
9/03/2005	729 1		PAD D- NORTH OF SEART				1852	1408	31.5	4.6				094/05	P
9/03/2005	730 2		PAD D- NORTH OF SEART				1834	1494	22.8	11.8				094/05	F
9/03/2005	731 3		RETEST OF TEST NO 2				1766	1314	34.4	7.2				094/05	RP
9/03/2005	732 4		PAD D- NORTH OF SEART				1888	1443	30.9	3.2				094/05	P
9/03/2005	733 5		PAD D- NORTH OF SEART				1906	1465	30.1	2.9				094/05	P
9/03/2005	734 1		NORTH OF SEART										178	096/05	P
9/03/2005	735 2		NORTH OF SEART										139	096/05	P
9/03/2005	736 3		NORTH OF SEART										UTP	096/05	P
9/03/2005	737 4		NORTH OF SEART										155	096/05	P
9/03/2005	738 5		NORTH OF SEART										142	096/05	P
9/03/2005	739 6		NORTH OF SEART										224	096/05	P
9/03/2005	740 7		NORTH OF SEART										UTP	096/05	P
9/03/2005	741 8		NORTH OF SEART										UTP	096/05	P
9/03/2005	742 9		NORTH OF SEART										185	096/05	P
9/03/2005	743 10		NORTH OF SEART										205	096/05	P
9/03/2005	744 11		NORTH OF SEART										191	096/05	P
9/03/2005	745 12		NORTH OF SEART										155	096/05	P
9/03/2005	746 13		NORTH OF SEART										168	096/05	P
9/03/2005	747 14		NORTH OF SEART										182	096/05	P
9/03/2005	748 15		NORTH OF SEART										152	096/05	P
9/03/2005	749 16		NORTH OF SEART										215	096/05	P
9/03/2005	750 17		NORTH OF SEART										230+	096/05	P

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							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
9/03/2005	751 18		NORTH OF SEART										188	096/05	P
9/03/2005	752 19		NORTH OF SEART										230+	096/05	P
9/03/2005	753 20		NORTH OF SEART										155	096/05	P
9/03/2005	754 21		NORTH OF SEART										UTP	096/05	P
9/03/2005	755 22		NORTH OF SEART										182	096/05	P
9/03/2005	756 23		NORTH OF SEART										230+	096/05	P
9/03/2005	757 24		NORTH OF SEART										149	096/05	P
9/03/2005	758 25		NORTH OF SEART										215	096/05	P
9/03/2005	759 26		NORTH OF SEART										162	096/05	P
9/03/2005	760 27		NORTH OF SEART										UTP	096/05	P
9/03/2005	761 28		NORTH OF SEART										UTP	096/05	P
9/03/2005	762 29		NORTH OF SEART										185	096/05	P
9/03/2005	763 30		NORTH OF SEART										UTP	096/05	P
9/03/2005	764 31		NORTH OF SEART										UTP	096/05	P
9/03/2005	765 32		NORTH OF SEART										180	096/05	P
9/03/2005	766 33		NORTH OF SEART										168	096/05	P
9/03/2005	767 34		NORTH OF SEART										UTP	096/05	P
9/03/2005	768 35		NORTH OF SEART										165	096/05	P
9/03/2005	769 36		NORTH OF SEART										139	096/05	P
9/03/2005	770 37		NORTH OF SEART										UTP	096/05	P
9/03/2005	771 38		NORTH OF SEART										142	096/05	P
9/03/2005	772 39		NORTH OF SEART										UTP	096/05	P
9/03/2005	773 40		NORTH OF SEART										142	096/05	P
9/03/2005	774 41		NORTH OF SEART										UTP	096/05	P
9/03/2005	775 42		NORTH OF SEART										178	096/05	P
9/03/2005	776 43		NORTH OF SEART										158	096/05	P
9/03/2005	777 44		NORTH OF SEART										165	096/05	P
9/03/2005	778 45		NORTH OF SEART										UTP	096/05	P
9/03/2005	779 46		NORTH OF SEART										162	096/05	P
9/03/2005	780 47		NORTH OF SEART										191	096/05	P

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							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/RF/NA
9/03/2005	781 48		NORTH OF SEART										230+	096/05	P
9/03/2005	782 1	0.2	PAD D - NORTH OF SEART										230+	095/05	P
9/03/2005	783	0.4	PAD D - NORTH OF SEART										230+	095/05	P
9/03/2005	784	0.6	PAD D - NORTH OF SEART										178	095/05	P
9/03/2005	785 2	0.2	PAD D - NORTH OF SEART										230+	095/05	P
9/03/2005	786	0.4	PAD D - NORTH OF SEART										230+	095/05	P
9/03/2005	787	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	788 3	0.2	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	789	0.4	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	790	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	791 4	0.2	PAD D - NORTH OF SEART										224	095/05	P
9/03/2005	792	0.4	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	793	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	794 5	0.2	PAD D - NORTH OF SEART										129	095/05	P
9/03/2005	795	0.4	PAD D - NORTH OF SEART										119	095/05	P
9/03/2005	796	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	797 6	0.2	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	798	0.4	PAD D - NORTH OF SEART										145	095/05	P
9/03/2005	799	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	800 7	0.2	PAD D - NORTH OF SEART										230+	095/05	P
9/03/2005	801	0.4	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	802	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	803 8	0.2	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	804	0.4	PAD D - NORTH OF SEART										UTP	095/05	P
9/03/2005	805	0.6	PAD D - NORTH OF SEART										UTP	095/05	P
11/03/2005	806 1	0.2	NORTH OF SEART										UTP	098/05	P
11/03/2005	807 2	0.2	NORTH OF SEART										UTP	098/05	P
11/03/2005	808 3	0.2	NORTH OF SEART										230+	098/05	P
11/03/2005	809	0.4	NORTH OF SEART										UTP	098/05	P
11/03/2005	810 4	0.2	NORTH OF SEART										UTP	098/05	P

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11/03/2005	811	0.4	NORTH OF SEART										230+	098/05	P
11/03/2005	812 5	0.2	NORTH OF SEART										UTP	098/05	P
11/03/2005	813 6	0.2	NORTH OF SEART										UTP	098/05	P
11/03/2005	814	0.4	NORTH OF SEART										UTP	098/05	P
11/03/2005	815 7	0.2	NORTH OF SEART										185	098/05	P
11/03/2005	816	0.4	NORTH OF SEART										UTP	098/05	P
11/03/2005	817 8	0.2	NORTH OF SEART										UTP	098/05	P
11/03/2005	818 9	0.2	NORTH OF SEART										UTP	098/05	P
11/03/2005	819	0.4	NORTH OF SEART										172	098/05	P
11/03/2005	820 1		NORTH OF SEART										224	099/05	P
11/03/2005	821 2		NORTH OF SEART										178	099/05	P
11/03/2005	822 3		NORTH OF SEART										UTP	099/05	P
11/03/2005	823 4		NORTH OF SEART										178	099/05	P
11/03/2005	824 5		NORTH OF SEART										168	099/05	P
11/03/2005	825 6		NORTH OF SEART										UTP	099/05	P
11/03/2005	826 7		NORTH OF SEART										218	099/05	P
11/03/2005	827 8		NORTH OF SEART										201	099/05	P
11/03/2005	828 9		NORTH OF SEART										224	099/05	P
11/03/2005	829 10		NORTH OF SEART										178	099/05	P
11/03/2005	830 11		NORTH OF SEART										175	099/05	P
11/03/2005	831 12		NORTH OF SEART										218	099/05	P
11/03/2005	832 13		NORTH OF SEART										168	099/05	P
11/03/2005	833 14		NORTH OF SEART										230+	099/05	P
11/03/2005	834 15		NORTH OF SEART										188	099/05	P
11/03/2005	835 16		NORTH OF SEART										224	099/05	P
11/03/2005	836 1		NORTH OF SEART				2067	1694	22.1	1.3				097/05	P
11/03/2005	837 2		NORTH OF SEART				2038	1657	23	1.9				097/05	P
11/03/2005	838 3		NORTH OF SEART				1865	1421	31.3	4.1				097/05	P
11/03/2005	839 4		NORTH OF SEART				1897	1510	25.7	6.6				097/05	P
11/03/2005	840 5		NORTH OF SEART				1944	1607	21	8				097/05	P

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11/03/2005	841 6		NORTH OF SEART				1949	1562	4.8	4.8				097/05	P
11/03/2005	842 7		NORTH OF SEART				1814	1398	7.8	7.8				097/05	P
11/03/2005	843 8		NORTH OF SEART				2001	1561	0	0				097/05	P
11/03/2005	844 9		NORTH OF SEART				1979	1634	6.3	6.3				097/05	P
15/03/2005	845 1		NORTH OF SEART										188	101/05	P
15/03/2005	846 2		NORTH OF SEART										198	101/05	P
15/03/2005	847 3		NORTH OF SEART										UTP	101/05	P
15/03/2005	848 4		NORTH OF SEART										172	101/05	P
15/03/2005	849 5		NORTH OF SEART										UTP	101/05	P
15/03/2005	850 6		NORTH OF SEART										185	101/05	P
15/03/2005	851 7		NORTH OF SEART										195	101/05	P
15/03/2005	852 8		NORTH OF SEART										211	101/05	P
15/03/2005	853 9		NORTH OF SEART										211	101/05	P
23/03/2005	854 1		SOUTH OF SEART				1879	1478	27.1	6.4				104/05	P
23/03/2005	855 2		SOUTH OF SEART				1939	1601	21.1	8.2				104/05	P
23/03/2005	856 3		SOUTH OF SEART				2059	1683	22.3	1.5				104/05	P
23/03/2005	857 1		NORTH OF SEART				1897	1567	31.6	2.3				102/05	P
23/03/2005	858 2		NORTH OF SEART				2001	1642.9	27.9	0				102/05	P
23/03/2005	859 3		NORTH OF SEART				1896	1499.4	29	4.1				102/05	P
23/03/2005	860 4		NORTH OF SEART				1868	1537.5	29.5	5.2				102/05	P
23/03/2005	861 1	0.2	SOUTH OF SEART										215	105/05	P
23/03/2005	862	0.4	SOUTH OF SEART										230+	105/05	P
23/03/2005	863	0.6	SOUTH OF SEART										UTP	105/05	P
23/03/2005	864 2	0.2	SOUTH OF SEART										195	105/05	P
23/03/2005	865	0.4	SOUTH OF SEART										UTP	105/05	P
23/03/2005	866 3	0.2	SOUTH OF SEART										UTP	105/05	P
23/03/2005	867 4	0.2	SOUTH OF SEART										230+	105/05	P
23/03/2005	868	0.4	SOUTH OF SEART										UTP	105/05	P
23/03/2005	869 1	0.2	NORTH OF SEART										218	103/05	P
23/03/2005	870	0.4	NORTH OF SEART										230+	103/05	P

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JOB NO: 21432

FILE/FOLDER: Sylvia Park Earthworks

TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
23/03/2005	871	0.6	NORTH OF SEART										UTP	103/05	P
23/03/2005	872 2	0.2	NORTH OF SEART										UTP	103/05	P
23/03/2005	873	0.4	NORTH OF SEART										218	103/05	P
23/03/2005	874	0.6	NORTH OF SEART										UTP	103/05	P
23/03/2005	875 3	0.2	NORTH OF SEART										195	103/05	P
23/03/2005	876	0.4	NORTH OF SEART										UTP	103/05	P
23/03/2005	877	0.6	NORTH OF SEART										UTP	103/05	P
23/03/2005	878 4	0.2	NORTH OF SEART										230+	103/05	P
23/03/2005	879	0.4	NORTH OF SEART										230+	103/05	P
23/03/2005	880	0.6	NORTH OF SEART										221	103/05	P
23/03/2005	881 5	0.2	NORTH OF SEART										162	103/05	P
23/03/2005	882	0.4	NORTH OF SEART										UTP	103/05	P
23/03/2005	883 6	0.2	NORTH OF SEART										230+	103/05	P
23/03/2005	884	0.4	NORTH OF SEART										UTP	103/05	P
23/03/2005	885 7	0.2	NORTH OF SEART										230+	103/05	P
23/03/2005	886	0.4	NORTH OF SEART										230+	103/05	P
23/03/2005	887	0.6	NORTH OF SEART										UTP	103/05	P
23/03/2005	888 8	0.2	NORTH OF SEART										172	103/05	P
23/03/2005	889	0.4	NORTH OF SEART										195	103/05	P
23/03/2005	890	0.6	NORTH OF SEART										230+	103/05	P
13/04/2005	891 1		CARPARK 1- SOUTH OF SEART				1790	1106	61.9	0				107/05	P
13/04/2005	892 2		CARPARK 1- SOUTH OF SEART				1806	1311	37.8	3				107/05	P
13/04/2005	893 3		CARPARK 1- SOUTH OF SEART				1702	1070	59.1	0				107/05	P
13/04/2005	894 4		CARPARK 1- SOUTH OF SEART				1913	1412	35.5	0				107/05	P
13/04/2005	895 5		CARPARK 1- SOUTH OF SEART				1864	1378	35.3	1.5				107/05	P
13/04/2005	896 1	0.2	CARPARK 1- SOUTH OF SEART										215	108/05	
13/04/2005	897 2	0.2	CARPARK 1- SOUTH OF SEART										UTP	108/05	
13/04/2005	898 3	0.2	CARPARK 1- SOUTH OF SEART										198	108/05	
13/04/2005	899 4	0.2	CARPARK 1- SOUTH OF SEART										132	108/05	F
13/04/2005	900 5	0.2	CARPARK 1- SOUTH OF SEART										UTP	108/05	
13/04/2005	901 6	0.2	CARPARK 1- SOUTH OF SEART										92	108/05	F-

GEOTECHNICS LTD.
Sylvia Park Earthworks
Phone: 021 378 385

Data Input By: TPG Date:

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JOB NO: 21432

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TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test: Field Bulk Density (kg/m³)	Nuclear Density Test: Corr. Dry Density (kg/m³)	Nuclear Density Test: Oven Water Content (%)	Nuclear Density Test: Corr. Air Voids (%)	GEO Impact Value CIV	Average Scala (Blows/ 0.2m)	Hand Shear Vane (kPa)	Lab Ref No SPE-	Status P/F/RP/ RF/NA
13/04/2005	902 7	0.2	CARPARK 1- SOUTH OF SEART										145	108/05	P
13/04/2005	903 8	0.2	CARPARK 1- SOUTH OF SEART										230+	108/05	P
13/04/2005	904 9	0.2	CARPARK 1- SOUTH OF SEART										162	108/05	P
18/04/2005	905 1	0.2	RETEST OF TEST NO 4-SPE108/05										201	109/05	RP
18/04/2005	906 2	0.2	RETEST OF TEST NO 6-SPE108/05										158	109/05	RP
28/04/2005	907 1		POND-NORTH OF SEART										201	110/05	P
28/04/2005	908 2		POND-NORTH OF SEART										228	110/05	P
28/04/2005	909 3		POND-NORTH OF SEART										198	110/05	P
28/04/2005	910 4		POND-NORTH OF SEART										178	110/05	P
28/04/2005	911 5		POND-NORTH OF SEART										211	110/05	P
28/04/2005	912 6		POND-NORTH OF SEART										utp	110/05	P
28/04/2005	913 7		POND-NORTH OF SEART										utp	110/05	P
28/04/2005	914 8		POND-NORTH OF SEART										165	110/05	P
28/04/2005	915 9		POND-NORTH OF SEART										165	110/05	P
28/04/2005	916 10		POND-NORTH OF SEART										135	110/05	P
28/04/2005	917 11		POND-NORTH OF SEART										149	110/05	P
28/04/2005	918 12		POND-NORTH OF SEART										178	110/05	P
28/04/2005	919 13		POND-NORTH OF SEART										v soft	110/05	F
28/04/2005	920 14		POND-NORTH OF SEART										v soft	110/05	F
28/04/2005	921 15		POND-NORTH OF SEART										195	110/05	P
28/04/2005	922 1		POND-NORTH OF SEART				1901	1513	25.7	6.4			230+	111/05	P
28/04/2005	923 2		POND-NORTH OF SEART				1823	1321	38	1.9			218	111/05	P
2/05/2005	924 1		RETEST TEST N0 13-SPE-110/05										152	112/05	RP
2/05/2005	925 2		RETEST TEST N0 14-SPE-110/05										218	112/05	RP
2/05/2005	926 1		POND-NORTH OF SEART										188	113/05	P
2/05/2005	927 2		POND-NORTH OF SEART										UTP	113/05	P
2/05/2005	928 3		POND-NORTH OF SEART										191	113/05	P
2/05/2005	929 4		POND-NORTH OF SEART										162	113/05	P
2/05/2005	930 5		POND-NORTH OF SEART										185	113/05	P
2/05/2005	931 6		POND-NORTH OF SEART										218	113/05	P
2/05/2005	932 7		POND-NORTH OF SEART										UTP	113/05	P-

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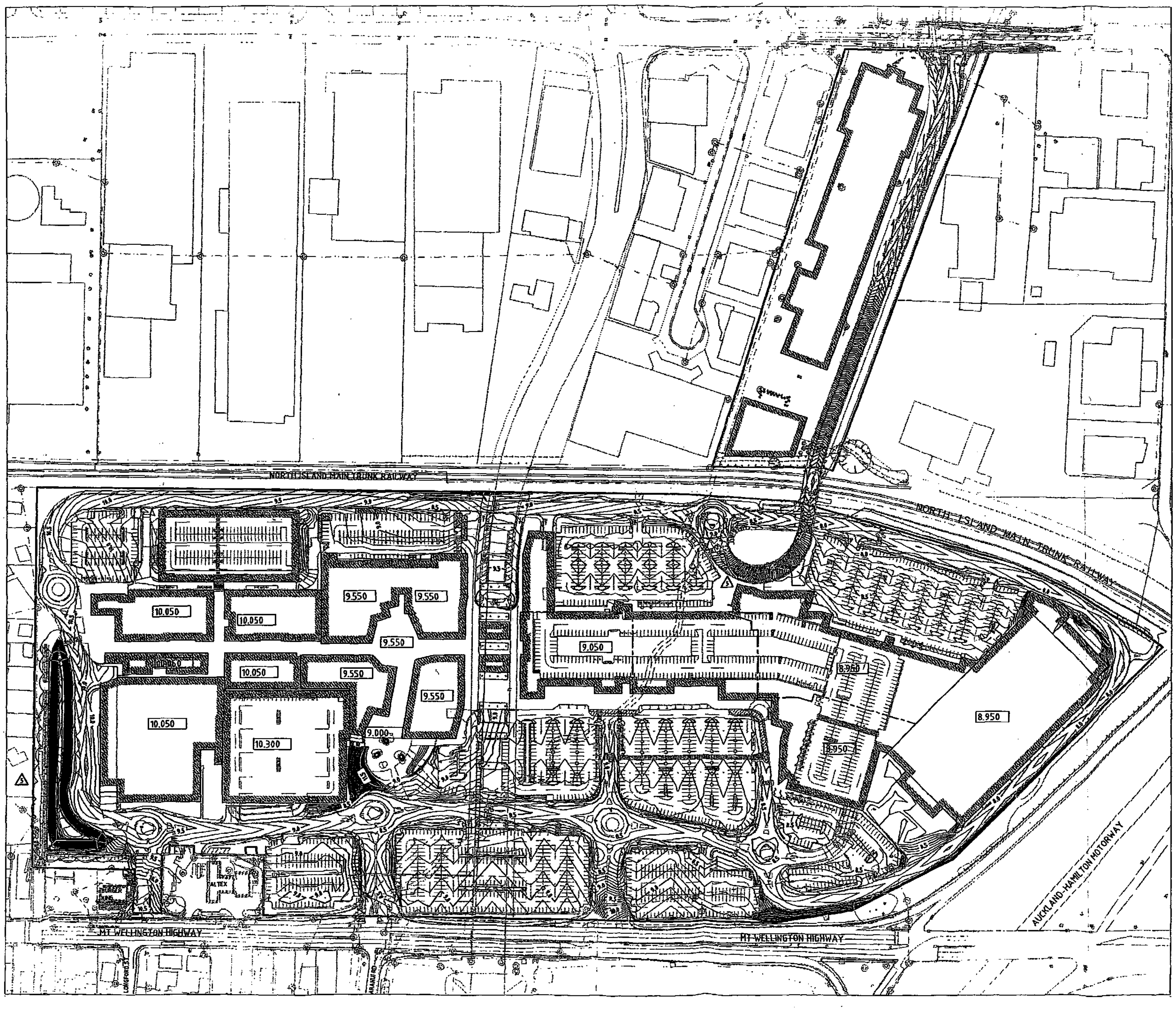
TEST RESULT SUMMARY REPORT

Date	Test No.	Zone	Location / Comments	Northing mN	Easting mN	RL (m)	Nuclear Density Test				GEO	Average	Hand	Lab	Status
							Field Bulk Density (kg/m³)	Corr. Dry Density (kg/m³)	Oven Water Content (%)	Corr. Air Voids (%)	Impact Value CIV	Scala (Blows/ 0.2m)	Shear Vane (kPa)	Ref No SPE-	P/F/RP/ RF/NA
2/05/2005	933 8		POND-NORTH OF SEART										178	113/05	P
2/05/2005	934 9		POND-NORTH OF SEART										188	113/05	P
2/05/2005	935 10		POND-NORTH OF SEART										201	113/05	P
2/05/2005	936 11		POND-NORTH OF SEART										142	113/05	P
2/05/2005	937 12		POND-NORTH OF SEART										205	113/05	P
2/05/2005	938 13		POND-NORTH OF SEART										201	113/05	P
2/05/2005	939 14		POND-NORTH OF SEART										208	113/05	P
2/05/2005	940 15		POND-NORTH OF SEART										198	113/05	P
2/05/2005	941 16		POND-NORTH OF SEART										185	113/05	P



KEYPLAN

ZONE NAME

0A

NOTES

LEGEND

SITE
- OPEN DRAIN
- TOP OF BANK (TOB)
- FENCELINE
- INDICATIVE CONTOUR LEVEL (8.5)
- RESTRICTED EARTHWORKS CORRIDOR

SERVICES DISCLAIMER

EXISTING SERVICES ARE BASED ON INFORMATION PROVIDED BY THE RESPECTIVE SERVICE PROVIDER AND ARE ASSUMED TO BE INDICATIVE ONLY. PRIOR TO ANY WORK COMMENCING ON SITE, THE CONTRACTOR IS TO VERIFY THE LOCATION OF ALL EXISTING SERVICES AND LIASE WITH THE ENGINEER ACCORDINGLY

No.	Revision	By	Chk	Appd	Date
5	CONTOURS REVISED	NBL	TSH	TSH	24 MAY 06
4	FINAL GRADING REVISED	NBL	TSH	TSH	24 NOV 05
3	23 DEC 04 REVISION	SDH	AH	TSH	31 JAN 05
2	DEVELOPED DESIGN 100%	JSD	TJW	AG	05 JAN 05
1	BLD PLATFORM RAISED	JSD	TJW	AG	10 NOV 04
D	EASTERN ACCESS ADDED	BLD	TSW	AG	4 NOV 04
C	FOR CONSTRUCRPON	JSD	TSW	AG	22 OCT 04
B	PRELIMINARY DESIGN 100%	JSD	TSW	AG	10 SEPT 04
A	PRELIMINARY DESIGN 80%	JSD	TSW	AG	25 AUG 04

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FIRE ENGINEERING PH 895 3473 HOLMES FIRE & SAFETY	TRAFFIC PH 302 0901 TRAFFIC DESIGN GROUP
SERVICES PH 529 6019 CONNELL MOTT MACDONALD	CIVIL/SURVEY PH 913 8900 SINCLAIR KNIGHT MERZ
QUANTITY SURVEYOR PH 309 1074 RIDER HUNT	STRUCTURAL PH 309 5838 MURRAY JACOBS LTD

PROJECT / CLIENT

SYLVIA PARK BUSINESS CENTRE LTD

KIWI INCOME PROPERTY TRUST

CIVIL

NORTH

SHEET

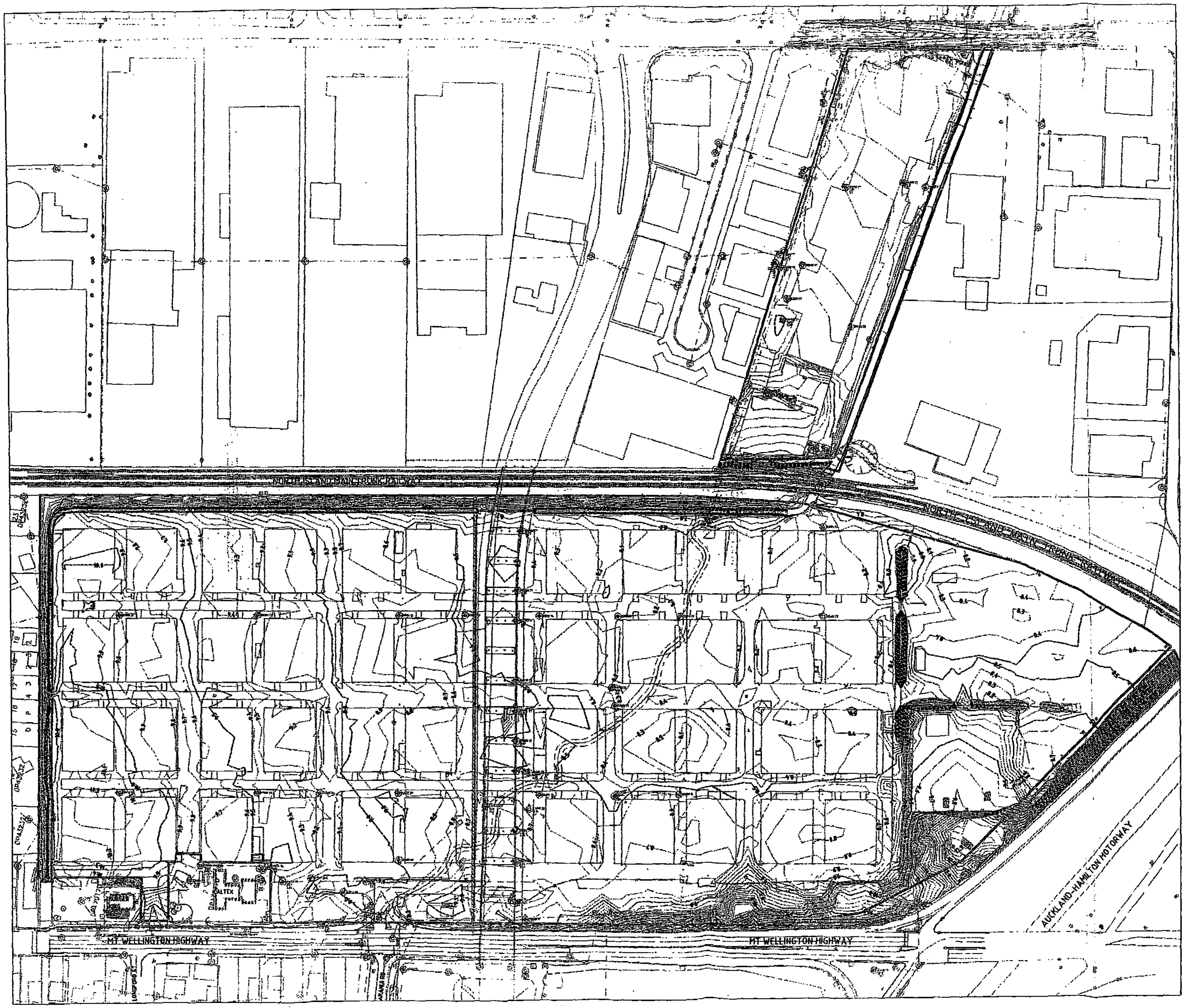
BULK EARTHWORKS FINISHED CONTOURS OVERALL PLAN SHEET 1

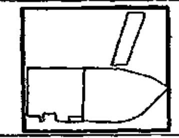
SCALE (A1) 1 to 1250

Sinclair Knight Merz		MILESTONE ISSUES	REVISION AND DATE
DESIGN	JSD	FIRST ISSUED	A 25th AUG 2004
DRAWN	GJA	RESOURCE CONSENT	-
CHECKED	TSW	BUILDING CONSENT	-
APPROVED	NFK	SCHEDULING	-
		TENDER	-

JOB NUMBER	ZONE	DRAWING NUMBER	REVISION
AN00667	0A	C8–230	5

FOR CONSTRUCTION





KEYPLAN

ZONE NAME

0A

NOTES

LEGEND

- SITE
- OPEN DRAIN
- TOP OF BANK (TOB)
- FENCELINE
- 8.5 INDICITIVE CONTOUR LEVEL
- RESTRICTED EARTHWORKS CORRIDOR

SERVICES DISCLAIMER

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GCR GEOTECHNICAL COMPLETETION REPORT

No.	Revision	By	Chk.	Appd	Date
A	ISSUED FOR GCR	NBL	TSH	TSH	24 MAY 06

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SERVICES PH 520 6019 CONNELL MOTT MACDONALD	CIVIL/SURVEY PH 913 8900 SINCLAIR KNIGHT MERZ
QUANTITY SURVEYOR PH 309 1074 RIDER HUNT	STRUCTURAL PH 309 5838 MURRAY JACOBS LTD

PROJECT / CLIENT

SYLVIA PARK BUSINESS CENTRE LTD

KIWI INCOME PROPERTY TRUST

CIVIL

NORTH

SHEET

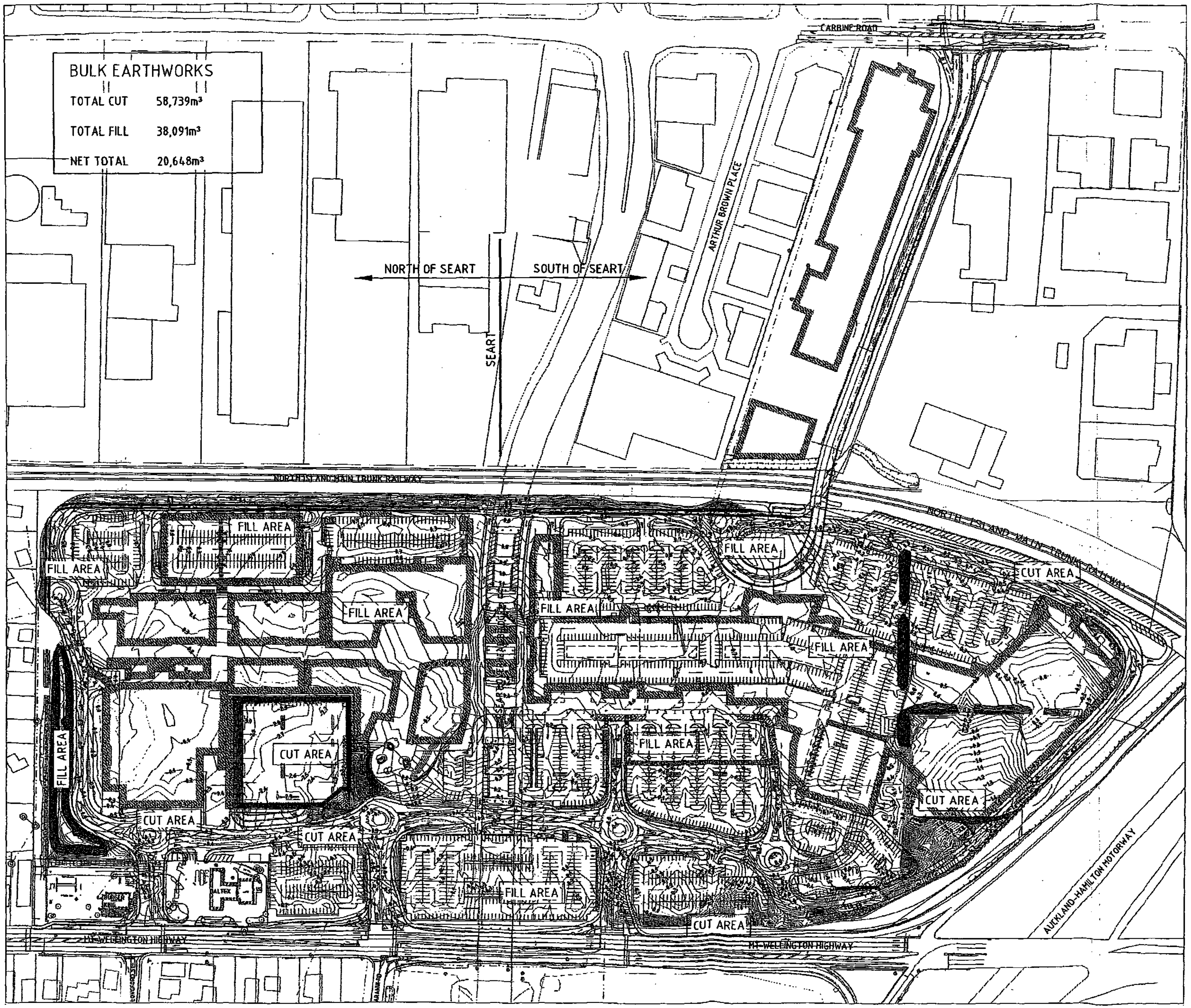
BULK EARTHWORKS
EXISTING CONTOURS
OVERALL PLAN
SHEET 1
SCALE (A1) 1 to 1250

Sinclair Knight Merz		MILESTONE ISSUES	REVISION AND DATE
DESIGN	JSD	FIRST ISSUED	A 19 MAY 2006
DRAWN	SSG	RESOURCE CONSENT	-
CHECKED	TSH	BUILDING CONSENT	-
APPROVED	TSH	SCHEDULING	-
		TENDER	-

JOB NUMBER	ZONE	DRAWING NUMBER	REVISION
AN00667	0A	SK-248	A

FOR GCR

DO NOT SCALE. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND LOCATIONS ON SITE BEFORE COMMENCING ANY WORK.



KEYPLAN

ZONE NAME

0A

NOTES

COPYRIGHT

LEGEND

SITE
- OPEN DRAIN
- TOP OF BANK (TOB)
- FENCELINE
- 8.5 INDICATIVE CONTOUR LEVEL
- RESTRICTED EARTHWORKS CORRIDOR
- CUT CONTOUR
- FILL CONTOUR
- GCR GEOTECHNICAL COMPLETETION REPORT

SERVICES DISCLAIMER

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No.	Revision	By	Chk	Appd	Date
A	ISSUED FOR GCR	NBL	TSH	TSH	24 MAY 06

SKM

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QUANTITY SURVEYOR PH 309 1074 RIDER HUNT	STRUCTURAL PH 309 5838 MURRAY JACOBS LTD

PROJECT / CLIENT

SYLVIA PARK BUSINESS CENTRE LTD

KIWI INCOME PROPERTY TRUST

CIVIL

NORTH

SHEET

BULK EARTHWORKS CUT & FILL DEPTHS OVERALL PLAN

SCALE (A1) 1 to 1250

Sinclair Knight Merz	
DESIGN	JSD
DRAWN	SSG
CHECKED	TSH
APPROVED	TSH

MILESTONE ISSUES		REVISION AND DATE
FIRST ISSUED	◄	A 19 MAY 2006
RESOURCE CONSENT	◄	-
BUILDING CONSENT	◄	-
SCHEDULING	◄	-
TENDER	◄	-

JOB NUMBER	ZONE	DRAWING NUMBER	REVISION
AN00667	0A	SK-247	A

FOR GCR

PLOT DATE: 11:39 05/08/03

FILENAME: AN00667SK247