Broadwater Wastewater Management Strategy

Assessment of wastewater collection and transportation options for the town of Broadwater

quality solutions sustainable future

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Assessment of wastewater collection and transportation options for the town of Broadwater

Prepared for: Richmond Valley Council
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1 Introduction

1.1 Background

This report follows a previous report prepared by GeoLINK in 2001, *Broadwater Wastewater Management Strategy – Report outlining options for wastewater collection, wastewater treatment and reclaimed water management for the town of Broadwater*. The 2001 report investigated a wide range of wastewater management options for the town of Broadwater, including:

- Upgrading existing on-site systems;
- Installing various methods of collection and transport;
- Building new wastewater treatment works at Rileys Hill or Broadwater, or expanding the existing Evans Head Wastewater Treatment Works (WWTW);
- Using reclaimed water in agriculture, industry (the Broadwater Sugar Mill), and/or via dual water supply; and
- Disposing reclaimed water via release to the Richmond River or deep well injection as part of the operations of the Evans Head WWTW.

Although the 2001 report did not make any specific recommendations, its conclusions included the following:

- *On-site systems.* In 1998, the NSW Government introduced more stringent requirements for on-site systems. As a result, the majority of on-site systems in Broadwater cannot be upgraded due to the following physical constraints:
  - Close proximity to Richmond River;
  - The flood liability of the land;
  - The high watertable; and
  - Inadequate size of the existing residential lots in regard to specified buffer distances.
- *Collection and transport*. In general, vacuum systems were the most attractive collection and transport option due to their relatively lower cost and their suitability to the area's flat terrain and high watertable. Other systems are less attractive due to higher costs and/or restrictions associated with flood prone nature of the area.
- *Wastewater treatment works*. In consideration with likely reuse options, pumping sewage to the Evans Head Wastewater Treatment Works appears to be the most cost effective solution.
- *Use of reclaimed water*. Costs and low levels of demand suggested that extensive reuse of reclaimed water may not be cost-effective.
- *Disposal of reclaimed water*. Modelling indicated that 100% release to the Richmond River would have a negligible effect, and treatment levels achieved at the Evans Head WWTW would make effluent suitable for deep well injection.

Following the 2001 report, Council was directed by the Department of Environment and Conservation that disposal to the Richmond River would not be acceptable, and, through a separate process, Council has decided to upgrade the Evans Head WWTW. In response to these developments, GeoLINK has been engaged by Council to update the assessment of the options for the collection and transportation of sewage from Broadwater on the assumption that the sewage will be treated at the upgraded Evans Head WWTW.

The report will assist Council in selecting a preferred collection and transport option. This report makes no recommendations as to a preferred collection and transport option for the study area.

1.2 Objectives

The purpose of this report is to provide concept designs for the following options for the collection and transportation of wastewater:

- conventional gravity;
- modified low-cost gravity;
- low pressure pumping (grinder pump); and
- vacuum sewerage.

This report also outlines the technical, financial, social and environmental aspects of those options in the context of a 25 year planning horizon.

In considering current population and development data for Broadwater as well as new information available on the sewerage collection and transportation systems, this report will be used to inform the decision as to the preferred wastewater collection and transport system for the town.

1.3 Report Structure

The structure and scope of this report are as follows:

- Section 2 describes the investigation area and its context;
- Section 3 describes the wastewater management system currently in place for Broadwater;
- Section 4 describes the concept designs for the sewerage collection and transport options; and
- Section 5 provides conclusions.

2

Background

2.1 Study Area

As shown in Illustration 2.1, the study area is situated in Richmond River basin located on the north coast of New South Wales and within the Aboriginal Nation of the Bundjalung. It comprises the town of Broadwater and its immediate surrounds, the site of the Evans Head WWTW, and the road linking Broadwater and Evans Head.

Broadwater is located on the Pacific Highway 11 kilometres north of Woodburn and 25 kilometres south of Ballina. The Evans Head WWTW is located near the coast approximately 10 kilometres to the south of Broadwater.

Broadwater is surrounded by rural land with Broadwater National Park located to the east and south of the town. The study area is shown in Illustration 2.2.

2.2 Landform

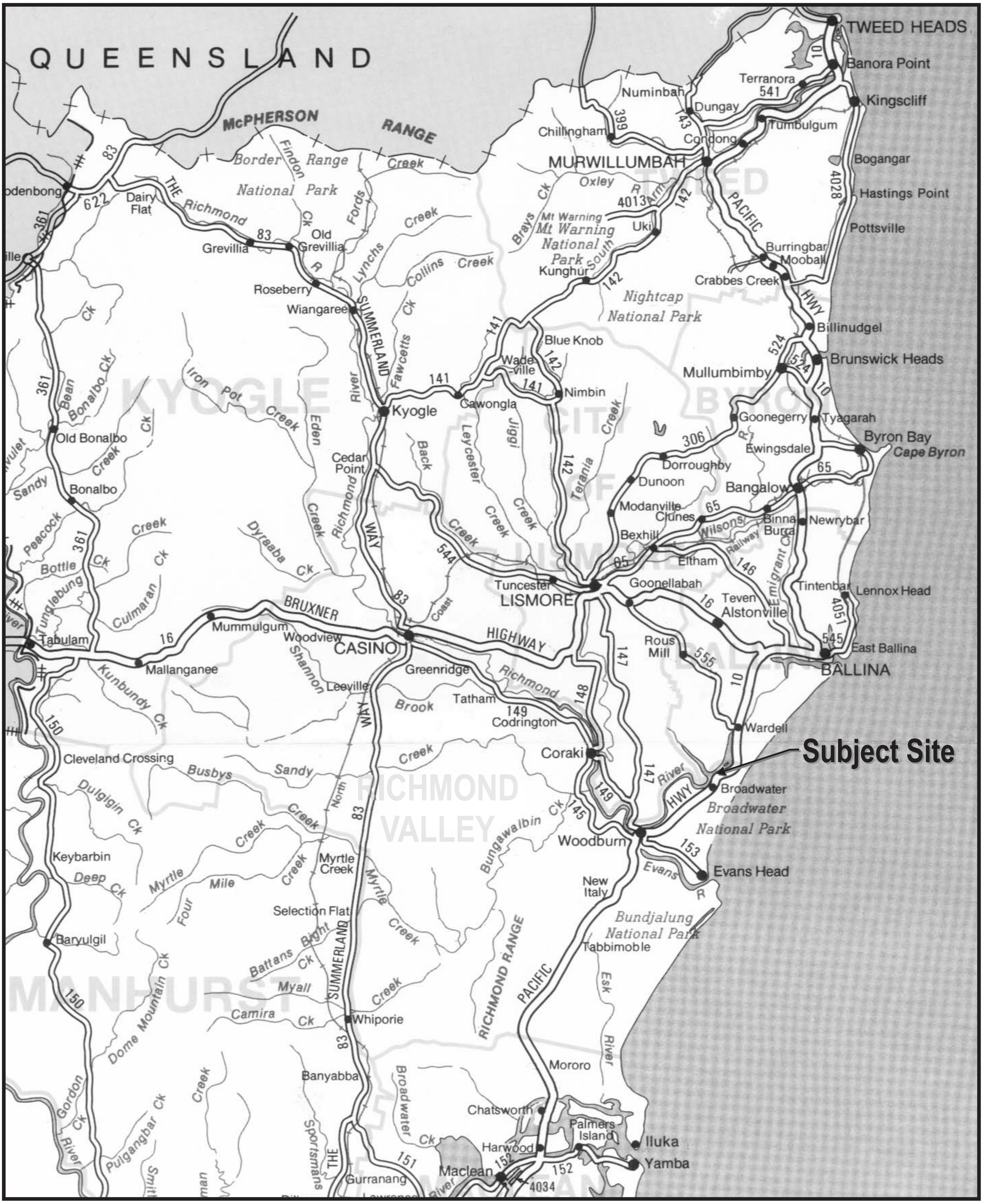
The topography within the area primarily comprises a flat coastal plain lying at a level generally lower than 10 m AHD. The only elevated ground in the town consists of three small hills. The largest, Cooks Hill, located about half a kilometre to the east of the centre of the town, is steep sided and rises to a height of approximately 70 m AHD. The other two hills, less than 30 m AHD in elevation, are located on the southern outskirts of town. The land is drained by three small creeks, Eversons Creek, Rattle Gully, and Montis Gully, all of which flow into the Richmond River.

The geology of the area is dominated by low to gently undulating land with Quaternary deposits of dune sand along the coastline. Soils vary from clay loams to sandy soils. Soils throughout the urban area of Broadwater, and between Broadwater and Rileys Hill, are characteristic of the Iluka soil landscape (Morand, 2000) which generally comprises highly permeable acidic and generally well drained soils with a high watertable. The area surrounding Broadwater is characterised by the Bundjalung soil landscape (Morand, 2000) which contains generally acidic and very poorly drained soils with a high watertable.

Acid Sulfate Soil Risk Mapping (Land and Water Conservation, 1997) indicates that all of Broadwater has a high risk of acid sulfate soils occurring at a depth of between 1 and three metres below the surface.

2.3 Flooding

The majority of the town is subject to flooding with floodwaters being recorded at depths of up to 2 metres in parts of the town (PWD, 1981). Based on flood mapping for the Lower Richmond River (PWD, 1983), the 1 in 20 year flood inundates the majority of the town as shown reaching a level of 3.1 to 3.3 m AHD. The 1 in 100 year flood level ranges from 3.8 to 4.0 m AHD.



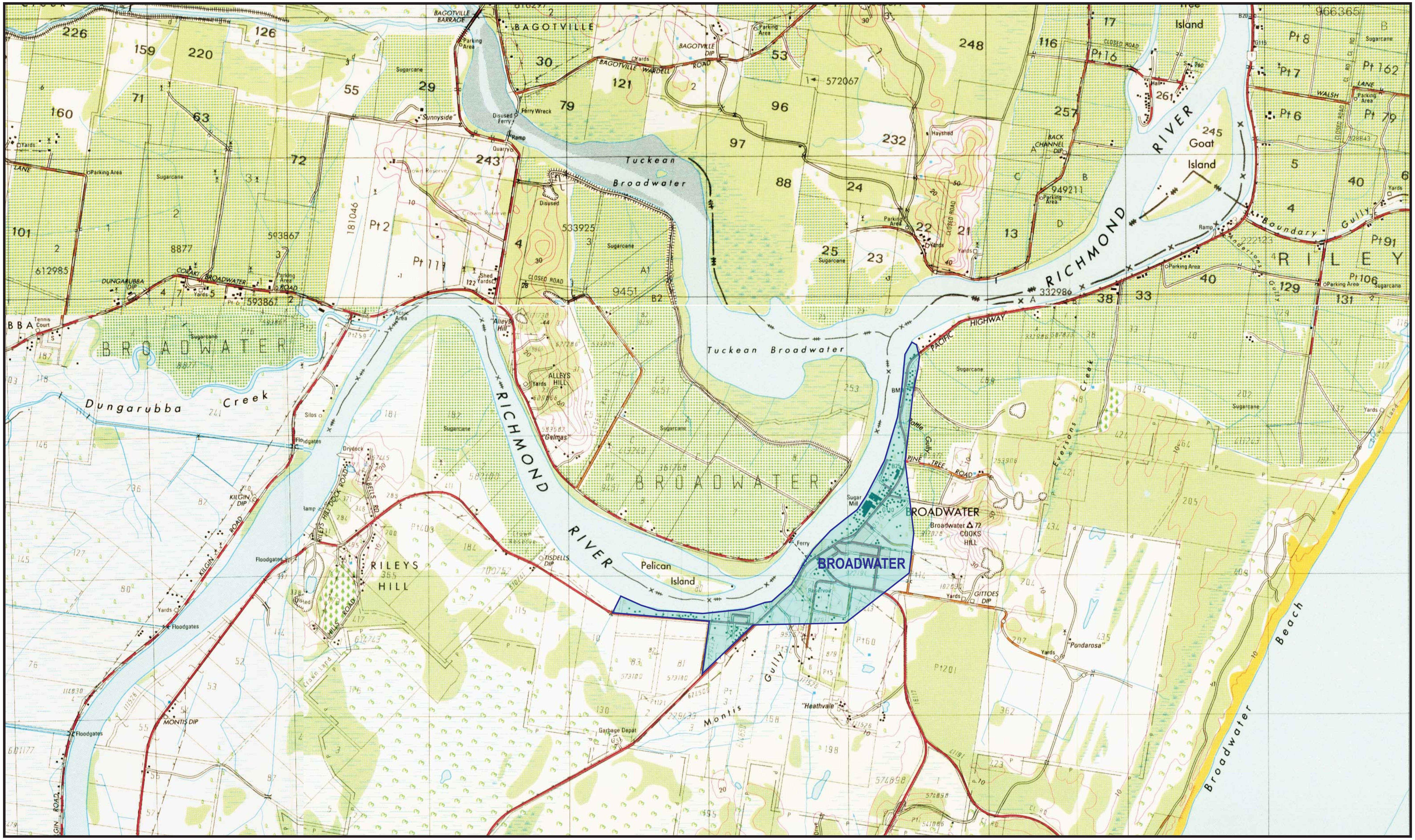
North
0 NTS

Source: RTA Map
Date: August 2006
UPR 0863866

Illustration 2.1

LOCALITY MAP

GeoLINK



North

0 1km

Source: CMA Topographic Map
Date: August 2006
UPR 0863867

Illustration 2.2

STUDY AREA

2.4 Climate

The climate in the Broadwater area is characterised by mild winters and warm summers with temperature ranges of 7°C to 20°C and 15°C to 29°C respectively.

The rainfall and evaporation figures for Broadwater Sugar Mill and Alstonville respectively are shown in Table 2.1.

Table 2.1 Monthly rainfall & evaporation averages

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*	*Ann.*
Mean Monthly Rainfall (mm)	166	173	189	155	148	129	102	78	54	80	91	116	1,483
Mean Monthly Evaporation (mm)	180	140	136	108	84	75	90	112	138	158	171	189	1,600

2.5 Land use

Broadwater was originally developed as a result of the establishment of Broadwater Sugar Mill. The development of the town is characterised by "ribbon" type development along the Pacific Highway. Residential, industrial and commercial activities of the town are primarily concentrated close to the bank of Richmond River.

To the north of the town, the low-lying land is used for sugar cane farming. To the south and east of the town, the low-lying land is primarily used for cattle grazing. A quarry is located on the eastern side of Cooks Hill. Beyond these areas, to the east and south, lies Broadwater National Park.

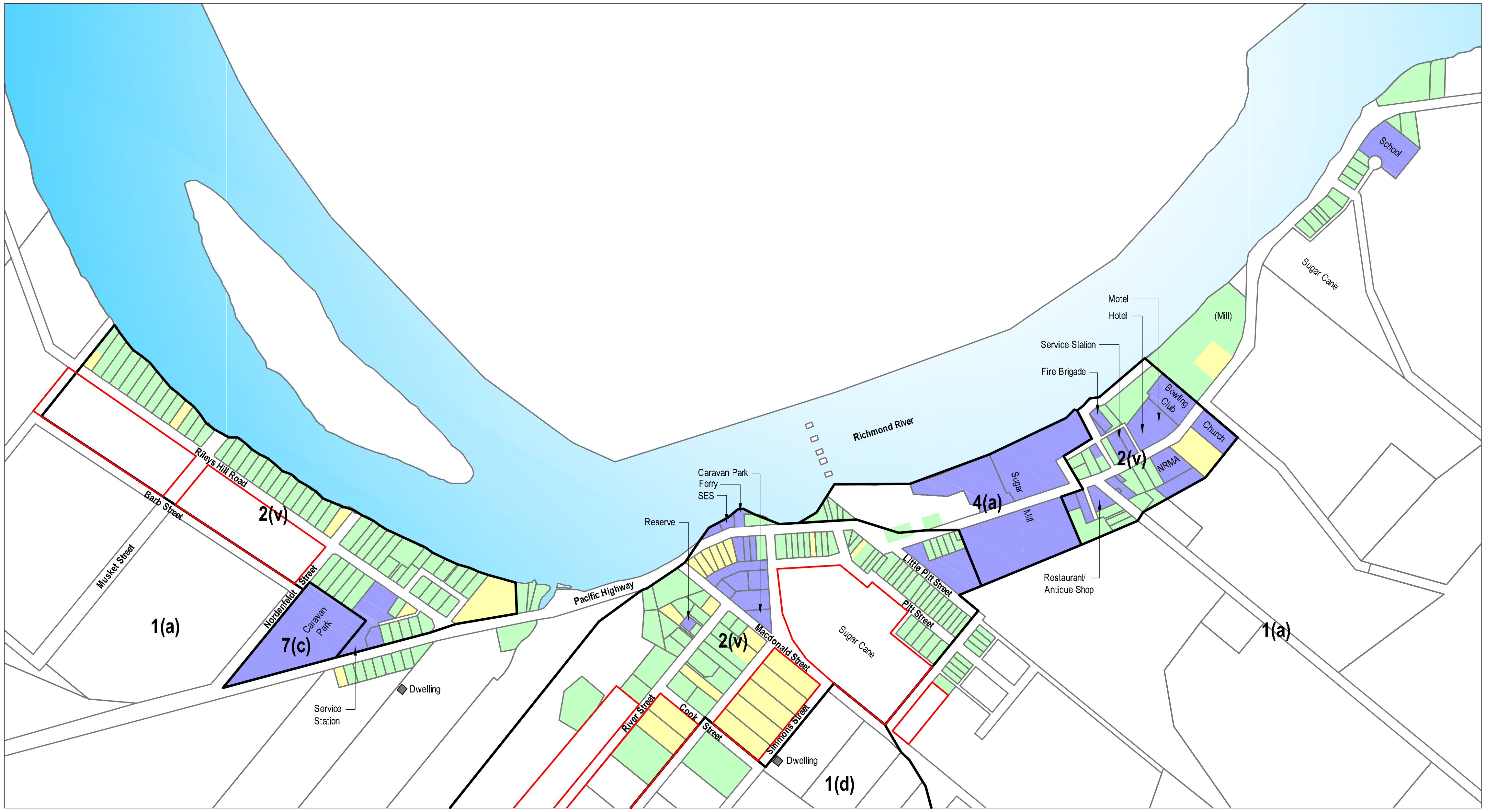
The existing urban area of Broadwater primarily accommodates detached dwellings with approximately 190 dwellings in the town as reported in the 2001 census. Ancillary urban developments are listed in Table 2.2.

Table 2.2 Non-residential development in Broadwater

	Number
Sugar Mill	1
Primary School	1
Club (Broadwater Bowling Club)	1
Community Centre	1
Hotel	1
Motel	1
Churches	2
Service Stations	2
NRMA Depot and Garage	1
Antique Shop/Restaurant	1
Caravan/Camping Parks	2

The zoning in the vicinity of Broadwater is shown in Illustration 2.3. Undeveloped areas shown in Illustration 2.3 could potentially accommodate up to an additional 250 dwellings based on a lot size of 900 m². However, future development within these areas is likely to be limited due to flooding considerations and limited demand for settlement in Broadwater (as advised by Council, see Section 2.6).

Source: GIS / GeoLINK Date: September 2006



Legend:

- Occupied lots
- Vacant lots
- Special or commercial
- Potential future development
- 1(a) Rural (Prime Agricultural Land) Zone
- 1(d) Rural (Urban Investigation) Zone
- 2(v) Village Zone
- 4(a) Industrial Zone
- 7(c) Environmental Protection (Flora and Fauna) Zone

North

0 250m

Existing Land Uses

Illustration 2.3

The NSW Sugar Milling Co-operative is the main industry in Broadwater. Raw sugar is manufactured from sugar cane at the mill. The co-operative is currently expanding the co-generation capability at the mill, whereby electricity is generated from by-products of the sugar manufacturing process. Under current plans, the cogeneration plant is expected to generate approximately 40 kL/d of brine wastewater. If Broadwater is sewered, disposal of this brine to Broadwater's sewerage system is the most cost-effective means of managing this wastewater. However, there are options available to the Sugar Mill, primarily sourcing feed-water for the cogeneration plant from groundwater, that would allow wastewater to be discharged to the Richmond River. Allowances for this reduction in sewer load are noted below.

2.6 Population Growth

The most recent census, conducted in 2001, reported the population of Broadwater to be 408 and the number of dwellings to be 189, whereas the 1996 census reported a population of 531. This indicates that on average, the population declined at the rate of 4.6% per annum between the 1996 and the 2001 censuses.

Despite the negative trend between 1996 and 2001, Council has assumed a population growth rate of 1.0% per annum since the 2001 census for a 20 year timeframe. Adoption of this growth rate for the 25 year planning horizon suggests the residential population of Broadwater will be approximately 550 in 2031. Applying the occupancy rate of 2.2 residents per dwelling indicated in the 2001 census suggests a total of 250 residential dwellings by 2031. There is however a trend towards a decreasing household occupancy rate, so the actual number of additional dwellings associated with such a population growth may be higher.

It is assumed that the estimated 61 additional dwellings will be accommodated within the undeveloped areas shown in **Illustration 2.3**.

Council estimates that there is currently approximately 22ha of available land zoned 'undeveloped' that could accommodate around 150 dwellings within Broadwater.

2.7 Utility Services

The Broadwater locality is provided with adequate telephone and electricity services.

Town water is supplied throughout the town by the Rous Water system which draws water from Rocky Creek Dam.

In terms of wastewater management, Broadwater is served by on-site management systems, primarily septic tanks and absorption trenches. Results of groundwater sampling conducted in 1999 suggest that many of the systems may not be performing satisfactorily.

Additionally, most if not all of these on-site systems are unlikely to comply with the *Environment & Health Protection Guidelines – On-site Sewage Management for Single Households* (NSW DLG, 1998) due to reasons outlined in Section 1.1.

Existing Wastewater Management

3.1 Introduction

At present the town of Broadwater relies on the use of on-site wastewater management systems whereby domestic wastewater is treated and disposed of within each individual allotment.

The majority of the on-site systems in Broadwater consist of septic tanks and absorption trenches. A survey conducted by Richmond Valley Council in 1999 indicates that approximately 96% of the systems are septic tanks with absorption trenches, 2% are aerated systems with surface irrigation and 2% are composting toilets with a separate greywater system.

Many of these systems within Broadwater are failing or do not comply with state government guidelines. The systems are also having adverse groundwater impacts and causing resident complaints.

Following community consultation, and in light of the decision to upgrade the Evans Head WWTW, Council has decided to provide Broadwater with a reticulated sewerage collection and transport system that will deliver sewage to the Evans Head WWTW.

Section 4 of this report provides concept designs for a number of sewage collection and transportation options.

4

Wastewater Collection and Transportation Options

4.1 General

The wastewater collection and transport systems that have been evaluated for Broadwater include:

- conventional gravity;
- modified low-cost gravity;
- low pressure pumping (grinder pump); and
- vacuum sewerage.

4.2 Wastewater Loads

Assessment of options for centralised wastewater management requires estimation of a variety of loading characteristics that impact on the different components of the scheme. The various loading characteristics estimated for this study include:

- Average Dry Weather Flow (ADWF) – the average flow in sewers during a period of dry weather;
- Peak Dry Weather Flow (PDWF) – the expected peak rate of flow in sewers during a period of dry weather. This typically occurs in the morning and to a lesser extent in the evening as a result of people using the kitchen, toilet and bathroom facilities; and
- Peak Wet Weather Flow (PWWF) – the expected peak rate of flow in sewers during a period of wet weather. This increased rate of flow occurs during storm periods and results from the inflow and infiltration of surface waters and groundwater into a sewer system via manhole covers, cracks or joints in pipelines or illegal connections of residential stormwater.

For the purpose of this report, the following loadings have been adopted based on standard design criteria according to the DPWS Sewer Design Manual (PW, 1987):

- ADWF = 240 L/ep.d (litres per equivalent person per day);
- PDWF[1] = 2.8 x ADWF; and
- PWWF[1] = 7 × ADWF (or 4 x ADWF for vacuum and grinder pumping systems).

[1] The factors for calculating PDWF and PWWF from ADWF are based on an estimate of 318 equivalent tenements in Broadwater (derived from consideration of the cadastre of Broadwater, an assumption that population increase will reside on existing allotments, 2031 estimates of non-residential .e.t.'s provided in Table 4.3, and not including the e.t.'s associated with the stand-alone cogeneration plant) and the formulae provided in Appendix B of PW, 1987.

No consideration has been made for wastewater flows being reduced by the introduction of water demand management initiatives.

Design of a wastewater management scheme requires loadings to be expressed in terms of equivalent persons (e.p.). One person permanently residing in a residential house is counted as being one e.p. The amount of wastewater generated by other sources such as industries or tourists, is converted to the relevant number of e.p.'s in comparison to this benchmark.

The total loading for a wastewater collection and transport system or wastewater treatment works is normally based on the *maximum* number of e.p., from both domestic and non-domestic sources, that can potentially discharge to the system or works at any one time. Consequently, the total loading attributable to Broadwater needs to account for the permanent population, workers, students, holiday makers and visitors. Table 4.1 shows the estimations of e.p.'s, and the bases for those estimations, for all of the population groups that could contribute to the wastewater loading in Broadwater.

Table 4.1 Estimates of the size of various population groups

Group	*2006 Estimation*[1]	*2006 e.p.*	*2031 Estimation*	*2031 e.p.*
Permanent population	Estimated from 2001 census results and Council's assumed annual growth rate of 1%	429	Estimated from 2001 census results and Council's assumed annual growth rate of 1%	551
Workers at sugar mill[2]	Advice from management is 115 EFT workers at the mill. Assume worker load is equivalent to a tourist load (0.6 e.p.)	69	Advice from management is that 150 EFT would be a conservative (high) estimate (i.e. 90 e.p.). It is also assumed that the cogeneration plant will be in operation producing 40 kL/d of wastewater (i.e. 167 e.p.)	257
Students at Broadwater Public School[3,4]	34 students and 4.5 EFT staff. Assume student and staff loads are equivalent to a visitor load of 50 L/p.d (0.2 e.p.)	8	Estimate growth to match annual population growth rate of 1%	11
Regular customers – Commercial Hotel	Management advises approximate maximum of 50 customers per day. Assume loads equivalent to visitor load of 50 L/p.d (0.2 e.p.)	10	Estimate growth to match annual population growth rate of 1%	13
Regular customers – Service Stations	Managers advise approximate maximum of 200 customers per day (400 total). Assume half of all customers use facilities and customer load equivalent to visitor load of 50 L/p.d (0.2 e.p.)	40	Estimate growth to match annual population growth rate of 1%	52
Regular customers – Bowling Club	Management advises approximately 30 customers per day. Assume load equivalent to a visitor (0.2 e.p.)	6	Estimate growth to match annual population growth rate of 1%	8
Regular customers – Restaurant	Management advises approx. 4000 customers per year. Assume 11 per day and load equivalent to a visitor (0.2 e.p.)	3	Estimate growth to match annual population growth rate of 1%	4

Group	2006 Estimation[1]	2006 e.p.	2031 Estimation	2031 e.p.
Holiday makers[5]	▪ Stopover Tourist Park capacity for ~55 holiday makers ▪ Sunrise Caravan Park capacity for ~43 holiday makers ▪ Commercial Motel capacity 41 people Tourist load assumed to be 0.6 e.p.	84	Estimate no growth as 2006 estimates based on full capacity	84
Additional holiday customers – Commercial Hotel	Managers advise a doubling of standard customer turnover. Assume same rates as standard times	10	Estimate growth to match annual population growth rate of 1%	13
Additional holiday customers – Service Stations	Managers advise a doubling of standard customer turnover. Assume same rates as standard times	40	Estimate growth to match annual population growth rate of 1%	52
Additional holiday customers – Bowling Club	Management advises very little change, and estimate of regular customers already high	0		0
Additional holiday customers – Restaurant	Management advises very little change, and estimate of regular customers averaged across whole year	0		0
Permanent e.p.		565		896
Additional e.p. at holiday times		134		149
TOTAL e.p.		699		1045

[1] Estimates of e.p.'s for tourists and visitors taken from Appendix B of PW, 1987

[2] Load from sugar mill workers derives from toilet, hand-basin and shower use and is therefore assumed to be equivalent to a tourist load (0.6 e.p.)

[3] Loads from staff at commercial premises and school students derive from toilet and hand-basin use and are therefore assumed to be equivalent to a visitor load (50 L/p.d or 0.2 e.p.)

[4] Overall load from school is relatively low, therefore no allowance for school holidays is made.

[5] Permanent caravan park residents are included under 'Permanent Population' in census figures (ABS, pers. comm., 2/8/06)

Table 4.2 shows the wastewater loadings based on the estimates of e.p.'s for the population groups outlined in Table 4.1. These wastewater loads are derived from the assumption provided in PW, 1987, which states an ADWF of 240 L/ep.d, and the relationships between ADWF, PDWF and PWWF outlined above in this section.

Table 4.2 Estimated wastewater design loads based on estimates of e.p.'s and an ADWF of 240 L/ep.d

	2006[1]	2031[1]
Permanent Loads		
ADWF (kL/d)	136	215
PDWF (kL/d)	381	602
PWWF (kL/d) (vacuum and grinder systems)	544	860
PWWF (kL/d)	952	1505
Loads during holiday periods		
ADWF (kL/d)	168	251
PDWF (kL/d)	404	703
PWWF (kL/d) (vacuum and grinder systems)	672	1004
PWWF (kL/d)	1176	1757
Annual flow[2] (ML)	61	98

[1]2006 estimates do not include wastewater from the cogeneration plant
[2]Annual flow is estimated as 1.2 x ADWF with "holiday periods" assumed for 6 weeks of the year

Infrastructure capacities will be designed for the PWWF that occurs during holiday periods at the design horizon, however, estimations of operating costs are based on holiday loading only during Christmas and Easter holiday periods (assumed to be 6 weeks) and a 'permanent' loading scenario for the remainder of the year.

4.3 Design Considerations

A wastewater collection and transport system requires provision of emergency storage to retain flows during unscheduled events such as power failure or mechanical/electrical breakdown of pumping equipment.

The NSW Environment Protection Authority (DEC) requires a minimum storage of 4 hours detention at ADWF to be provided to prevent the occurrence of overflows from the system. This storage will be provided manholes and in pump stations, or in the case of a vacuum system, in holding chambers.

In flood areas it is desirable that the top of a pump station well is either located 0.5m above the 1 in 100 year flood level or provided with watertight covers. Electrical switchgear should also be located above flood levels. The standard practice is to locate the base of the switchgear at least 600mm above the 1 in 100 year flood level.

The hydraulic design of a wastewater collection and transport system is based on the maximum number of equivalent tenements (e.t.) contributing or connected to the system. A block of land occupied by a single residential house is counted as one e.t. and allowances are made for other types of residential dwellings and non-residential land use.

Table 4.3 **Estimates of equivalent tenements for non-residential premises** (based on estimates of equivalent persons provided in Table 4.1 and the assumption of 2.7 ep/et provided in PW 1987)

	2006 e.p.	*2006 e.t.*	*2031 e.p.*	*2031 e.t.*
Sugar Mill	69	26	257[1]	96[1]
Primary School	8	3	11	5
Club (Broadwater Bowling Club)	6	3	8	3
Community Centre	n/a	1	n/a	1
Hotel	10	4	13	5
Motel	25	10	25	10
Churches	n/a	1 each	n/a	1 each
BP Service Station	20	8	26	10
Volume Plus Service Station	20	8	26	10
NRMA Depot and Garage	n/a	2	n/a	2
Restaurant	3	2	4	2
Sunrise Caravan Park	70[2]	26	70[2]	26
Stopover Caravan Park	48[2]	18	48[2]	18
TOTAL non-residential e.t.		113		190

[1] Includes wastewater from proposed cogeneration plant
[2] Includes permanent residents and holiday makers

The undeveloped areas identified in **Illustration 2.3** are not included in the assessed wastewater collection and transport systems. Future development of these areas would require the developer to provide water and wastewater services compatible with the future Broadwater wastewater management scheme.

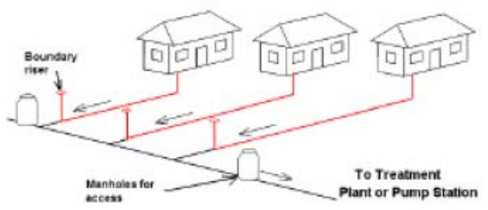
4.4 Conventional Gravity System

4.4.1 Description

A conventional gravity (CG) system involves wastewater from each allotment flowing through pipework to a central point under gravity. This point could be a sewage pumping station or a treatment plant.

The collection system comprises lengths of sidelines, gravity sewer mains (usually 150 mm diameter) and manholes. The sidelines connect the allotment to the sewer mains.

Manholes are located along the sewer mains at changes in direction, gradient and pipe size, at pipe junctions and at regular intervals. The manholes provide a convenient means of accessing the sewer mains for inspection and maintenance purposes.



Simple schematic of a conventional gravity system (Eurobodalla Shire Council, 2006)

Because sewer mains are designed to provide gravitational flow of the wastewater, each sewer catchment usually drains to a low point where the mains join into a sewer pumping station. The sewer pumping station transports the wastewater by pumping to the treatment works either directly or via other sewer catchments. The pipeline through which the wastewater is pumped under pressure, is termed a rising main.

A typical sewer pumping station comprises an in-ground circular concrete well, to provide short term storage of the wastewater, and two submersible pumps – one servicing as the normal duty pump and the other as a standby in case of mechanical failure of the duty pump. Wastewater flowing into the pumping station fills the well to a predetermined level, at which the pumps are automatically switched on to pump the collected flow through the rising main.

4.4.2 Design

The layout of the CG system for Broadwater is shown in Illustration 4.1. The CG layout comprises:

- approximately 7,400m of gravity sewer mains with nominal diameters of 150 mm and 225 mm at varying depths of up to 5m;
- approximately 2,090m of rising mains within the collection network;
- approximately 87 manholes of various depths located along the sewer mains;
- approximately 2 small lifting stations to avoid excessive depth of gravity mains in specific locations;
- four small pumping stations;
- one major pumping station to deliver all of the town's wastewater to the Evans Head Wastewater Treatment Plant;
- approximately 9,600m of rising main to the Evans Head Wastewater Treatment Plant; and
- associated sidelines for connection to residences and non-domestic premises.

The storage capacity of a gravity system is provided by the pump wells associated with the pumping stations and the pipe work of the collection system. This gravity system provides approximately 185 kL of storage, which equates to approximately 17 hours storage time under ADWF conditions (240 L/e.p./d) and standard occupancy rates (2.7 e.p./dwelling) at the planning horizon.

4.4.3 Cost estimate

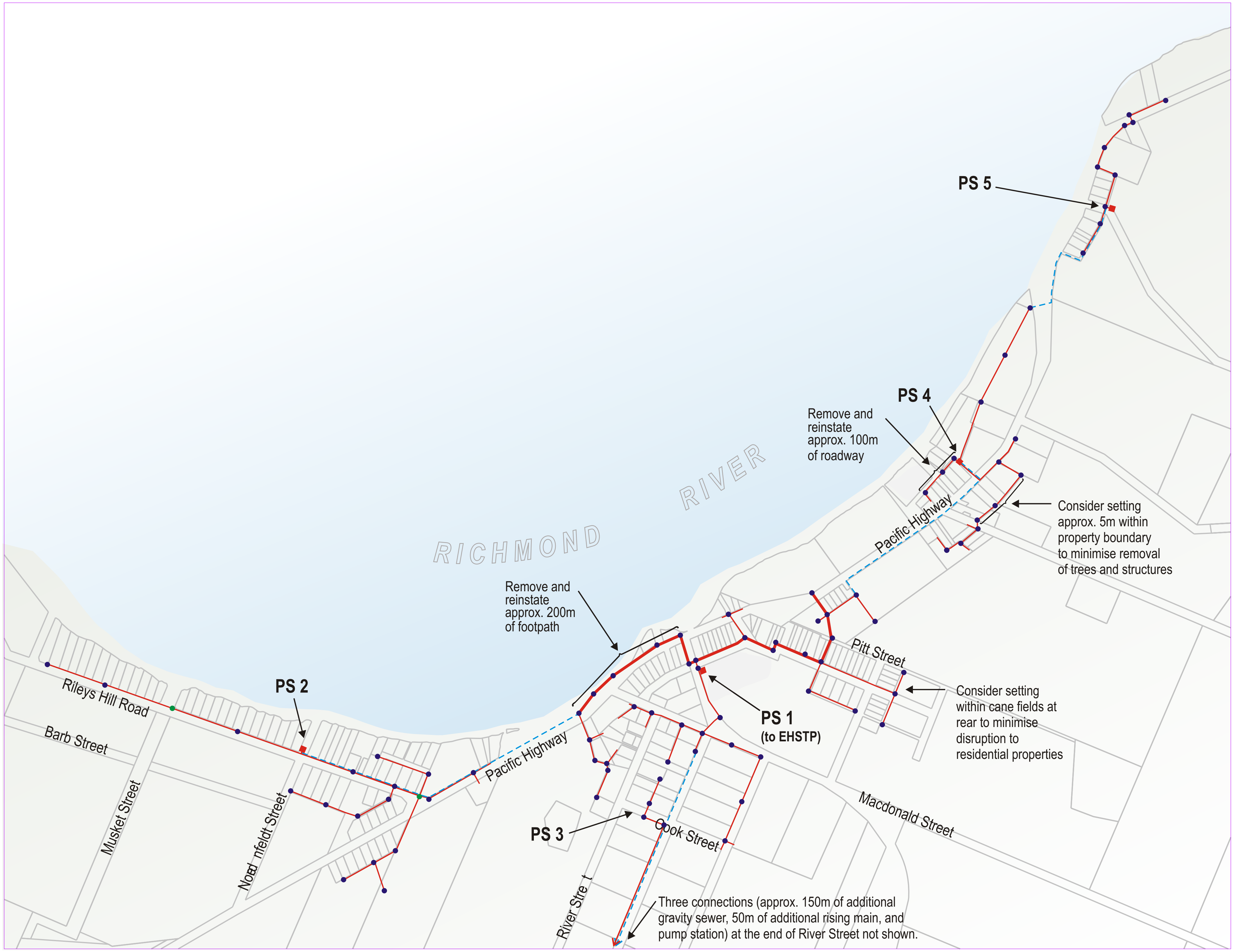
The Net Present Value (7% discount rate) of a conventional gravity system, including all capital, operation and maintenance costs over a 25 year planning horizon, is estimated at $8,062,000 (ex GST). The bases of cost estimates are outlined in Appendix A.

4.5 Modified Gravity System

4.5.1 Description

A modified gravity (MG) system works on the exactly the same principles as a CG system, with the exception of the addition of small pump stations (lift stations) where necessary to allow the sewer pipelines to be installed at a relatively shallow depth. In addition to ensuring that the maximum depth of the sewer mains are not excessive, the flow rate generated by these small pump stations allows the gravity sewers to be laid at flatter grades while still achieving self cleaning flows within the pipelines .

Manholes are still required at significant changes in direction, gradient and pipe size, and at pipe junctions, however the lift stations act as access points along long stretches of gravity main. The manholes and lift stations provide a convenient means of accessing the sewer mains for inspection and maintenance purposes. For greater economy a modified gravity system adopts lampholes (basic entry points) instead of manholes at various non-critical points such as line ends, minor direction changes and at intervals along straight sections of pipe.



Legend

- Rising main
- 150mm Gravity main
- 225 Gravity main
- Pump Station
- Manhole
- Lift station

North

0 250m

Source: GeoLINK
Date: August 2006
UPR 0863739

Illustration 4.1

WASTEWATER COLLECTION SYSTEM - Gravity Option

A MG system still requires sewer pumping stations to transport the wastewater between collection catchments by pumping to a downstream catchment or eventually to the treatment works.

4.5.2 Design

The layout of the MG system for Broadwater is shown in Illustration 4.2. The MG layout comprises:

- approximately 7,100m of gravity sewer mains with nominal diameters of 150 mm and 225 mm maintained above 2m depth;
- approximately 1,300m of rising mains within the collection network;
- approximately 45 manholes and 18 lampholes of varying depths above 2m;
- approximately 19 small lift stations;
- one major pumping station to deliver all of the town's wastewater to the Evans Head Wastewater Treatment Plant;
- approximately 9,600m of rising main to the Evans Head Wastewater Treatment Plant; and
- associated sidelines for connection to residences and non-domestic premises.

The storage capacity of a modified gravity system is provided by the pump wells associated with the pumping stations, the pump wells associated with the lift stations, and the pipe work of the collection system. This modified gravity system provides approximately 210 kL of storage, which equates to approximately 20 hours storage time under ADWF conditions (240 L/e.p./d) and standard occupancy rates (2.7 e.p./dwelling) at the planning horizon.

4.5.3 Cost estimate

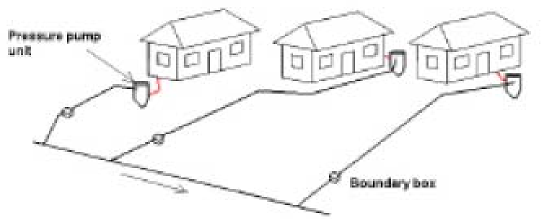
The Net Present Value (7% discount rate) of a modified gravity system, including all capital, operation and maintenance costs over a 25 year planning horizon, is estimated at $7,876,000 (ex GST). The bases of cost estimates are outlined in Appendix A.

4.6 Low Pressure Pumping (Grinder Pump) System

4.6.1 Description

A low pressure pumping (LP) system comprises macerating pumps capable of grinding normal constituents of domestic wastewater into a slurry and then pumping the wastewater into a reticulated pressure sewer main.

The contemporary grinder pump system involves the use of commercial package units comprising a prefabricated pump station with grinder pump and associated controls and electrical equipment. The pumps have a flow rate of about 0.7 L/s and can pressurise the reticulated pressure sewer main network to about 45 metres in head.

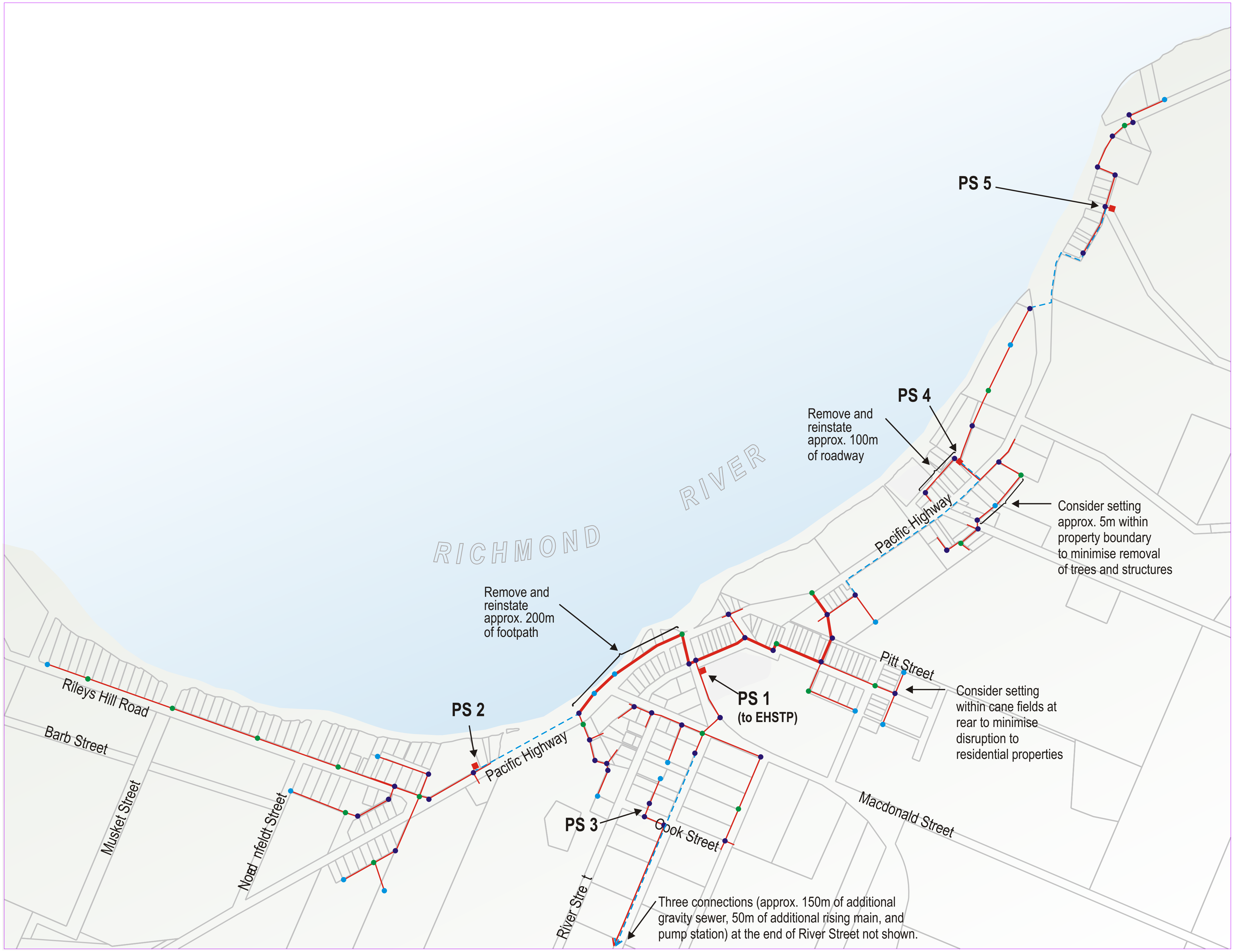


Simple schematic of a low pressure system (Eurobodalla Shire Council, 2006a)

NSW Health requires at least 660L storage in the holding tank of each separate pumping unit (i.e. per allotment), although many units provide more storage. This minimum capacity represents approximately 24 hours storage time under ADWF (240 L/e.p./d) and standard occupancy rates (2.7 e.p./dwelling).

The reticulated pressure sewer main is pressurised by the individual pumps on each allotment. It can serve several hundred homes and discharge to either the treatment works or a major pumping station. A major pumping station will be required to pump the sewage to Evans Head.

GeoLINK



Legend

- Rising main
- 150mm Gravity main
- 225mm Gravity main
- Pump Station
- Manhole
- Lamphole
- Lift Station

North

0 250m

Source: GeoLINK
Date: August 2006
UPR 0863868

Illustration 4.2

WASTEWATER COLLECTION SYSTEM - Modified Gravity Option

By reducing excavation depths in comparison to conventional gravity systems, low pressure pumping systems are suitable in areas of high water tables and/or flat terrain. This system also has the advantage of requiring smaller diameter pipelines, and reducing the amount of inflow/infiltration in wet weather or high groundwater conditions.

This type of system can significantly reduce the number of major pumping stations in the reticulation system but because of the large number of small pumping stations required, the level of maintenance required can be expected to be higher than with a conventional gravity system. The pumps and associated valves need to be maintained to prevent failure of the system. Repair of the system can also at times require whole sections of the reticulated pressure sewer main to be isolated and individual lots to be taken out of service while the repairs are undertaken.

4.6.2 Design

The layout of the LP system for Broadwater is shown in Illustration 4.3. The LP layout comprises:

- approximately 205 individual grinder pump stations for residential and non-residential dwellings which transfer flows to the reticulated sewer;
- approximately 7,530 m of pressure mains not including the rising main to the treatment works;
- one major pump station to deliver all of the town's wastewater to the Evans Head Wastewater Treatment Plant;
- approximately 9,600m of rising main to the Evans Head Wastewater Treatment Plant; and
- associated sidelines for connection to residences and non-domestic premises.

The storage capacity of a low pressure system is provided by the wells associated with each separate pumping unit (i.e. on each allotment). NSW Health requires at least 660L storage in the holding tank of each separate pumping unit, although many units provide more storage. This minimum capacity represents approximately 24 hours storage time under ADWF (240 L/e.p./d) and standard occupancy rates (2.7 e.p./dwelling) at the planning horizon.

4.6.3 Cost Estimate

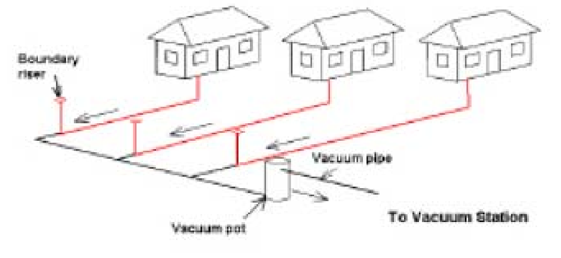
The Net Present Value (7% discount rate) of a low pressure system, including all capital, operation and maintenance costs over a 25 year planning horizon, is estimated at $6,226,000 (ex GST). The bases of cost estimates are outlined in Appendix A.

4.7 Vacuum System

4.7.1 Description

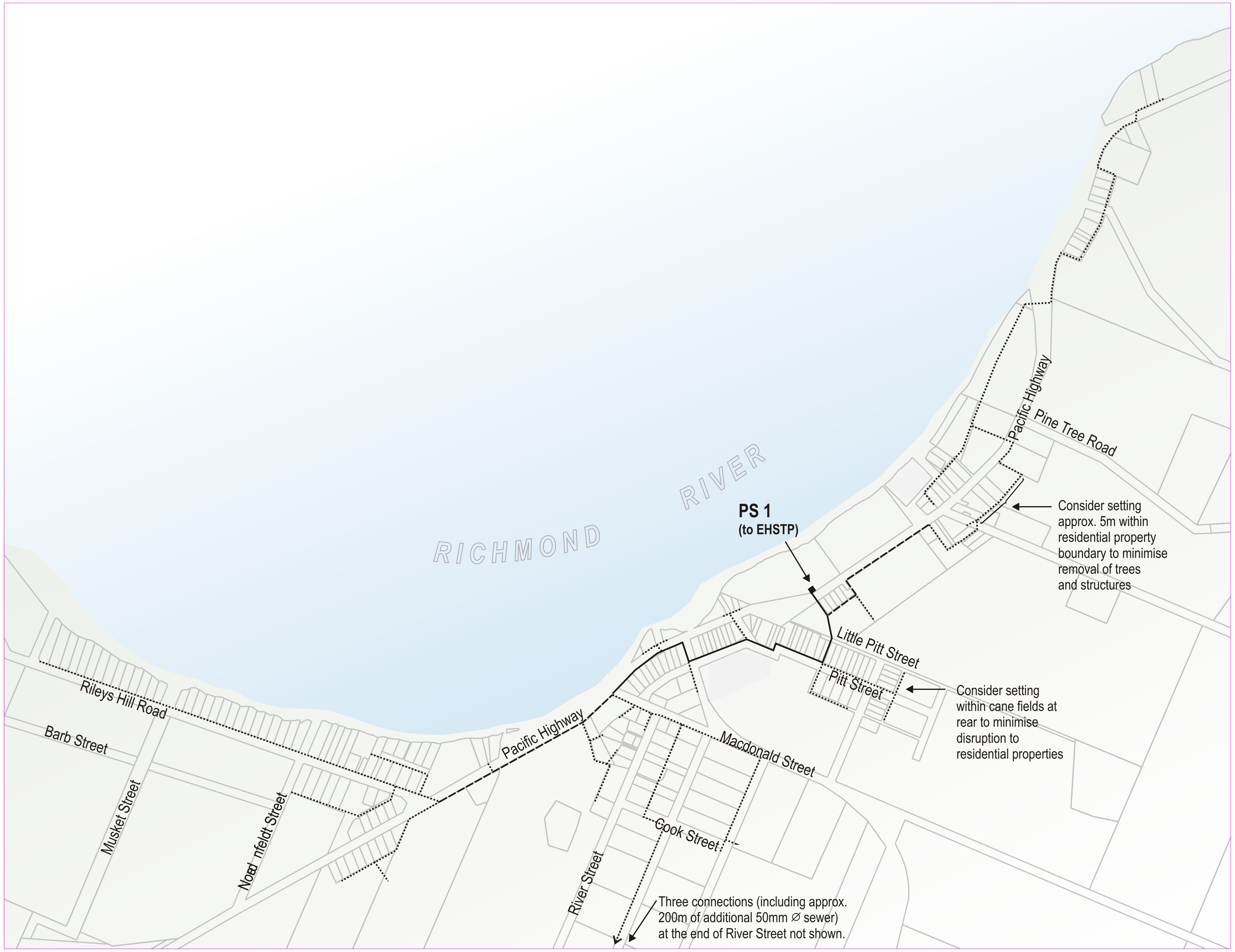
In this type of system, the wastewater is collected by vacuum generated at a central vacuum collection station. The vacuum mains radiate from the collection station and connect to holding chambers which are placed strategically within the reticulation area.

Wastewater from each lot is piped under gravity to a holding chamber that normally serves up to 6 dwellings or e.t.'s. Each holding chamber is equipped with an interface valve that is automatically actuated when the small sump in the base of the chamber fills with sewage. The wastewater in the chamber is drawn into the small diameter vacuum reticulation mains as a slug of liquid. The wastewater is then drawn to the vacuum collection station for transfer by pumping to the treatment works.



Simple schematic of a vacuum system (Eurobodalla Shire Council, 2006b)

GeoLINK



Legend

110 ⌀ pressure main
80 ⌀ pressure main
50 ⌀ pressure main

North
0 250m

Source: GeoLINK
Date: August 2006
UPR 0863803

Illustration 4.3

WASTEWATER COLLECTION SYSTEM - Low Pressure (Grinder Pump) Option

This type of system is most economical in flat terrain, high water table, or hard rock areas since the vacuum lines may be laid at minimal depth. This system has the advantage of requiring smaller diameter pipelines, and reducing the amount of inflow/infiltration in wet weather or high groundwater conditions.

4.7.2 Design

The layout of the vacuum system for Broadwater is shown in Illustration 4.4. The vacuum layout comprises:

- approximately 6610m of vacuum mains with nominal diameters of 110mm and 125mm;
- approximately 3400m of gravity mains to link sidelines with the vacuum chambers;
- approximately 73 vacuum collection chambers;
- one combined vacuum station and pump station to collect all of the town's wastewater and then deliver it to the Evans Head Wastewater Treatment Plant;
- approximately 9,600m of rising main to the Evans Head Wastewater Treatment Plant; and
- associated sidelines for connection to residences and non-domestic premises.

The storage capacity of a vacuum system is provided by the vacuum chambers and the gravity pipe work that both serve up to 6 e.t.'s. Each vacuum chamber provides approximately 2 kL of storage and the pipe work for each e.t. provides approximately 400 L of storage. The 720 L of total storage available to each e.t. represents approximately 26 hours storage time under ADWF (240 L/e.p./d) and standard occupancy rates (2.7 e.p./dwelling) at the planning horizon.

4.7.3 Cost Estimate

The Net Present Value (7% discount rate) of a vacuum system, including all capital, operation and maintenance costs over a 25 year planning horizon, is estimated at $6,935,000 (ex GST). The bases of cost estimates are outlined in Appendix A.

4.8 Sugar Mill Cogeneration Plant

As noted above, all of the flow estimates and concept designs in the previous sections assume that the cogeneration plant at the Broadwater Sugar Mill be in operation soon (cost estimates are based on it being in operation within a year). It is estimated that the cogeneration plant will produce around 40 kL/d of wastewater that will be disposed of by the collection system for the rest of Broadwater's wastewater needs. Should the cogeneration plant not proceed there will be some minor modifications to the designs and cost estimates.

The concept designs of the main pumping station and rising main to the Evans Head Wastewater Treatment Plant are based on Peak Wet Weather Flows of between 1004 kL/d and 1757 kL/d, depending on the collection system installed. Should the cogeneration plant not proceed, the reduction in flow of 40 kL/d is not sufficient to warrant a change in the design of the rising main or main pumping station.

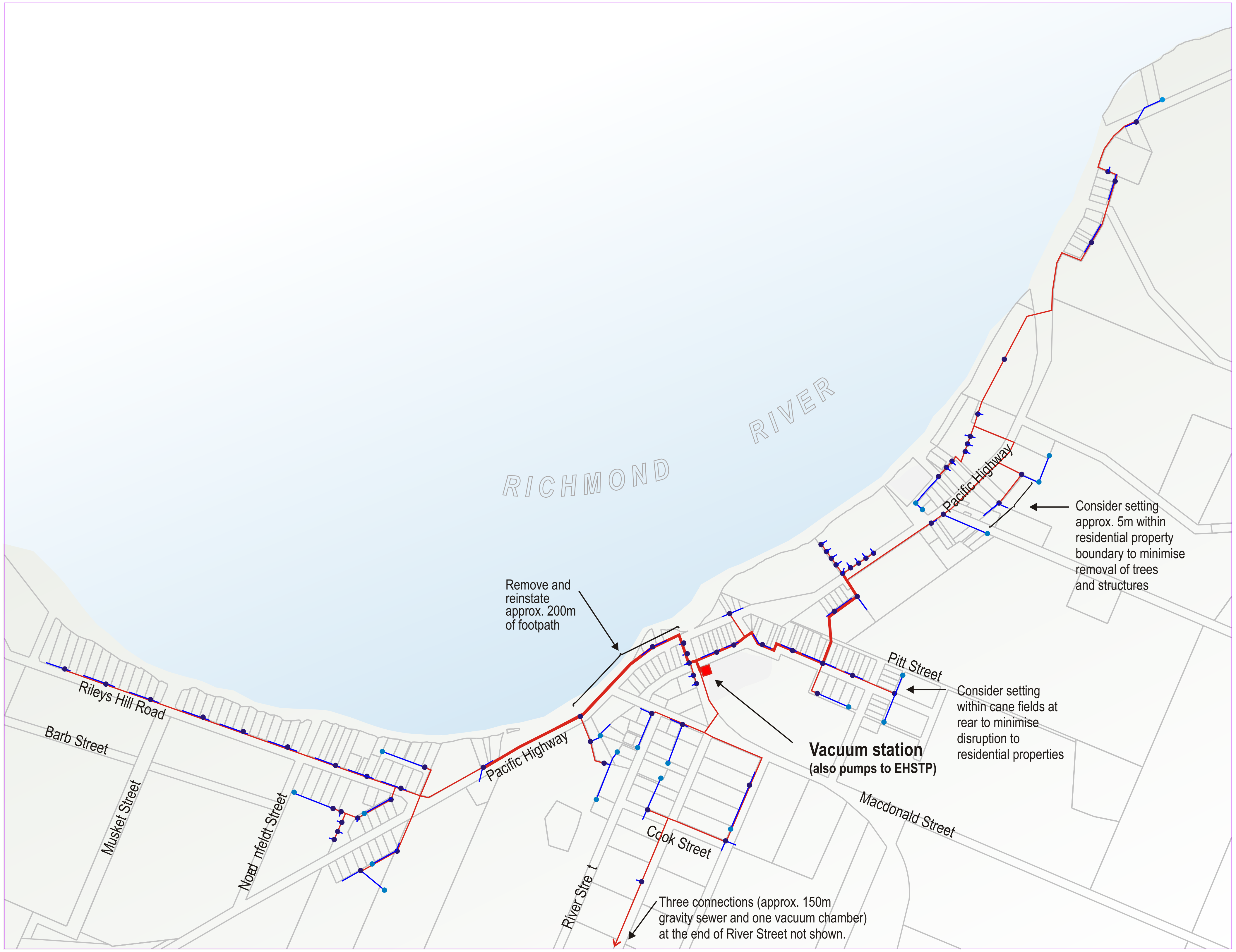
4.8.1 Conventional Gravity System

Should the cogeneration plant not proceed, the following changes could be made to the conventional gravity system concept design presented in Section 4.4:

- approximately 200m of 225mm diameter gravity main could be replaced with 150mm diameter gravity main.

The revised Net Present Value (7% discount rate) of the conventional gravity system would be approximately $8,049,000.

GeoLINK



Legend

- 110mm Vacuum main
- 125mm Vacuum main
- Gravity main
- Vacuum interface chamber
- Vacuum Station
- Manhole

North

0 250m

Source: GeoLINK
Date: August 2006
UPR 0863804

Illustration 4.4

WASTEWATER COLLECTION SYSTEM - Vacuum Option

4.8.2 Modified Gravity System

Should the cogeneration plant not proceed, the following changes could be made to the modified gravity system concept design presented in Section 4.5:

- approximately 200m of 225mm diameter gravity main could be replaced with 150mm diameter gravity main.

The revised Net Present Value (7% discount rate) of the modified gravity system would be approximately $7,863,000.

4.8.3 Low Pressure Pumping System

Should the cogeneration plant not proceed no major changes could be made to the low pressure pumping system concept design presented in Section 4.6. The main pumping station has been sited on the grounds of the sugar mill to accommodate the “point source” of wastewater flowing from the site and should remain as the mill will still represent a “point source’ of 34 e.t.

The revised Net Present Value (7% discount rate) of the low pressure pumping system would be approximately $6,222,000.

4.8.4 Vacuum System

Should the cogeneration plant not proceed, the following changes could be made to the vacuum system concept design presented in Section 4.7:

- approximately 4 vacuum chambers could be removed from the sugar mill site.

The revised Net Present Value (7% discount rate) of the vacuum system would be approximately $6,873,000.

5

Conclusions

5.1 Analysis of Options

The previous section of this report describes the concept designs for four alternative options for the collection and transportation of wastewater from the town of Broadwater to the Evans Head WWTW.

Table 5.1 compares all of these options against the following criteria:

- environmental impacts and social disruption during construction;
- protection of urban amenity;
- potential for infiltration and flood impacts;
- reliability and lifespan;
- monitoring, operation and maintenance issues; and
- indicative capital, operation and maintenance costs.

Table 5.1 Summary of options analysis

Criterion	*Conventional Gravity*	*Modified Gravity*	*Low Pressure*	*Vacuum*
Environmental disruption during construction	Significant trenching required (i.e. up to 5m depth particularly along Rileys Hill Rd and on various sections of Pacific Hwy) in sandy substrate and below water table. This will require the use of heavy earthmoving equipment and significant disturbance to the urban amenity. Extensive dewatering will also be required and this may require the implementation of water treatment measures. Extensive excavation below the water table may also disturb acid sulfate soils. Precise laying of gravity mains required. Requires removal and reinstatement of pavement south of and in vicinity of SES building.	Shallower trenching required, however, added disruption due to installation of small in-line pump (lift) stations. Precise laying of gravity mains required. Removal and reinstatement of pavement south of and in vicinity of SES building. Because of the excavation depths are still significant, heavy earthmoving equipment will be needed to install the system and significant disturbance to the urban amenity will result. Dewatering will also be required and this may require the implementation of water treatment measures. Excavation below the water table may also disturb acid sulfate soils	Very small bore polyethylene pressure mains can be laid at minimum depth without great precision. Shallow trenching requires smaller plant and will result in less disruption and lower likelihood of ASS disturbance.	Small bore polyethylene pressure pipe laid in shallow (1m) trench – minimal excavation and backfill requirements. Shallow trenching requires smaller plant and will result in less disruption and lower likelihood of ASS disturbance

Criterion	*Conventional Gravity*	*Modified Gravity*	*Low Pressure*	*Vacuum*
Protection of urban amenity	4 pump stations required, however, low urban impact. Future repairs to deep sewer mains may entail significant disruption.	4 pump stations and approximately 19 lift stations required, however, low urban impact. Future repairs to deeper sewer mains may entail significant disruption.	Each household will require a small 1 metre diameter well pump buried below the ground and connected to the household electricity. Few repairs to the mains are likely to be necessary.	Every fifth or sixth household will require a small 1metre diameter vacuum well buried below the ground. Few repairs to the mains are likely to be necessary.
Potential for infiltration and flood impacts	High potential for infiltration, estimated at around 5000 L/d/et. All electrical control gear would be located above flood level. Pumps are submersible and would not be adversely impacted by flooding. During a flood, the system would be turned off.	Slightly lower potential for infiltration, estimated at around 4000 L/d/et. All electrical control gear would be located above flood level. Pumps are submersible and would not be adversely impacted by flooding. During a flood, the system would be turned off.	Low potential for infiltration, estimated at around 1000 L/d/et. All electrical control gear would be located above flood level. Pumps are submersible and would not be adversely impacted by flooding. During a flood, the system would be turned off.	Low potential for infiltration, estimated at around 1000 L/d/et. All electrical control gear and mechanical gear in the vacuum station would be located above flood level. The vacuum valves are submersible and would not be adversely impacted by flooding. During a flood, the system would be turned off.
Reliability and lifespan	Well understood, simple system, able to be maintained in most instances by Council staff (other than pump station maintenance). Repairs to deep sewer mains is very costly.	Slightly higher potential for partial failure due to high number of pumping units. However, pumps and pipe work easily maintained and/or repaired in most instances by Council staff (other than pump station maintenance). Repairs to deep sewer mains is very costly.	Only installed in Australia in recent years, but well proven and widespread system used successfully for over 30 years in America. Relatively easy to maintain and diagnose faults.	This type of system is widely used in Australia and overseas. Vacuum systems have been in operation in Australia for over 30 years. A more complex system requiring special training of staff. Fault finding can be problematic.

Criterion	*Conventional Gravity*	*Modified Gravity*	*Low Pressure*	*Vacuum*
Monitoring, operation and maintenance issues	Subject to sewer chokes primarily from root intrusion. Sewage pumps and control gear (5 No.) can malfunction. Remote monitoring system can be provided to warn of failures.	Subject to sewer chokes primarily from root intrusion. Pumps and control gear (19 lift stations and one major station) can malfunction. Remote monitoring system can be provided to warn of failures.	Pressure pumps and control gear (200 pressure pumps and one major station.) can malfunction, although anecdotal evidence suggests they are very reliable. Remote monitoring system can be provided to warn of failures.	Very low risk of blockages due to high flow (around 6 m/s). Interface valves and controller (69 No.) and major sewage pumps, vacuum pumps and control gear can malfunction. Remote monitoring system can be provided to warn of failures.
Indicative capital, and operation and maintenance costs over 25 year planning horizon	NPW (7% discount rate) estimated at $8,062,000.	NPW (7% discount rate) estimated at $7,876,000.	NPW (7% discount rate) estimated at $6,226,000.	NPW (7% discount rate) estimated at $6,935,000.

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A

Cost Estimates

Broadwater Sewer Concept Designs
Cost Estimates for Collection and Transport System Options

COLLECTION AND TRANSPORT SYSTEM Capital Costs				Conventional Gravity		Modified Gravity		Low Pressure Pumping		Vacuum Sewerage	
Item	Description	Unit	Rate	Quantity	Amount($)	Quantity	Amount($)	Quantity	Amount($)	Quantity	Amount($)
1.0	Gravity mains (incl. excavation, trenching, ASS treatment, supply, lay, joining, and backfilling)										
	Gravity pipeline up to 2m depth										
1.1	uPVC RRJ Class 12 150 mm dia.	m	110	2,153	236,830	6,476	712,360			3,403	374,330
1.2	uPVC RRJ Class 12 225 mm dia.	m	150	462	69,300	924	138,600				
	Gravity pipeline beyond 2m depth										
1.3	uPVC RRJ Class 12 150 mm dia.	m	230	4,323	994,290						
1.4	uPVC RRJ Class 12 225 mm dia.	m	320	462	147,840						
2.0	Vacuum mains (incl. excavation, trenching, ASS treatment, supply, lay, joining, and backfilling)										
2.1	110 mm diameter	m	110							5,353	588,830
2.2	125 mm diameter	m	120							1,263	151,560
										6,616	
3.0	Pressure mains										
3.1	50 mm diameter	m	65	920	59,800	920	59,800	6,078	395,070		
3.2	80 mm diameter	m	80	1,172	93,760	730	58,400	784	62,720		
3.3	110 mm diameter	m	100					674	67,400		
3.4	150 mm diameter (to EHSTP)	m	120					9,600	1,152,000	9,600	1,152,000
3.5	200mm diameter (to EHSTP)	m	160	9,600	1,536,000	9,600	1,536,000				
4.0	Manholes and lampholes										
4.1	up to 2m depth	each	2,100	66	138,600	45	94,500			23	48,300
4.2	beyond 2m depth	each	3,500	21	73,500						
4.4	Lamphole	each	800			18	14,400				
5.0	Sidelines and Risers										
5.1	Gravity, modified gravity and vacuum systems	each	2,000	320	640,000	320	640,000			320	640,000
5.2	Low pressure systems	each	1,200					320	384,000		
6.0	Pump stations (incl. overflow structure, land purchase, civil/mechanical/electrical works)										
6.1	PS 1 - primary pump station to EHSTP (380 et)	each		1	295,000	1	295,000	1	295,000	1	385,000
6.2	Gravity PS 2 (102 et)	each		1	120,000	1	120,000				
6.3	Gravity PS 3 (7 et)	each		1	75,000	1	75,000				
6.4	Gravity PS 4 (76 et)	each		1	100,000	1	100,000				
6.5	Gravity PS 5 (20 et)	each		1	80,000	1	80,000				
6.7	Lift stations	each	25,000	2	50,000	19	475,000				
7.0	Vacuum Collection Chambers										
7.1	Vacuum Collection Chambers	each	5,000							73	365,000
8.0	Small pumping units (incl. instalation)										
8.1	Small pumping units for low pressure pumping system (e1 units)	each	5,500					205	1,127,500		
9.0	Removal and restoration of surfaces										
9.1	Removal of concrete pavement	lump sum	8,000	1	8,000	1	8,000			1	8,000
9.2	Replacement of concrete pavement	m	100	200	20,000	200	20,000			200	20,000
9.3	Removal and replacement of bitumen road	lump sum	10,000	1	10,000	1	10,000	1		1	10,000
9.4	Landscaping heavy disturbance	m	30	6,480	194,400						
9.5	Landscaping light disturbance	m	20	1,742	34,840	7,800	156,000	6,816	136,320	8,949	178,980
10.0	Ancilliary works										
10.1	Underboring up to 125mm pipe	m	500	200	100,000	200	100,000	280	140,000	280	140,000
10.2	Underboring up to 225mm pipe	m	800	120	96,000	120	96,000	40	32,000	40	32,000
10.3	Traffic control	lump sum	20,000	1	20,000	1	20,000	1	20,000	1	20,000
11.0	Remote monitoring/telemetry system	lump sum			60,000		80,000		200,000		110,000
12.0	Septicity control										
12.1	Aeration unit at EHSTP	lump sum			80,000		80,000		80,000		80,000
13.0	Testing and commisioning	lump sum	15,000		15,000		30,000		40,000		40,000
14.0	Work-As-Executed package	lump sum	30,000		30,000		15,000		15,000		15,000
15.0	Survey, design and investigation (20%)				1,075,632		1,002,812		829,402		871,800
16.0	Contingencies (15%)				968,069		902,531		746,462		784,620
	Total Capital Cost				7,421,861		6,919,403		5,722,874		6,015,420

Note: All costs are exclusive of GST

Collection and Transport System Costs		5,378,160		5,014,060		4,147,010		4,359,000
Survey, design and investigation (20%)		1,075,632		1,002,812		829,402		871,800
Contingencies (15%)		968,069		902,531		746,462		784,620
Total		7,421,861		6,919,403		5,722,874		6,015,420

COLLECTION AND TRANSPORT SYSTEM Annual operation and maintenance costs				Conventional Gravity		Modified Gravity		Low Pressure Pumping		Vacuum Sewerage	
Item	Description	Unit	Rate	Quantity	Amount($)	Quantity	Amount($)	Quantity	Amount($)	Quantity	Amount($)
1.0	Mains maintenance										
1.1	Sewer chokes or repairs	each	600	12	7,200	10	6,000	3	1,800	3	1,800
2.0	Pump station maintenance										
2.1	major service	each	1,000	10	10,000	10	10,000	2	2,000	6	6,000
2.2	Monthly service	each	300	50	15,000	50	15,000	10	3,000	10	3,000
2.3	Weekly check and clean	each	200	200	40,000	200	40,000	40	8,000	40	8,000
2.4	Call outs	each	600	1	600	1	600	1	600	1	600
3.0	Lift station maintenance										
6.1	Regular service throughout town (6 monthly)	each	600			19	11,400				
6.2	Call outs	each	600			19	11,400				
4.0	Vacuum chambers maintenance										
4.1	6 monthly clean out	each	300							146	43,800
4.2	Call outs (10%)	each	3,000							7	21,000
5.0	Low pressure pumping unit maintenance										
5.1	Maintenance (parts, service etc.)	each	150					205	30,750		
5.2	Call outs (5%)	each	600					10	6,000		
6.0	Rising main to EHSTP maintenance										
6.1	Repairs	each	3,000	1	3,000	1	3,000	1	3,000	1	3,000
6.2	Aeration unit at EHSTP	each	8,000	1	8,000	1	8,000	1	8,000	1	8,000
	TOTAL Annual O&M other than power				83,800		105,400		63,150		95,200
	Power cost per e.p.				4.05		4.50		6.00		8.10

Broadwater Concept Sewer Designs

Net Present Value for Collection and Transportation Options (includes costs associated with transport to EHSTP)

Note: It is assumed that the Sugar Mill cogeneration plant will come into operation in year 1

It is assumed operating and maintenance costs will increase by 1% pa in line with assumed population growth

Collection Option			Net Present Value			
			Discount Rate (%)			
			0	4	7	10
Conventional Gravity	Capital Costs:		7,421,861	7,136,405	6,936,319	6,747,146
	Operating Costs:	Power	93,525	55,770	40,408	30,986
		Other O & M	2,474,248	1,488,330	1,085,158	827,384
	Total		9,989,634	8,680,504	8,061,885	7,605,516
Modified Gravity	Capital Costs:		6,919,403	6,653,272	6,466,732	6,290,366
	Operating Costs:	Power	103,917	61,966	44,898	34,139
		Other O & M	3,112,002	1,871,957	1,364,864	1,043,836
	Total		10,135,321	8,587,195	7,876,494	7,368,341
Low Pressure Pumping	Capital Costs:		5,722,874	5,502,763	5,348,480	5,202,613
	Operating Costs:	Power	138,555	82,622	59,864	45,519
		Other O & M	1,864,544	1,121,576	817,753	625,410
	Total		7,725,973	6,706,961	6,226,097	5,873,542
Vacuum Sewerage	Capital Costs:		6,015,420	5,784,058	5,621,888	5,468,564
	Operating Costs:	Power	187,050	111,540	80,816	61,451
		Other O & M	2,810,840	1,690,800	1,232,781	942,819
	Total		9,013,310	7,586,397	6,935,485	6,472,834

Capital costs and annual operating and maintenance costs

Collection Option		Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		e.p.	699	760	770	781	791	802	812	823	834	845	857	868	880	892	904	916	928	940	953	966	979
Conventional Gravity	Capital Costs:		7,421,861																				
	Operating Costs: Power		2,831	3,078	3,119	3,161	3,203	3,246	3,290	3,334	3,379	3,424	3,470	3,516	3,563	3,611	3,659	3,709	3,758	3,809	3,860	3,911	3,964
	Other O & M		83,800	84,638	85,484	86,339	87,203	88,075	88,955	89,845	90,743	91,651	92,567	93,493	94,428	95,372	96,326	97,289	98,262	99,245	100,237	101,240	102,252
Modified Gravity	Capital Costs:		6,919,403																				
	Operating Costs: Power		3,146	3,420	3,466	3,512	3,559	3,607	3,655	3,704	3,754	3,804	3,855	3,907	3,959	4,012	4,066	4,121	4,176	4,232	4,288	4,346	4,404
	Other O & M		105,400	106,454	107,519	108,594	109,680	110,776	111,884	113,003	114,133	115,274	116,427	117,591	118,767	119,955	121,155	122,366	123,590	124,826	126,074	127,335	128,608
Low Pressure Pumping	Capital Costs:		5,722,874																				
	Operating Costs: Power		4,194	4,560	4,621	4,683	4,746	4,809	4,874	4,939	5,005	5,072	5,140	5,209	5,279	5,350	5,421	5,494	5,568	5,642	5,718	5,795	5,872
	Other O & M		63,150	63,782	64,419	65,064	65,714	66,371	67,035	67,705	68,382	69,066	69,757	70,454	71,159	71,871	72,589	73,315	74,048	74,789	75,537	76,292	77,055
Vacuum Sewerage	Capital Costs:		6,015,420																				
	Operating Costs: Power		5,662	6,156	6,238	6,322	6,407	6,493	6,580	6,668	6,757	6,848	6,939	7,032	7,127	7,222	7,319	7,417	7,516	7,617	7,719	7,823	7,927
	Other O & M		95,200	96,152	97,114	98,085	99,066	100,056	101,057	102,067	103,088	104,119	105,160	106,212	107,274	108,346	109,430	110,524	111,629	112,746	113,873	115,012	116,162

Broadwater Concept Sewer Designs Continued
Net Present Value for Collection and Transportation Options (includes costs associated with transport to EHSTP)

Note: It is assumed that the Sugar Mill cogeneration plant will come into operation in year 1
It is assumed operating and maintenance costs will increase by 1% pa in line with assumed population growth

				21	22	23	24	25
				992	1005	1019	1032	1046
Conventional Gravity	Capital Costs:							
	Operating Costs:		Power	4,017	4,071	4,125	4,181	4,237
			Other O & M	103,274	104,307	105,350	106,404	107,468
		Total						
Modified Gravity	Capital Costs:							
	Operating Costs:		Power	4,463	4,523	4,584	4,645	4,707
			Other O & M	129,894	131,193	132,505	133,830	135,168
		Total						
Low Pressure Pumping	Capital Costs:							
	Operating Costs:		Power	5,951	6,031	6,111	6,193	6,276
			Other O & M	77,826	78,604	79,390	80,184	80,986
		Total						
Vacuum Sewerage	Capital Costs:							
	Operating Costs:		Power	8,034	8,141	8,250	8,361	8,473
			Other O & M	117,324	118,497	119,682	120,879	122,088
		Total						