Tweed Shire Council

Tweed Shire Council
Recycled Water Opportunities
Concept Designs

Final Report

February 2006

MWH

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Tweed Shire Council

Recycled Water Opportunities Concept Design Final Report

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Glossary

DEUS	Department of Energy Utilities and Sustainability (NSW)
DIPNR	Department of Infrastructure Planning and Natural Resources (NSW)
DoH	Department of Health (NSW)
EIS	Environmental Impact Statement (under the Environmental Planning & Assessment Act, 1979)
EP	Equivalent Population (as in the capacity of an STP)
EPA	Environment Protection Authority (NSW)
DEC	Department of Environment and Conservation (NSW)
KL	Kilolitre (1000 litres)
LEP	Local Environmental Plan (of TSC)
ML	Megalitre (1 million litres)
NPV	Net Present Value
NSW	New South Wales
STP	Sewage Treatment Plant
TSC	Tweed Shire Council

Executive Summary

Background and Project Drivers

This report provides an outline of the options and costs for recycled water supply from several different Sewage Treatment Plants (STP) which are operated by Tweed Shire Council, (TSC). These include the Kingscliff STP, Banora Point STP, Uki STP, Hastings Point STP and Tyalgum STP. Potential recycled water sites include a memorial gardens, various parks and sporting fields, a private golf course, a Ti-tree farm, a turf farm and a plant nursery. This report provides concept designs of various options and demonstrates the technical feasibility of recycled water supply for irrigation on these various public and private sites.

The key driver for this project is the NSW EPA endorsement of the TSC Recycled Water Strategies:

- NSW EPA has recommended that beneficial recycled water reuse from Sewage Treatment Plants be maximised to reduce disposal of nutrients into the waterways.
- TSC is committed to extending its drinking water supplies by substituting potable water where it is used for irrigation purposes.

The progressive implementation of recycled water will have clear environmental benefits including reduction in nutrient loads and other pollutants currently discharged to Tweed River. Future effluent water quality license requirements set by the EPA for discharges to Tweed River may depend on the extent of recycled water achieved and the resultant reduction in pollutant loads on the river.

The key findings of this study as detailed in this report are summarized below.

Proposed Recycled Water Customers

Should all the irrigation options examined under these recycled water schemes be implemented as outlined in this report, approximately 2150 ML/Year of recycled water would be utilised for irrigation of TSC's parks, reserves and by private land owners. This will have a major impact in reducing the effluent discharge loading to the Tweed River. There also would be indirect benefits including the reduction in potable water, abstraction from boreholes or ground water as a private irrigation source.

Recycled Water Pipeline Alignment Options

The construction of new recycled water pipelines along road reserves would be reasonably straightforward. There would be added costs (compared with a rural route) associated with locating and avoiding (eg. by boring under) various services (water, sewer, power, etc), sensitive vegetation, river crossings and running some sections of the pipelines under road pavement.

Recycled Water Demands

The capacity of the recycled pipeline network and pipe diameters are critically dependent on the assumed peak water demands. Peak water demand is dictated by:

- peak irrigation demand and area under irrigation on each irrigation site during hot and dry periods;

- limited hours of watering determined by 4 hour public access withholding period as specified in NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*.

Maximum irrigation demand can be as high as 10mm/day during heat wave periods but this is only likely to occur for a few days each year. Using such a higher rate for design purposes is not considered cost effective for pipeline design because it would result in significant increase in pipe size/capacity and therefore cost. This higher cost would be only to meet the highest demands occurring only for a few days each year. On such days it is suggested that a shortfall in the irrigation should occur and other measures be put in place, e.g. maximum irrigation before and after the dry period.

Extended dry periods in this sub-tropical location tend to occur in the cooler winter and early spring. Therefore, a more conservative 5mm/day was assumed for concept design purposes, as well as 100% of all parks watered concurrently during the hot/dry periods. This is consistent with a previous assessment of existing irrigation water use data (potable and bore water) at each of TSC's parks and reserves as well as private customers.

Recycled Water Scheme Options

The assessment of recycled water schemes examines three key options. The feasibility of each option has been investigated with regard to each of the proposed irrigation sites.

1. **Option 1** – The irrigation system will be directly fed by a pumping station located at the source treatment works. This could be from modification to existing outfall or by the construction of new purpose built irrigation pumping station. The pumps and pipes will be sized to deliver the required flows at the necessary heads and velocities to ensure efficient operation of the irrigation system. Where ever possible this is the preferred method
2. **Option 2** - The irrigation system will be fed using an on site irrigation pumping station. The pumping station will be fed from the source works, if possible by gravity or from an existing pumped main. If this can not be achieved and a new pumping station is required at the source works, then this is not a viable option. The pumps and pipes will be sized to deliver the required flows at the necessary heads and velocities to ensure efficient operation of the irrigation sprinklers. This is only an option if there is no need to double pump (e.g. fed is from an existing outfall main)
3. **Option 3** - A full day's irrigation will be stored below ground in a circular reinforced concrete tank unless otherwise stated. The tank will be fed from the source work by gravity if possible otherwise from a pumped main. The irrigation pumps will be housed within the storage tank and will be sized to deliver the required flows at the necessary heads and velocities to ensure efficient operation of the irrigation sprinklers. Storage is required on some sites due to insufficient effluent discharge from the source STP.

Pipeline Sizes

The pipelines have been sized for limited friction losses within the pipe whilst keeping velocities to a minimum of 1m/s to allow for self-cleansing. As different sites have different flow requirements there are various pipe diameters (from 100mm at Hastings Point Rugby Club to 300mm for the feed to the Chinderah Golf Course.) The model has used PVC pipes and actual internal pipe diameters.

Pump Station Options

Where possible the existing outfall pumping station will be used directly to source the irrigation requirements. If this is not feasible then an on site, irrigation pumping station will be used. Where sites require storage, the irrigation pumps will be housed within the tanks.

At the new Kingscliff STP two separate pumping stations on the site of the treatment plant are proposed for feeding the Chinderah Golf Course and Ti Tree Plantation. Inline flow meters will be used to record and control the flows to each of the sites.

At Uki recycled water can be pumped directly from the existing 10 ML on site storage dam to an existing irrigation system for the nursery. An existing pump station and rising main are in place to feed recycled water to several Eucalyptus tree plantations on the site. A new rising main can be branched off the existing rising main to feed the proposed recycled water to the existing irrigation system for the nursery.

For Tyalgum there again already exists a pump station and some irrigation mains for current open field irrigation. Calculations confirm this pump station can be reused for the new type of irrigation for the eucalyptus trees, albeit at different times and lengths. Some of the existing distribution mains can also be reused but not all due to inappropriate layout.

Recycled Water Storage Options

Banora Point Schemes
As the outfall main from Banora Point is gravity, except at high tides, storage will be required at both the proposed irrigation sites, Arkinstall Park and Tweed Heads South Cemetery. It is proposed to fill the Cemetery storage tank by tapping into the existing outfall main upstream of the online booster pumps and then use the Cemetery irrigation pumps to fill the storage tank at Arkinstall Park when they are not irrigating.

It was noted at the Review Meeting (8 February 2006) that the Outfall Main could be modified to act as the storage for irrigation requirements at both Arkinstall Park and the Memorial Gardens. This would remove the need for any storage at either site and utilise the existing final effluent lagoon. The proposal would guarantee that the existing outfall main would always be full therefore ensuring a constant final effluent supply. The option could bring significant cost savings but if this proposal were to be accepted and taken to a concept design stage, a more detailed analysis of the outfall main configuration and operation would need undertaken. Until this is undertaken no guarantees can be given as to its validity.

Hastings Point Schemes
Approximately 80% of the outfall flows from Hastings Point STP may be utilised to meet the irrigation requirements. Therefore to meet all the irrigation requirements storage will be required. It is proposed to use the existing final effluent lagoon at Hastings Point STP as the source for the irrigation. One irrigation pumping station sized to deliver all the flows to the 3 proposed sites and will be constructed at Hastings Point STP. Controls will be used to ensure only one site is irrigated at a time. If no sites are irrigation then the outfall main will operate as normal.

Kingscliff Schemes
The outflows from the new Kingscliff STP at present are insufficient to provide all the irrigation requirements for both the Ti Tree Plantation and the Golf Course. This may change as the population increases. In addition the requirements of the Ti Tree Plantation exceed the outflows from the STP. Therefore, it is proposed at present

to provide final recycled water for irrigation purposes to the Golf Course only. Also it was noted in the Kingscliff Recycled Water Scheme 1 Concept Design that a balancing tank would be required to prevent excessive draw down of the chlorine contact tanks. This is still the case.

Uki and Tyalgum Schemes
Uki and Tyalgum both have existing storage dams onsite that are more than adequate for the reuse needs.

Cost Assessment

The indicative capital cost estimate for the preferred options are detailed below:

Table ES-1 TSC Recycled Water Opportunities Preferred Option Costs

OPTION	Best Case	Medium Case	Worst Case
Table B1 - Cost Estimate Arkinstall Municipal Park (Banora Point)			
Preferred Option Sub-surface Irrigation and ½ Day Storage Tank	$ 1,225,000	$ 1,629,000	$ 2,041,000
Table B2 - Cost Estimate Tweed Head Cemetery (Banora Point)			
Preferred Option Surface Irrigation and Full Day Storage within pump station wet well	$ 398,000	$ 524,000	$ 667,000
Table B6 - Cost Estimate for Combined Storage (Hastings Point)			
Preferred Option Sub-surface Irrigation and Day Storage Tank at Hastings Point STP	$ 2,424,000	$ 3,117,000	$ 3,803,000
Table B7 - Cost Estimate for Ti Tree Plantation (Kingscliff)			
Without Irrigation or Storage (**NOTE**: Landowner does not want Final Recycled water Irrigation)	N/A	N/A	N/A
Table B8 - Cost Estimate for the Golf Course (Kingscliff)			
Total for scheme Without Irrigation or Storage	$ 336,000	$ 420,000	$ 524,000
Table B9 - Cost Estimate for Uki Nursery			
Total for scheme New Pump Station plus Rising Main	$ 35,000	$ 48,000	$ 62,000
Table B10 - Cost Estimate for Tyalgum			
Total for scheme new surface irrigation system	$ 122,000	$ 163,000	$ 197,000
PROPOSED SOLUTION TOTAL COST	**$ 4,540,000**	**$ 5,901,000**	**$ 7,281,000**

Preferred Option Scope of Works:

Banora Point:

Banora Point, Arkinstall Municipal Oval - Subsurface Irrigation, on site Storage and on site Irrigation Pumping Station and Rising Main
Banora Point, Tweed Heads Cemetery - Surface Irrigation, on site Storage and on site Irrigation Pumping Station and Rising Main

Hastings Point

Hastings Point – Combined storage for the 3 proposed irrigation sites on site at Hastings Point STP and new dedicated irrigation pumping station.
Rugby Club - Subsurface Irrigation
Barry Sheppard Oval and Round Mountain Pony Club - Subsurface Irrigation
Turf Farm – Direct supply

Kingscliff

Kingscliff, Chinderah Ti Tree Plantation - Nothing
Kingscliff, Chinderah Golf Course - Irrigation PS & RM

Uki

Uki, Nursery – direct pump utilising a branch off the existing pump station and rising main to existing nursery irrigation from existing storage dam.

Tyalgum

Tyalgum – reuse existing pump station and some of the feed pipelines for new surface irrigation similar in design to UKI recycled water scheme on Eucalyptus Tree plantations.

The costs for the storage and irrigation systems are not included for Chinderah Golf Course and the Ti Tree Plantation as their need is for a supply only.

The preliminary estimated costs quoted in this report are indicative for the purposes of comparing scheme options based on concept designs outlined in this report. They are sufficiently accurate for these stated purposes. However, depending on the order of accuracy required and amount of contingency to be included, functional designs or detailed designs are required if cost estimates are to be used for accurate budgeting purposes.

Triple Bottom Line Considerations

The key common advantages and disadvantages of all options include:

Advantages

- Social — Greening and drought proofing of TSC parks. And recreational areas
- Economic — Lower cost of recycled water supply compared with existing potable supply. Savings for TSC & other customers, and possible new income stream for TSC.
- Environmental — Reduced discharges to Tweed River and reduced environmental impacts on estuarine ecosystem.
  Reduced potable water use.

Disadvantages

- Social — Site access restrictions to public parks and reserves to avoid exposure to recycled water. Adverse public perceptions (health and aesthetic concerns) to recycled water irrigation and/or storage at these public reserves. Although these are removed if subsurface irrigation is used
- Economic — High capital expenditure for low used flow volumes.

- Environmental Possible high watertable, salinity and waterlogging issues at recycled water sites.

Recommendations

The next steps recommended in the Implementation Strategy as outlined in this report include further concept designs, engineering, planning, environmental, social and economic investigations and consultations. Completion of such investigations should include pre-consultation with NSW EPA (now incorporated into DEC) and other relevant regulatory authorities, as well as pre-consultation with the local community (including residents, parks user, sports clubs, etc).

TSC will need to educate the local community (including residents, sports clubs and park users) about recycled water use and erect warning signs to ensure restricted access during irrigation and the 4 hour withholding period to prevent exposure of humans to recycled water. If the public access cannot be effectively restricted, then TSC will need to consider higher levels of treatment and disinfection of the recycled water to enable unrestricted irrigation uses on the parks and reserves or utilise subsurface irrigation methods. The costs estimated in this report do not include costs of higher level of treatment, which would need to include tertiary treatment and filtration (eg. filter or membranes, and higher levels of disinfection). Costs of this higher level of treatment in the long term can be of the order $1000/ML.

All the above options were discussed at a Review Meeting with Tweed Shire Council on Wednesday, 8th February 2006, (see Appendix I), with the aim of identifying the preferred options to highlight in the final version of this report. The priority for each option is outlined in Appendix J.

1. Introduction

1.1 Background and Key Project Drivers

Tweed Shire Council ("TSC") is proactively planning for the supply of recycled water to several sites, using effluent from several the Treatment Plants (STP) under the Council's control. The STPs being addressed for possible reuse options include the Banora Point STP, Hastings point STP, Uki STP, Tyalgum STP and Kingscliff STP. The Kingscliff STP reuse options were investigated in the 'Kingsclif Recycled Water Scheme Stage 1 – Concept Design report, conducted by MWH in April 2005. The Kingscliff STP is currently being relocated with a new plant being built on a new site further away from local residents. Whilst the April 2005 report did take into account the new STP, it was based on a concept design. Therefore this report re-addresses the Kingscliff option, taking into account the actual proposed design of the plant currently under construction.

The potential reuse sites include,

- the Tweed Heads Crematorium and Memorial Gardens and Arkinstall Park sports fields for Banora Point STP;
- a nearby Ti Tree Plantation and the Chinderah Golf Course, both privately owned and operated for Kingscliff STP;
- a Pony Club and Barry Shepherd Oval, the Bogangar Rugby field and a Turf Farm for Hastings Point STP;
- a further potential reuse opportunity on a nearby Council run nursery for Uki STP, already currently recycling wastewater for use on Eucalyptus trees for the Currumbin Wildlife Sanctuary;
- a further site for Eucalyptus trees for the Currumbin Wildlife Sanctuary for Tyalgum STP, which currently reuses recycled water to irrigate surrounding fields via large surface spray sprinklers.

With the rapid increase in population occurring in the Tweed Shire, there is expected to be a commensurate increase in demand on the potable supply system, resulting in the need for major expansion in water supply infrastructure. Recycled water use will have a number of important water conservation and sustainability benefits, the key ones being:

1. Substitution of potable water currently used for irrigating TSC's parks and reserves;
2. Easing of peak demands on Tweed's potable water supply, particularly during the winter (irrigation) season;
3. Reduction in groundwater abstraction by private landowners;
4. Economic benefits through stimulation of development, irrigated agriculture and possibly industry through the availability of a reliable recycled water supply for restricted (non-potable) uses.
5. Redirection of the nutrient loads from discharging effluent into the Tweed River to beneficial application of irrigated pasture / crops. Recycled water schemes for Uki and Tyalgum will reduce the risks of contamination in the water supply catchments.

A key driver for this project is the NSW EPA endorsement of Tweed Shire Council's Recycled Water Strategy. This included a part of the basis of the NSW government approval of the proposed new Kingscliff STP. In their letter in January 2003, NSW EPA (now incorporated into DEC) stated their endorsement of the Recycled Water Strategy and recommended that Tweed Shire Council maximise recycled water and replace current potable water irrigation uses on Public Open Space. The EPA letter also indicates that future effluent quality

requirements for Tweed STP discharges to the Tweed River and other discharge locations will depend on the extent of recycled water achieved and the resultant reduction in pollutant load on the river.

This report outlines the options assessment and conceptual design and costs of recycled water supply from the relocated Kingscliff, and the existing Banora Point, Hastings Point, Uki and Tyalgum STP, to numerous sites in Tweed Shire, including private customers. The purpose of this report is to illustrate the feasibility and benefits of recycled water supply infrastructure enabling about 1800 ML/Yr recycled water use to irrigate TSC's sports and recreation fields parks and other amenities. At present not all sites have potable water irrigation so in most cases there will be no large net benefit to current potable water demands, however reductions in ground water abstractions is a possibility.

1.2 Report Scope

The scope for this Concept Design Study was outlined in MWH's proposal to TSC dated 13 September 2005. MWH's approach to this study has involved the following general tasks:

1. Review of background information including:
   - effluent management options outlined in the EIS for the new Kingscliff STP (GHD December 2002),
   - recycled water pumping options from MWH's Concept Design Report for Kingscliff STP (July 2004), and
   - other information provided by TSC and potential private recycled water customers;
2. Visits to the Tweed Shire Council study area and further consultations with TSC and potential private customers (various visits and discussion between August 2005 and January 2006);
3. Identifying recycled water pipeline route selection options between the various STP's and potential recycled water sites;
4. Recycled water pipeline sizing, and storage and pumping requirements from hydraulic modeling of peak and daily recycled water demands expected from the range of potential TSC and private recycled water sites;
5. Investigating alternative storage dams and/or tank sizing and siting options at the STP sites and/or at individual recycled water sites;
6. Preliminary capital cost estimates of new recycled water pipeline, pumping and storage infrastructure based on conceptual design and hydraulic modelling;
7. Recycled water quality issues and resultant irrigation design and public access restrictions according to NSW EPA and National guidelines to prevent exposure of humans to recycled water;
8. Indicative timelines for planning, design, approvals (EPA, TSC and others), construction (including consideration of constructability issues) and commissioning;
9. Preparation of a Draft Report of above investigations;
10. Presentation of the options and recommendations to TSC (Review Meeting on 8 February 2006);
11. Preparation of a Final Report incorporating the comments and feedback from TSC.

1.3 Extent of Field Investigations and Consultations

In early October 2005, area inspections of each site and surrounding environs were undertaken. The extent of the Study area included (also shown in Appendix A)

- current Kingscliff, Banora Point, Hastings Point, Uki and Tyalgum sewerage system and recycled water pipe routes;
- locations of sport and recreational fields and other open spaces for potential recycled water use;
- locations of potential recycled water storage tanks/dams near or at recycled water end-use sites;
- possible alternative routes for new recycled water pipelines in existing road reserves, starting from the proposed source STP, to the various proposed sites including the Chinderah Golf Course, and private sites such as the Hastings Point Turf Farm, the Chinderah Ti Tree Plantation and Uki Nursery.

An initial site visit was held on the 27th October 2005 that included onsite discussions with TSC parks and reserves operators. The purpose of these meetings and discussions was early engagement and capturing the local knowledge base of these experienced persons as well as to discuss the background information, options and potential cost savings for recycled water pipelines, pumping, storage, irrigation reuse, environmental and public health management.

Various other follow up discussions and information requests were made by further meetings on site and at council offices, telephone, correspondence and emails between October 2005 and January 2006.

A review workshop was conducted on Wednesday February 8th 2006 between Tweed Shire Council and MWH Gold Coast. This review meeting discussed the draft Recycled Water Opportunities Concept Design Report using a presentation format. The presentation for this workshop is in Appendix I.

2. Description of the Study Area

2.1 Location and Extent of the Study Area

Banora Point STP has a current catchment population of 42,500 and is expected to grow to 56,500 EP by the year 2015.
Hastings Point STP has a current catchment population of 12,000 and is expected to grow to 17,200 EP by the year 2015.
Kingscliff and surrounding areas (including Cudgen and South Kingscliff) are growing rapidly. The current sewage catchment population of the Kingscliff STP is over 10,000, and is expected to grow to around 40,000 equivalent population ("EP") by the year 2031.
Uki STP has a current catchment population of 400 and is expected to grow to 500 EP by the year 2015.
Tyalgum STP has a current catchment population of 300 and is expected to grow to 400 EP by the year 2015.

(Refer to Appendix A for location plans.)

NOTE: Figures taken from Sludge Production Spreadsheet (High Growth)

The study area for the purposes of this recycled water concept design report includes:

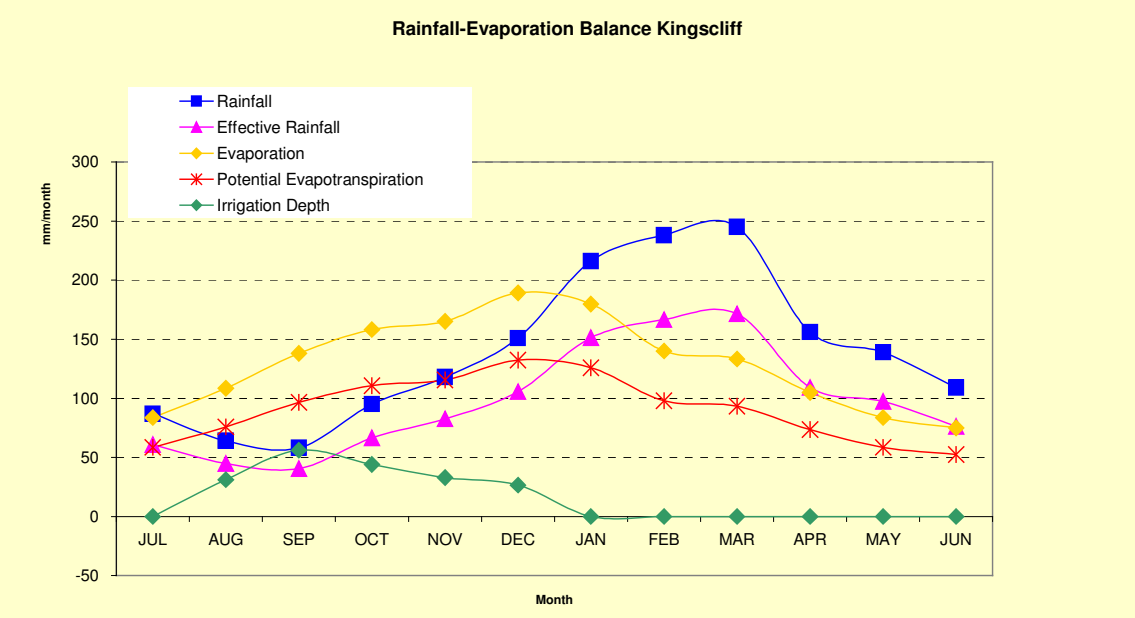
- Banora Point Sports and Recreation Field (TSC);
- Tweed Heads Cemetery (TSC);
- Barry Sheppard Oval and Pony Club (TSC);
- Hasting Point Rugby Club (TSC);
- Hastings Point Turf Farm (privately owned);
- Chinderah Golf Course (private ownership);
- Chinderah Ti Tree Plantation (private ownership);
- Uki Nursery (TSC);
- Tyalgum (TSC)

2.2 Climate and Irrigation Potential

Kingscliff, Hastings Point and Banora Point all experience a subtropical climate, with most of the annual rainfall occurring during the wet season (~70% between December and May). The wettest months are January to March, when ~40% of annual rainfall occurs. The Environmental Impact Assessment for the proposed relocated Kingscliff STP (GHD December 2002) indicated that the Kingscliff area experiences a high annual rainfall (average 1374 mm/yr, with an average of around 158 rain days per year). Recent Tweed Shire Council rainfall records indicate annual rainfall is about 1680 mm/yr in the Kingscliff coastal region.
Tyalgum and Uki are located further inland to the west from the coast. Data from the Bureau of Meteorology Tyalgum weather station indicates an average rainfall of 1555mm/year with an average of 115 rain days per year. Evaporation rate on average is 1088mm/year.

Kingscliff experiences high evaporation (~1560 mm/yr based on Bureau of Meteorology Alstonville station). Figure 2.1 illustrates the typical monthly rainfall and evaporation profile (in mm/month) throughout the year as well as irrigation demand (depth in mm/month) for warm season grasses based on potential monthly evapotranspiration (crop factor 0.7) minus effective monthly rainfall (roughly 70% of actual rainfall for grass).

Figure 2.1 Rainfall and Evaporation Profile for Kingscliff Area & Potential Irrigation Demand (mm/month)



Demand for irrigation water is obviously dependent on amount of rainfall and evaporation throughout the year. Based on potential evapotranspiration minus effective rainfall as per Figure 2.1 above, there is a relatively low irrigation demand of about 2 ML/Ha/Yr (compared with high demand further inland), particularly in the drier months between August/September through to December/January. The EIS for the proposed relocated Kingscliff STP (GHD December 2002) indicated irrigation demand of up to 5 ML/Ha/Yr for park and gardens, and 1.5 ML/Ha/Yr for sugar cane. A peak daily irrigation rate of 5 mm/day (or 50 KL/Ha/day) has been assumed in this report based on December/January potential evapotranspiration as per Figure 2.1.

Potable water use at the proposed irrigation sites was assessed by review of TSC's potable meter records for recent years – see Table 2.1. This provided some basis for determining annual irrigation rates for design of the recycled water irrigation scheme.

Table 2.1 Existing Potable Water Use at Proposed Irrigation Sites (Based on TSC Meter Readings)

Park/Reserve	Existing Area Irrigated	Annual Use #	Annual Use per area irrigated	
	Ha	ML/Yr	ML/Ha/Yr	mm/yr
Arkinstall Park (02/03)	0.15	10,129	67,530	6,753
Arkinstall Park (03/04)	0.15	13,890	92,600	9,260
Arkinstall Park (04/05)	0.15	4,479	29,860	2,986

Note to above table: # Water use would include some toilet/amenities usage (low in proportion to irrigation use).

Based on the climatic conditions, it is anticipated that the long term sustainable irrigation demand could range from 2 to 4 ML/Ha/Yr based on plant needs only. The lower irrigation demand rates are more appropriate for the sandy coastal/foreshore areas and cane growing areas, whilst the higher demand values may be needed

further inland (market gardens, tree plantations, etc). However, with the highly permeable sandy soils across the study area and expected seepage losses, irrigation demand may need to be as high as 4-6 ML/Ha/Yr. This is more consistent with existing irrigation water use on TSC's parks/reserves and previous recycled water irrigation investigations by TSC (eg. 1995 proposal for a turf farm at the existing Kingscliff STP).

2.3 Soil and Land Capability

Soils mapping (Morand, 1996) covers three of the five re-use areas (Banora Point, Hastings Point and Chinderah). This mapping forms the basis for determining the capability of soils for recycled water application at these sites.

The other two sites (Uki and Tyalgum) have had site specific studies. At Uki, a recycled water re-use study has already been undertaken by Agricultural Water Management (1998) whilst at Tyalgum, MWH undertook borehole descriptions and numerous samples were analysed for a range of soil parameters.

Prior to the implementation of any recycled water schemes in this study, a comprehensive soils investigation and analysis is required to confirm the absorptive capacities of the sites.

2.3.1 Banora Point Re-Use Areas

2.3.1.1 Arkinstall Park and Tweed Heads Memorial Garden

Arkinstall Park and the Memorial Gardens sites comprise 2 different soil types, as described by Morand, 1996. These are:

- Billinudgel (bi) – Cemetery ; and
- Kingscliff variant (kib) – Arkinstall Park.

Morand (1996) has described the Billinudgel soil as '…very low hills often forming footslopes with relief of 10-30 m and slopes up to 10%. Soils consist of deep moderately well drained Yellow Earths and Yellow Podzolic soils on the slopes and Red Podzolic soils on the crests'. Essentially, these soils have an increased clay content with depth and are well structured.

The Kingscliff (variant) soil type is described as level to gently undulating sand sheets and minor beach ridges of the inner barrier system. The topography is extremely low, level to gently undulating beach ridge plains and sand sheets. These soils nominally contain up to 30 cm of dark loamy sand (A1 horizon) overlying 150 cm of bleached sand (A2 horizon) and may contain cemented pans (coffee rock) at depth.

2.3.1.2 Limitations to recycled water application

The Billinudgel soil type has few limitations. These soils have high phosphorus sorption capacity (Critical P sorption capacity[1] of between 2,500 and 5,000 kg/Ha). In comparison, the Kingscliff (kib) soil type has many limitations. These soils are highly permeable with low p-sorption capacity (Critical P-Sorption capacity of @ 50 kg/Ha.). The capacity for phosphorus sorption is roughly 50 times less than the Billinudgel soil type. Additionally these soils have low available water holding capacity and there may be the presence of potential acid sulfate soils.

Cemetery appears to be Billinudgel type therefore there is no anticipated problems.

[1] P-Sorption figures are sourced from the NSW Effluent Irrigation Guidelines

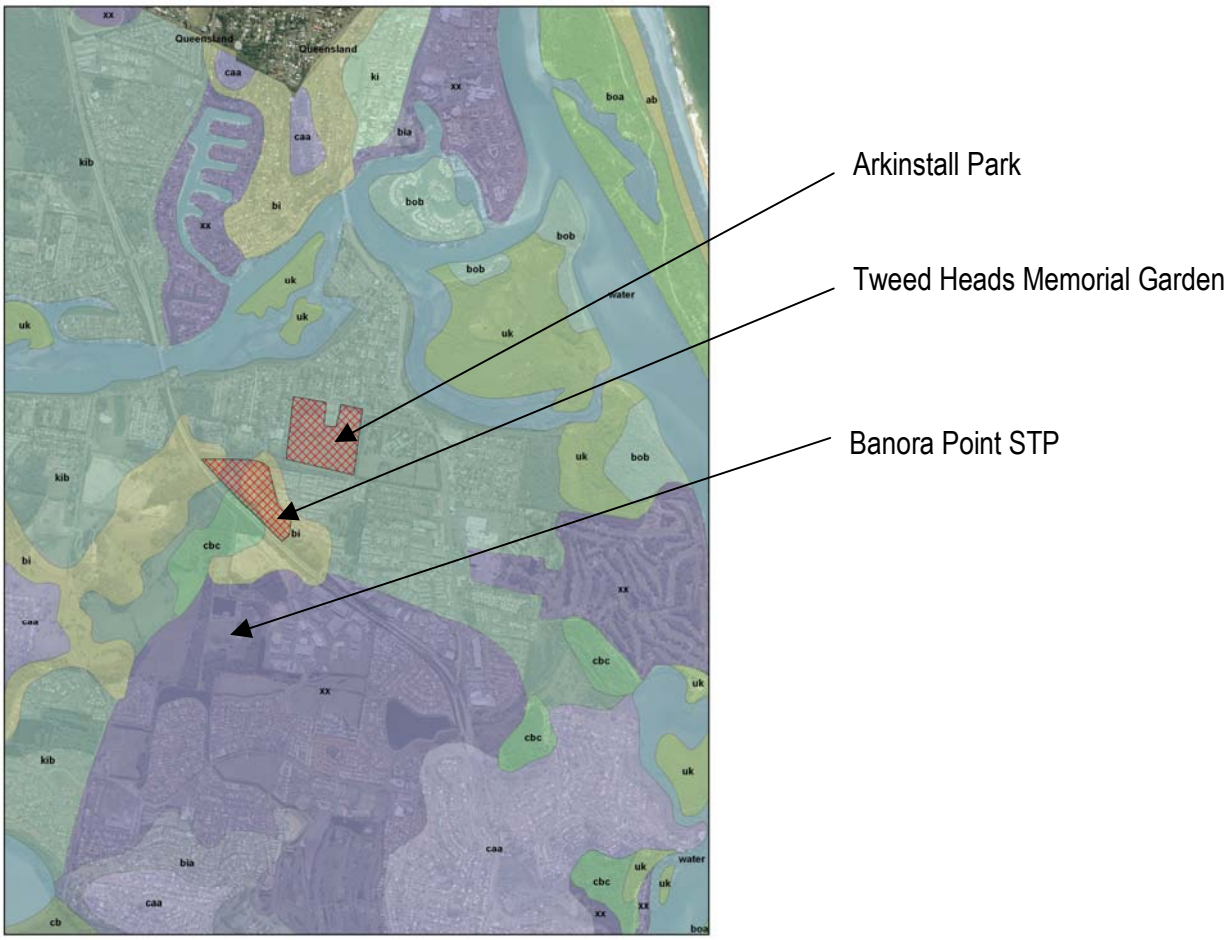


Figure 2-2 Banora Point Soils distribution

2.3.2 Hastings Point Re-use Area

2.3.2.1 Rugby Grounds, Pony Club and Turf Farm

The Hastings Point rugby grounds are situated on disturbed soils (xx). These soils are man made land varying from level plains to undulating terrain, which has been disturbed by human activity to a depth of at least 1 m. The soil may contain land-fill which includes soil, rock, building and waste material. The original soil would have been the Kingscliff soil landscape.

The Pony Club is situated on the Kingscliff soil landscape (ki) and consists of extremely low level to gently undulating Pleistocene sand sheets. The landscape is characterised by slopes of 0 – 2 %; elevation 1 – 5 m and local relief of 1 – 2 m. The original vegetation has been extensively cleared and now consists of disturbed open-heathland and forest.

The Hastings Point Turf Farm is located on the boundary between the soil landscape unit Kingscliff variant (kib) and Ophir Glen (og), with the vast majority of the land occurring on the Kingscliff variant. The Ophir Glen landscape is described as sheet flood fans, alluvial fans and valley in-fills which occur throughout the Burringbar

Hills. The landscape has elevations of 5 –50 m, local relief of less than 3m and slopes of 1 – 5 %. The vegetation is described as extensively cleared open-forest (wet sclerophyll).

2.3.2.2 Limitations to recycled water application

For the disturbed soil type, the limitations to recycled water application are dependent on the nature of the fill material. These limitations may include soil impermeability (leading to poor drainage), the presence of toxic materials and potential acid sulphate materials.

The limitations of the Kingscliff soil have already been elucidated. These are high permeability some localised waterlogging and some very localised occurrences of acid sulphate sands.

The limitations of the Ophir Glen soil type are essentially the same as the Kingscliff landscape These include waterlogging, high watertables, flood hazard, high run-on and water erosion hazard.

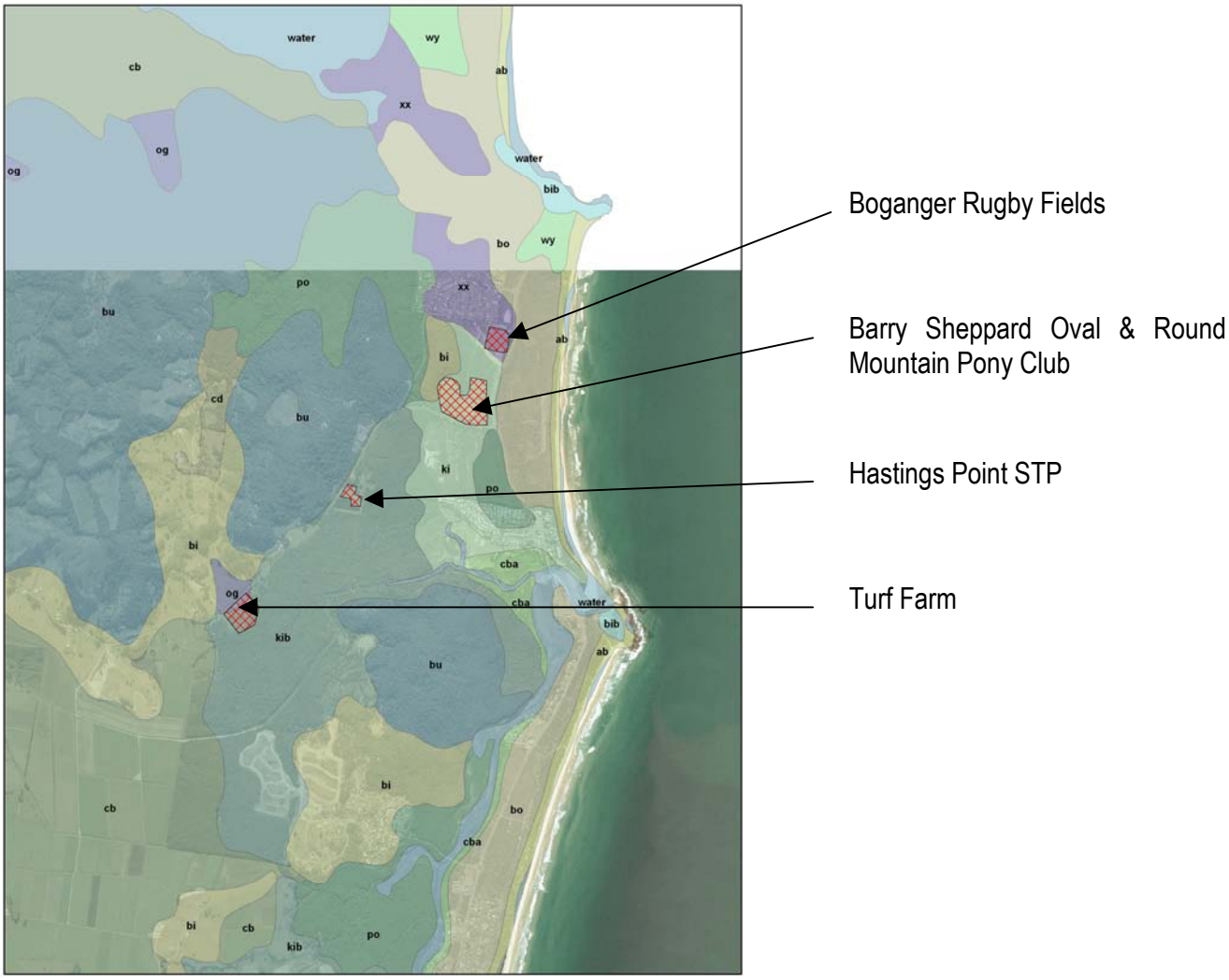


Figure 2-4 Hastings Point Soils Distribution

2.3.3 Chinderah Re-Use Area

2.3.3.1 Chinderah Golf Club and Chinderah Ti-Tree Plantation

The Chinderah Golf Course is situated on the Tweed River floodplain and the topography is mostly flat and low lying. The soil type is described as Tweed - Landscape Variant (twb). These soils are described as poorly drained Humic Gleys, which are moderately deep. Essentially, these soils contain water in the major part of the profile for a period greater than 3 months of the year.

The Chinderah Ti-tree plantation is also located on the Tweed floodplain. The site is mapped as Tweed (Tw) and also Tw (b). The Tweed soil type is described as an extensive marine plain consisting of deep Quaternary alluvium and estuarine sediments. The tweed landscape variant unit has been previously described

2.3.3.2 Limitations to recycled water application

The Tweed landscape unit has numerous limitations for recycled water application These limitations include high watertables, waterlogging, the extensive occurrence of potential acid sulfate soils and impermeable soils. The p-sorption capacity of this soil type is likely to be low[2].

With potential acid sulphate soils present across the area, excavation works (ie. for pipe trenches, pump sumps, dams, etc) will require acid sulphate management measures for protection of steel and concrete fittings and structures. High watertables present some risks for irrigation, underground storage and pipe construction.

[2] No estimation has been given for these soil types in the NSW Effluent Irrigation Guidelines

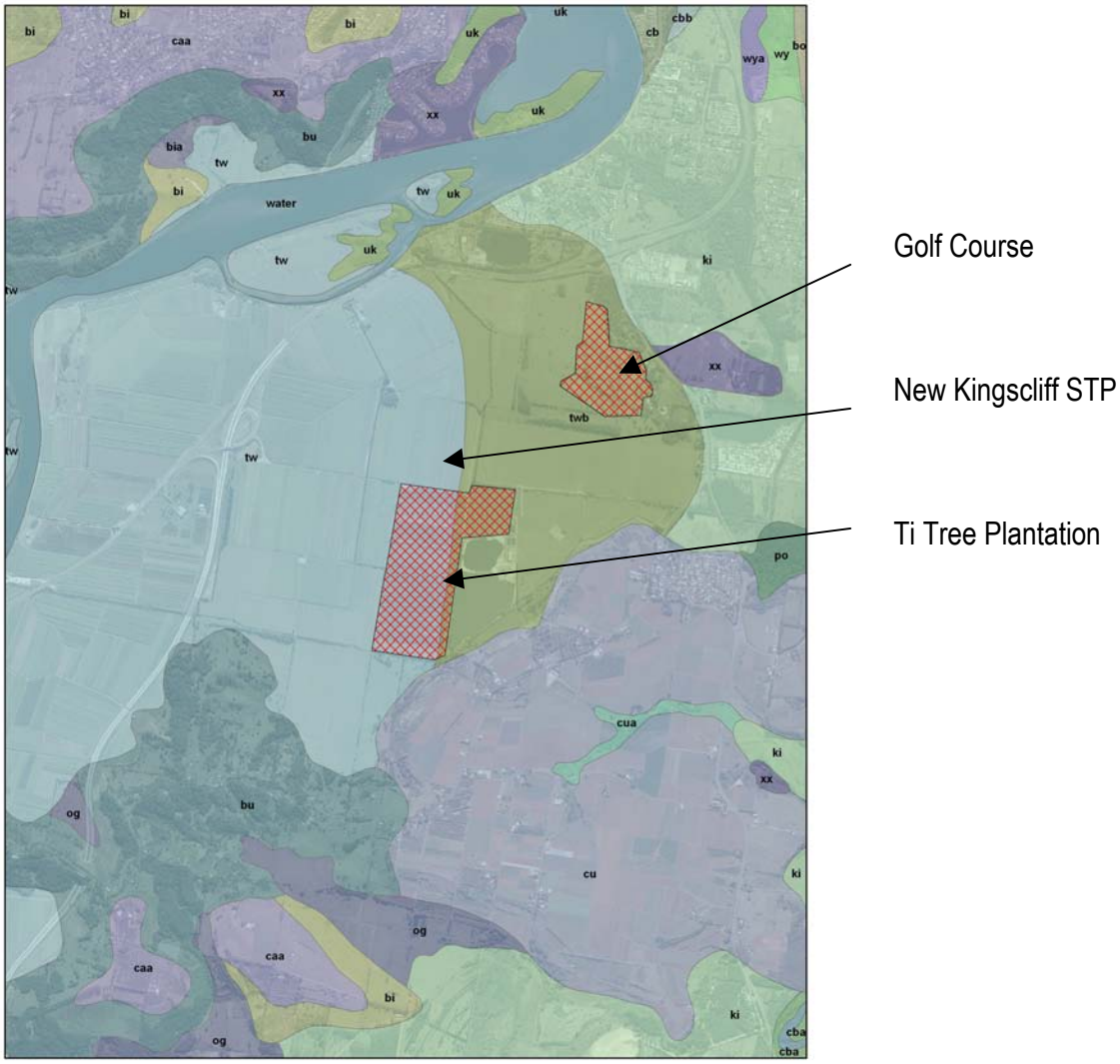


Figure 2-3 Chinderah Soils distribution

2.3.4 Uki Re-Use Area

The proposed recycled water scheme at Uki is to irrigate plants within pots at the nursery. However these pots are located outside in open air and hence there may be an issue with run-off from excess recycled water. The soils have been described in this area in the Uki Effluent Re-Use study (From Agricultural Water Management Study 1998). These are essentially the same as the Burringbar landscape as described by Morand, 1996. These soils are located on rolling to steep hills on metamorphics of the Neranleigh-Fernvale Group. These soils range from red and yellow podzolics to red-earths. The phosphorus sorption capacities of these soils are high. From the re-use study it has been determined that it is unlikely that P will leach from the re-use area and enter groundwaters.

2.3.5 Tyalgum Re-Use Area

Marginally different soil types were encountered across the re-use area, with changes in pH with depth across the site. From an analysis of the soil characteristics, the main limitation to recycled water application is the Phosphorus sorption of the respective soils. These low sorption values may be due to the long term phosphorus loading the site has experienced. It is anticipated that conversion to eucalyptus tree plantations should aid in phosphorus sorption.

3. Background Information Review

3.1 Information Sources

Tweed Shire Council planning and engineering staff, as well as parks and reserves operators have supplied valuable background information and plans about the proposed Kingscliff STP and the existing STPs at Banora Point, Hastings Point, Uki and Tyalgum along with associated sewerage infrastructure. Chinderah Golf Course manager (Jeff Holloway) also provided valuable information about current and future golf course proposals, including a proposed new storage dam and expanded golf course. TSC, Jeff Holloway as well as local land developers possess a great amount of documented information as well as extensive local knowledge about the local water systems and other infrastructure, land uses, soil/land capability, future development and recycled water use opportunities. It is important that the extensive information and local knowledge base of these organisations, developers and individuals be tapped for detailed investigations.

3.2 Tweed Shire Council

TSC planners and engineers have provided MWH with current land use and infrastructure maps, future development maps (including the Gales Holdings Local Structure Plan for Kingscliff, Chinderah and Cudgen), and various background study reports to the "Tweed Futures" (2004) and Tweed Coast Strategy (2003), and a prior MWH report into the reuse opportunities for the Kingscliff STP.

TSC has also provided meter readings for current potable water volumes used at the proposed irrigation sites, including areas under irrigation and methods of irrigation. Previous recycled water studies for Kingscliff and Tumbulgum were also provided to MWH as follows:

- TSC Environmental Impact Statement: Proposed Disposal of Effluent and Biosolids by Application to Turf. Chinderah Sewage Treatment Works (MFA Consulting Engineers 1994-1995); and
- Tumbulgum Effluent Irrigation Investigation (Agricultural Water Management, 1998).

To determine the planning and development context for this recycled water concept design study, MWH has also reviewed various planning documents and instruments from TSC's Planning Service website including:

- Tweed Local Environmental Plan (LEP, 2000), and proposed Amendment (No.21) to the Tweed LEP;
- Various Development Control Plans (DCP) and Plans of Management including for Kingscliff, West Kingscliff, South Kingscliff, etc;
- Tweed Shire Open Space Infrastructure Policy (2002);
- Vegetation management plans including lists and maps of rare and significant trees and other vegetation on TSC's recreational reserves.

3.3 EIS for the Kingscliff Treatment Plant Relocation

TSC has also provided details of the EIS for the proposed relocation of the Kingscliff Sewage Treatment Plant. This EIS was prepared by GHD (December 2002) and contains a broad assessment of effluent management options based on previous studies and included a proposed strategy for development of reuse (within 3-4 km)

from the relocated STP. This EIS refers to the need for assessment of recycled water proposals for any future Development Application under the EP&A Act 1979.

This Recycled Water Concept Design Study further explores some of the recycled water opportunities identified in the EIS with a focus on Kingscliff's parks and foreshore reserves as Stage 1. This Concept Design report is intended to assist TSC with any future Development Application for a new recycled water scheme for Kingscliff.

3.4 Works Information

Tweed Shire Council provided detailed flow and sampling records for each sewage treatment plant in the study. Although every care has been taken to ensure the information below is correct there was insufficient time for a detailed analysis of the data. Therefore, there can be no guarantee to the accuracy of the information below. Once a preferred solution has been selected a more in depth analysis should be undertaken particularly with regards to diurnal flows.

3.5 Banora Point STP

Data received from TSC on Daily incoming flows to the STP dating from 1992 to the present day indicate the following.

- Average daily flow of 9.674 ML/day. After analysis of the data it should be noted that average flows are increasing, as for 2004 the Average is 11.95 ML/day and 2005 the figure stands at 11.92 ML/day.
- Maximum flow entering the works over the same period is 69.2 ML/day although this is rain affected with over 250 mm of rain falling on the day. Other rain affected days exist when flows are over 40 ML/day so this data would appear accurate although extreme flows such as these are infrequent.
- Minimum flow entering the works over the same period is 0.005 ML/day. This result is suspect, after analysis of the date a more realistic but still conservative figure would be 5 ML/day.

Areas already supplied by Banora Point STP:

- Banora Point Golf Course are consented to take up to 2 ML/day. The records show they have been receiving flows since May 2003.
- Average daily usage by the golf club is 0.62 ML/day
- Maximum daily usage is 6.29 ML/day. This exceeds the license and contradicts the information received from the Golf Course, which states that the maximum daily flow they receive is in the region of 1.2 ML/day.
- Minimum daily usage is 0 ML/day

Irrigation requirements for each area has been solely based on 50KL/hectare (5mm Rainfall). Areas for potential reuse to be supplied by Banora Point STP include:

- Tweed Heads Cemetery (0.1 ML/day);
- Recreation Fields (0.58 ML/day).

3.6 Hastings Point STP

Data received from Tweed Shire Council on Daily flows to the STP dating from 1992 to the present day indicate the following.

- Average daily flow of 1.563 ML/day.

- Maximum flow entering the works over the same period is 11.681 ML/day (The maximum flow figure is rain affected.)
- Minimum flow entering the works over the same period is 0.600 ML/day.

As the majority of the flow data predates the new STP a more accurate average for the daily flow will be attained if just the data for 2005 is used.

- Average daily flow of 2.524 ML/day.
- Maximum flow entering the works over the same period is 11.681 ML/day (The maximum flow figure is rain affected.)
- Minimum flow entering the works over the same period is 1.897 ML/day.

Irrigation requirements for each area has been solely based on 50 KL/hectare (5 mm Rainfall). Areas for potential reuse to be supplied by Hastings Point STP include:

- Rugby Club (0.15 ML/day);
- Barry Sheppard Oval and Round Mountain Pony Club (0.6 ML/day);
- Turf Farm (0.275 ML/day). Although after site visit they have requested 1 ML/day

3.7 Kingscliff STP

In July 2004, MWH prepared a Concept Design Report for TSC for the proposed relocated Kingscliff STP. That STP Concept Design report provides valuable background in terms of future sewage flows, possible STP site layout, recycled water pump station sizing, outfall pipeline alignment, local soil and groundwater conditions, etc.

Since the concept design report by MWH, GHD has completed the Detailed Design. TSC have provided updated site layout plans (showing revised location of recycled water pump stations and outfall pipelines) and STP inflow projections for the proposed new Kingscliff STP.

Data taken from the Environmental Impact Statement for the existing Kingscliff STP covers 1992 to the present day and indicates the following.

- Average daily flow of 2.12 ML/day.
- Maximum flow entering the works over the same period is 15.70 ML/day. (The maximum flow figure is rain affected.)
- Minimum flow entering the works over the same period is 0.13 ML/day. This result is suspect, after analysis of the date a more realistic but still conservative figure would be 0.5 ML/day.

Irrigation requirements for each area has been solely based on a maximum required flow of 50KL/hectare (5 mm Rainfall). Areas for potential reuse to be supplied by Kingscliff STP include:

- Chinderah Golf Course(1.1 ML/day);
- Ti Tree Farm (2.6 ML/day).

3.8 Uki STP

Data received from TSC with regards the daily flows to the Uki STP beginning on 1st July 2004 through to the present indicate the following

- Average daily flow of approximately 33 KL.
- Minimum daily flow recorded of 22 KL

- Maximum daily flow recorded of 751 KL, although this was an anomaly that occurred after a heavy rainfall, indicating flow to the works is heavily influenced by local rainfall and runoff.

Due to the small size of the catchment area and the treatment plant, fluctuations occur on a daily basis. Note that this is only taking into account the flows from 2005 as there was an obvious gradual increase in flows over the final 6 months of 2004, from an average of 14 KL to 25 KL, possibly due to an increase in the population connected to the works.

3.9 Tyalgum STP

Data received from the TSC with regards the daily flows to the Tyalgum STP began in 1995. However, more extensive testing and recording began in January 2003. From January 2003 to the present the flows have remained relatively constant. Therefore for the purposes of this report only the data from January 2003 to the present will be considered. This data indicates the following

- Average daily flow of approximately 50 KL
- Minimum daily flow recorded of 32 KL
- Maximum daily flow of 352 KL, although this was an anomaly that occurred after a heavy rainfall, indicating flow to the works is heavily influenced by local rainfall and runoff.

Again as per Uki, due to the small size of the catchment and the treatment plant fluctuations occur on a daily basis.

4. Proposed Recycled Water Customers

4.1 Proposed Recycled Water Irrigation Sites

The proposed recycled water customers are as follows:

- Banora Point STP – Arkinstall Park Municipal Oval(TSC);
- Banora Point STP – Tweed Heads Cemetery (TSC);
- Hastings Point STP – Barry Sheppard Oval and Pony Club (TSC);
- Hastings Point STP – Rugby Club (TSC);
- Hastings Point STP – Turf Farm (privately owned);
- Kingscliff STP – Chinderah Golf Course (private ownership);
- Kingscliff STP – Chinderah Ti Tree Plantation (private ownership);
- Uki STP – Nursery (TSC);
- Tyalgum STP – Currumbin Wildlife Sanctuary Eucalyptus Tree Plantation

4.2 Description of Recycled Water Irrigation Sites

Appendix 1 of the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation,* indicate that for urban areas with controlled public access irrigation is required to be performed during times of no public access. A withholding period of 4 hours or until irrigated area is dry is required before public access is allowed.

After discussions with TSC, the parks, gardens and nurseries require a restricted/controlled access status. Therefore, any above ground irrigation would need to be at night allowing for a 4 hour drying off period. The irrigation time would be for 4 hours between 2300 and 0300. Signage would need to be displayed stating the necessary risk to public health of recycled water for irrigation.

Should subsurface irrigation be employed the problems of contamination of the surface and possible health risks to the public are removed. Hence subsurface irrigation can be performed at any time of the day or night. This provides an advantage in that it can reduce the storage on site, by allowing the storage tank to be refilled and emptied numerous times in a 24 hour period instead of once.

Note that the aerial photographs provided by TSC were of low resolution and there has been no other detailed survey. All the sites should be subject to a detail feature and vegetation survey prior to any detailed design of the recycled water scheme and any new irrigation development. This should be undertaken to accurately determine the total areas, location of natural and manmade features to be avoided, and available open space areas for recycled water irrigation and the required setbacks.

Brief discussion of each irrigation site is given in the subsections to follow, with Recycled Water Site Summary Sheets for each potential irrigation site given in Appendix C.

4.2.1 Banora Point – Arkinstall Park Municipal Oval

Arkinstall Park Municipal Oval is located within Tweed Head South to the east of the Tweed Heads Crematorium and Memorial Gardens. It is managed by TSC. The potential area for irrigation is the open space flat grassed area between Oxley Street and Sullivan Street covering approximately 11.6Ha.

The park is a public area and is used for many sporting activities ranging from football (soccer) to netball, tennis and softball.

Housing estates and four schools surround the Parks: Lindisfarne Anglican Primary School and High School and the Tweed Head South Public School and High School. The proximity of the schools may result in significant opposition, regarding the possible health risks involved with any above ground sprinkler irrigation. Access to the site is gained from Cunningham Street.

The estimated water demands for Arkinstall Park are shown in Table 4.1 for an assumed irrigation rate of 5 mm/day (or 50 KL/Ha/day) for hot/dry days. Predicted demands are critically dependent on this assumed daily irrigation rate and total area irrigated on that day. Peak demand (40.29 L/s) for Arkinstall Park is dependent on the assumed times of watering, which are also shown in Table 4.1.

Based on review of aerial photographs, site visits to pace the area the total available irrigation area for recycled water use at Arkinstall Park is roughly estimated to be between 11 and 12 Ha (assumed 11.6Ha).

4.2.2 Banora Point – Tweed Heads Crematorium and Memorial Gardens

The Tweed Heads Crematorium and Memorial Gardens are located on a hillside off Sunshine Avenue in Tweed Heads South. At the bottom of the hill, near the entrance to the crematorium is a transfer pump station through which the effluent from Banora Point STP is passed on. This is the closest take-off point for the recycled water available, removing the need to provide a new main from the Treatment Plant, which is approximately 400m from the site and across the Pacific Hwy. The potential area for re-use of the recycled water is difficult to quantify without a full survey, as the memorial gardens are broken up into several different areas. Each of these areas is at different levels up the hillside. However an estimate taken from site visits to pace the area and measured off GIS data supplied from Tweed Shire Council indicates a total area of approximately 2 Hectares. This includes up to 8 different areas ranging in size from 450m^2 up to 5,600m^2. The difference in RL from the entrance to the crematorium at the base of the hill, up to the highest point of the memorial gardens is approximately 15m.

The Tweed Heads Crematorium and Memorial Gardens are public space. However access is restricted at night times via a locked gate. This suits the use of above ground irrigation at night time with the requirement of a 4 hour drying period before the gate is re-opened. As the opening hours of the memorial gardens are between 0730 and 1800, above ground irrigation can occur anytime between 1800 and 0330.

4.2.3 Hastings Point – Rugby Club

The Rugby Club is located to the south of Bogangar off Tweed Coast Road. They are managed by TSC. The potential area for irrigation is the open spaced flat grassed area covering approximately 30Ha.

The park is a public area and is used for sporting activities. The main user is Tweed Heads Rugby League Football Club although a skate park is present on site.

To the north of the Rugby club is a housing estate, to the east is the Tweed Coast road. The south and west are both natural forest and vegetation. Access to the site is gained from Tweed Coast Road. There are three lakes within the vicinity that may be directly linked to the ground water therefore careful control will need to be applied to the irrigation system. As there are houses within the locality and the lakes, there may be opposition, regarding the possible health risks and pollution of the groundwater involved with any above ground sprinkler irrigation. The NSW EPA Environmental Guidelines - *Use of Effluent by Irrigation* recommend a separation distance of 50m for low strength recycled water (as the Hastings Point recycled water is defined). This is to avoid spray drift of recycled water containing pathogens offsite near houses and waterbodies where spray irrigation gives rise to aerosols. However, the optimal buffer zone for a particular site can only be determined following an assessment of the irrigation practices proposed and the sensitivity of the receiving environment.

The estimated water demands for the Rugby Club are shown in Table 4.1 for an assumed irrigation rate of 5 mm/day (or 50 KL/Ha/day) for hot/dry days. Predicted demands are critically dependent on this assumed daily irrigation rate and total area irrigated on that day. Peak demand (10.42 L/s) for the Rugby Club is dependent on the assumed times of watering, which are also shown in Table 4.1.

Based on review of aerial photographs, site visits to pace the area, and providing the above mentioned setbacks, total available irrigation area for recycled water use at the Rugby Club is roughly estimated as 3.0 Ha.

4.2.4 Hastings Point – Barry Sheppard Oval and Round Mountain Pony Club

The Barry Sheppard Oval and the Round Mountain Pony Club are located to the south of Bogangar on the north side of Round Mountain Road. They are managed by TSC. The potential area for irrigation is the open spaced flat grassed covering approximately 11 Ha.

The park is a public area and is used for many sporting activities ranging from hockey to horse riding and Rodeos. The Oval is surrounded on all sides by trees and vegetation. Access to the site is gained from Round Mountain Road.

The estimated water demands for the Oval and the Pony Club are shown in Table 4.1 for an assumed irrigation rate of 5 mm/day (or 50 KL/Ha/day) for hot/dry days. Predicted demands are critically dependent on this assumed daily irrigation rate and total area irrigated on that day. Peak demand (38.19 L/s) for Oval and the Pony Club is dependent on the assumed times of watering, which are also shown in Table 4.1.

Based on review of aerial photographs, site visits to pace the area, and providing the above mentioned setbacks, total available irrigation area for recycled water use at the Oval and Pony Club is roughly estimated to be 11.5 Ha.

4.2.5 Hastings Point – Turf Farm

The Hastings Point Turf Farm is located approximately 1.5km south west of the Hastings Point STP along Round Mountain Road. The land is privately owned and managed by a company called Coastal Turf, a father

and son business of John and Robert Commens The potential area for irrigation is the flat grassed area covering approximately 10Ha.

The proposed land for irrigation is a privately controlled commercial Turf Farm. As the Turf Farm is privately owned the public has no right of access and therefore controlled irrigation can occur at any time within the daily 24 hour period assuming safety training of staff.

As the Turf Farm is surrounded by agricultural land, at the time of the site visit it was mostly sugar cane. It is unlikely that there be any significant opposition to the use of above ground sprinklers and final recycled water as an irrigation source, unless it the farm is certified as organic.

The estimated water demands for the Turf Farm are shown in Table 4.1 for an assumed irrigation rate of 5 mm/day (or 50 KL/Ha/day) for hot/dry days. Predicted demands are critically dependent on this assumed daily irrigation rate and total area irrigated on that day. Peak demand (35.1L/s over a 4 hour period) for the Turf Farm is dependent on the assumed times of watering, which are also shown in Table 4.1.

Based on review of aerial photographs, site visits to pace the area, discussions with land owners, and providing the above mentioned setbacks, total available irrigation area for recycled water use at the Turf Farm is roughly estimated to be 10.1 Hectares.

The landowner already has an irrigation system on site and abstracts directly from the three groundwater storage lagoons on site. After a site visit the Turf Farm owner indicated that he could use as much as 1Ml/day and that he would prefer any storage to be situated at the source STP.

4.2.6 Chinderah – Ti Tree Plantation

The Ti Tree Plantation is located approximately 0.5km to the South of the proposed new Kingscliff STP. The land is privately owned and managed by the Bolster family. The potential area for irrigation is approximately 50 Ha.

The proposed land for irrigation is a privately controlled agricultural farm. As the land is privately owned the public has no right of access and therefore controlled irrigation can occur at any time within the daily 24 hour period.

As the Ti Tree Plantation is surrounded by agricultural land, it is unlikely that there be any significant opposition to the use of above ground sprinklers and final recycled water as an irrigation source.

The estimated water demands for Ti Tree Plantation are shown in Table 4.1 for an assumed irrigation rate of 5 mm/day (or 50 KL/Ha/day) for hot/dry days. Predicted demands are critically dependent on this assumed daily irrigation rate and total area irrigated on that day. Peak demand (175 L/s over a 4 hour period) for the Ti Tree Plantation is dependent on the assumed times of watering, which are also shown in Table 4.1.

There is an existing irrigation system on site, which uses the water table as a source. The landowner already has an irrigation supply pipe for final recycled water from the existing Kingscliff STP although it has not been used.

At present the solution being designed is to provide an irrigation pumping station at the new Kingscliff STP to provide the Ti Tree Plantation with its daily irrigation requirements. An investigation is underway to determine the best method of achieving this and it will be covered later in this report.

Based on review of aerial photographs, site visits to pace the area, and providing the above mentioned setbacks, total available irrigation area for recycled water use at the Ti Tree Plantation is roughly estimated to be between 50 and 51 Ha (assumed 50.5Ha).

4.2.7 Chinderah Golf Course

Chinderah Golf Course presently has 18 holes, with tees and greens manually irrigated using onsite bore water and onsite catchment dam water. About 1.5 Ha area (tees and greens) is currently irrigated, with about 125 KL/day maximum use using small petrol driven pumps on the bore and each dam. There are proposals to expand the golf course to the west with 9 new longer fairways, and refurbish the existing 18 holes with irrigation to also include fairways (ultimately up to about 21 Ha area under irrigation, 700-1400 KL/day maximum use). The golf course owner proposed to build a new 6 ML dam in the golf course, about 600-700 m from the proposed site of the relocated STP.

The peak demand for Chinderah Golf Course (77 L/s) is given in Table 4.1. This estimated demand is based on approximately 21 Ha of ultimate irrigation area, 5 mm/day irrigation rate, and pumping (4 hours per day) directly into the proposed golf course dam. The golf course would then irrigate from the dam using their own irrigation pump station, which is to be upgraded by the golf course at their own expense as part of the future expansion.

4.2.8 Uki – Nursery

Minimisation of effluent discharge to Smiths Creek needs to be optimised to reduce the risk of contaminants entering the water supply catchment.

The Uki STP currently provides recycled water for irrigation for Eucalyptus Tree plantations for the Currumbin Wildlife Sanctuary. These plantations are adjacent to the STP and the access road, with all being located on to the east of the township of Uki, off Smiths Creek Road. Within the treatment plant site is a storage dam, fed by a a gravity sewer that connects to the outlet of the STP, capable of holding 10 ML of recycled water. This is the take-off point for the recycled water available for the existing eucalyptus tree irrigation and proposed nursery irrigation. Peak daily flow requirements for this existing irrigation amount to 210 KL/day, although it is noted this is not required everyday and cannot be met every day as far exceeds influent flow to the Uki STP.

The nursery that is potentially a reuse customer is owned and operated by Tweed Shire Council where the seeds of native plants are grown in pots to a size suitable for transport to other areas of the Shire to be planted for landscaping purposes. The potential area to irrigate for the nursery is difficult to quantify as the number and size of the plants varies over time. The nursery plants will only be irrigated in pots, therefore the soil type of the surrounding area is not an issue. There is an existing irrigation system watering the nursery, utilising the potable water supply to the site. This irrigation system is run three times a day for approximately 20 mins each time. Assuming the potable water feed main to the nursery irrigation is only 25 mm, this equates to approximately 2-3 KL per day.

The Uki STP site, including the nursery and eucalyptus tree plantations, is a restricted access site, with access only by Tweed Shire Council personnel and Currumbin Wildlife Sanctuary personnel. With public access

restricted via a locked gate, this relaxes the treatment and irrigation time requirements. As the nursery plants are not for human consumption, this also relaxes the treatment requirements for the recycled water. This allows the current system of irrigating three times per day for 20 mins a time, to be maintained with the recycled water. This satisfies the EPA guidelines for Recycled water. However, a problem may occur with the quality of the recycled water causing problems for the growth of new plants within the nursery. Established native plants are suited to the recycled water, as noted by the current usage on the eucalyptus plantations. However, new plants require extra care and attention for the required application of the effluent. As a guide the Total Nitrogen within the recycled water should not exceed 21mg/L, the total Phosphorus 2mg/L and the total Potassium should not exceed 11mg/L. Phosphorus is particularly stringent as high levels promote weed growth, which can eventually overwhelm the native plants, if not eradicated.

4.2.9 Tyalgum

Minimisation of effluent discharge to Brays Creek needs to be optimised to reduce the risk of contaminants entering the water supply catchment.

Tyalgum STP currently reuses recycled water to surface irrigate the surrounding open space paddocks. The treatment plant and surrounding paddocks are located south of the Tyalgum township, off Brays Creek Road. Within the STP are several ponds, a catch pond, maturation pond and finally an effluent storage dam. It is from this recycled water storage dam that the current reuse scheme withdraws its recycled water to reuse for irrigation. It is proposed to change the use of these paddocks from open space to more useful eucalyptus tree plantations for the Currumbin Wildlife Sanctuary. Therefore the peak recycled water usage demands change from 150 KL/day up to 182 KL/day.

To change the site from open space paddocks to eucalyptus plantations the method of irrigation needs to be addressed. Currently irrigation is by surface sprinklers with a radius of 30m. However with eucalyptus tree plantations the trees are placed in six (6) m wide rows, with individual trees in each row spaced about 3m apart. Therefore after a certain amount of growth the existing sprinklers will become inefficient, as the trees will stop the spray, resulting in areas of over-irrigation and under-irrigation. Therefore a new method of irrigation needs to be installed. Uki STP, as mentioned previously, currently uses recycled water to irrigate existing eucalyptus tree plantations and hence a similar method of irrigation can be utilised for Tyalgum. Mini-sprinklers with a radius of only 3m, installed in rows parallel to the eucalyptus trees is the best option. The Tyalgum STP is a restricted access site, with access only by Tweed Shire Council personnel and in the future Currumbin Wildlife Sanctuary personnel. With public access restricted via a locked gate, this relaxes the treatment and irrigation time requirements. Therefore whilst subsurface irrigation is an alternative means it is more expensive and hence not justified.

Current irrigation requirements show a recycled water pump station with a pump duty of 7.8 l/s at 37m head. Investigation explained later in this report have determined that this pump station can be reused for the irrigation of the eucalyptus tree plantation.

4.3 Alternative Recycled Water Irrigation Options

The infiltration rate of soil is an important consideration in the type of irrigation method used and the way it is operated. Recycled water needs to be applied uniformly and at a rate less then the nominal infiltration rate to avoid surface runoff.

4.3.1 Surface Irrigation

Various options were considered when supplying surface irrigation with and without storage tanks. The advantage of surface irrigation is that installation is about 25% cheaper than subsoil methods, although this is offset by higher operational and maintenance costs. However there are public access issues associated with surface irrigation, including the need for restricted watering hours to periods when the irrigated areas are not expected to have public access. Even with a tight watering period of 2300 to 0300 (to provide 4-hour withholding), there is no guarantee that the public will not use the sites during irrigation times and inside the 4-hour withholding period.

Issues may also arise with potential aerosol drift from high pressure surface irrigation. Because none of the STP's effluent quality meets the criteria for pathogen reduction for use on raw human food crops high pressure systems cannot be used on these sites. Aerosol drift and the potential for odour can be minimised by using drip or trickle irrigation where pressurised water is discharged through micro-emitters. The water is dripped thereby minimising the risk of aerosols.

4.3.2 Subsurface irrigation

Options were considered for providing subsoil irrigation to the existing recreational reserves, gardens and nurseries. Subsurface irrigation has some advantages over surface irrigation, including no public access issues, longer watering periods, lower peak flows and capacity requirements for the recycled water supply infrastructure, potential direct irrigation and possible reduction in size or the avoidance entirely of storage tanks.

Any irrigation refurbishment would put playing fields out of action for some time potentially disrupting the use of these fields by local sports clubs. In addition the sub-soil irrigation systems do not provide as uniform irrigation as surface methods, which are most important for athletics and ball sports like cricket, soccer, hockey and rugby.

Even though sub-soil irrigation would be 25% more expensive to install, it would have following major advantages over the surface irrigation option:

- Direct irrigation and possible reduction in the size of onsite storage tank;
- Longer watering periods and therefore lower peak demands, resultant smaller pipe and pump sizing;
- Flexibility to install lines;
- More efficient irrigation (25-50% less water wastage) due to no evaporation and spray drift losses;
- More accurate control of irrigation rates to minimise impacts on foreshore vegetation, etc;
- Lower Operational and maintenance costs
- No public access issues, provided recycled water does not come to the surface;
- Overall cost savings and no public objections based on all of the above.

Potential disadvantages of subsoil irrigation include the possibility of biological slimes/algal growth and root intrusion into the dripper lines. Sub-soil irrigation products such as Netafim™ Eflow are widely and successfully utilised in agriculture and woodlots using wastewater, recycled water and other algal laden water supplies. Netafim poly-tubes and emitters can be impregnated with registered herbicides to control root intrusion (10 year effectiveness warranty available). The turbulent flow through the labyrinth of the in-line emitters, regular flushing cycles and proper maintenance ensures control over blockages from slimes/algae build-up.

Care also needs to be taken to ensure that the irrigation lines are at a depth so as to avoid damage during aeration (forking) of the parks. A minimum safe installation depth of 200mm is proposed

4.4 Summary of Recycled Water Demands

Table 4.1 provides a summary of the estimated peak recycled water demands based on the above discussion of potential recycled water irrigation sites. The peak demands given in Table 4.1 are the basis for analysing pipeline diameters, pumping requirements and recycled water storage requirements both at the STP and at individual recycled water sites.

4.4.1 Banora Point STP

If Banora Point STP is to deliver all the irrigation requirements for the recreational fields and the Tweed Heads Memorial Gardens then the total daily irrigation demand is 0.68 ML/day. If direct irrigation is to be employed then this figure will need to be met over a 4 hour period. Using the average daily flow figure and assuming a uniform flow entering the works, then over a 4 hour period 1.67 ML will be available for irrigation from the STP. The STP can achieve the required flows for direct irrigation however as the outfall main is tidal there can be no guarantee as to the irrigation times. This leaves a storage solution as the only viable option. Should subsurface irrigation be employed the storage size can be reduced but the tidal nature of the discharging recycled water still dictates that some storage will be needed so irrigation can take place when required.

The recycled water quality is deemed suitable for the purpose of irrigating a golf course and memorial gardens, provided there is controlled public access, according to NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*, where there is a median thermo-tolerant coliform count of less than 1000cfu/100mls. Based on figures from the year to November 2004, the final recycled water from Banora Point STP is of sufficient quality for these irrigating purposes.

4.4.2 Hastings Point STP

If Hastings Point STP is to deliver all the irrigation requirements for the Rugby Club, The Barry Sheppard Oval and Round Mountain Pony Club and the Turf Farm then the total daily irrigation demand is 1.73 ML/day. If direct irrigation is to be employed then this figure will need to be met over a 4 hour period. Using the average daily flow figure and assuming a uniform flow entering the works, then over a 4 hour period 0.2605 ML will be available for irrigation from the STP. This figure is significantly short of the requirements. It must also be noted that the flows at night are generally less then during the day so this figure may be high. As a result if all the irrigation requirements are to be met by Hastings Point STP then some on site storage will be required.

The Final effluent from Hastings Point STP is of sufficient quality to be used as an irrigation source for any of the irrigation options.

Operational Staff have stated that Hastings Point STP has an existing chemical dosing system with dosing points upstream and downstream of the filters. Should the final recycled water quality require additional treatment before it can be utilised as an irrigation source, it is proposed to modify the existing system. Alternatively subsurface irrigation can be employed to remove the need for additional treatment.

4.4.3 Kingscliff STP

If the new Kingscliff STP is to deliver all the irrigation requirements for the Chinderah Golf Course and the Ti Tree Farm then the total daily irrigation demand is 3.72 ML/day. As the land is privately owned and there is controlled or no access to the public, then the irrigation can take place as the owner requires.

To irrigate both sites would require more than double the average daily flow to be treated by the existing Kingscliff STP. As the flows from the works cannot be increased, a priority case will need to be developed.

The Kingscliff STP has been designed for final effluent for irrigation purposes. The proposed recycled water quality falls well within the Guideline parameters.

4.4.4 Uki STP

There is an existing storage dam onsite at the Uki STP, which provides adequate storage for the Eucalyptus tree plantations. Given that the additional demands for the proposed nursery are calculated to be only 3Kl./day the existing storage will be adequate to meet the extra needs. The peak daily irrigation demand is approximately 285 KL for both the Eucalyptus tree plantations and the nursery combined. This is more than 9 times the current average influent (30 KL) to the STP. This peak demand is not expected to occur frequently and the 10 ML storage dam will replenish periodically, as required, in times of low demand. TSC own and operate the pump station that feeds recycled water to the Eucalyptus Tree plantations. This pump station and rising main are available for use by the TSC for the irrigation of the nursery.

The final recycled water quality from Uki STP is of sufficient quality for irrigation of Koala feed trees and the native tree nursery, according to the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*. However, as the plants to be irrigated are grown from seedlings within a pot, there is a danger that the recycled water may cause problems with the initial growth stage if treatment is unsatisfactory. Guidelines for recycled water quality for use on native plants, include an recycled water with total Nitrogen less than 21 mg/L, total Phosphorus less then 2 mg/L, and total Potassium less then 11 mg/L. Historical records indicate that whilst nitrogen counts are satisfactory, the total Phosphorus count averages approximately 3.5 mg/L. Therefore additional treatment possibly involving chemical dosing and microfiltration to reduce the Phosphorus could be required along with disinfection. To overcome the need for two processes, microfiltration and disinfection, a reverse osmosis filter may be used as this removes precipitates along with thermotolerant coliforms. Note that Potassium levels are not recorded on the site but given that the source of influent is mainly residential, Potassium is not deemed to be a significant issue in the influent, although substantial stormwater ingress to the sewer system can cause fertilisers containing potassium oxide to enter the wastewater.

4.4.5 Tyalgum STP

Tyalgum, as for Uki STP, has existing on-site recycled water storage, with an existing recycled water pump station also in use that has a pump duty of 7.8 L/s at 37 m head. The recycled water demands for the proposed Eucalyptus Tree plantations are based on the current irrigation system in place for the Uki STP plantations. This places parallel lines of irrigation feed mains spaced 6m apart, with sprinklers along each line placed 2.7 m apart. Over the designated area at Tyalgum STP this estimates to be approximately 1735 sprinklers in total. With each sprinkler discharging 70 L/hr over 1.5 hours the total peak daily flow is estimated to be 182 KL.

However, as this flow is discharged over only 90 minutes then the flow rate is 33 L/s. This is not within the capabilities of the existing pump station so it is proposed to split the site into four (4) smaller areas to allow for

smaller flows to the system. As the time frame is only 90 minutes for irrigation this gives a total timeframe for irrigation of only 6 hours, easily achievable in 1 day. This results in a required flow of 8.25 L/s. However, the current pumping rate of 7.9 L/s can be used with a simple extension of total irrigation time by 5 minutes to gain the required irrigation. The maximum head required for the proposed irrigation is 31 m, taking into account static head, friction and minor losses and the required pressure of 20m head at the sprinklers. The duty point of the existing pumps show 37m head pressure, indicating the pumps are adequate. However, pressure reducing valves may be required on some laterals to reduce pressures in those areas.

The final recycled water quality from Tyalgum STP is of sufficient quality for irrigation of Koala feed trees and pasture. Hence further treatment of the recycled water is not required. There is a concern with Phosphorus within the existing soils, but as recycled water irrigation already exists on site the proposal will not provide any additional concerns, and indeed changing to eucalytpus trees may assist with the problem concerning Phosphorus.

The reduction of effluent discharge to Brays Creek at Tyalgum and to Smiths Creek at Uki will reduce the risk of contamination entering the water supply catchment of the Tweed River.

5. Recycled Water Options

5.1 Introduction

The assumed water demands were discussed in Section **4** and **Table 4.1** The critical cost issue is whether the costs of on-site storage tanks and irrigation systems offset the costs of larger supply pipelines for the higher flow direct irrigation (no-storage) options.

After considering various sub-options based on the above permutations and combinations, three primary options were short-listed as follows:

1 Option 1 – The irrigation system will be directly fed from the source treatment works. This could be from modification to existing outfall or by the construction of new purpose built irrigation pumping station. The pumps and pipes will be sized to deliver the required flows at the necessary heads and velocities to ensure efficient operation of the irrigation system.

2 Option 2 - The irrigation system will be fed using an on site irrigation pumping station. The pumping station will be fed from the source works, if possible by gravity or from an existing pumped main. If this can not be achieved and a new pumping station is required at the source works, then this is not a viable option. The pumps and pipes will be sized to deliver the required flows at the necessary heads and velocities to ensure efficient operation of the irrigation sprinklers.

3 Option 3 - A full day's irrigation will be stored below ground in a circular reinforced concrete tank, unless stated otherwise. The tank will be fed from the source works by gravity if possible, otherwise from a pumped main. The irrigation pumps will be housed within the storage tank and will be sized to deliver the required flows at the necessary heads and velocities to ensure efficient operation of the irrigation sprinklers. A cost/benefit investigation has been undertaken to determine whether reduction in the tank volume will being any significant advantages. The major reason behind any reduction in volume is the installation of subsurface irrigation. Subsurface irrigation is not subject to the same time constraint as surface irrigation and therefore irrigation can take place at any time during a 24 hour period. This would enable the storage tank to fill and empty numerous times over the same time frame. The Storage Options are covered in more detail in **Section 6 Storage Options at Recycled Water Sites.**

4 Additional Treatment – In some cases the recycled water from the Sewage Treatment Plant may not be of sufficient quality to enable reuse as irrigation. The recycled water may fail according to the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*, which are set out to ensure the recycled water does not become a health hazard to people, either through people using the area where irrigation occurs or on crops that may ultimately be used for human consumption. The Guidelines are also in place to ensure the environment is protected. In these cases the recycled water may require further treatment involving disinfection, chemical dosing or filtration to provide a suitable recycled water for reuse.

5 Type of Irrigation – Where reuse opportunity sites are owned and maintained by Tweed Shire Council the method of irrigation is also addressed. This will consider the possibilities of surface spray, pop-up sprinklers and subsurface irrigation.

The preferred irrigation arrangements for each of the sites is discussed to include any additional treatment to ensure the recycled water is suitable for reuse and the method of irrigation for sites owned and maintained by TSC. The need for on-site storage is discussed in more detail in **6.0 Storage Options at Recycled Water Sites**.

Each option was assessed at the Review Meeting held on the 8 February 2006, where the preferred options were agreed and assigned a priority rating. The table of ratings is shown in Appendix I.

5.2 Banora Point

Recycled water quality from the Banora Point STP needs to be monitored to ensure that the recycled water quality remains within the NSW EPA Environmental Guidelines*: Use of Effluent by Irrigation.* Thermo-tolerant coliforms in the recycled water need to be below 1000cfu/100mls for irrigation of an open space with controlled public access. Based on historical figures, Banora Point STP's effluent quality has fallen short of this target on numerous occasions and during these times it is not suitable for the reuse purpose without further treatment. The issue is that whilst the effluent entering the storage lagoon at the treatment plant is typically treated to a suitable quality, once in the lagoon, which is open to the surrounding environment, outside influences can adversely affect the effluent quality. This creates concerns with maintaining the recycled water quality to the irrigation sites and hence further treatment may be required to the effluent on-site before it is used for irrigation.

It was noted at the Review Meeting that the Outfall Main could be modified to act as storage for the irrigation requirements of both Arkinstall Park and the Memorial Gardens. This would remove the need for any storage at either site and utilise the existing final effluent lagoon. The proposal would ensure that the existing outfall main would always be full, therefore ensuring a constant effluent supply. This option could bring significant cost savings but until a more detailed analysis of the outfall main configuration and operation has been undertaken, no guarantees can be given as to its viability. Therefore, for until further investigations are completed, the proposed options are as follows.

5.2.1 Arkinstall Municipal Oval

5.2.1.1 Option Discussion and Evaluation

The operating nature of the outfall main from Banora Point STP means that any direct irrigation option is dependent on the timing of the tides. This would mean that irrigation could only occur twice a day at dictated times. Arkinstall Park is a relatively large area to irrigate and to guarantee that the irrigation can be achieved during the operational time window of the tidal outfall main is doubtful. This discounts the direct irrigation option and leaves a storage solution as the preferred alternative.

Should the installed irrigation system be above ground sprinklers then due to the irrigation's timings of 2300 to 0300, a full days storage tank would be required to guarantee that the irrigation demand is met. Monitoring of the recycled water would need be carried out with the possibility of additional treatment should the recycled water fall outside the stipulated quality for final effluent irrigation.

If sub-surface irrigation was installed, then the required storage tank could be half the size of the above ground sprinkler option, as the tank can be filled twice daily, once on each tide. This has obvious capital cost savings. The need for any extra treatment is also avoided.

As houses and schools surround the recreational field, the use of large area sprinklers for irrigation is not the preferred option, as these require buffer zones. This leaves only the sub-surface irrigation, although it is a more costly installation, as the only available option.

5.2.1.2 Description of Preferred Option

A connection will be made near the Banora Point Outfall Intermediate Pumping Station (PS). The connection will be made upstream of the outfall booster pump station and will feed directly into the irrigation pumping station for Tweed Heads Crematorium and Memorial Gardens. (Discussed in 5.2.2) This PS when not irrigating will be used to fill a storage tank located on site at Arkinstall Park. The flows will be controlled using water levels and valves with manual override. Once the tank is full the pumps will shut off.

Irrigation pumps within the storage tank will then be used to irrigate Arkinstall Park using a subsurface irrigation method. Irrigation will take place twice a day at time dictated by the operator.

5.2.2 Banora Point – Tweed Head Crematorium and Memorial Gardens

5.2.2.1 Option Discussion and Evaluation

The Banora Point Outfall feeds Tweed Heads Crematorium and Memorial Gardens. The issues associated with the tidal operation are applicable and storage will be required.

The Tweed Heads Crematorium and Memorial Gardens are open to the public between 0730 and 1800. Outside these hours a locked gate restricts public access, however staff and maintenance personnel are onsite outside these hours. Subsurface irrigation was addressed, but ruled out due to the extensive pipe network required. Whilst there are no plans to release any more grave plots, there are existing plots that may be re-excavated to bury relatives of people already buried in the memorial gardens. This action may disturb any underground pipelines, therefore it is recommended to keep underground pipelines to a minimum. The site has controlled public access, and in the interests of the health and safety of the staff and maintenance personnel it is recommended that irrigation is not undertaken when they are on site.

The recycled water from the STP, in particular during times of high flows, has adequate capacity to provide for the required flows to irrigate the memorial gardens. However irrigation will be required to be at night during the hours of 1900 and 0300 to allow the required 4hour buffer after irrigation. Hence storage will be required at the feed pump station to allow for adequate flows during the night for irrigation. Hence option 2, with an onsite direct feed irrigation pump station with storage within the wet well, feeding surface irrigation, becomes the recommended option for the Tweed Heads Crematorium and Memorial Gardens. No further treatment of the recycled water is required.

5.2.2.2 Description of Preferred Option

As for Arkinstall Park a connection will be made at the Banora Point Outfall Intermediate Pumping Station (PS). The connection will be made upstream of the outfall booster pump station and will feed directly into the irrigation pumping station for Tweed Heads Crematorium and Memorial Gardens. This PS will irrigate the memorial gardens during the required hours of 1900 – 0300. The flows will be controlled using water levels and valves

with manual override. Storage of 100KL will be required within the memorial garden irrigation pumping station wet well to meet the daily irrigation requirements.

5.3 Hastings Point

Recycled water quality from the Hastings Point STP needs to be monitored to ensure that the irrigated recycled water quality remains within the NSW EPA *Environmental Guidelines: Use of Effluent by Irrigation.* Thermotolerant coliforms in the irrigated recycled water need to be below 1,000cfu/100mls for irrigation of a sportsground with controlled public access. Based on recent figures, Hastings Point STP's recycled water quality falls short of this standard and is therefore not suitable for this purpose without additional treatment.

5.3.1 Bogangar Rugby Field

5.3.1.1 Option Discussion and Evaluation

It may be possible to provide the irrigation requirements directly from the existing outfall PS at Hastings Point STP by making modifications to the existing variable speed pumps.

As the irrigation requirement is small it is not envisaged to have any on site storage. The Hastings Point STP should be able to provide all the flows directly, although the timing of the irrigation would need to coincide with the operation of the outfall main.

However, the times of irrigation will need co-ordinating with the other proposed irrigation sites connected to Hastings Point STP, so a combined solution for Hastings Point is preferred and discussed in **Section 5.3.4**

5.3.2 Hastings Point – Barry Sheppard Oval & Pony Club

5.3.2.1 Option Discussion and Evaluation

Due to the large irrigation demand a direct pumping option does not appear viable. It is unlikely that the night flows from Hastings Point STP will be large enough to meet the demand. This will be the same for an on site irrigation pumping station.

As the irrigation requirement is large, on site storage will be required. If above ground sprinklers are used, then the tank has been designed for a full days irrigation requirement. The tank will be fed over a 24 hour period from the existing pressurised outfall main and have level control. If subsurface irrigation is implemented then the tank size can be reduced. To keep the option comparative the tank size has been halved for the subsurface option.

Consideration must also be given to which site has preference i.e. the Pony Club or the Turf Farm, when it comes to the irrigation needs as a sequential filling of both storage tanks will need to be implemented.

As there are no amenities, housing estates, school within the locality, above ground sprin,kler irrigation is acceptable; although controlled public access to the site during the irrigation times cannot be guaranteed.

The times of irrigation will need coordinating with the other proposed irrigation sites connected to Hastings Point STP, so a combined solution for Hastings Point is preferred and discussed in **Section 5.3.4**.

5.3.3 Hastings Point – Turf Farm

5.3.3.1 Option Discussion and Evaluation

Due to the large irrigation demand, a direct pumping option does not appear viable. It is unlikely that the night flows from Hastings Point STP will be large enough to meet the demand. This will be the same for an on site irrigation PS. As the land is privately owned and public access is not an issue, irrigation could take place at anytime. Therefore, if the landowner wishes to irrigate over periods when the flows leaving Hastings Point STP are higher during the day, then a direct irrigation system maybe viable.

As the irrigation requirement is large, on site storage will be required. The Turf Farm is privately owned and any cost incurred for the storage will have to be met by the landowner. The design caters for pumping the required irrigation volume to the on site storage. The storage has been estimated for the purpose of this report as a full day's irrigation requirement. The storage would be best fed over 24 hour period from a new PS on site at Hastings STP. This will reduce the demand on the works. Subsurface irrigation is not an option as the Landowner wishes to use his above ground irrigation system. As the land is privately owned and therefore public access is controlled, a reduced volume tank may be a viable option.

Having met with the Landowner a preference for any storage requirement to be located at the treatment works and directly fed has been expressed.

Consideration must also be given to which site has preference i.e. the Pony Club or the Turf Farm, when it comes to the irrigation needs as a sequential filling of both storage tanks will need to be implemented.

As there are no amenities, housing estates, school within the locality above ground sprinkler irrigation is acceptable. The actual type of irrigation system installed and associated cost will be borne by the landowner.

The times of irrigation will need coordinating with the other proposed irrigation sites connected to Hastings Point STP, so a combined solution for Hastings Point is preferred and discussed in **Section 5.3.4**.

5.3.4 Hastings Point Combined Storage Solution

5.3.4.1 Description of Preferred Option

Instead of a storage at each individual site, it is preferred to locate the irrigation storage on site at Hastings Point STP. This has significant advantages as only one tank would be required albeit for a larger volume. The tank could be constructed as an above ground tank and space is available on site within the redundant storage lagoon. As the lagoon is below ground it has the added benefit of lowering the height of the storage tank. If this option were selected, only 1 irrigation pumping station would be required to feed all 3 sites and controlled so that only 1 site is operating at a time to reduce the demand on the source STP. The storage tank could be located within the existing Final Effluent Lagoon, currently not used

An alternative to meet the irrigation requirements is to utilise the existing Final Effluent Lagoon at Hastings Point as the source for the irrigation. One irrigation pumping station sized to deliver all the flows to the 3 proposed sites and will be constructed at Hastings Point. Controls will be used to ensure only one site is irrigated at a time. If no site is being irrigated then the outfall main will operate as normal. Preliminary investigation show that this option is viable and would remove the need for any storage, providing a significant reduction in capital cost.

Further investigation into the risk to process and exact levels of draw down is recommended before the success of this option can be guaranteed.

The on site storage will need to be approximately 1.73ML, which equates to approximately 85% of the final effluent leaving the STP. This figure has been calculated assuming the Turf farm received the 1Ml/day that has been requested.

5.4 Chinderah

5.4.1 Ti Tree Plantation

5.4.1.1 Option Discussion and Evaluation

The total irrigation demand for the Ti Tree farm exceeds the total available effluent from Kingscliff STP. The Ti Tree Farm owner must therefore be willing to accept partial flows from the STP.

If Chinderah Golf Course takes its full requirement then the partial flows left for the Ti Tree farm will be, on average, less then 20% of the Total requirement, therefore the capital installation cost of PS and rising main would be uneconomical for the Ti Tree farm.

5.4.1.2 Description of Preferred Option

The Ti Tree Plantation Land owner has expressed a desire not to have recycled water.

5.4.2 Chinderah Golf Course

5.4.2.1 Option Discussion and Evaluation

The Golf Course is building on site storage in the form of a Final Recycled water Lagoon. This will be used to provide storage for all the irrigation requirements. The design has been based on having a 6 ML storage lagoon located on the southern edge of the Gold Course. The Golf Course requires 1.11 ML/day.

5.4.2.2 Description of Preferred Option

The preferred option is to provide a pumping station at the Kingscliff STP and rising main to feed on site storage that will be constructed by the Golf Course. The PS can operate over a 24 hour period if required and therefore there should be no issue in delivering the required volumes.

The golf course requires approximately 50% of the average annual flows leaving the STP.

5.5 Uki

5.5.1 Nursery

The proposal for Uki STP is to provide irrigation for a small nursery existing at the plant. This nursery is currently irrigated by potable water, via a 50mm dia pipeline. TSC has advised that this nursery irrigates 3

times per day for a maximum of 20mins each time. Using an average velocity of 1.1m/s through the 50mm potable water this equates to approx 10KL per day of potable water used for the nursery irrigation.

5.5.1.1 Option Discussion and Evaluation

Uki STP has a 10ML recycled water storage dam on-site. The nursery is also on the site of the STP and currently has an irrigation system in place utilising potable water. The Eucalyptus tree plantations that currently reuse the Uki STP recycled water are also on site. The Eucalyptus Tree plantations use an existing recycled water PS and rising main that draws recycled water from the storage dam and directly feeds to the 8 different areas off irrigation for one and half-hours at a time for a total of 12 hours

According to the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*, the recycled water for Uki is satisfactory, given the site has restricted public access at all times, and the plants being irrigated are not for human consumption. However, there is a concern that the recycled water will be detrimental to the growth of seedlings. As the nursery is growing the plants from seedlings within pots, the relative immaturity of the plants causes them to be more susceptible to impurities within the recycled water.

The levels of Nitrogen, Phosphorus and Potassium can affect the health and growth of the immature plants. Recommended levels include for Total Nitrogen are 21 mg/L, for Total Phosphorus 2 mg/L and Potassium 11 mg/L. Historical records indicate the Total Nitrogen levels fall well within the limits and hence are not a problem. The Total Phosphorus levels average around 4 mg/L, double the recommendation. The recommended levels of 2 mg/L are mainly in place due to the fact that higher levels of Phosphorus in the recycled water can promote growth of weeds which act in competition to the native plants, with the eventual possibility of killing the native plant through starvation and dehydration. However as the nursery has all plants within pots the occurrence of weeds are actually easier to control and hence the phosphorus levels recorded may be tolerable. Notwithstanding this possible tolerance there is currently in place within the Uki treatment process methods of removing Phosphorus via chemical dosing. If the dosing can be more tightly controlled then the levels of phosphorus may be brought under the desired levels, reducing the risk to the nursery. If this is not possible and the nursery plants cannot tolerate the excessive Phosphorus, then additional treatment via further chemical dosing and removal of precipitate by a filter will be required before the recycled water is suitable for reuse.

5.5.1.2 Description of Preferred Option

It is proposed to utilise the existing pumping station to feed the nursery by the addition of a new T section on the existing rising main.

5.6 Tyalgum

5.6.1 Eucalyptus Tree Plantation

5.6.1.1 Option Discussion and Evaluation

The existing recycled water pump station has pumps that operate at a duty point of 7.8 L/s at 37m head. Uki currently has in place a suitable irrigation method for Eucalyptus tree plantations that can be replicated for Tyalgum. This involves parallel laterals of reuse pipelines laid 6m apart with small sprinklers that have a spray

radius of only 3, laid 2.7m apart along each lateral. Using a similar design for the irrigation at Uki, i.e. peak design flow of 70 L/hr per sprinkler for 1.5 hours gives a required flow of 33 L/s, if all areas are irrigated at once at Tyalgum. However, if the areas are split into 4 sections the required flow is reduced to 8.25 L/s for 1.5 hours. Therefore the existing pumps can be reused, albeit with the possibility of adding 5 minutes extra irrigation time to make up for any shortcomings to total required recycled water, due to the slightly lower flow rate.

It is noted that these are peak flow requirements and for the most part these flow rates for the length of time will not be required, hence the flow rate for the pumps are more than adequate.

Calculations also have confirmed the available head from the pumps of 37m is also adequate. Taking into account the worst case scenario of static head, friction and minor losses within the pipeline network and the required head of 20m at each sprinkler the required head at the pump is only 31m. Therefore the available head is sufficient and will actually potentially require pressure-reducing valves in certain areas of the irrigation site.

As the site for reuse is restricted to public access and the native trees proposed to be irrigated are not for human consumption, then the quality of the treated recycled water satisfies the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*. Hence no further treatment of the recycled water is required.

5.6.1.2 Description of Preferred Option

For Tyalgum STP there is an existing recycled water irrigation scheme set up to irrigate surrounding paddocks. Existing on site facilities include a recycled water storage dam, and a recycled water PS feeding a network of pipelines and a surface spray system of sprinklers that have a spray radius of 15m. The existing paddocks are proposed to be reused as Eucalyptus Tree plantations for the Currumbin Wildlife Sanctuary. Therefore, the existing irrigation system will become inefficient as the 15m radius of the sprinklers will be interfere with by the number of trees and hence will create areas of over irrigation and areas of under irrigation. Therefore, option is to reuse the onsite storage, PS and part of the existing pipeline network to feed a new irrigation system designed to irrigate the new Eucalyptus tree plantations, via sprinklers with only a 3m radius. These sprinklers can be laid at 2.7m spacings along feeder mains that are laid parallel to each other with 3m separation.

6. Storage Options at Recycled Water Sites

6.1 Storage Requirements

Due to the tidal nature of the Banora Point outfall main storage is required at both the Tweed Heads Memorial Garden and Arkinstall Park. For the Memorial Gardens, the irrigation system is above ground and the storage tank will need to have a capacity to hold a full days irrigation requirements. The proposal is to hold the Memorial Gardens storage within the irrigation pumping station located next to the booster pump station on the outfall main. The storage at Arkinstall park will need to hold 12 hours or half a day as the irrigation system is sub surface and is not restricted by irrigation times. A half day storage has been designed around the tides, i.e. the tank can only be filled twice in any given 24 hour period.

For Hastings Point, storage is required for the Barry Sheppard Oval and the privately owned Turf farm. To provide this storage on site is costly. Therefore, as the preferred option is a combined solution for all 3 sites (including the Boganger Rugby Field) the storage if required will be located at Hastings Point STP and sized to fulfil the need of all 3 sites. As approximately 80% of the Final Recycled water from Hastings Point will be potentially reused, any storage tank will need to be a full days tank. The preferred option is to avoid the need for any storage and utilise the existing final effluent pond directly.

Reuse opportunities from Kingscliff STP are to privately owned developments and hence storage requirements are the responsibility of the end-users and do not need to be addressed by Tweed Shire Council.

For the Uki and Tyalgum STPs, there are existing recycled water storage dams on site. As both reuse options, the nursery at Uki and the Eucalyptus Trees at Tyalgum, are within the STP site, additional storage is not required for either reuse option.

6.2 Storage Tank Capacities

The storage tank capacity was initially sized for holding a full days irrigation allowing for a 24 period to fill the tank. This was to ensure that if surface sprinklers were employed the full irrigation could take place within the 4 hour window from 2300 to 0300. The storage is necessary due to insufficient flows coming from the source STP. It is not due to any specific requirements of the employed irrigation system. If a subsurface irrigation system is installed then the constraints on the irrigation times are removed and the tank storage can be reduced. The storage for the subsurface options has been reduced by 50%, which brings significant cost savings to the project. The savings however are offset by the need to refill the tank 2 times a day to fulfil the irrigation requirements. See Table 6.1 for expected recycled water storage tank capacities.

Table 6.1 Recycled Water Site Storage Tanks and Approximate Capacities

Recycled water site:	Storage Capacity	Possible Storage Tank Type
Arkinstall Municipal Oval	580KL	Reinforced Concrete, Plastic, Steel
Memorial Gardens	100KL	Within Pump Station Wet Well
Hastings Point Combined Storage Options *	1,750KL	Reinforced Concrete, Plastic, Steel

NOTE: This is the Storage Capacity, not the actual required Tank size.
*** The storage maybe met by the existing final effluent pond.**

6.3 Storage Tank Siting and Construction Issues

An assessment of the possible construction techniques has been carried out using reinforced concrete in both above and below ground applications as well as investigation into the overall footprint sizes. For above ground storage other tank types i.e. tank type (plastic, steel, and concrete), dimensions, heights (above ground and below ground considerations), and required storage tank compound footprints has been undertaken for each recycled water site.

6.4 Above Ground Tanks

The tank at the Arkinstall Municipal Oval would require a large footprint within the public reserve, which could draw community objections. If a single storage tank was employed the tank would be 13 m in diameter and over 5 m in height. This would require 20 x 20 m (400 m^2) compound. Should the height be an issue then 2 no 6 m diameter tanks would be used at only 3 m height. This option offers no significant advantages and would increase the size of the required compound area.

Above ground tanks for the Memorial Gardens would introduce double pumping and therefore is an unrealistic option.

For Arkinstall Park the subsurface option may be utilised, then the 50% reduction in the tanks size from 600 KL to 150 KL would mean above ground tank would be a more realistic option and prefabricated units could be employed.

Refer to Appendix F, Figures F1 to F10 for sketches of possible compound arrangements for above ground tanks at relevant recycled water sites, and expected footprints (shown on aerial photographs).

The combined solution for Hastings Point STP would place the storage at the source STP. The combined solution does have a larger storage requirement. The storage requirements however could be met but the on site Final Recycled water Lagoon feeding an irrigation pumping station which if large enough would have no impact on the process and output from the STP would remove the need for any additional storage.

There are numerous potential social impacts and construction limitations associated with the siting of above ground tanks in municipal parks – see Table 6. The permanent occupation of public land with large and unsightly tanks may result in strong objections from local residents, park users and community groups.

For the other options, should irrigation storage be required, then it would be significantly smaller and therefore considered more feasible to construct. Should the Turf Farm and Ti Tree Plantation want storage then above ground tanks are an option, as the land is privately owned. The storage will be constructed at the owner's' cost.

Table 6.2 Above Ground Recycled Water Storage Tank Costs and Construction Issues

Recycled Water site:	**Storage Tanks Type**	**Indicative Cost** (supply & installation) ($K)	**Construction Issues/Limitations**
Arkinstall Municipal Oval	Prefabricated	$ 184,000*	Tall tank, large compound on public land, difficult to hide from view, unsightly, community objections
	Reinforced Concrete	$ 309,000*	
Hastings Point STP Combined Storage Solution	Prefabricated	$ 300,000*	Reduced objection from the Public and location on existing STP.
	Reinforced Concrete	$ 724,000*	

* Denotes that the option has Subsurface irrigation and therefore the storage tank has been reduce to ½ a days storage

6.4.1 Underground Storage Tanks

As an alternative to above ground tanks, underground concrete tanks were considered for each recycled water site, to avoid the above mentioned community objections. Whilst underground tanks would present lower social impacts and issues with aesthetics and occupation of public land, there are additional construction issues and costs as listed in Table 6. Whether an above ground storage at Arkinstall Oval would cause such public distress as to warrant under ground storage is a decision that TSC should investigate.

The underground tanks for the Memorial Gardens are to be sited next to the existing outfall booster pumps station. They will hold the full 24 hour irrigation requirement for the Memorial Gardens whilst also acting as a feeder pump station for the Arkinstall Park storage.

The combined solution for Hastings Point STP has a very large storage requirement and therefore the costs involved in placing such a large structure within the ground are significant, and as an underground tank has no significant benefits it has been discounted as a viable option.

The cost of underground tanks is roughly double the construction cost of prefabricated above ground tanks.

Table 6.3 Underground Recycled Water Storage Tank Costs and Construction Issues

Recycled Water site:	Indicative Cost (supply & installation) ($K)	Construction Issues/Limitations
Arkinstall Municipal Oval	$ 364,000*	• Limit the tanks to 15m Diameter. This will reduce excavation depths to less then 4m • More extensive excavations • De-watering of excavations to deal with high watertables • Protection of concrete and associated below ground works from saline groundwater and acid sulphate soils • Water proofing of tanks to prevent saline groundwater infiltration • Higher geotechnical and structural concrete costs • Offsite soil cartage and disposal.
Memorial Garden	$ 208,000	

* Denotes that the option has Subsurface irrigation and therefore the Storage tank has been reduce to ½ a days storage

6.4.2 Storage Dams

Construction of small storage dams were not considered feasible at public parks and reserves due to costly construction, lining and groundwater issues, public safety and public opposition. However, Chinderah Golf Course is proposing a new 6 ML dam within the private land and at the owner's cost, which could be safely used for recycled water storage.

7. Cost Assessment

7.1 Capital Costs

Preliminary estimates of capital costs for the options are summarised in
Table 7.1 based on the concept designs outlined in this report. Estimated cost rates for various works items including pipeline and pump station supply and installation, irrigation system infrastructure, recycled water storage tanks (above and below ground as required), etc are provided in Appendix G. These cost estimates are based on recent MWH design projects, budget rates from pipe, pump and tank suppliers, local (NSW and Southeast Queensland) contractors and TSC.

Given the preliminary nature of this report a cost range (Best, Medium, Worst Case) has been provided. The main cost sensitivities are associated with variability in pipeline supply and installation costs. Given that survey and geo-technical investigations for pipeline alignments and storage tank locations have not yet been undertaken, there are cost uncertainties at this concept stage of this project. Pipeline supply costs also vary significantly in response to global markets, pipe supplier activity and also in-situ conditions such as the presence of high water tables along the proposed pipe alignment.

There is no inclusion in the costs for water buffer storage should it be required at Kingscliff STP.

Option 1&2 (Direct Irrigation Options) have been priced identically as the difference in locations of the pumping station has no significant cost benefits in either Capital or Operational expenditures. Additionally if the on site irrigation pumping station could not be fed without the need for a new pumping station at the source works then the option was discounted on the basis of double pumping. Option 3 prices cover the same solutions but include costs for storage as required. The storage is sized as stated for each site. This has been calculated from the 5mm/hectare-irrigation figure. It has not been factored to take into account any advantages/disadvantages of the proposed irrigation system. Irrigation system costs have been calculated for the private landowners using both systems and have been included.

Table 7.1 summarises the preferred options investigated, cost estimates and other factors considered in the options determination. The estimated capital costs for all the options and the cost breakdowns including for sprinkler systems, irrigation pump station and delivery pipe work are given in Appendix G.

There are 2 irrigation systems that have been priced, surface irrigation in the form of pop-up sprinklers, and sub surface.

No costs have been included for upgrading the existing source STPs, so should additional treatment be necessary at the works, e.g. further chemical dosing, then the proposed costs would rise.

There are many factors involved in the selection of appropriate types of sprinklers, involving proximity to schools and houses, heights above the groundwater table and the need for buffer zones. Pop-up sprinkler systems are generally preferred for sports fields, where ground conditions are suitable and where a uniform coverage is required.

As each solution has a pumping station, then direct irrigation is theoretically possible for the all the sites. However this is not the case as outflows from the works and the time scale of the irrigation ensure that more flow is required for the irrigation than available, so on some sites storage will be necessary to meet the irrigation demands. This is particularly a problem for Hastings Point schemes.

These factors show that in reality a combination of all of the options is required to deliver a solution that offers robustness, reliability and most importantly the required flows, therefore the estimated range (Best – Worst) for the Preferred Solution as Summarised from
Table 7.1:

Table 7.1 TSC Recycled water Opportunities Preferred Option Costs

OPTION	Best Case	Medium Case	Worst Case
Table B1 - Cost Estimate Arkinstall Municipal Park (Banora Point)			
Preferred Option Sub-surface Irrigation and ½ Day Storage Tank	$ 1,225,000	$ 1,629,000	$ 2,041,000
Table B2 - Cost Estimate Tweed Head Cemetery (Banora Point)			
Preferred Option Surface Irrigation and Full Day Storage within pump station wet well	$ 398,000	$ 524,000	$ 667,000
Table B6 - Cost Estimate for Combined Storage (Hastings Point)			
Preferred Option Sub-surface Irrigation and Day Storage Tank at Hastings Point STP	$ 2,424,000	$ 3,117,000	$ 3,803,000
Table B7 - Cost Estimate for Ti Tree Plantation (Kingscliff)			
Without Irrigation or Storage (**NOTE**: Landowner does not want Final Recycled water Irrigation)	N/A	N/A	N/A
Table B8 - Cost Estimate for the Golf Course (Kingscliff)			
Total for scheme Without Irrigation or Storage	$ 336,000	$ 420,000	$ 524,000
Table B9 - Cost Estimate for Uki Nursery			
Total for scheme New Pump Station plus Rising Main	$ 35,000	$ 48,000	$ 62,000
Table B10 - Cost Estimate for Tyalgum			
Total for scheme new surface irrigation system	$ 122,000	$ 163,000	$ 197,000
TOTAL COST - ALL SCHEMES	**$ 4,540,000**	**$ 5,901,000**	**$ 7,281,000**

7.2 Operating Costs

Preliminary operating cost estimates for the preferred solution are summarised in Table 7.2 (see also Appendix G). The preliminary operating cost estimates listed in Table 7.2 include: Operating and Maintenance (O&M), Labour, Equipment replacement, Power costs for infrastructure including pipelines, main pump station, irrigation site storage tanks and irrigation systems, and associated equipment.

Table 7.2 Estimated Operating Costs for TSC Reuse Opportunities.

Equipment	Annual Cost Calculation Basis	Operating Costs $/Yr	Comments
Pump station	**Annual Power Costs**		Pump KW Ratings
Arkinstall Municpal Park (40 L/s)	50 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	$7,200	< 20 L/s = 20 KW Motors
	50 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 2,520	20 < 50 L/s = 50 KW Motors
Tweed Heads Cemetery (32 L/s)	20 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	$2,880	50 < 100 L/s = 100 KW Motors
	20 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 1,008	> 100 L/s = 200 KW Motors
Hasting Point Rugby Club (10 L/s)	20 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	$2,880	All pumping rates are 4 hours a day split 50/50 between peak and off peak unless stated
	20 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 1,008	
Barry Sheppard Oval & Pony Club (40 L/s)	50 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	$7,200	
	50 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 2,520	
Turf Farm (35 L/s)	50 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	$7,200	
	50 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 2,520	
Ti Tree Plantation (18 Ll/s)	200 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	N/A	
	200 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	N/A	
Chinderah Golf Course (77 L/s)	100 kW pump x 4hrs x 180 days x peak $0.20 /kWh =	$14,400	
	100 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 5,040	
Uki Nursery	20 kW pump x 8hrs x 180 days x peak $0.20 /kWh =	$2,880	
	20 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 1,008	

Tyalgum	20 kW pump x 8hrs x 180 days x peak $0.20 /kWh =	$2,880	Reusing existing pumps
	40 kW pump x 4hrs x 180 days x off-peak $0.07 /kWh =	$ 1,008	
	Total pumping power cost/year =	$ 103,032	
Equipment	**Cost Calculation Basis**	**Operating Costs $/Yr**	**Comments**
Labour O&M	(2 visits x 1hr x 35 wks) + (2 visits x 5hrs) x $62.50/hr =	$ 45,000	TSC would get a more competitive (bulk) power tariff than that assumed here, therefore power costs could be lower (by ~25%)
Equipment replacement	2% of capital cost (~$157,000) =	$ 28,260	
Pipeline			2 major servicing visits per year, 35 regular checks during the year @ 9 Pumping Stations
O&M	0.25% of capital =	$ 2,011	2% of capital for PS civil, mechanical and Electrical works @ 9 Pumping Stations
TSC Storage Tanks			
O&M	0.25% of capital ($0) =	$ 2,860	0.25% of capital for pipeline, valve and fittings. Does not included for Hastings Point Combined Option if it is required.
Irrigation @ TSC Sites			
O&M Surface	15% of irrig.capex	$ 325,620	1 visit/yr per tank prior to irrigation season
O&M Sub Surface	7.5% of irrig.capex	$ 224,550	
	Total Surface Irrigation OPEX ($K)	**$ 507,000**	
	Total Sub-surface Irrigation OPEX ($K)	**$ 406,000**	

Notes to above table:

- Above O&M costs do not include TSC's administration costs and corporate overhead for managing, monitoring, staffing and auditing the recycled water scheme,
- Above does not account for possible income from TSC recycled water charges on private customers.

The above cost estimates will need to be subject to more detailed financial modelling, once the recycled water demands, design and costs of the recycled water supply infrastructure (pipelines, pump stations, storage, etc) are better understood. In addition, this financial model will need to take into account the impact of:

- TSC's recycled water charges to private customers,
- income or losses for TSC from substitution of current potable water uses with recycled water, and
- the impact of numerous other externalities expected for any new recycled water infrastructure.

7.3 Division of Costs

Table 7.3 shows the capital construction costs for the installation of the irrigation main and the delivery of the recycled water to site, it does not include preliminaries or setup costs. The irrigation system costs include sprinklers, feed lines and any on site irrigation pumping station. The delivery costs cover the main feed pipework to the sites, pumping stations located at the source treatment works and any associated storage costs.

Table 7.3 Division of Costs (Irrigation/Delivery)

COST SPLIT (IRRIGATION/DELIVERY)	COSTS
Arkinstall Municipal Park (Banora Point)	
Irrigation System	$ 535,000
Delivery System	$ 761,250
Tweed Head Cemetery (Banora Point)	
Irrigation System	$ 71,000
Delivery System	$ 370,000
Combined Storage (Hastings Point)	
Irrigation System	$ 688,000
Delivery System	$ 1,902,000
Ti Tree Plantation (Kingscliff)	
Irrigation System	N/A
Delivery System	N/A
Golf Course (Kingscliff)	
Irrigation System	N/A
Delivery System	$ 245,500
Uki Nursery	
Irrigation System	N/A
Delivery System	$ 34,000
Tyalgum	
Irrigation System	$ 105,200
Delivery System	$ 32,250

The individual cost breakdowns for each site are available within Appendix G of this report

7.4 Net Present Value (NPV) Comparisons of Surface/Subsurface Systems

After the Review Meeting on the 8 February 2006, TSC a requested an NPV analysis of the sites where either a sub-surface or surface irrigation system could be used. The analysis was to cover a 20 year period. The 3 sites that where reviewed on this basis were

- Arkinstall Park;
- Bogangar Rugby Field;
- Barry Sheppard Oval and Round Mountain Pony Club.

The comparison has been carried out assuming the recycled water quality is suitable for uncontrolled public access as defined under the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation.* At present this is not the case, and additional treatment will be required to ensure the recycled water is of sufficient quality. Any cost associated with additional treatment, whether it is a Membrane Filter, UV or additional chemical dosing have not been included in the analysis and will increase the NPV. These costs will only be applicable the surface irrigation systems.

Table 7.4 shows the direct comparative cost for the 3 options investigated. The full breakdown is in Appendix G.

Table 7.4 Surface/Subsurface NPV Analysis

OPTION SUMMARY	Surface NPV	Subsurface NPV
Arkinstall Park	$ 3,249	$ 3,258
Barry Sheppard Oval	$ 3,637	$ 3,617
Bogangar Rugby Club	$ 1,732	$ 1,658
TOTAL	$ 8,618	$ 8,533

7.5 Caution on Use of Capital and Operating Cost Estimates

The costs quoted in this section and elsewhere in this report are preliminary cost estimates for the purposes of comparing scheme options based on concept designs outlined in this report. They are sufficiently accurate for these stated purposes. However, depending on the order of accuracy required and amount of contingency to be included functional design or detailed design is required if cost estimates are to be used for accurate budgeting purposes.

8. Implementation Strategy

8.1 Further Investigations

More detailed assessment for TSC Recycled water Opportunities is required of the following:

1. Recycled water demands for all customers.
2. A construction review should be undertaken to inspect recycled water pipeline routes and possible storage tank locations. This should identify and report on any serious barriers to construction including existence of utilities and services, existence of acid sulphate soils, high watertables, etc.
3. At the same time as item 2 above, the proposed pipeline alignments will need to be walked by qualified environmental and archaeological/heritage specialists (also familiar with the area) to assess and report on the potential impacts of any pipeline on native or historically important flora and fauna, aboriginal sites and other sites of potential archaeological significance.
4. Carry out water balance, nutrient and salt loading calculations for all proposed parks and reserves based on NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation (Oct 2004)*, including the "Recycled water Irrigation Model" (ERIN) outlined in the guidelines. Alternative irrigation water balance models should be considered including "Model for Effluent Disposal Using Land Irrigation (MEDLI) or other models that may be approved by NSW DEC. Any water balance modelling should be undertaken to determine the range of application rates throughout the year including winter, as well as long-term sustainable irrigation rates taking into account soil and groundwater factors and vegetation impacts.
5. Recycled water pumping system requirements should be verified based on review of irrigation water demands, pipeline routes and capacities from the investigations 1 to 4 above.
6. Further assessment of the need for a buffer storage downstream of the proposed chlorine contact tank (CCT) at the new Kingscliff STP, to prevent excessive drawdown of the CCT is required.
7. Investigation into the suitability of the Banora Point outfall main to act as the irrigation storage for both Arkinstall Park and the Memorial Gardens. The report should investigate any required modifications to the outfall structures and directly compare with the on site storage options. Reference should be made to the Banora Point Outfall Study currently being undertaken and any necessary allowances made.
8. Investigation into the suitability of the Hasting Point final effluent lagoon act as the irrigation storage for all the Hastings Point irrigation options. The investigation should focus on the effects to the process and make recommendations as to maximum drawn downs.
9. Other more detailed engineering, planning, environmental including part IV planning approval, vegetation, social and economic impact assessments to enable the project to proceed the design and implementation phase.
10. A review of the irrigation proposals in line with any other Council department redevelopment plans is required, i.e. Arkinstall Park is to be redeveloped as a regional sports centre and this may reduce the required irrigation demand.

Completion of the above further investigations should be as part of a consultation and functional design phase prior to approval, detailed design and tendering phases. Consultation to include designer, environmental, EPA, DIPNR, DoH, DEUS and end users along with the local community,

8.2 Approvals Phase

The two primary approval processes for the TSC Recycled water are through TSC as the planning authority for Development Consents and EPA (now incorporated into DEC) for possible Environment Protection Licences. Note that TSC is the relevant regulatory authority for the use of recycled water at the private customer sites – unless EPA considers a licence is necessary. Given TSC is the owner and operator of the recreational and sports fields, then EPA would become the appropriate regulatory authority to assess and approve recycled water.

8.2.1 TSC

TSC is the responsible authority for Development consents for the recycled water scheme infrastructure including:

- Pipelines including road reserves and crossings as well as canal crossings;
- Pump station
- Storage tanks, dams, irrigation pump stations and other significant infrastructure on parks, reserves and private customers sites;
- Removal/disturbance and restoration of important vegetation and archaeological artifacts associated with construction works.

Further details of subsequent investigation and design phases are given in Appendix H.

8.2.2 DEC (incorporating EPA)

NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation (Oct 2004)* provides an outline of the possible approval requirements for recycled water irrigation schemes that are not on the STP site. Unless specifically required to be licensed under the *Protection of the Environment Operations Act 1997* (POEO Act), an environment protection licence is not likely to be required for recycled water irrigation schemes operating in accordance with the DEC guideline.

Recycled water irrigation is not specifically listed in the Schedule 1 of the POEO Act, therefore it does not generally have to be licensed. If the recycled water is used or stored on a site not directly associated with the STP, then the recycled water scheme proposal needs to be characterised to determine if it is allowed and whether development consent is required under the Local Environment Plan (LEP).

Prior to any detailed design and environmental investigations, it is recommended that the proposal be discussed at these early planning stages with relevant authorities including:

- DEC incorporating NSW EPA;
- DIPNR;
- NSW Health;
- Workcover NSW.

In addition to the above authorities, pre-consultation should be undertaken with potential private customers as identified in this Concept Design including:

- Chinderah Golf Course management (Jeff Holloway, Golf Operations Manager)
- Chinderah Ti Tree Plantation
- Hasting Point Turf Farm (John and Robert Commens).

Pre-consultation with the local community including residents adjacent to the potential recycled water use sites and park users is required as part of the application processes to the relevant authorities. Early pre-consultation is fundamental to demonstrating the social and environmental benefits of recycled water use and potable water substitution and obtaining public support for this recycled water scheme.

8.3 Design and Tendering

Options for the detailed design and tendering phases include:
Pipelines, storage tanks and pumping stations:

(i) Functional Design then Detailed Design and Tendering, or
(ii) Functional Design then Design and Construct contract documentation and tendering;

New irrigation systems:

(i) Functional Design then Design and Construct contract documentation and tendering

8.4 Construction Program

Estimated time to complete design is about 6–9 months.

EPA and TSC Planning approvals are likely to take at least 3 months.

Tendering typically takes 2-3 months, including evaluation and contract award.

Construction should take at least 6–12 months but is heavily dependent on the structure of the contract. The timescale could be reduced if each site was individually tendered.

Therefore, TSC should allow at least 18-24 months for the planning, approval, detailed design and construction and commissioning phases to be completed. Allowance for a 24 month program for TSC Recycled water Opportunities is recommended.

8.5 Operation and Maintenance

8.5.1 Recycled Water Supply Infrastructure

The supply pipelines and pumps will require dedicated staff for operation and maintenance. These could be existing STP plant operators, but our experience is that new specifically trained and dedicated recycled water supply staff are required to properly manage (e.g. schedule flow demands) and maintain the recycled water scheme and all the potential customers drawing from the system.

The respective owners would manage the private pipelines, whilst TSC should remain responsible for the irrigation pumping stations for an annual contract fee.

8.5.2 Recycled Water Site Practices

For all sites proposing to utilise recycled water for irrigation, there will need to be changes to watering practices and public access restrictions. This applies to all the public recreational parks and sports fields as well as for private Customers sites such as the Chinderah Golf Course, Chinderah Ti Tree Plantation and Hastings Point Turf Farm. To avoid exposure of humans to the recycled water, a range of site controls and best practice measures will need to be implemented in accordance with Department of Environment and Conservation (NSW) *Environmental Guidelines Use of Effluent by Irrigation* (DEC, October 2004).

New site practices and works should include:

- Night-time watering for surface irrigation applications (irrigation during times of no public access, and timed to finish 4 hours before public access to the site);
- Possible sub-surface irrigation to avoid public exposure and thereby allowing watering at any time;
- Signs stating for example: "*Warning, Recycled Water in Use – Do Not Drink & Avoid Exposure to Irrigation Sprays*";
- Adequate setbacks to site boundaries and waterways from irrigation areas;
- Soil and groundwater monitoring to check for impacts on soils and seepage to groundwater;
- New OH&S working practices for TSC parks and reserves operators and contractors;
- Color coding of pipe mains and irrigation, laterals, above ground taps, tanks, pumps, pumpsheds, etc

Monitoring of the following will also be needed to check customer performance and impacts of recycled water use:

- Recycled water quality from the STP's and within the pipeline: by TSC STP operators;
- Soil conditions at each recycled water site (fertility, salinity, sodicity, acidity, etc);
- Watertables and groundwater quality in areas of high unconfined aquifers (applicable to most of the recycled water sites); and
- vegetation impacts –

All of the above best management practices and new works should be documented in an environmental/site management plan addressing all of the DEC guideline requirements.

9. Conclusions and Recommendations

9.1 Conclusions

This report provides an outline of the concept design options and costs for recycled water opportunities from four sewage treatment plants under the operation of TSC, to several public parks, sporting fields, reserves and private lands in the Shire. This report has demonstrated the technical feasibility of recycled water supply for irrigating these facilities.

The key drivers for this project are the EPA recommendations that effluent from the sewage treatment plants should be recycled for beneficial reuse, to reduce the nutrient load in the waterways and the need for Council to extend its drinking water supplies by substituting potable water where it is used for irrigation purposes.

Progressive implementation of recycled water schemes will deliver clear environmental benefits including reduction in nutrient loads and other pollutants currently discharged to Tweed River. Future STP licence requirements set by the EPA may be influenced by the extent of recycled water achieved and the resultant reduction in pollutant loads in the river.

The establishment of recycled water schemes as outlined in this report, should enable Tweed Shire Council to make proactive steps towards satisfying the future directions of DEC and other regulatory agencies.

The key conclusions of these Concept Designs of Options studies are as follows:

1. The construction of new recycled water pipelines along road reserves should be straightforward due to the relative short lengths of the pipelines.
2. The capacities of the recycled water pipelines are dependent on the following factors:
   - Peak irrigation demands and areas under irrigation on each irrigation site during hot and dry periods;
   - Limited hours of watering determined by 4-hour public access withholding period as specified in NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation*. The time limits on the irrigation are removed with subsurface irrigation systems.

     Note that the NSW EPA Environmental Guidelines: *Use of Effluent by Irrigation* requires a 4 hour withholding period before public access to sites irrigated with recycled water. Therefore, hours of watering will need to be at night time for above ground irrigation systems. These restrictions significantly shorten the available hours to water each park and reserve and have a major impact on peak water demand estimates and the sizing of recycled water supply mains and pump stations, as well as size of possible irrigation pumps and on-site storage tanks. Some of the openly accessible parks and gardens will be restricted to a 4 hour watering period (2300 – 0300) to prevent exposure of the public to recycled water.
3. TSC should consult with and educate the local community (including residents, sports clubs and park users) about recycled water use and install appropriate warning signs to ensure restricted public access during irrigation and the 4 hour withholding period to prevent direct exposure to recycled water. If public access cannot be effectively restricted, then Council will need to consider higher levels of treatment and disinfection of the recycled water to enable unrestricted irrigation uses on the parks and reserves. The costs estimated

in this report do not include costs of higher level of treatment, which would need to include tertiary treatment and filtration (eg. filter or membranes, and higher levels of disinfection). Costs of higher levels of treatment can be of the order $1000/ML in the long term.

4. Maximum irrigation demand can be as high as 10 mm/day during heat wave periods but this is only likely to occur for a few days each year. Using this higher rate for design purposes is not considered a cost effective means of pipeline design, because it would result in significant increase in pipe main capacity and costs for very high demands that only occur rarely.
5. Extended dry periods tend to occur in the cooler winter early spring in this sub-tropical location. Therefore, this report assumes a conservative 5 mm/day for concept design as well as 100% of all parks irrigated concurrently over a 4-hour period, where discharge from the STP is allowed.
6. The assessment of recycled water options has examined three key options as well as investigating the 2 main irrigation techniques, surface and sub-surface.
   - **Option 1** – Direct Irrigation using pumping station located at the STPs
   - **Option 2** – Direct Irrigation using pumping station located on site
   - **Option 3** – On-site storage and irrigation pumping station

The diversity of applications means that no single option is applicable for all potential schemes.

7. Where possible, sub-surface systems have been suggested, as they offer significant advantages for public health, timing of the irrigation system operations and can help reduce storage tank sizes. Sub-surface systems are more costly to install, but have lower operational and maintenance cost than the surface spray systems.
8. The pipeline diameters are based on delivery pressures at most irrigation sites of at least 20m, whilst maintaining velocities of over 1 m/s to ensure the pipes remain free from clogging.
9. It is proposed to adopt on-site below ground storage at Arkinstall Municipal Park. The storage is 290 KL, and is required due to the tidal nature of the Banora Point Outfall. The tank has been sized to hold a ½ days irrigation demand and consequently it will need to be filled twice a day on the tide.
10. The Hastings Point combined solution utilises the existing effluent pond at the STP as the storage for the irrigation of all 3 sites. Carefully controlled irrigation times will be implemented to ensure that the pond retains an effective polishing process. When irrigation requirements have been satisfied, then the outfall pumps shall operate as normal.
11. The storages have been costed as below-ground tanks, and therefore effectively doubles the construction costs when compared with the equivalent above-ground tanks. The rationale behind the selected storage is covered in detail within **Section 6** of this report. Below ground storages however, do not require any above ground compound and therefore no significant reduction to the recreational and sports fields. There will need to be access points and therefore several manhole covers will be visible.
12. The financial viability of the schemes depend on connecting large volume recycled water users, such as the Chinderah Golf Course, Arkinstall Municipal Oval, the Barry Sheppard Oval and Round Mountain Sports Club and the Hastings Point Turf Farm.
13. Implementation of the schemes could be spread over a number of financial years to lessen the impact on Council's financial reserves.

9.2 Recommendations

Sub-surface irrigation systems are recommended for the following irrigation sites:

- Arkinstall Municipal Park – from Banora Point STP
- Bogangar Rugby Club – from Hastings Point STP
- Barry Shepherd Oval and Pony Club – from Hastings Point STP

In these cases, subsurface systems offer greater flexibility over irrigation times, reduces the risks to public health, eliminates any need for additional treatment at the STP's and can help reduced the storage tank requirements.

Surface spray irrigation systems are recommended for the following irrigation sites:

- Tweed Heads Memorial Gardens – from the Banora Point STP
  This is due to the ongoing excavations of new graves and the need to minimise underground pipelines.
- Native Plant Nursery - at Uki STP
  This nursery has an existing irrigation system that can be reused for the recycled water with a new rising main branched off the existing rising main to feed directly into this existing irrigation system.
- Eucalyptus Tree plantations - at Tyalgum STP, similar to the system currently used at Uki STP, fed by the existing pump station and rising main.

Recycled Water systems involving transfer pipelines to private end-users are recommended for the following sites:

- Commens Turf Farm – from Hastings Point STP
- Chinderah Golf Course – from the new Kingscliff STP
  Once the new Kingscliff STP is commissioned, the recycled water pipeline could be connected to the Chinderah Golf Course.

Further engineering, planning, environmental, social and economic investigations and consultations are required for any of the recycled water schemes as outlined in **Section 8** of this report and should be undertaken as part of the functional design phase, prior to the detailed design and tendering phases.

Completion of the above further investigations should include pre-consultation with DEC and other relevant regulatory authorities, as well as consultation with the local community, including residents, parks users, sports clubs, etc.

Appendices

List of Appendices

Appendix A TSC Recycled water Opportunities Scheme Maps

List of Figures:

Figure A. 1 – Location Plan


BANORA PONT
FINGAL HEAD
KINGSCLIFF
TYALGUM
HASTINGS POINT
UKI
Innisplain
Hillview
downey
Lamington
Nat Pk
Lamington Plateau
National
Tetrabora
Carool
Park
Tumbulgum
Chillingham
Condong
Cudgen Lake
MURWILLUMBAH
Tyalgum
Oxley
River
Cougal
Mount Warning Nat Pk
Mt Warning
Stoker
Loadstone
Uki
Burringbar
Mount Lion
The Lion
The Risk
Kunghur
Doon Doon
Jerusalem Mountain
Horseshoe Creek
Blue Knob
Nimbin
Peach Mountain
BRUNSWICK HEADS
MULLUMBIMBY

Figure A. 2 – Banora Point STP and Irrigation Sites

Banora Point STP and Irrigation Sites

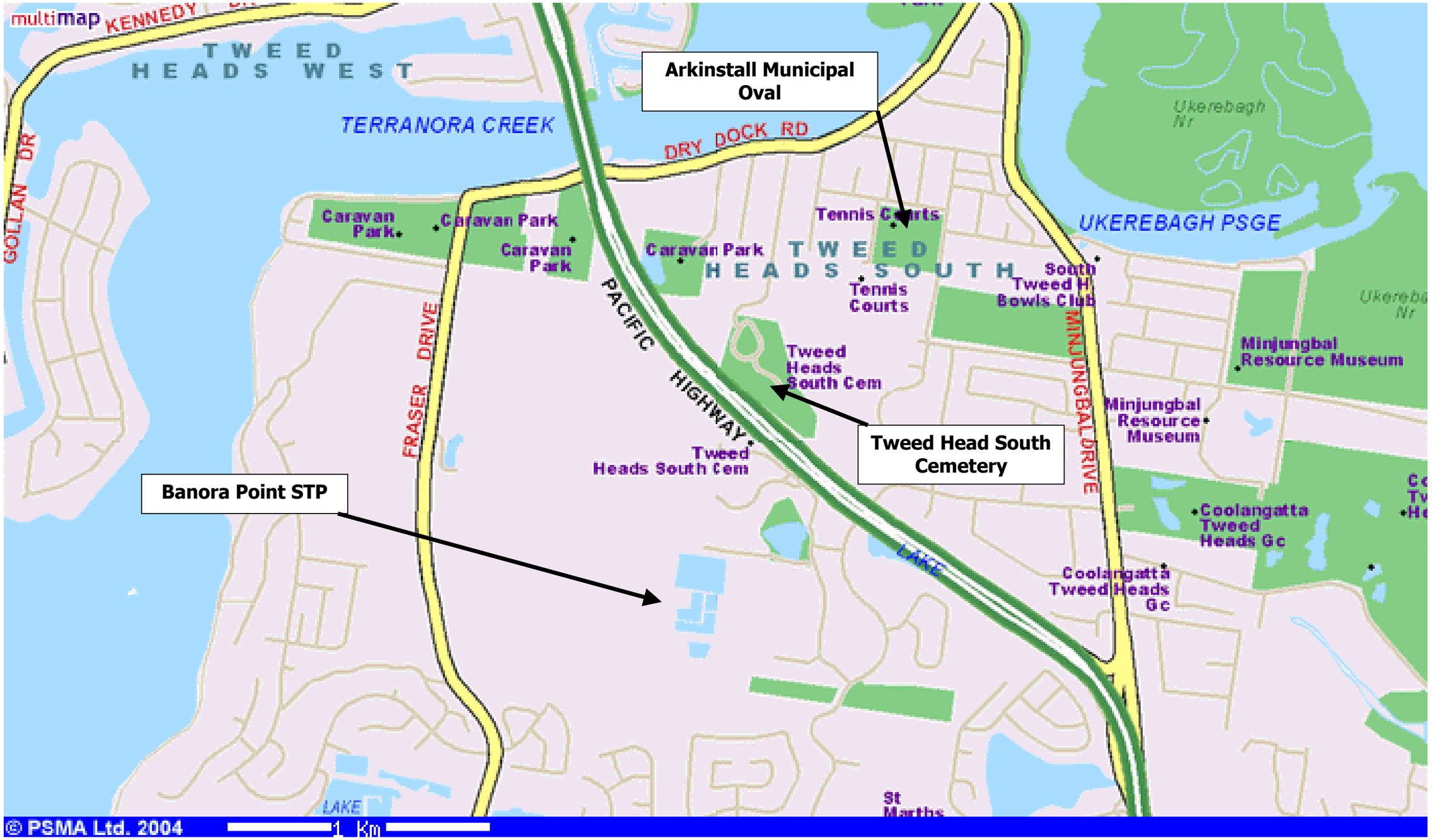


Figure A. 3 – Hastings Point STP and Irrigation Sites

Hastings Point STP and Irrigation Sites

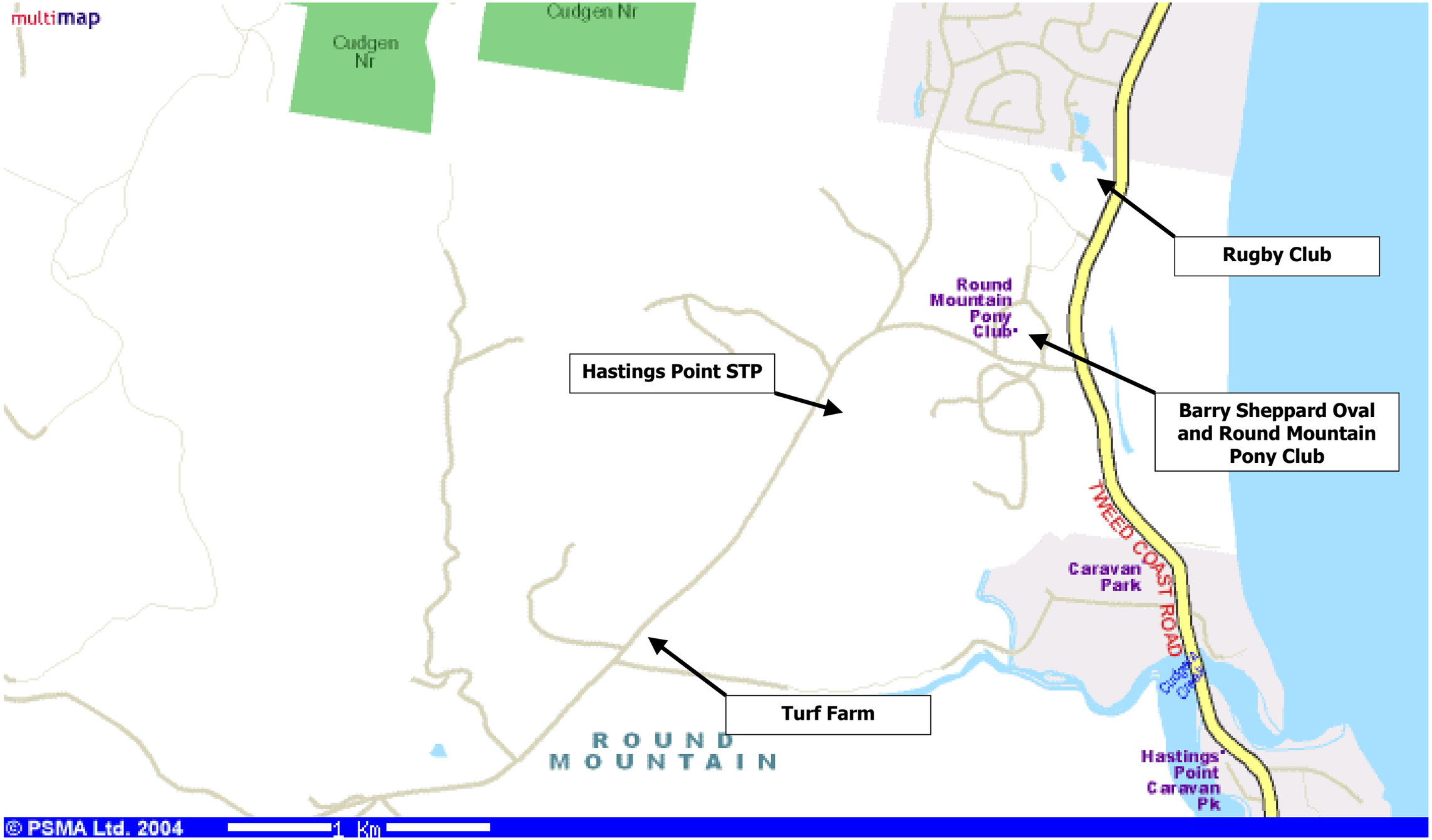


Figure A. 4 – Kingscliff STP and Irrigation Sites

Kingscliff STP and Irrigation Sites

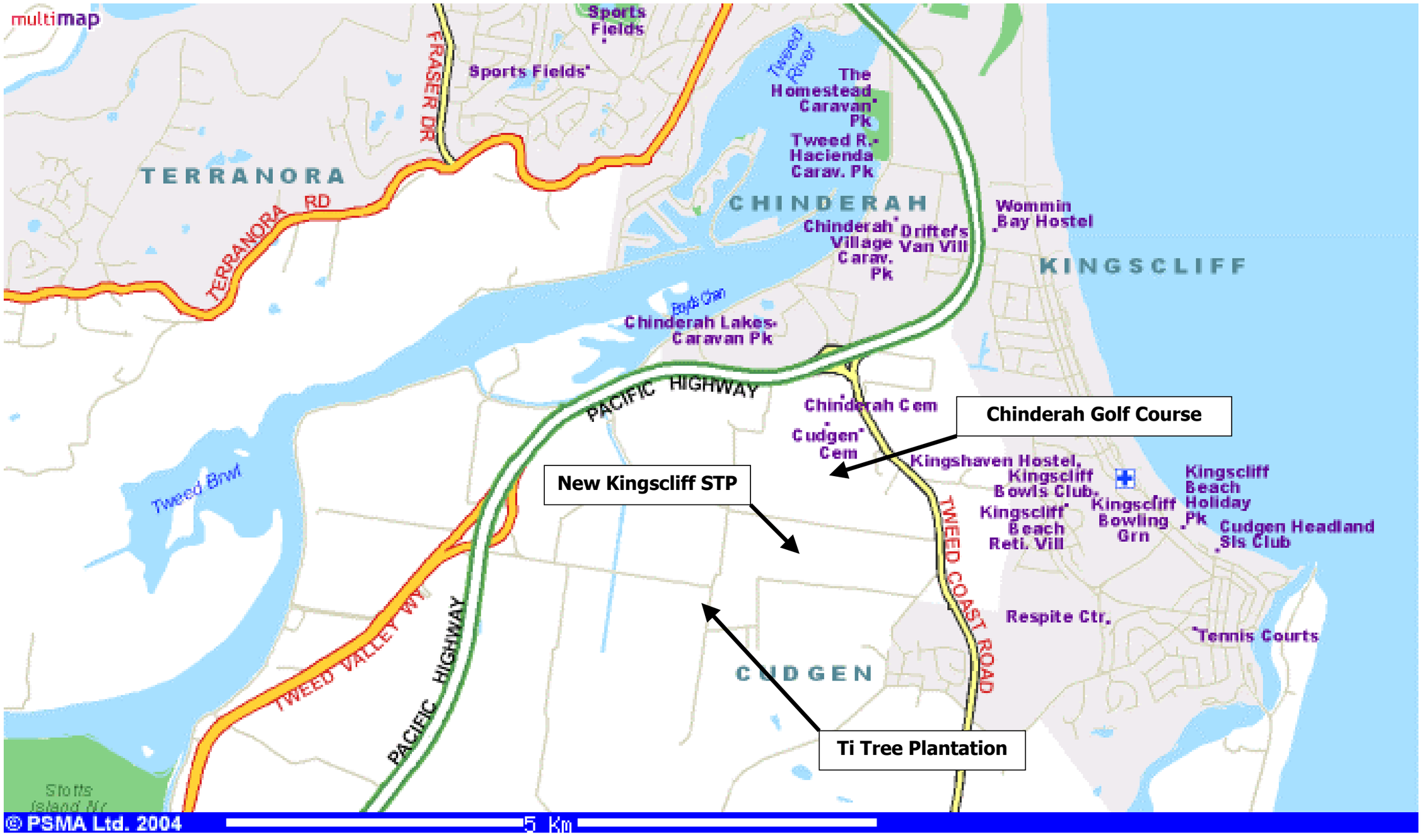


Figure A. 5 – Uki STP and Irrigation Sites

Uki STP and Irrigation Sites

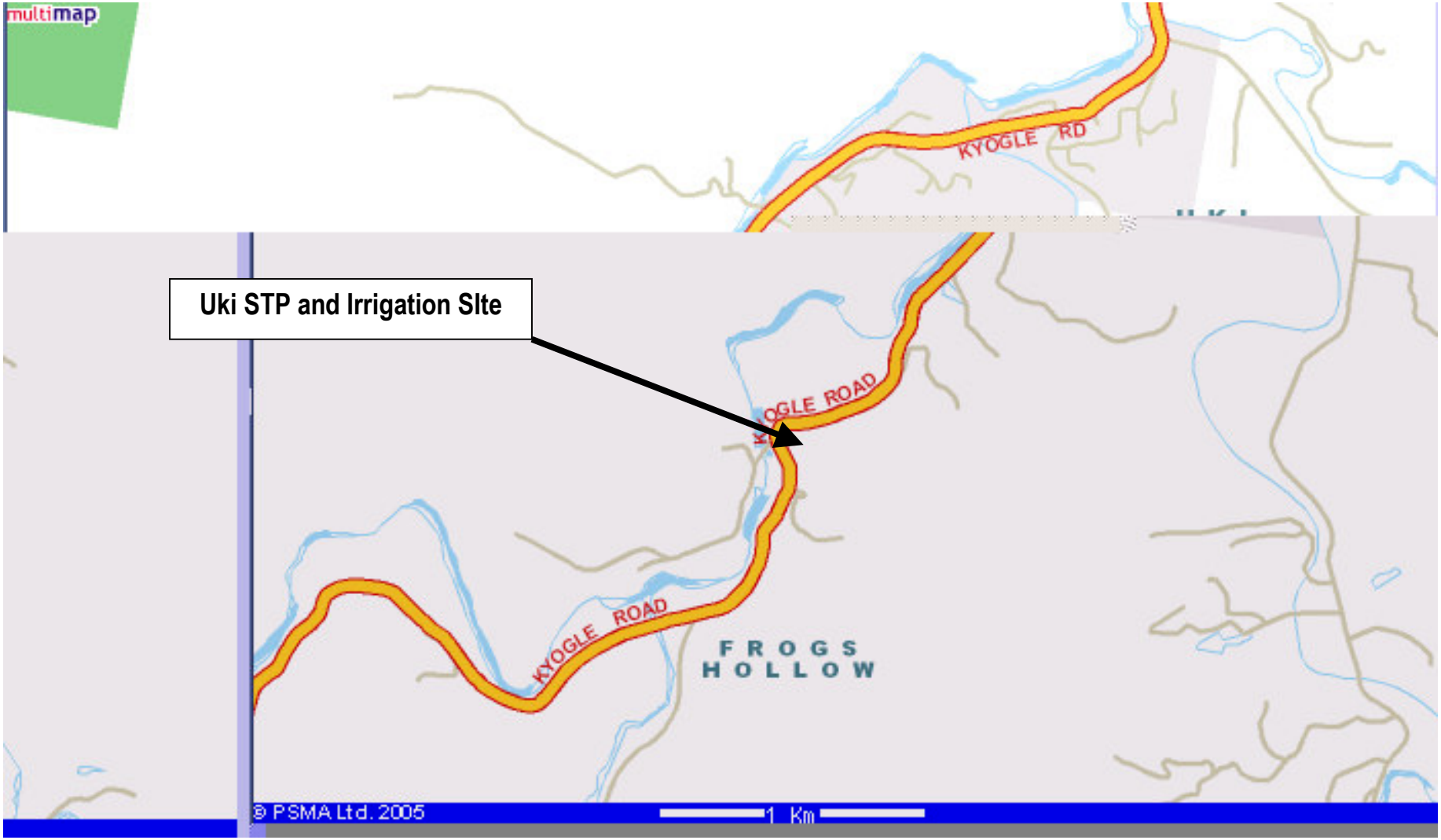
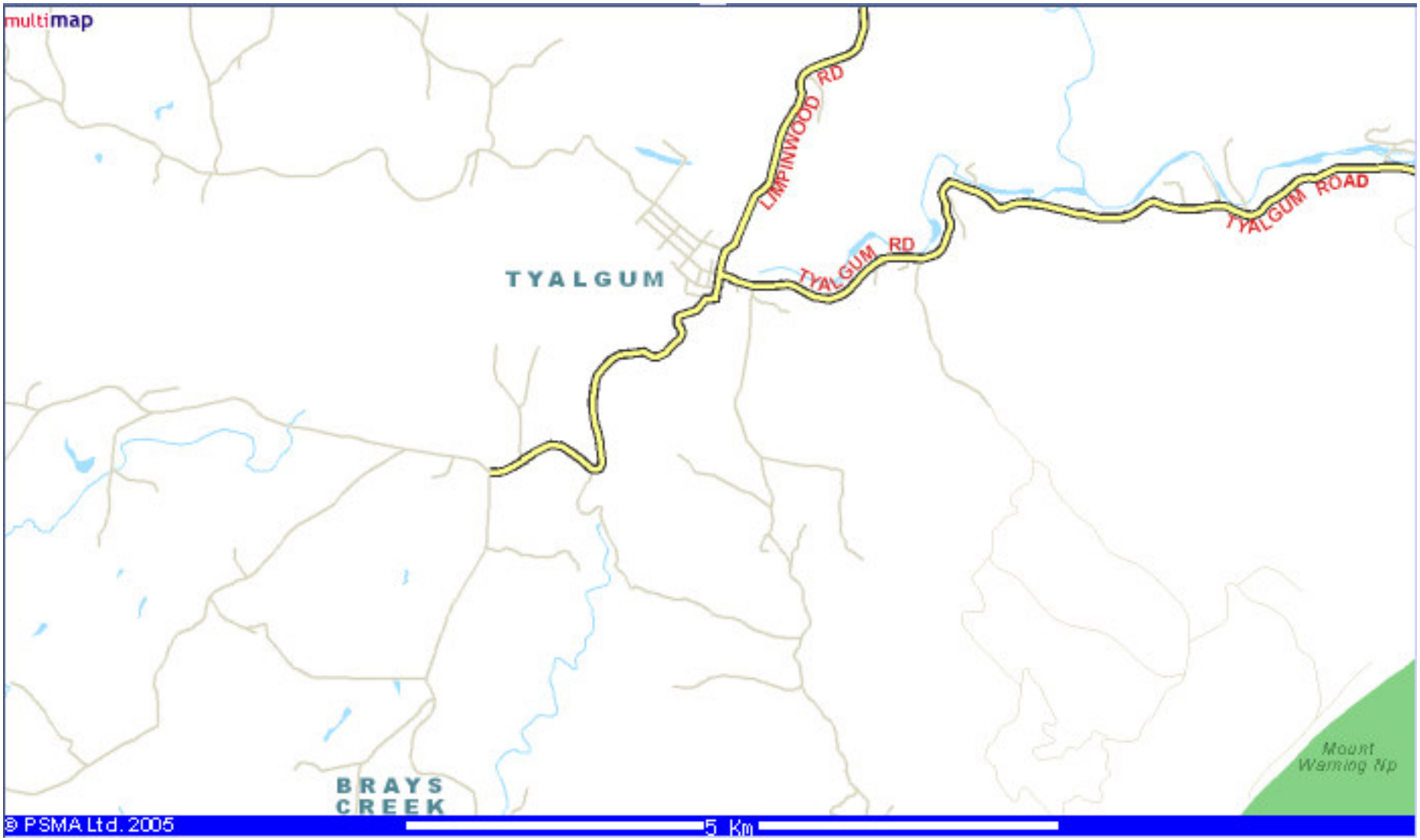


Figure A. 6 – Tyalgum STP and Irrigation Sites

Tyalgum STP and Irrigation Sites



Appendix B Potential Recycled Water Customers & Demands

Appendix B Potential Recycled Water Opportunities Summary

For Irrigation calculations assume maximum demand for recycled effluent is 5mm/day, ie 50kL/hectare/day

WWTP	Potential Reuse Site	Description of Area to Irrigate	Area to Irrigate (m^2)	Area to Irrigate (Hectares)	Potential Peak Daily Demand kL (50kL/hec for sprinkler systm)	Flow l/s assume irrigation over set time	Irrigation Method	Irrigation Requirments (Based on 30m Radius Sprinklers)	Potential Annual Demand ML	Potential Capacity Identified pre-concept ML/Annum	WWTP Capacity
Banora Point	Tweed Heads Crematorium	Several different areas around crematorium of varying size and at different heights	20000.0	2.0	100.0	32.2	Pop-up Sprinkler	FM = 380m, SL = 650m, No. of sprinklers = 30	36.5	175ML/Annum	4200ML/Annum (11.5ML/day)
	Municipal Ovals - Arkinstall Park	Large area with a number of football fields and some surrounding areas including softball field and spectator areas. Also includes tennis and Basketball courts but these are not grass	116050.0	11.6	580.3	40.3	Pop-up Sprinkler	Feed Main (RM) = 1,550m, Sprinkler Lines = 3,000m, No Of Sprinklers = 80	211.8	TBC	
Kingscliff	Chinderah Golf Course	18 hole golf course with driving range and potential to expand with another 9 holes nearby. Effluent to be fed in to on-site storage dam	220000	22	1100.0	76.4	Pop-up Sprinkler	FM = 0,000m, SL = 0,000m, No of Sprs = 312	401.5	70-80ML/Annum for tees and Greens	950ML/Annum (2.6ML/day)
	Chinderah Ti-Tree	Ti-Tree plantation near to new STP site	521000	52.1	2605.0	180.9	Pop-up Sprinkler (Unsure if this will be effective)	FM = 4,370m, SL = 10,800m, No of Sprs = 305	950.8	Combined with GC total 300ML/Annum	
Hastings Point	Turf Farm	Several areas dedicated to growing new grass for commercial use	10,100	10.1	505.0	35.1	Pop-up Sprinkler	FM = 1,625m, SL = 1,500m, No of Sprs = 50	184.3	2ML/day at capacity but not all can be recycled effluent	650ML.Annum (1.8ML/day)
	Barry Sheppard Pony Club	Llarge open space public parks and a pony club area.	115000	11.5	575.0	39.9	Pop-up Sprinkler	FM = 1,595m, SL = 2,750m, No of Sprs = 90	209.9	Combined with Turf Farm, potential 200ML/year	
	Rugby Club	Rugby Fields	30000	3	150.0	10.4	Pop-up Sprinkler	FM = 1,595m, SL = 2,750m, No of Sprs = 90	54.8		
Uki	Nursery	Small area approximately 20m by 20m with plants and seedlings in pots watered by either overhead drip feed or spray depending on age and size of plants	400	0.04	3kL - based on 25mm feed main, plus number and type of sprinklers already installed with individual sprinkler flow rate	1ML	Pop-up Sprinkler Already installed	FM = 75m	1.1	TBC	600EP
	Currumbin Sanctuary Eucalyptus Trees	Eucalyptus trees already currently watered therefore not part of this project	NA	NA	NA		NA	NA	NA	NA	NA
Tyalgum	WWTP grounds with potential for Eucalyptus Trees	Irrigation system already in place connected to	40000	4	200.0		Pop-up Sprinkler	FM = 200m SL = 500m	14.6	TBC	20ML/Annum

Appendix C Potential Recycled Water Site Summary Sheets

This Appendix contains a summary of Potential Recycled Water Irrigation Sites, key site features, public access and recycled water management issues important to the assumptions behind the recycled water demand calculations and concept design.

List of Tables:

Table C.1 Banora Point, Arkinstall Municipal Oval – Key Site Features

Recycled Water Use Purposes	*Sport and Recreational Fields – (Grass)*
Existing Water Sources (Potable, Bore, Other)	*Potable on 1 No Football Field*
Total Property Area (Ha)	*11.6*
Potential Recycled Water Irrigation Area (Ha)	*11.6*
Maximum Daily Recycled Water Use (Ml/day)	*0.58*
Average Annual Recycled Water Use (Ml/Year)	*212**
Recycled Water Watering Times	*Anytime (only with subsoil irrigation)*
Peak Flows (l/s)	*40.29 (based on 4 hour irrigation time)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*Below Ground Reinforce Concrete Tank (0.29)*
Method(s) of Irrigation	*Subsoil Irrigation*
Soil Profile/Types (topsoil & subsoil)	*Billinudgel (bi) and Kingscliff variant (kib).*
Adjacent Sensitive Land Uses	*Residential to the North and South Sides. Schools to the East and West.*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	*Drainage outlet along the full length of south side boundary to Creek.*
Public Access (Hrs of Opening)	*Unrestricted 24 hours.*

* Based on 5mm Irrigation figure - (Average Daily Rainfall per month – Daily Evaporation.) The maximum irrigation on any given day is 5mm even if more is required. The figure does not take into account any evapotranspiration or soil conditions. Rainfall and evaporation figures are from data provided by Bureau of Meteorology.

Table C.2 Banora Point, Tweed Heads Cemetery – Key Site Features

Recycled Water Use Purposes	*Memorial Gardens*
Existing Water Sources (Potable, Bore, Other)	*Potable*
Total Property Area (Ha)	*2.2 Ha*
Potential Recycled Water Irrigation Area (Ha)	*1.9 Ha*
Maximum Daily Recycled Water Use (Ml/day)	*100 KL/day*
Average Annual Recycled Water Use (Ml/Year)	*30 Ml/yr*
Recycled Water Watering Times	*1900 to 0300*
Peak Flows (l/s)	*32 l/s*
Type of Recycled Water Storage Tank & Capacity (Ml)	*100KL in Wet Well*
Method(s) of Irrigation	*Surface Spray*
Soil Profile/Types (topsoil & subsoil)	*Billinudgel (bi) and Kingscliff variant (kib).*
Adjacent Sensitive Land Uses	*Residential to North, East and South, area includes Cemetery*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	*Surface drainage to Terranora Creek 500m away*
Public Access (Hrs of Opening)	*0730 to 180 to*

.

Table C.3 Hastings Point, Rugby Club – Key Site Features

Recycled Water Use Purposes	*Rugby Playing Fields (Grass)*
Existing Water Sources (Potable, Bore, Other)	*None*
Total Property Area (Ha)	*3*
Potential Recycled Water Irrigation Area (Ha)	*3*
Maximum Daily Recycled Water Use (Ml/day)	*0.15*
Average Annual Recycled Water Use (Ml/Year)	*55**
Recycled Water Watering Times	*Anytime (only with subsoil irrigation)*
Peak Flows (l/s)	*10.42 (based on 4 hour irrigation time)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*Combined Storage at Hastings Point STP*
Method(s) of Irrigation	*Sub-surface*
Soil Profile/Types (topsoil & subsoil)	*Disturbed Soils / Landfill*
Adjacent Sensitive Land Uses	*Residential to the North and ground water lakes in the vicinity*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	
Public Access (Hrs of Opening)	*Unrestricted 24 hours*

Table C.4 Hastings Point, Barry Sheppard Oval and Round Mountain Pony Club – Key Site Features

	
Recycled Water Use Purposes	*Hockey Fields and Pony Club*
Existing Water Sources (Potable, Bore, Other)	*None*
Total Property Area (Ha)	*11.5*
Potential Recycled Water Irrigation Area (Ha)	*11.5*
Maximum Daily Recycled Water Use (Ml/day)	*0.58*
Average Annual Recycled Water Use (Ml/Year)	*210**
Recycled Water Watering Times	*Anytime (only with subsoil irrigation)*
Peak Flows (l/s)	*49.9 (based on 4 hour irrigation time)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*Combined Storage at Hastings Point STP*
Method(s) of Irrigation	*Sub-surface*
Soil Profile/Types (topsoil & subsoil)	*Kingscliff soil landscape (ki)*
Adjacent Sensitive Land Uses	*None*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	
Public Access (Hrs of Opening)	*Unrestricted 24 hours however site is isolated.*

.

Table C.5 Hastings Point, Turf Farm – Key Site Features

Recycled Water Use Purposes	*Commercial Grass*
Existing Water Sources (Potable, Bore, Other)	*Bore*
Total Property Area (Ha)	*10.1*
Potential Recycled Water Irrigation Area (Ha)	*10.1*
Maximum Daily Recycled Water Use (Ml/day)	*1.0*
Average Annual Recycled Water Use (Ml/Year)	*365*
Recycled Water Watering Times	*Anytime – Private Property*
Peak Flows (l/s)	*35.1 (based on 4 hour irrigation time)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*Combined Storage at Hastings Point STP*
Method(s) of Irrigation	*Reuse Existing Irrigation System*
Soil Profile/Types (topsoil & subsoil)	*Kingscliff variant (kib) and Ophir Glen (og)*
Adjacent Sensitive Land Uses	*None*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	*On Site Ditch*
Public Access (Hrs of Opening)	*None Private Property*

.

Table C.6 Kingscliff, Chinderah Ti Tree Plantation – Key Site Features

	
Recycled Water Use Purposes	*Commercial Ti Tree Plantation*
Existing Water Sources (Potable, Bore, Other)	*None*
Total Property Area (Ha)	*52.1*
Potential Recycled Water Irrigation Area (Ha)	*52.1*
Maximum Daily Recycled Water Use (Ml/day)	*2.61*
Average Annual Recycled Water Use (Ml/Year)	*951**
Recycled Water Watering Times	*Anytime – Private Property*
Peak Flows (l/s)	*180.90 (based on 4 hour irrigation time)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*None*
Method(s) of Irrigation	*None*
Soil Profile/Types (topsoil & subsoil)	*Tweed (Tw) and Tw (b)*
Adjacent Sensitive Land Uses	*None*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	
Public Access (Hrs of Opening)	*None Private Property*

Table C.7 Kingscliff, Chinderah Golf Course – Key Site Features

Recycled Water Use Purposes	*18 Hole golf Course & Driving Range*
Existing Water Sources (Potable, Bore, Other)	*Bore Water & Onsite Catchment Dams (current watering of tees and greens only)*
Total Property Area (Ha)	*22.5*
Potential Recycled Water Irrigation Area (Ha)	*22.1 (for extended 18hole golf course, greens, tees, fairways, driving range)*
Maximum Daily Recycled Water Use (Ml/day)	*1.10*
Average Annual Recycled Water Use (Ml/Year)	*402**
Recycled Water Watering Times	*Overnight: 1900 to 0300*
Peak Flows (l/s)	*76.74 ((based on 4 hour irrigation time)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*6ML dam (proposed)*
Method(s) of Irrigation	*Pop-up spray & hand held hoses*
Soil Profile/Types (topsoil & subsoil)	*Tweed - Landscape Variant (twb)*
Adjacent Sensitive Land Uses	*Rural residential adjacent to south east corner of golf course, 50m from nearest greens/tees.*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	*Drainage to open drain from south west corner (ultimately to Tweed River via open drains)*
Public Access (Hrs of Opening)	*Daylight Hours (dawn to dusk).*

Table C.8 Uki, Nursery – Key Site Features

Recycled Water Use Purposes	*Proposed nursery, (existing Eucalyptus Trees)*
Existing Water Sources (Potable, Bore, Other)	*Potable*
Total Property Area (Ha)	*0.04*
Potential Recycled Water Irrigation Area (Ha)	*0.04*
Maximum Daily Recycled Water Use (KL/day)	*3 KL/day*
Average Annual Recycled Water Use (Ml/Year)	*1Ml/year*
Recycled Water Watering Times	*3 x 20min intervals during day*
Peak Flows (l/s)	*10l/s*
Type of Recycled Water Storage Tank & Capacity (Ml)	*None required, existing 10ML storage dam*
Method(s) of Irrigation	*Small radius spray*
Soil Profile/Types (topsoil & subsoil)	*Plants are in pots*
Adjacent Sensitive Land Uses	*None*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	*Discharge to creek 30m away*
Public Access (Hrs of Opening)	*No public access, only TSC personnel*

Table C.9 Tyalgum – Key Site Features

Recycled Water Use Purposes	*Eucalyptus Tree Plantation*
Existing Water Sources (Potable, Bore, Other)	*Recycled Water on to open paddocks*
Total Property Area (Ha)	*4 Ha*
Potential Recycled Water Irrigation Area (Ha)	*4 Ha*
Maximum Daily Recycled Water Use (Ml/day)	*185KL/day*
Average Annual Recycled Water Use (Ml/Year)	*9Ml/year*
Recycled Water Watering Times	*Anytime*
Peak Flows (l/s)	*33l/s (Using existing pumps 7l/s over 4 areas)*
Type of Recycled Water Storage Tank & Capacity (Ml)	*Not required, existing storage dam onsite*
Method(s) of Irrigation	*Small Radius Surface Spray*
Soil Profile/Types (topsoil & subsoil)	*Low phosphorus sorption rates*
Adjacent Sensitive Land Uses	*None*
Drainage Outlets & Nearest Surface Waters (name & buffer distance)	*Discharge via surface drain to creek 200m away*
Public Access (Hrs of Opening)	*No Public Access, TSC personnel only*

Appendix D Hydraulic Modeling of TSC Recycled water Opportunities Options

This appendix contains the rising main and pump station wetwell spreadsheets that have been used for calculating the sizes of the pumps and pipelines for all the options as discussed in **Section 5**.

List of Figures:

Figure D.1 – Banora Point, Arkinstall Municipal Oval – Rising Main Design

Arkinstall Municipal Oval

Influent Raw Sewage Properties

Liquid Raw Sewage - parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout the plant

Density of liquid	***Dens =***		998.200	kg/m3
Kinematic Viscosity of liquid	***KV =***	***See attached worksheet***	1.00E-06	m2/s
	KVcst =	***KV x 1E6***	1.002	cSt
Head of vapour pressure	***HV =***	***See attached worksheet***	0.238	m liq

Pipeline Details

Pipe Description	PE Rising Main			200	mm NB
Inside Diameter	***Dmm =***	***Use accurate internal diameter from***		208.500	mm
	D =	***Dmm / 1000***		0.209	m
Area	***A =***	***Π / 4 x D²***		0.034	m2 area
Flow	***Q =***			40.290	L/s
				0.040	m3/s
Velocity	***V =***	***Q / A***		1.180	m/sec
Reynolds number	***Re =***	***V x D / KVcst***		2.46E+05	
Pipe Wall Roughness	***k =***	***See attached worksheet D***		3.00E-05	

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.016

hydr gradient ***HG =*** $\lambda \dfrac{x\ 100\ x\ V^2}{D\ x\ 2\ x\ g}$ 0.553 m/100 m

Quantity		AS k value			
1,550.00	m of Pipe length		***x HG / 100***	8.576	m liq
1	x Sudden Enlargement	1.0	***per fitting x V² / 2 / g***	0.071	m liq
4	90 Degree	1.0	***per fitting x V² / 2 / g***	0.284	m liq
0	75 Degree	0.6	***per fitting x V² / 2 / g***	0.000	m liq
2	45 Degree	0.4	***per fitting x V² / 2 / g***	0.057	m liq
1	22.5 Degree	0.2	***per fitting x V² / 2 / g***	0.014	m liq

Sub total	***dP(3.2) =***	***Sum of friction losses***	**9.002**	m liq
Static Head				m
TOTAL HEAD			**9.002**	**m liq**

Taken from Survey

Figure D.2 – Banora Point, Arkinstall Municipal Oval – Pumping Station Design

PUMP SUMP SIZING & SEPTICITY CALC

Project Title: Arkinstall Municipal Oval

Project No:

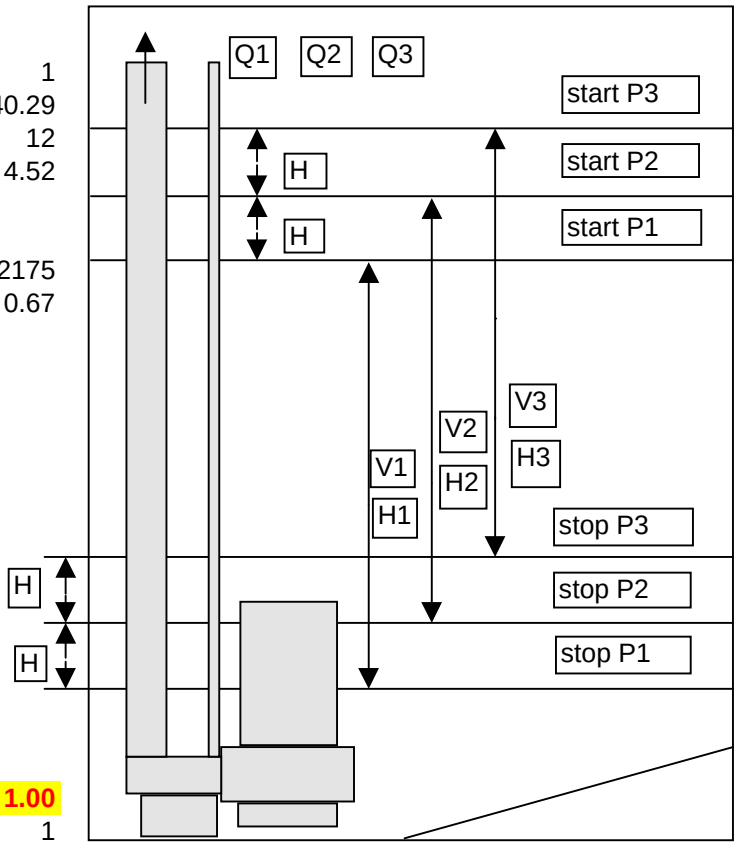
Date: 01-Dec-05

Input Data

Enter No of Pumps:	1
Enter Combined Flowrate (l/s):	40.29
Enter Max. No.of Starts/hr:	12
Enter X-sect. area of sump (m2):	4.52
Total Sump Op. Volume(m3) =	3.02175
Total Op.Height of Sump(m) =	0.67

Discharge Flow Data

Flow/pump Q1,Q2etc	40.29	l/s
Op. vol. V1,V2,etc	3.02175	m3
Op. Height H1,H2 etc	0.67	m
H =	0.15	m



Septicity Calculation

Enter Inflow Rate (l/s): (ADWF)		1.00
Pump On (sec/min) =	77	1
Pump Off (sec/min) =	3022	50
Actual no.of Starts/hr: =		1.16
Enter Length of Rising Main (m)		685
Enter Dia. of Rising Main (m)		0.0813
Rising Main Volume (m3) =		3.56
Retention Time (mins) =	60.78296	1.01 hrs

Figure D.3 – Banora Point, Tweed Heads Cemetery – Rising Main Design

Tweed Crematorium and Memorial Gardens

Jamie Docherty

Influent Raw Sewage Properties

Liquid Raw Sewage - parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout irrigation system

Density of liquid	*Dens =*		998.200	kg/m3
Kinematic Viscosity of liquid	*KV =*	*See attached worksheet*	1.00E-06	m2/s
	KVcst =	*KV x 1E6*	1.002	cSt
Head of vapour pressure	*HV =*	*See attached worksheet*	0.238	m liq

Pipeline Details

Pipe Description	PVC irrigationMain		100	mm NB	
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*	105	mm	
	D =	*Dmm / 1000*	0.105	m	
Area	*A =*	*Π / 4 x D²*	0.009	m2 area	
Flow	*Q =*		9.200	L/s	(assumes worst case scenario 8 sprinklers)
			0.009	m3/s	
Velocity	*V =*	*Q / A*	1.071	m/sec	
Reynolds number	*Re =*	*V x D / KVcst*	1.12E+05		
Pipe Wall Roughness	*k =*	*See attached worksheet D*	3.00E-05		

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.019

hydr gradient $HG = \lambda \dfrac{x\ 100 \times V^2}{D \times 2 \times g}$ 1.067 m/100 m

Quantity		AS k value			
100.00	m of Pipe length		*x HG / 100*	1.067	m liq
1	x Sudden Enlargement	1.0	*per fitting x V² / 2 / g*	0.058	m liq
1	90 Degree	1.0	*per fitting x V² / 2 / g*	0.058	m liq
0	75 Degree	0.6	*per fitting x V² / 2 / g*	0.000	m liq
1	45 Degree	0.4	*per fitting x V² / 2 / g*	0.023	m liq
3	22.5 Degree	0.2	*per fitting x V² / 2 / g*	0.035	m liq
Sub total			*dP(3.2) = Sum of friction losses*	**1.243**	m liq

Static Head	**0.000**	m	reasonably flat over length
Required Head at Sprinkler	**20.000**	m	
TOTAL HEAD	**21.243**	**m liq**	

Figure D.4 – Banora Point, Tweed Heads Cemetery – Pumping Station Design

DETERMINE WET WELL OPERATING VOLUME REQUIRED:

Allowable Number of Starts per Hour:	10		Should be limited to 10 to 12 per hour.
Pump Capacity:	32	L/s	
Control Volume:	2880	L	Determined from 900*Pump Capacity/Starts per hour
	2.88	m^3	As per WSA 04-2001
Is wet well round or other?	round		Enter round or other here (lowercase).
If round, enter diameter:	5	m	If other, leave blank.
If other, enter length of side one:		m	If round, leave blank.
If other, enter length of side two:		m	If round, leave blank.
Area of wet well:	19.6	m^2	
Minimum operating depth required:	0.1	m	
Use operating depth:	0.500	m	

Editable cells
Calculation cells
Recommended quantity cells

DETERMINE WET WELL STORAGE:

Flow Requirements	32	L/s	
Hours allowable down time	1	hrs	Standard response time
Volume Required for daily irrigation	100.00	m^3	Determined from volume inflow over 4 hours
Is wet well round or other?	round		Enter round or other here (lowercase).
If round, enter diameter:	5	m	If other, leave blank.
If other, enter length of side one:		m	If round, leave blank.
If other, enter length of side two:		m	If round, leave blank.
Area of wet well:	19.6	m^2	
Minimum Emergency depth required:	5.1	m	
Use emergency depth:	5.000	m	

DETERMINE WET WELL OPERATING LEVELS:

Inlet Sewer Invert Level:	-0.53	AHD	
Alarm Top Water Level (ATWL):	-0.53	AHD	Should be set to top of wet well or at/below inlet sewer invert level.
Depth from Inlet Sewer Invert Level to ECL:	150	mm	Should be set about 150mm below the inlet sewer invert level.
Emergency Cut In Level (ECL):	-0.68	AHD	This is the level that the standby pump cuts on.
Depth from ECL to Normal Cut In Level (TWL):	100	mm	This can be varied, 100mm is a guideline.
Normal Cut In Level (TWL):	-0.78	AHD	
Depth from Bottom Water Level (BWL) to TWL:	500	mm	Should be equal to or greater than minimum operating depth.
Depth for emergency:	5000	mm	Should be equal to or greater than minimum operating depth.
Bottom Water Level (BWL):	-5.78	AHD	This is the pump cut off level.
Depth from BWL to Wet Well Base:	500	mm	Guidelines:
Wet Well Base Level:	-6.28	AHD	For submersible stations, should be set by pump manufacturer.
			For PC pump stations, need minimum 150mm from wetwell base to bottom of bellmouth.
			Need an additional 300mm from bottom of bellmouth to BWL.

DETERMINE DETENTION TIME:

Pump Capacity:	32	L/s
Pressure Main Length:	275	m
Pressure Main Internal Diameter:	209	mm
Average Dry Weather Flow:	32	L/s
Detention Time:	0.11	hr

If this number is over 2, then means of combating septicity shall be provided.
Detention Time = [(0.025*Pump Capacity) + (0.218*Length*Diameter^2)]/ADWF
As per WSA 04-2001

Figure D.5 – Hastings Point, Rugby Club – Rising Main Design

Rugby Club

Influent Raw Sewage Properties

Liquid Raw Sewage - parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout the plant

Density of liquid	***Dens =***		998.200	kg/m3
Kinematic Viscosity of liquid	***KV =***	***See attached worksheet***	1.00E-06	m2/s
	KVcst =	***KV x 1E6***	1.002	cSt
Head of vapour pressure	***HV =***	***See attached worksheet***	0.238	m liq

Pipeline Details

Pipe Description	PE Rising Main			100	mm NB
Inside Diameter	***Dmm =***	***Use accurate internal diameter from***		104.600	mm
	D =	***Dmm / 1000***		0.105	m
Area	***A =***	Π ***/ 4 x D²***		0.009	m2 area
Flow	***Q =***			10.400	L/s
				0.010	m3/s
Velocity	***V =***	***Q / A***		1.210	m/sec
Reynolds number	***Re =***	***V x D / KVcst***		1.26E+05	
Pipe Wall Roughness	***k =***	***See attached worksheet D***		3.00E-05	

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.019

hydr gradient ***HG =*** $\lambda \dfrac{x\ 100\ x\ V^2}{D\ x\ 2\ x\ g}$ 1.340 m/100 m

Quantity		AS k value			
685.00	m of Pipe length		***x HG / 100***	9.181	m liq
1	x Sudden Enlargement	1.0	***per fitting x V² / 2 / g***	0.075	m liq
2	90 Degree	1.0	***per fitting x V² / 2 / g***	0.149	m liq
0	75 Degree	0.6	***per fitting x V² / 2 / g***	0.000	m liq
2	45 Degree	0.4	***per fitting x V² / 2 / g***	0.060	m liq
2	22.5 Degree	0.2	***per fitting x V² / 2 / g***	0.030	m liq

Sub total	***dP(3.2) =***	***Sum of friction losses***	**9.495**	m liq
Static Head			**5.000**	m Taken from Survey
TOTAL HEAD			**14.495**	**m liq**

Figure D.6 – Hastings Point, Rugby Club – Pumping Station Design

PUMP SUMP SIZING & SEPTICITY CALC

Project Title: Rugby Club Irrigation Pumping Station Wetwell

Project No:

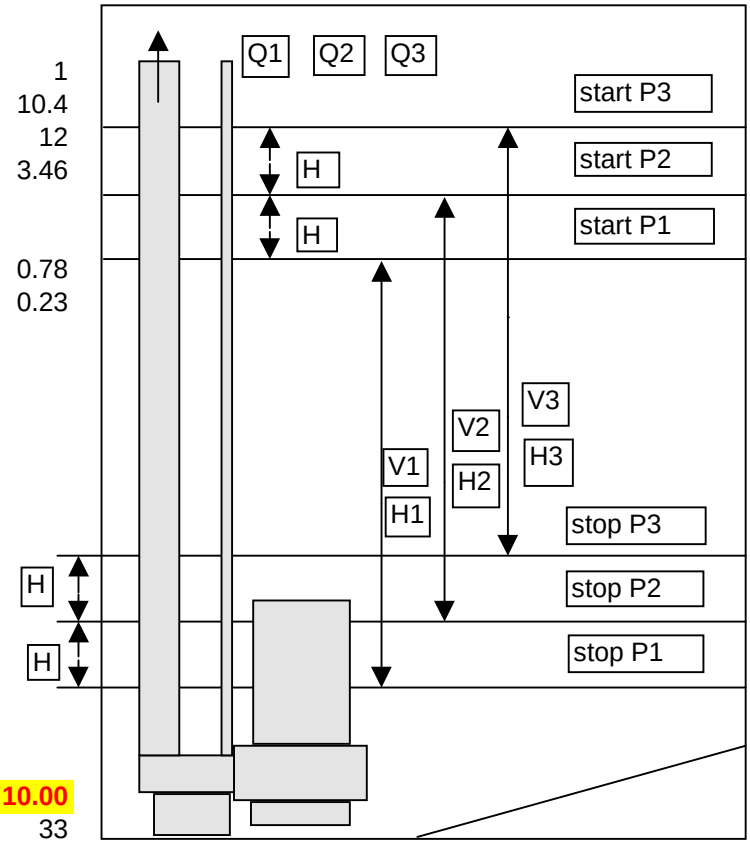
Date: 20-Jan-06

Input Data

Enter No of Pumps:	1
Enter Combined Flowrate (l/s):	10.4
Enter Max. No.of Starts/hr:	12
Enter X-sect. area of sump (m2):	3.46
Total Sump Op. Volume(m3) =	0.78
Total Op.Height of Sump(m) =	0.23

Discharge Flow Data

Flow/pump Q1,Q2etc	10.40	l/s
Op. vol. V1,V2,etc	0.78	m3
Op. Height H1,H2 etc	0.23	m
H =	0.15	m



Septicity Calculation

Enter Inflow Rate (l/s): (ADWF)		10.00
Pump On (sec/min) =	1950	33
Pump Off (sec/min) =	78	1
Actual no.of Starts/hr: =		1.78
Enter Length of Rising Main (m)		685
Enter Dia. of Rising Main (m)		0.0813
Rising Main Volume (m3) =		3.56
Retention Time (mins) =	154.1132	2.57 hrs

Figure D.7 – Hastings Point, Barry Sheppard Oval and Round Mountain Pony Club – Rising Main Design

Barry Sheppard Oval and Round Mountain Pony Club

Influent Raw Sewage Properties

Liquid Raw Sewage - parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout the plant

Density of liquid	*Dens =*		998.200	kg/m3
Kinematic Viscosity of liquid	*KV =*	*See attached worksheet*	1.00E-06	m2/s
	KVcst =	*KV x 1E6*	1.002	cSt
Head of vapour pressure	*HV =*	*See attached worksheet*	0.238	m liq

Pipeline Details

Pipe Description	PE Rising Main			200	mm NB
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*		208.500	mm
	D =	*Dmm / 1000*		0.209	m
Area	*A =*	Π / 4 x D^2		0.034	m2 area
Flow	*Q =*			39.900	L/s
				0.040	m3/s
Velocity	*V =*	*Q / A*		1.169	m/sec
Reynolds number	*Re =*	*V x D / KVcst*		2.43E+05	
Pipe Wall Roughness	*k =*	*See attached worksheet D*		3.00E-05	

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.016

hydr gradient $HG = \lambda \dfrac{x\ 100 \times V^2}{D \times 2 \times g}$ 0.543 m/100 m

Quantity		AS k value				
910.00	m of Pipe length		*x HG / 100*	4.945	m liq	
1	x Sudden Enlargement	1.0	*per fitting x V^2 / 2 / g*	0.070	m liq	
3	90 Degree	1.0	*per fitting x V^2 / 2 / g*	0.209	m liq	
1	75 Degree	0.6	*per fitting x V^2 / 2 / g*	0.042	m liq	
0	45 Degree	0.4	*per fitting x V^2 / 2 / g*	0.000	m liq	
1	22.5 Degree	0.2	*per fitting x V^2 / 2 / g*	0.014	m liq	

Sub total	*dP(3.2) = Sum of friction losses*	**5.279**	m liq	
Static Head		**5.000**	m	Assumed
TOTAL HEAD		**10.279**	**m liq**	

Figure D.8 – Hastings Point, Barry Sheppard Oval and Round Mountain Pony Club – Pumping Station Design

PUMP SUMP SIZING & SEPTICITY CALC

Project Title: Barry Sheppard Oval and Round Mountain Pony Club

Project No:

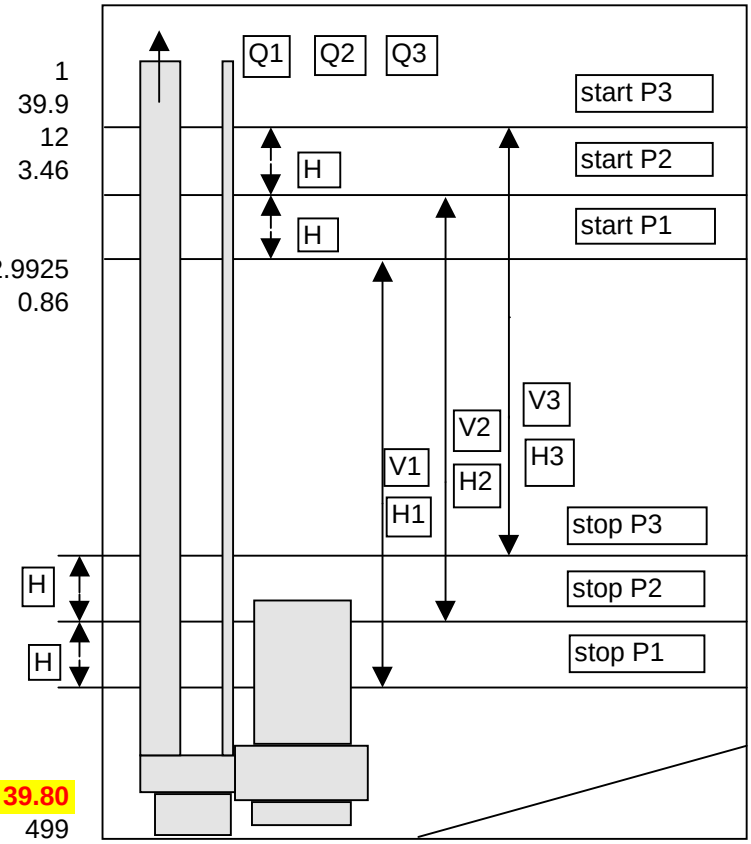
Date: 20-Jan-06

Input Data

Enter No of Pumps:	1
Enter Combined Flowrate (l/s):	39.9
Enter Max. No.of Starts/hr:	12
Enter X-sect. area of sump (m2):	3.46
Total Sump Op. Volume(m3) =	2.9925
Total Op.Height of Sump(m) =	0.86

Discharge Flow Data

Flow/pump Q1,Q2etc	39.90	l/s
Op. vol. V1,V2,etc	2.9925	m3
Op. Height H1,H2 etc	0.86	m
H =	0.15	m



Septicity Calculation

Enter Inflow Rate (l/s): (ADWF)		**39.80**
Pump On (sec/min) =	29925	499
Pump Off (sec/min) =	75	1
Actual no.of Starts/hr: =		0.12
Enter Length of Rising Main (m)		810
Enter Dia. of Rising Main (m)		0.1469
Rising Main Volume (m3) =		13.73
Retention Time (mins) =	2294.105	38.24 hrs

Figure D.9 – Hastings Point, Turf Farm – Rising Main Design

TURF FARM

Influent Raw Sewage Properties

Liquid Raw Sewage - parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout the plant

Density of liquid	*Dens =*		998.200	kg/m3
Kinematic Viscosity of liquid	*KV =*	*See attached worksheet*	1.00E-06	m2/s
	KVcst =	*KV x 1E6*	1.002	cSt
Head of vapour pressure	*HV =*	*See attached worksheet*	0.238	m liq

Pipeline Details

Pipe Description	PE Rising Main			200	mm NB
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*		208.500	mm
	D =	*Dmm / 1000*		0.209	m
Area	*A =*	Π */ 4 x D²*		0.034	m2 area
Flow	*Q =*			35.10	L/s
				0.035	m3/s
Velocity	*V =*	*Q / A*		1.028	m/sec
Reynolds number	*Re =*	*V x D / KVcst*		2.14E+05	
Pipe Wall Roughness	*k =*	*See attached worksheet D*		3.00E-05	

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.017

hydr gradient $HG = \lambda \dfrac{x\ 100\ x\ V^2}{D\ x\ 2\ x\ g}$ 0.428 m/100 m

Quantity		AS k value				
1,500.00	m of Pipe length		*x HG / 100*	6.420	m liq	
1	x Sudden Enlargement	1.0	*per fitting x V² / 2 / g*	0.054	m liq	
4	90 Degree	1.0	*per fitting x V² / 2 / g*	0.215	m liq	
0	75 Degree	0.6	*per fitting x V² / 2 / g*	0.000	m liq	
0	45 Degree	0.4	*per fitting x V² / 2 / g*	0.000	m liq	
2	22.5 Degree	0.2	*per fitting x V² / 2 / g*	0.022	m liq	

Sub total	*dP(3.2) = Sum of friction losses*	**6.711**	m liq	
Static Head		**5.000**	m	Taken from Survey
TOTAL HEAD		**11.711**	**m liq**	

Figure D.10 – Hastings Point, Turf Farm – Pumping Station Design

PUMP SUMP SIZING & SEPTICITY CALC

Project Title: Turf Farm Irrigation Pumping Station Wetwell

Project No:

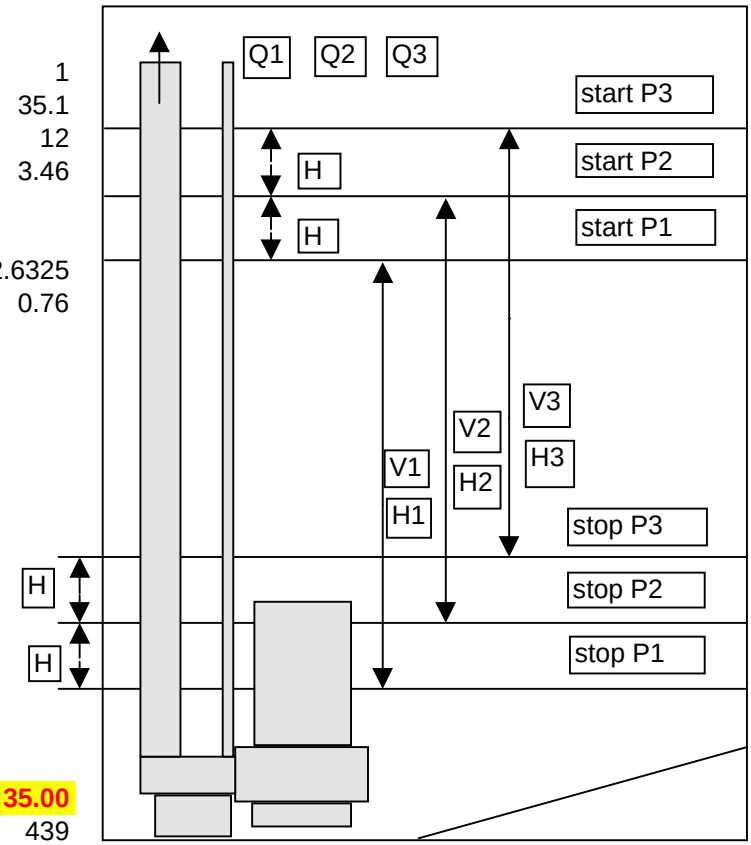
Date: 20-Jan-06

Input Data

Enter No of Pumps:	1
Enter Combined Flowrate (l/s):	35.1
Enter Max. No.of Starts/hr:	12
Enter X-sect. area of sump (m2):	3.46
Total Sump Op. Volume(m3) =	2.6325
Total Op.Height of Sump(m) =	0.76

Discharge Flow Data

Flow/pump Q1,Q2etc	35.10	l/s
Op. vol. V1,V2,etc	2.6325	m3
Op. Height H1,H2 etc	0.76	m
H =	0.15	m



Septicity Calculation

Enter Inflow Rate (l/s): (ADWF)		35.00
Pump On (sec/min) =	26325	439
Pump Off (sec/min) =	75	1
Actual no.of Starts/hr: =		0.14
Enter Length of Rising Main (m)		1500
Enter Dia. of Rising Main (m)		0.2085
Rising Main Volume (m3) =		51.22
Retention Time (mins) =	8561.254	142.69 hrs

Figure D.11 – Kingscliff, Chinderah Golf Course – Rising Main Design

Golf Course

Influent Raw Sewage Properties

Liquid Raw Sewage - parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout the plant

Density of liquid	*Dens =*		998.200	kg/m3
Kinematic Viscosity of liquid	*KV =*	*See attached worksheet*	1.00E-06	m2/s
	KVcst =	*KV x 1E6*	1.002	cSt
Head of vapour pressure	*HV =*	*See attached worksheet*	0.238	m liq

Pipeline Details

Pipe Description	PE Rising Main			300	mm NB
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*		292.000	mm
	D =	*Dmm / 1000*		0.292	m
Area	*A =*	Π */ 4 x D²*		0.067	m2 area
Flow	*Q =*			76.700	L/s
				0.077	m3/s
Velocity	*V =*	*Q / A*		1.145	m/sec
Reynolds number	*Re =*	*V x D / KVcst*		3.34E+05	
Pipe Wall Roughness	*k =*	*See attached worksheet D*		3.00E-05	

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.015

hydr gradient *HG =* $\lambda \dfrac{x\ 100\ x\ V^2}{D\ x\ 2\ x\ g}$ 0.349 m/100 m

Quantity		AS k value			
354.00	m of Pipe length		*x HG / 100*	1.235	m liq
1	x Sudden Enlargement	1.0	*per fitting x V² / 2 / g*	0.067	m liq
9	90 Degree	1.0	*per fitting x V² / 2 / g*	0.602	m liq
0	75 Degree	0.6	*per fitting x V² / 2 / g*	0.000	m liq
2	45 Degree	0.4	*per fitting x V² / 2 / g*	0.053	m liq
0	22.5 Degree	0.2	*per fitting x V² / 2 / g*	0.000	m liq

Sub total *dP(3.2) = Sum of friction losses* **1.958** m liq

Static Head m Taken from Survey

TOTAL HEAD **1.958 m liq**

Figure D.12 – Kingscliff, Chinderah Golf Course – Pumping Station Design

PUMP SUMP SIZING & SEPTICITY CALC

Project Title: Golf Course Irrigation Pumping Station Wetwell

Project No:

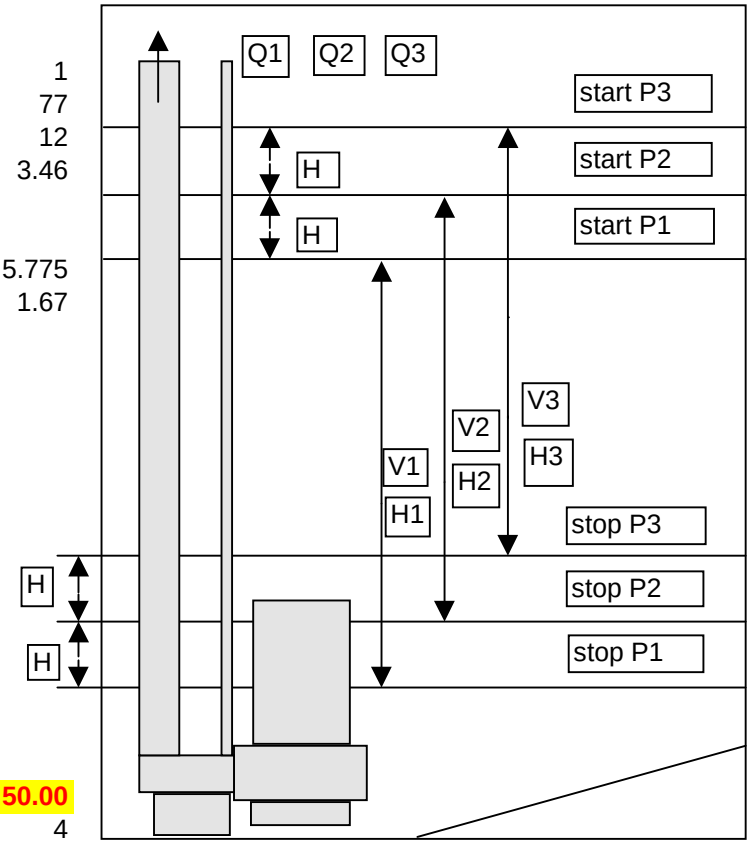
Date: 01-Dec-05

Input Data

Enter No of Pumps:	1
Enter Combined Flowrate (l/s):	77
Enter Max. No.of Starts/hr:	12
Enter X-sect. area of sump (m2):	3.46
Total Sump Op. Volume(m3) =	5.775
Total Op.Height of Sump(m) =	1.67

Discharge Flow Data

Flow/pump Q1,Q2etc	77.00	l/s
Op. vol. V1,V2,etc	5.775	m3
Op. Height H1,H2 etc	1.67	m
H =	0.15	m



Septicity Calculation

Enter Inflow Rate (l/s): (ADWF)		50.00
Pump On (sec/min) =	214	4
Pump Off (sec/min) =	116	2
Actual no.of Starts/hr: =		10.93
Enter Length of Rising Main (m)		354
Enter Dia. of Rising Main (m)		0.292
Rising Main Volume (m3) =		23.71
Retention Time (mins) =	22.53828	0.38 hrs

Figure D.13 – Uki, Nursery – Rising Main Design

UKI Nursery

Jamie Docherty

Tap Water Properties

Liquid Parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout irrigation system

Density of liquid	*Dens =*		998.200	kg/m3
Kinematic Viscosity of liquid	*KV =*	*See attached worksheet*	1.00E-06	m2/s
	KVcst =	*KV x 1E6*	1.002	cSt
Head of vapour pressure	*HV =*	*See attached worksheet*	0.238	m liq

Pipeline Details

Pipe Description	PVC irrigationMain		50	mm NB	**Based on 10kL/day feed**
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*	55	mm	
	D =	*Dmm / 1000*	0.055	m	
Area	*A =*	*Π / 4 x D²*	0.002	m2 area	
Flow	*Q =*		2.870	L/s	See flow calcs
			0.003	m3/s	
Velocity	*V =*	*Q / A*	1.199	m/sec	
Reynolds number	*Re =*	*V x D / KVcst*	6.61E+04		
Pipe Wall Roughness	*k =*	*See attached worksheet D*	3.00E-05		

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \dfrac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.022

hydr gradient $HG = \lambda \dfrac{x\ 100 \times V^2}{D \times 2 \times g}$ 2.894 m/100 m

Quantity		AS k value			
50.00	m of Pipe length		*x HG / 100*	1.447	m liq
1	x Sudden Enlargement	1.0	*per fitting x V² / 2 / g*	0.073	m liq
2	90 Degree	1.0	*per fitting x V² / 2 / g*	0.147	m liq
0	75 Degree	0.6	*per fitting x V² / 2 / g*	0.000	m liq
1	45 Degree	0.4	*per fitting x V² / 2 / g*	0.029	m liq
3	22.5 Degree	0.2	*per fitting x V² / 2 / g*	0.044	m liq
1	Ball valve	0.6	*per fitting x V² / 2 / g*	0.044	m liq

Sub total	*dP(3.2) = Sum of friction losses*	**1.784**	m liq	
Static Head		**7.000**	m	reasonably flat or fall over length
TOTAL HEAD		**8.784**	**m liq**	

SEE PRITNOUTS FOR POSSIBLE PUMPS - ONE SUBMERSIBLE, ONE PROGRESSIIVE CAVITY IN-LINE DRY WELL

Figure D.14 - Tyalgum – Rising Main Design

Tyalgum Pipelines

Jamie Docherty

Tap Water Properties

Liquid Parameters assumed to be similar to that for water @ 20 deg C

These properties are assumed to be consistent throughout irrigation system

Density of liquid	*Dens =*		998.200	kg/m3	
Kinematic Viscosity of liquid	*KV =*	*See attached worksheet*	1.00E-06	m2/s	
	KVcst =	*KV x 1E6*	1.002	cSt	
Head of vapour pressure	*HV =*	*See attached worksheet*	0.238	m liq	

Pipeline Details

Assume worst case scenario of furtherest point from Effluent PS at highest static head, ie far corner of Area 3

Pipe Description	PVC irrigationMain		100	mm NB	**Feeder main**
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*	105	mm	
	D =	*Dmm / 1000*	0.105	m	
Area	*A =*	*Π / 4 x D²*	0.009	m2 area	
Flow	*Q =*		7.800	L/s	Existing Pump Duty
			0.008	m3/s	
Velocity	*V =*	*Q / A*	0.908	m/sec	
Reynolds number	*Re =*	*V x D / KVcst*	9.48E+04		
Pipe Wall Roughness	*k =*	*See attached worksheet D*	3.00E-05		

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \frac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.020

hydr gradient $HG = \lambda \frac{100 \times V^2}{D \times 2 \times g}$ 0.787 m/100 m

Quantity		AS k value			
280.00	m of Pipe length		*x HG / 100*	2.203	m liq
1	x Sudden Enlargement	1.0	*per fitting x V² / 2 / g*	0.042	m liq
3	90 Degree	1.0	*per fitting x V² / 2 / g*	0.126	m liq
0	75 Degree	0.6	*per fitting x V² / 2 / g*	0.000	m liq
1	45 Degree	0.4	*per fitting x V² / 2 / g*	0.017	m liq
3	22.5 Degree	0.2	*per fitting x V² / 2 / g*	0.025	m liq
1	Ball valve	0.6	*per fitting x V² / 2 / g*	0.025	m liq

Sub total *dP(3.2) = Sum of friction losses* **2.438** m liq

Pipe Description	PVC irrigationMain		25	mm NB	**Sprinkler Lateral**
Inside Diameter	*Dmm =*	*Use accurate internal diameter from*	31	mm	
	D =	*Dmm / 1000*	0.031	m	
Area	*A =*	*Π / 4 x D²*	0.001	m2 area	
Flow	*Q =*		0.650	L/s	Maximum flow into lateral
			0.001	m3/s	
Velocity	*V =*	*Q / A*	0.890	m/sec	
Reynolds number	*Re =*	*V x D / KVcst*	2.71E+04		
Pipe Wall Roughness	*k =*	*See attached worksheet D*	3.00E-05		

FRICTION LOSSES

Reynolds number is above 2500, therefore flow may be considered turbulent

Lambda $\lambda = \frac{0.25}{(\log (k / 3.7 / D + 5.74 / Re^{0.9}))^2}$ 0.027

hydr gradient $HG = \lambda \frac{100 \times V^2}{D \times 2 \times g}$ 3.512 m/100 m

Quantity		AS k value			
30.00	m of Pipe length		*x HG / 100*	1.054	m liq
1	x Sudden Enlargement	1.0	*per fitting x V² / 2 / g*	0.042	m liq
0	90 Degree	1.0	*per fitting x V² / 2 / g*	0.000	m liq
0	75 Degree	0.6	*per fitting x V² / 2 / g*	0.000	m liq
0	45 Degree	0.4	*per fitting x V² / 2 / g*	0.000	m liq
1	22.5 Degree	0.2	*per fitting x V² / 2 / g*	0.008	m liq
1	Ball valve	0.6	*per fitting x V² / 2 / g*	0.025	m liq

Sub total *dP(3.2) = Sum of friction losses* **1.129** m liq

Static Head **7.000** m reasonably flat or fall over length

Required Head For Sprinklers **20.000** m

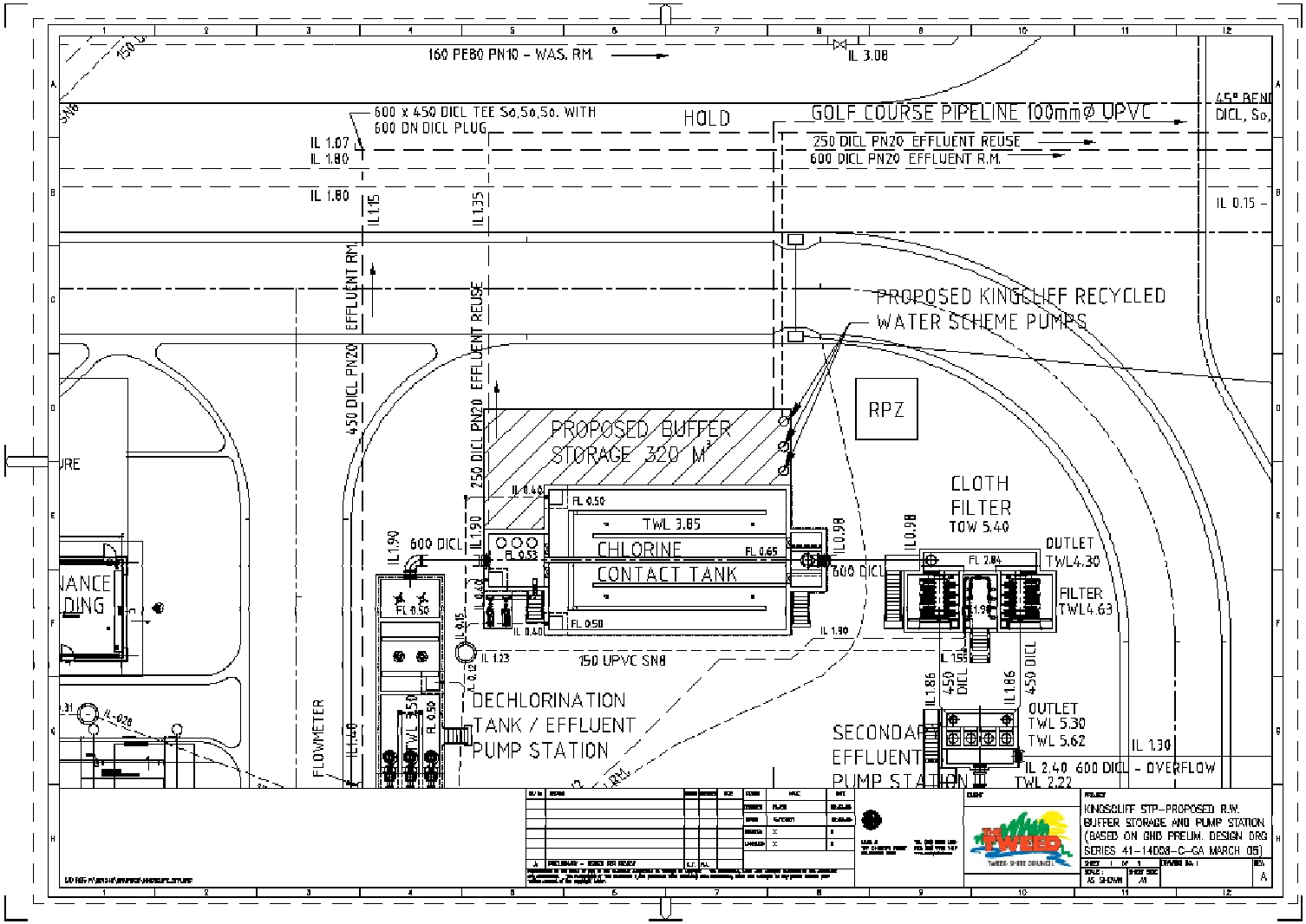
TOTAL HEAD REQUIRED **30.567 m liq**

Appendix E Buffer Storage at Kingscliff STP

Figure E1 in this appendix is a conceptual illustration of where a recycled water buffer storage (320m^3 capacity) could be located to ensure the Chlorine Contact Tank is not drawdown by the recycled water pumps during low STP flows.

This drawing is based on the preliminary design drawings by GHD of the proposed site arrangement of the relocated Kingscliff STP as at 9 March 2005.

Figure E.1 Conceptual Location of Buffer Storage Tank at new Kingscliff STP (NB. for illustration only – not for design)



Appendix F TSC Recycled water Opportunities Concept Layouts

List of Figures:

Figure F.1 – Irrigation Routes From Banora Point STP

IRRIGATION ROUTES FROM BANORA POINT STP – CONCEPT LAYOUT

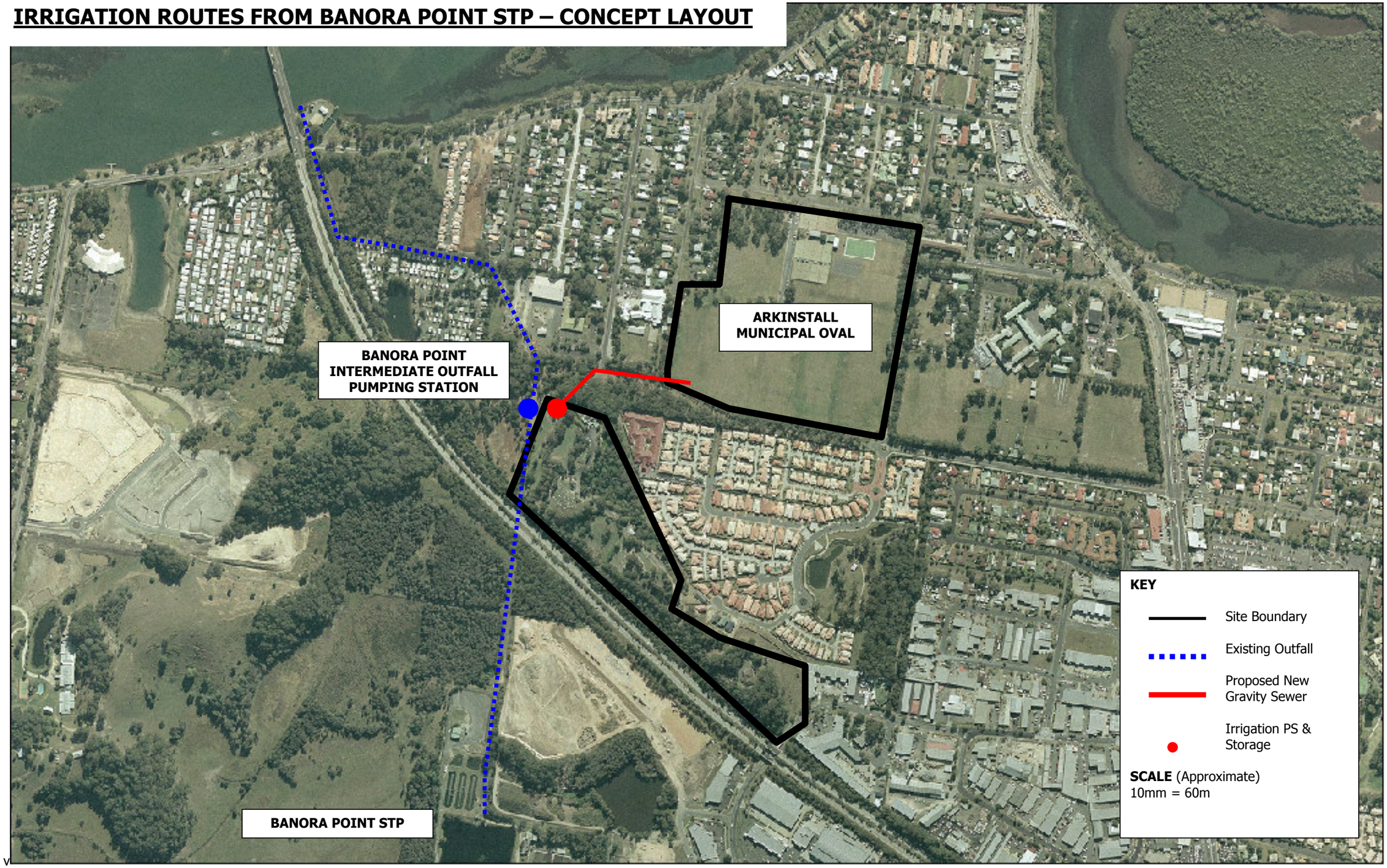


Figure F.2 – Banora Point, Arkinstall Municipal Oval

ARKINSTALL MUNICPAL OVAL – CONCEPT LAYOUT

Figure F.3 – Banora Point, Tweed Heads Cemetery


Existing Effluent Booster Pump Station
Irrigation Feed Pump Station
Tweed Heads Crematorium and Memorial Gardens Concept
Rising Main from Feed PS
Feeder Mains to Irrigation
Areas to be irrigated using subsurface irrigation

Figure F.4 – Irrigation Routes From Hastings Point STP

IRRIGATION ROUTES FROM HASTINGS POINT STP – CONCEPT LAYOUT

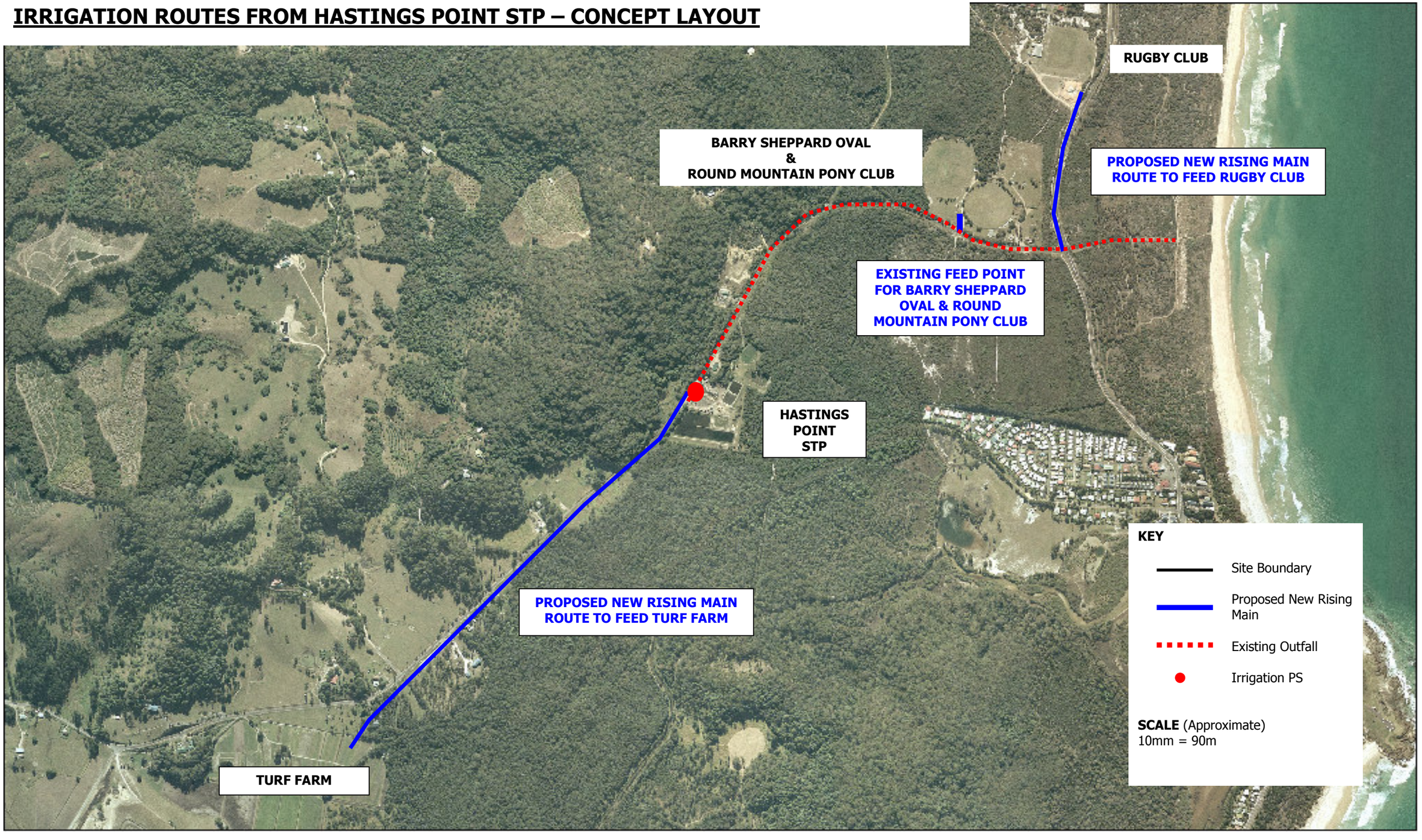


Figure F.5 – Hastings Point, Rugby Club

RUGBY CLUB – CONCEPT LAYOUT

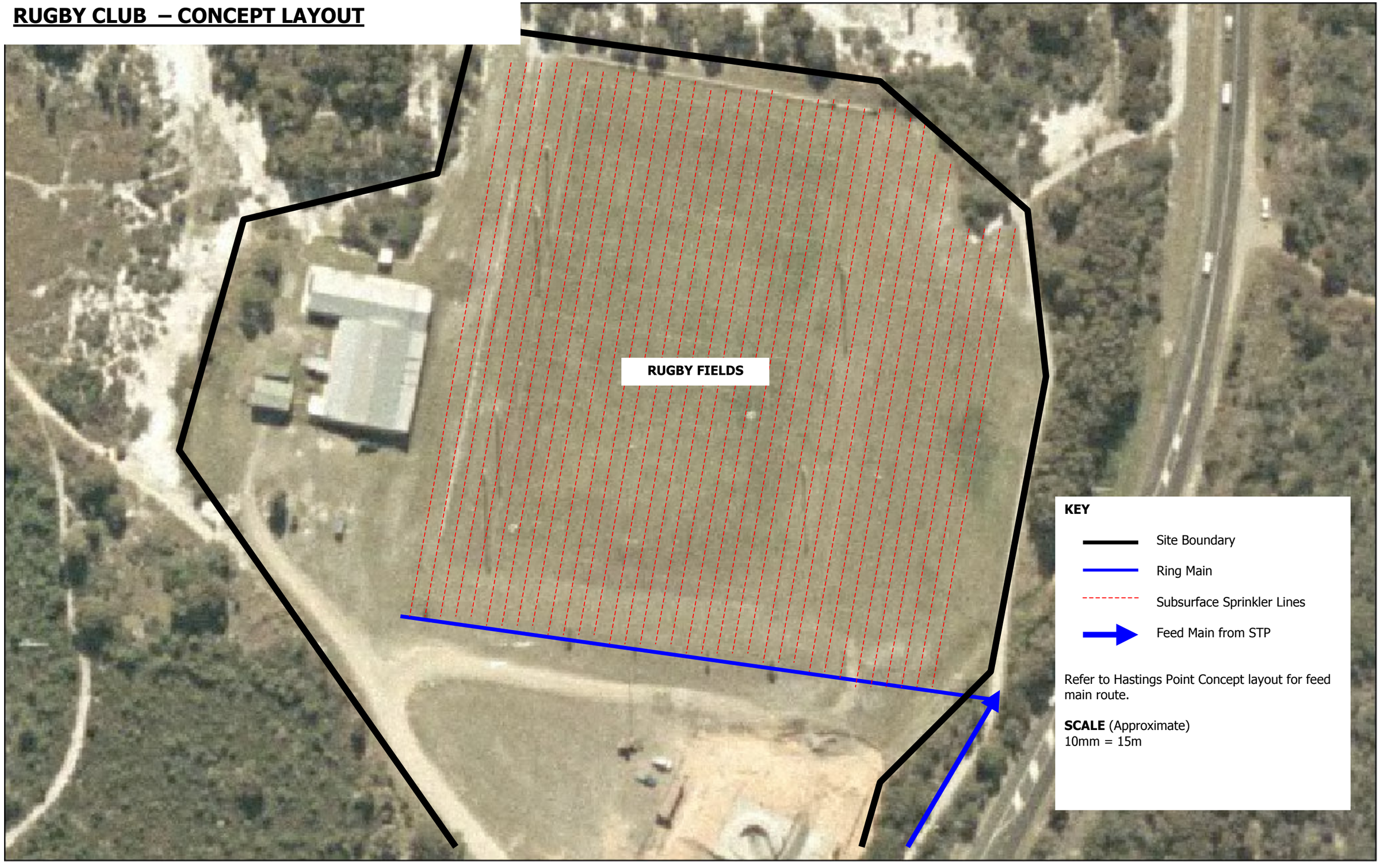


Figure F.6 – Hastings Point, Barry Sheppard Oval and Round Mountain Pony Club

BARRY SHEPPARD OVAL & ROUND MOUNTAIN PONY CLUB – CONCEPT LAYOUT

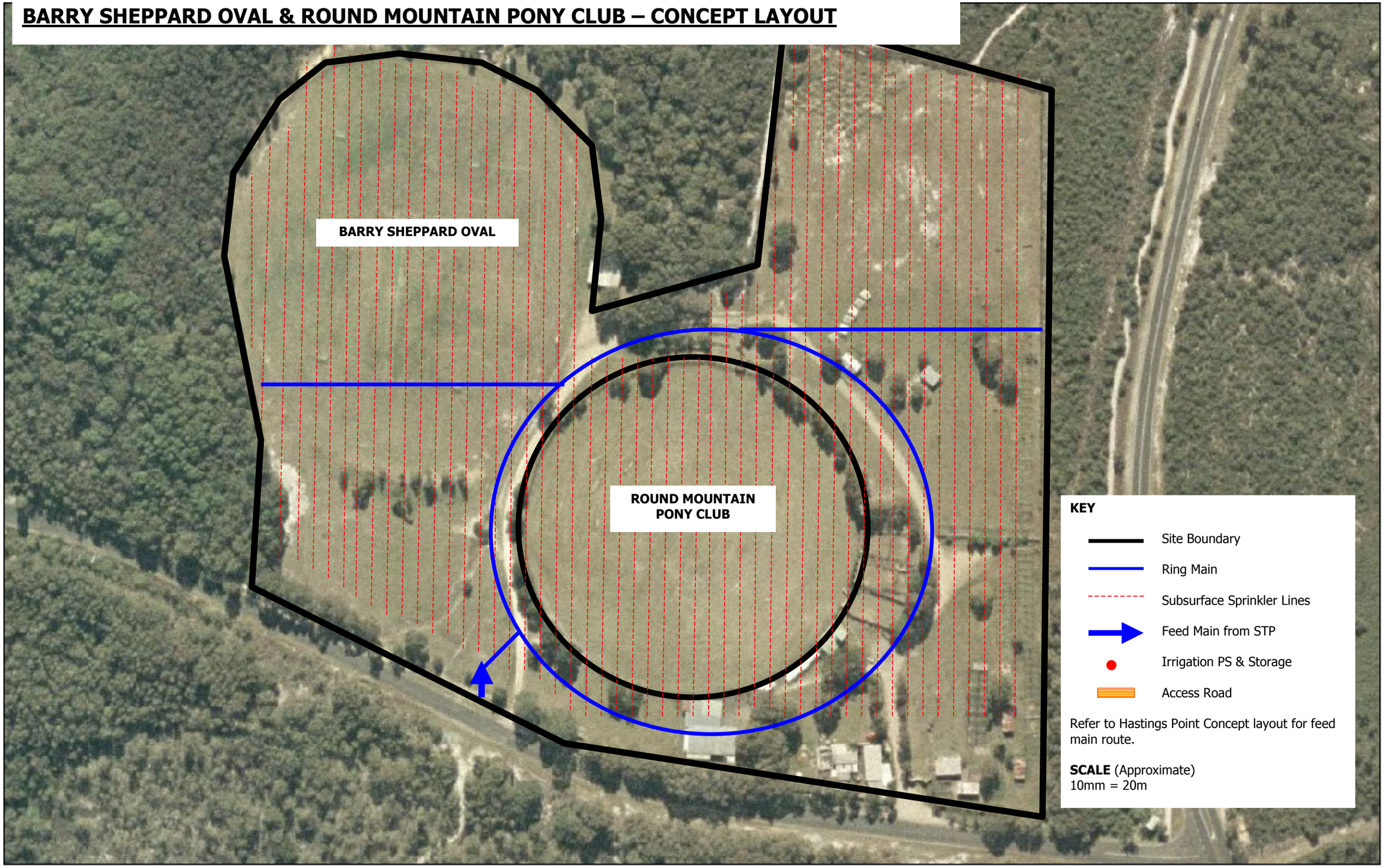


Figure F.7 – Hastings Point, Turf Farm

TURF FARM – CONCEPT LAYOUT

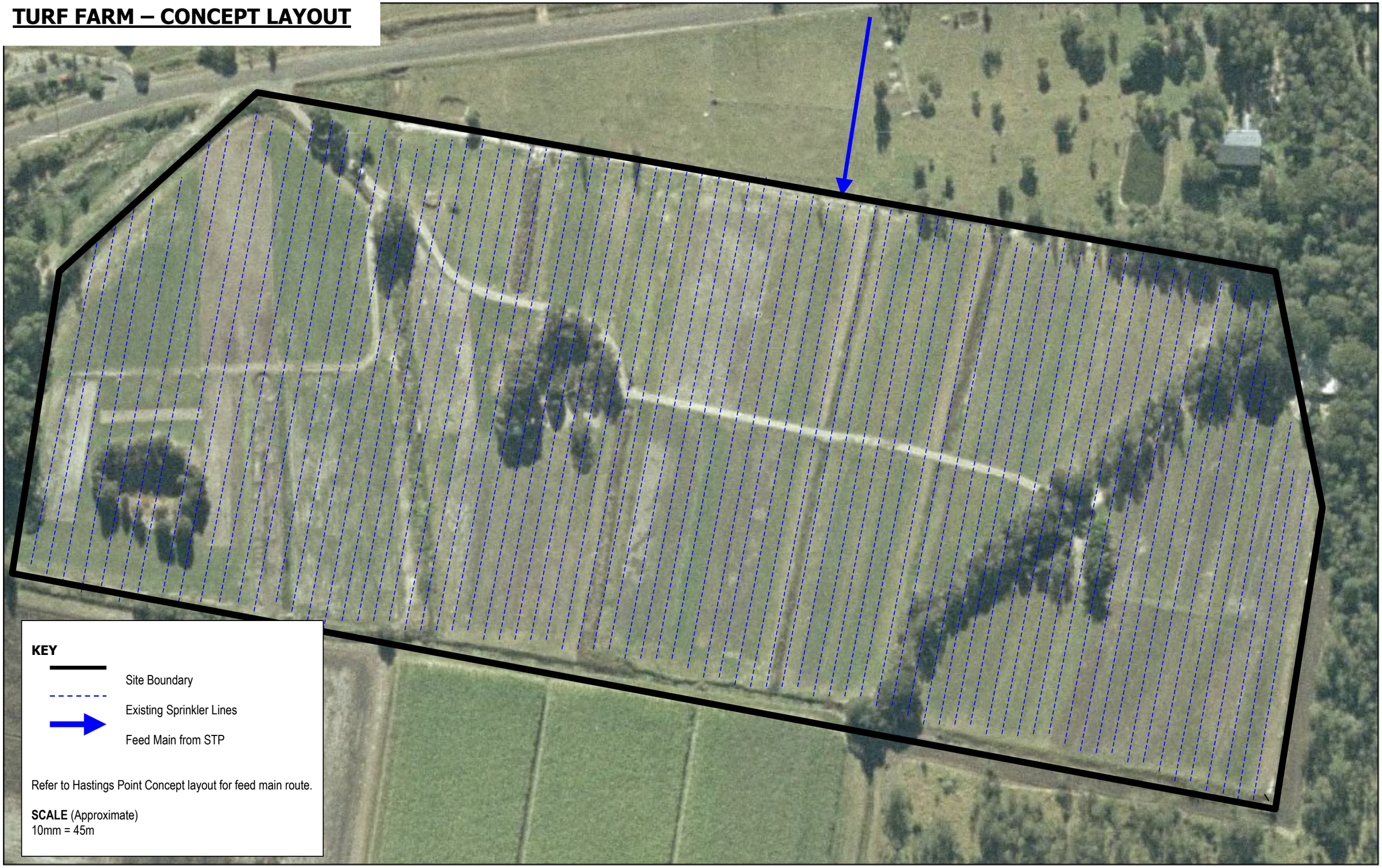


Figure F.8 – Irrigation Routes From Kingscliff STP

IRRIGATION ROUTES FROM KINGSCLIFFE STP – CONCEPT LAYOUT

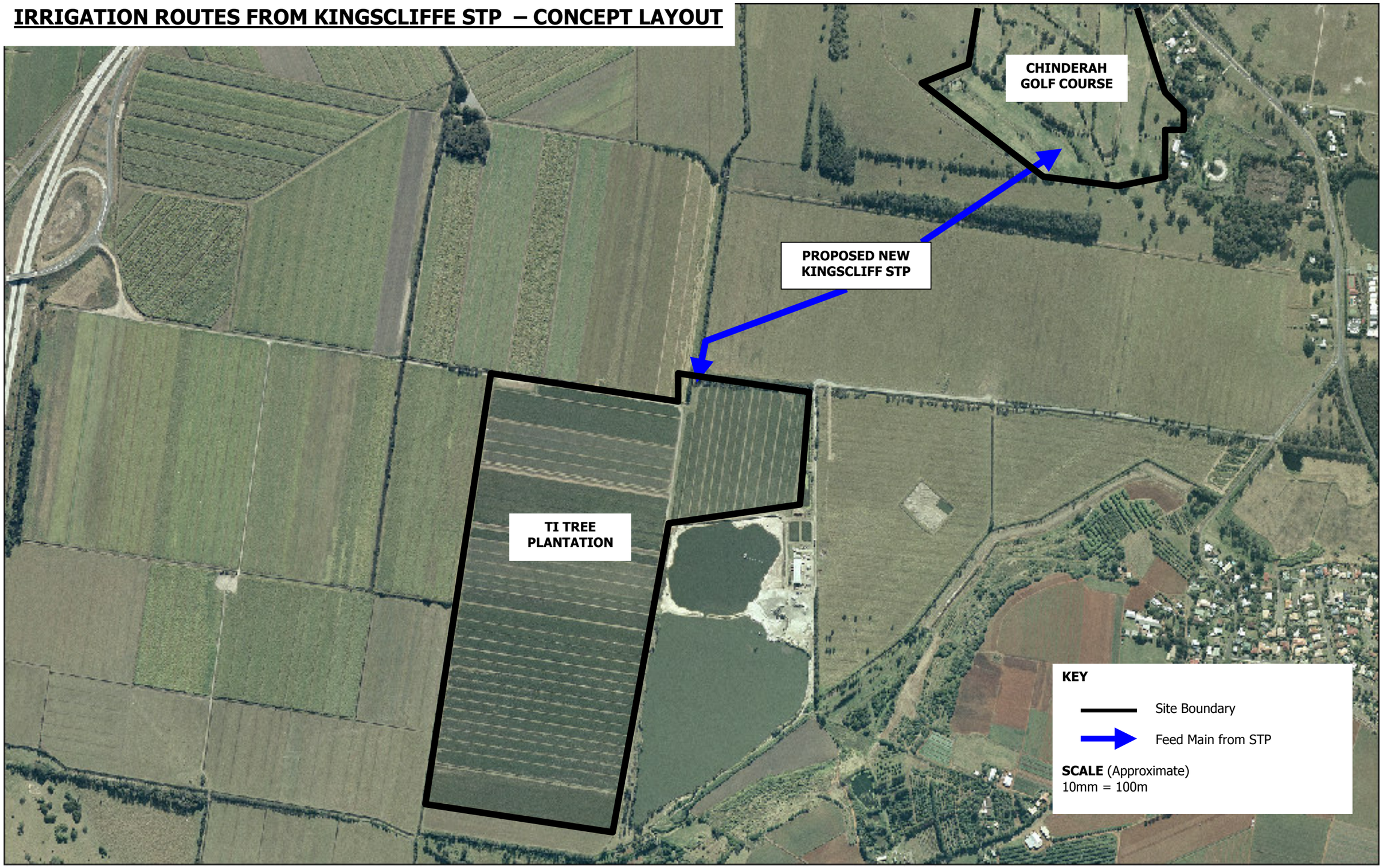


Figure F.9 – Uki, Nursery

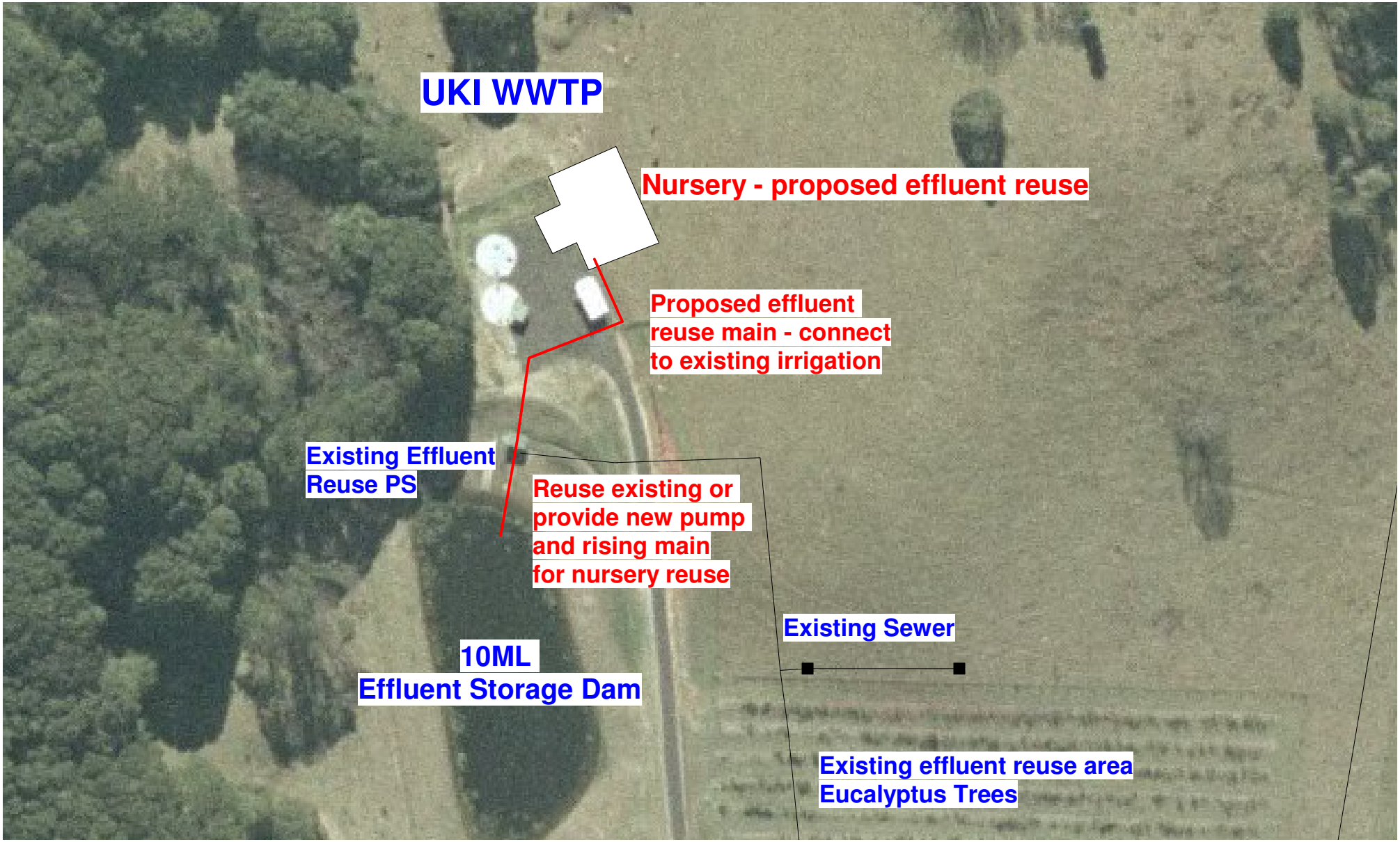
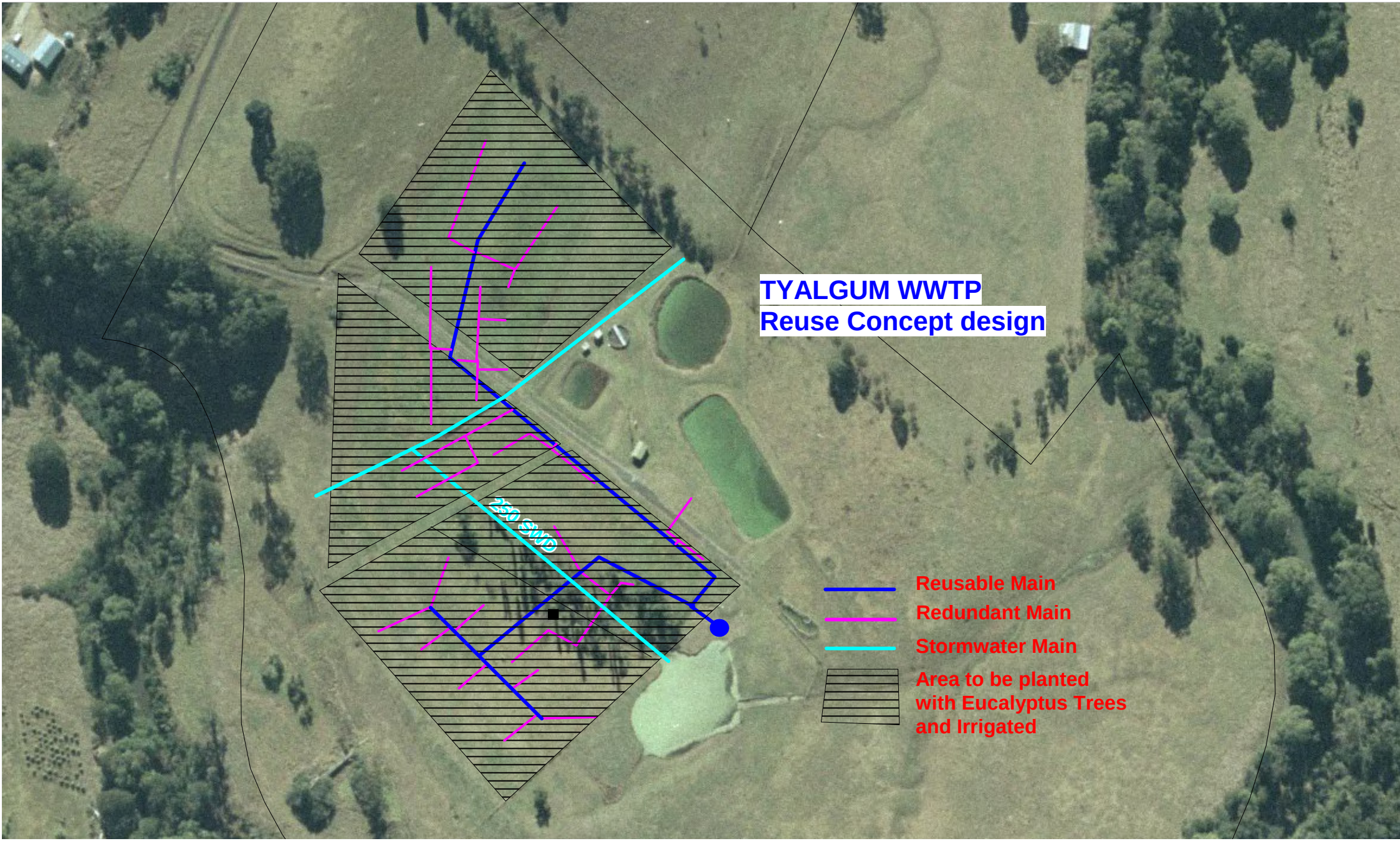

UKI WWTP
Nursery - proposed effluent reuse
Proposed effluent reuse main - connect to existing irrigation
Existing Effluent Reuse PS
Reuse existing or provide new pump and rising main for nursery reuse
Existing Sewer
10ML
Effluent Storage Dam
Existing effluent reuse area
Eucalyptus Trees

Figure F.10 - Tyalgum


TYALGUM WWTP
Reuse Concept design
250 Studs
Reusable Main
Redundant Main
Stormwater Main
Area to be planted
with Eucalyptus Trees
and Irrigated

Appendix G Cost Spreadsheets

This appendix contains preliminary ("first order") cost estimates for the TSC Recycled water Opportunities Scheme, including capital costs, operating and NPV.

Summary Table

	Best Case	Medium Case	Worst Case
Table B1 - Cost Estimate Arkinstall Municipal Park (Banora Point)			
Total for scheme Option 1 & 2 Surface Irrigation	$ 751,000	$ 1,037,000	$ 1,325,000
Total for scheme Option 3 Surface Irrigation	$ 1,065,000	$ 1,455,000	$ 1,827,000
Total for scheme Option 1 & 2 Sub-surface Irrigation	$ 911,000	$ 1,210,000	$ 1,539,000
Total for scheme Option 3 Sub-surface Irrigation	$ 1,225,000	$ 1,629,000	$ 2,041,000
Table B2 - Cost Estimate Tweed Head Cemetery (Banora Point)			
Total for scheme Option 1 & 2 Surface Irrigation	$ 218,000	$ 285,000	$ 367,000
Total for scheme Option 3 Surface Irrigation	$ 398,000	$ 524,000	$ 654,000
Total for scheme Option 1 & 2 Sub-surface Irrigation	$ 229,000	$ 314,000	$ 404,000
Total for scheme Option 3 Sub-surface Irrigation	$ 409,000	$ 554,000	$ 691,000
Table B3 - Cost Estimate for the Rugby Club (Hastings Point)			
Total for scheme Option 1 Surface Irrigation	$ 203,000	$ 287,000	$ 376,000
Total for scheme Option 2 Surface Irrigation	$ 323,000	$ 444,000	$ 570,000
Total for scheme Option 3 Surface Irrigation	$ 539,000	$ 732,000	$ 915,000
Total for scheme Option 1 Sub-surface Irrigation	$ 244,000	$ 332,000	$ 431,000
Total for scheme Option 2 Sub-surface Irrigation	$ 365,000	$ 489,000	$ 625,000
Total for scheme Option 3 Sub-surface Irrigation	$ 580,000	$ 777,000	$ 970,000
Table B4 - Cost Estimate for the Barry Sheppard Oval and Round Mountain Pony Club (Hastings Point)			
Total for scheme Option 1 Surface Irrigation	$ 552,000	$ 757,000	$ 956,000
Total for scheme Option 2 Surface Irrigation	$ 696,000	$ 937,000	$ 1,173,000
Total for scheme Option 3 Surface Irrigation	$ 1,220,000	$ 1,637,000	$ 2,012,000
Total for scheme Option 1 Sub-surface Irrigation	$ 717,000	$ 936,000	$ 1,177,000
Total for scheme Option 2 Sub-surface Irrigation	$ 861,000	$ 1,117,000	$ 1,394,000
Total for scheme Option 3 Sub-surface Irrigation	$ 1,386,000	$ 1,816,000	$ 2,233,000
Table B5 - Cost Estimate for Turf Farm (Hastings Point)			
Total for scheme Without Irrigation or Storage	$ 393,000	$ 560,000	$ 735,000
Total for scheme Option 1 & 2 Surface Irrigation	$ 681,000	$ 937,000	$ 1,180,000
Total for scheme Option 3 Surface Irrigation	$ 1,528,000	$ 2,091,000	$ 2,567,000
Total for scheme Option 1 & 2 Sub-surface Irrigation	$ 846,000	$ 1,144,000	$ 1,436,000
Total for scheme Option 3 Sub-surface Irrigation	$ 1,680,000	$ 2,255,000	$ 2,769,000
Table B6 - Cost Estimate for Combined Storage at Hastings Point			
Total for scheme Option 3 Surface Irrigation	$ 2,217,000	$ 2,858,000	$ 3,493,000
Total for scheme Option 3 Sub-surface Irrigation	$ 2,424,000	$ 3,117,000	$ 3,803,000
NOTE: Turf Farm will continue to use existing sprinklers			
Table B7 - Cost Estimate for Ti Tree Plantation (Chinderah)			
Total for scheme Without Irrigation or Storage	$ 368,000	$ 462,000	$ 580,000
Table B8 - Cost Estimate for the Golf Course (Chinderah)			
Total for scheme Without Irrigation or Storage	$ 336,000	$ 420,000	$ 524,000
Total for scheme Option 1 & 2 Surface Irrigation	$ 958,000	$ 1,249,000	$ 1,508,000
Total for scheme Option 3 Surface Irrigation	$ 958,000	$ 1,249,000	$ 1,508,000
Total for scheme Option 1 & 2 Sub-surface Irrigation	$ 1,263,000	$ 1,579,000	$ 1,915,000
Total for scheme Option 3 Sub-surface Irrigation	$ 1,263,000	$ 1,579,000	$ 1,915,000
Table B9 - Cost Estimate for Uki Nursery			
Total for scheme New Pump Station plus Rising Main	$ 35,000	$ 48,000	$ 62,000
Total for scheme New PS plus RM and further treatment	$ 81,000	$ 110,000	$ 156,000
Table B10 - Cost Estimate for Tyalgum			
Total for scheme New PS and Surface Irrigation	$ 122,000	$ 163,000	$ 197,000
Total for scheme New PS and Subsurface Irrigation	$ 165,000	$ 209,000	$ 254,000
OPTION 1&2 SURFACE IRRIGATION TOTAL COST	**$ 3,888,000**	**$ 5,225,000**	**$ 6,551,000**
OPTION 3 SURFACE IRRIGATION TOTAL COST	**$ 5,835,000**	**$ 7,837,000**	**$ 9,668,000**
OPTION 1&2 SUBSURFACE IRRIGATION TOTAL COST	**$ 4,879,000**	**$ 6,369,000**	**$ 7,958,000**
OPTION 3 SUBSURFACE IRRIGATION TOTAL COST	**$ 7,068,000**	**$ 8,729,000**	**$ 10,767,000**
PROPOSED SOLUTION TOTAL COST	**$ 4,540,000**	**$ 5,901,000**	**$ 7,281,000**

Preferred Option	Costs
Table B1 - Cost Estimate Arkinstall Municipal Park (Banora Point)	
Irrigation System	$535,000
Delivery System	$761,250
Table B2 - Cost Estimate Tweed Head Cemetery (Banora Point)	
Irrigation System	$71,000
Delivery System	$370,000
Table B6 - Cost Estimate for Combined Storage (Hastings Point)	
Irrigation System	$688,000
Delivery System	$1,902,000
Table B7 - Cost Estimate for Ti Tree Plantation (Kingscliff)	
Irrigation System	N/A
Delivery System	N/A
Table B8 - Cost Estimate for the Golf Course (Kingscliff)	
Irrigation System	N/A
Delivery System	$245,500
Table B9 - Cost Estimate for Uki Nursery	
Irrigation System	$0
Delivery System	$34,000
Table B10 - Cost Estimate for Tyalgum	
Irrigation System	$105,200
Delivery System	$32,250

Summary Table

Table B1 - Cost Estimate Arkinstall Municipal Park (Banora Point)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 40.3L/s @50m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 40,000	$ 50,000	$ 60,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	200mm PVC Rising Main	1,550	$ 139,500	$ 240,250	$ 356,500
	Sub total Item 1		**$ 264,500**	**$ 397,250**	**$ 545,500**
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	11.6	$ 278,400	$ 371,200.00	$ 440,800
2.11	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.12	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.13	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.1		**$ 288,400**	**$ 384,200.00**	**$ 456,800**
2.2	Subsoil Irrigation	11.6	$ 417,600	$ 522,000	$ 626,400
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 427,600**	**$ 535,000.00**	**$ 642,400**
3	**Below Ground Storage (See Underground Tanks Worksheet) -1/2 Day Storage**	1	**$ 273,000**	**$ 364,000**	**$ 436,800**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 80,000	$ 96,000	$ 120,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 100,000**	**$ 120,000**	**$ 150,000**
	Sub total for scheme Option 1 & 2 Surface Irrigation		**$ 652,900**	**$ 901,450**	**$ 1,152,300**
	Sub total for scheme Option 3 Surface Irrigation		**$ 925,900**	**$ 1,265,450**	**$ 1,589,100**
	Sub total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 792,100**	**$ 1,052,250**	**$ 1,337,900**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 1,065,100**	**$ 1,416,250**	**$ 1,774,700**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Option 1 & 2 Surface Irrigation		$ 65,290	$ 90,145	$ 115,230
	Option 3 Surface Irrigation		$ 92,590	$ 126,545	$ 158,910
	Option 1 & 2 Sub-surface Irrigation		$ 79,210	$ 105,225	$ 133,790
	Option 3 Sub-surface Irrigation		$ 106,510	$ 141,625	$ 177,470
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Option 1 & 2 Surface Irrigation		$ 32,645	$ 45,073	$ 57,615
	Option 3 Surface Irrigation		$ 46,295	$ 63,273	$ 79,455
	Option 1 & 2 Sub-surface Irrigation		$ 39,605	$ 52,613	$ 66,895
	Option 3 Sub-surface Irrigation		$ 53,255	$ 70,813	$ 88,735
	Total for scheme Option 1 & 2 Surface Irrigation		**$ 750,835**	**$ 1,036,668**	**$ 1,325,145**
	Total for scheme Option 3 Surface Irrigation		**$ 1,064,785**	**$ 1,455,268**	**$ 1,827,465**
	Total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 910,915**	**$ 1,210,088**	**$ 1,538,585**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 1,224,865**	**$ 1,628,688**	**$ 2,040,905**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B2 - Cost Estimate Tweed Head Cemetery (Banora Point)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 8L/s @37m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 20,000	$ 30,000	$ 40,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.5	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.6	000mm PVC Rising Main	500	$ 25,000	$ 50,000	$ 78,000
	Sub total Item 1		**$ 110,000**	**$ 162,000**	**$ 217,000**
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	2	$ 62,400	$ 64,000.00	$ 76,000
2.11	Flowmeter	1	$ 1,500	$ 2,000.00	$ 2,500
2.12	Connection to Rising Main and Valving	1	$ 2,500	$ 3,000.00	$ 3,500
2.13	Control System	1	$ 1,500	$ 2,000.00	$ 2,500
	Sub total Item 2.1		**$ 67,900**	**$ 71,000.00**	**$ 84,500**
2.2	Subsoil Irrigation	2	$ 72,000	$ 90,000	$ 108,000
2.21	Flowmeter	1	$ 1,500	$ 2,000.00	$ 2,500
2.22	Connection to Rising Main and Valving	1	$ 2,500	$ 3,000.00	$ 3,500
2.23	Control System	1	$ 1,500	$ 2,000.00	$ 2,500
	Sub total Item 2.2		**$ 77,500**	**$ 97,000.00**	**$ 116,500**
3	**Below Ground Storage (See Underground Tanks Worksheet)**	1	**$ 156,000**	**$ 208,000**	**$ 249,600**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 3,000	$ 3,600	$ 4,500
4.2	Site Cleanup, Demobilisation	1	$ 5,000	$ 6,000	$ 7,500
4.3	Commisioning & Defects	1	$ 4,000	$ 4,800	$ 6,000
	Sub total for Item 4		**$ 12,000**	**$ 14,400**	**$ 18,000**
	Sub total for scheme Option 1 & 2 Surface Irrigation		**$ 189,900**	**$ 247,400**	**$ 319,500**
	Sub total for scheme Option 3 Surface Irrigation		**$ 345,900**	**$ 455,400**	**$ 569,100**
	Sub total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 199,500**	**$ 273,400**	**$ 351,500**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 355,500**	**$ 481,400**	**$ 601,100**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Option 1 & 2 Surface Irrigation		$ 18,990	$ 24,740	$ 31,950
	Option 3 Surface Irrigation		$ 34,590	$ 45,540	$ 56,910
	Option 1 & 2 Sub-surface Irrigation		$ 19,950	$ 27,340	$ 35,150
	Option 3 Sub-surface Irrigation		$ 35,550	$ 48,140	$ 60,110
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Option 1 & 2 Surface Irrigation		$ 9,495	$ 12,370	$ 15,975
	Option 3 Surface Irrigation		$ 17,295	$ 22,770	$ 28,455
	Option 1 & 2 Sub-surface Irrigation		$ 9,975	$ 13,670	$ 17,575
	Option 3 Sub-surface Irrigation		$ 17,775	$ 24,070	$ 30,055
	Total for scheme Option 1 & 2 Surface Irrigation		**$ 218,385**	**$ 284,510**	**$ 367,425**
	Total for scheme Option 3 Surface Irrigation		**$ 397,785**	**$ 523,710**	**$ 654,465**
	Total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 229,425**	**$ 314,410**	**$ 404,225**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 408,825**	**$ 553,610**	**$ 691,265**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B3 - Cost Estimate for the Rugby Club (Hastings Point)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 10.42L/s @ 50m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 20,000	$ 30,000	$ 40,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	100mm PVC Rising Main	685	$ 34,250	$ 68,500	$ 106,860
	Sub total Item 1		**$ 139,250**	**$ 205,500**	**$ 275,860**
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	3	$ 72,000	$ 96,000.00	$ 114,000
2.11	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.12	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.13	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.1		**$ 82,000**	**$ 109,000.00**	**$ 130,000**
2.2	Subsoil Irrigation	3	$ 108,000	$ 135,000	$ 162,000
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 118,000**	**$ 148,000.00**	**$ 178,000**
3	**Below Ground Storage (See Underground Tanks Worksheet)**	N/A	**$ 187,500**	**$ 250,000**	**$ 300,000**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 40,000	$ 48,000	$ 60,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 60,000**	**$ 72,000**	**$ 90,000**
	Sub total for scheme Option 1 Surface Irrigation		**$ 176,250**	**$ 249,500**	**$ 326,860**
	Sub total for scheme Option 2 Surface Irrigation		**$ 281,250**	**$ 386,500**	**$ 495,860**
	Sub total for scheme Option 3 Surface Irrigation		**$ 468,750**	**$ 636,500**	**$ 795,860**
	Sub total for scheme Option 1 Sub-surface Irrigation		**$ 212,250**	**$ 288,500**	**$ 374,860**
	Sub total for scheme Option 2 Sub-surface Irrigation		**$ 317,250**	**$ 425,500**	**$ 543,860**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 504,750**	**$ 675,500**	**$ 843,860**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Option 2 Surface Irrigation		$ 17,625	$ 24,950	$ 32,686
	Option 2 Surface Irrigation		$ 28,125	$ 38,650	$ 49,586
	Option 3 Surface Irrigation		$ 46,875	$ 63,650	$ 79,586
	Option 1 Sub-surface Irrigation		$ 21,225	$ 28,850	$ 37,486
	Option 2 Sub-surface Irrigation		$ 31,725	$ 42,550	$ 54,386
	Option 3 Sub-surface Irrigation		$ 50,475	$ 67,550	$ 84,386
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Option 1Surface Irrigation		$ 8,813	$ 12,475	$ 16,343
	Option 2 Surface Irrigation		$ 14,063	$ 19,325	$ 24,793
	Option 3 Surface Irrigation		$ 23,438	$ 31,825	$ 39,793
	Option 1 Sub-surface Irrigation		$ 10,613	$ 14,425	$ 18,743
	Option 2 Sub-surface Irrigation		$ 15,863	$ 21,275	$ 27,193
	Option 3 Sub-surface Irrigation		$ 25,238	$ 33,775	$ 42,193
	Total for scheme Option 1 Surface Irrigation		**$ 202,688**	**$ 286,925**	**$ 375,889**
	Total for scheme Option 2 Surface Irrigation		**$ 323,438**	**$ 444,475**	**$ 570,239**
	Total for scheme Option 3 Surface Irrigation		**$ 539,063**	**$ 731,975**	**$ 915,239**
	Total for scheme Option 1 Sub-surface Irrigation		**$ 244,088**	**$ 331,775**	**$ 431,089**
	Total for scheme Option 2 Sub-surface Irrigation		**$ 364,838**	**$ 489,325**	**$ 625,439**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 580,463**	**$ 776,825**	**$ 970,439**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B4 - Cost Estimate for the Barry Sheppard Oval and Round Mountain Pony Club (Hastings Point)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 41.67L/s @ 50m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 40,000	$ 50,000	$ 60,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	200mm PVC Rising Main	910	$ 81,900	$ 141,050	$ 209,300
	Sub total Item 1		**$ 206,900**	**$ 298,050**	**$ 398,300**
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	12	$ 288,000	$ 384,000.00	$ 456,000
2.11	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.12	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.13	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.1		**$ 298,000**	**$ 397,000**	**$ 472,000**
2.2	Subsoil Irrigation	12	$ 432,000	$ 540,000	$ 648,000
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 442,000**	**$ 553,000**	**$ 664,000**
3	**Below Ground Storage (See Underground Tanks Worksheet)**	1	**$ 456,000**	**$ 608,000**	**$ 729,600**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 80,000	$ 96,000	$ 120,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 100,000**	**$ 120,000**	**$ 150,000**
	Sub total for scheme Option 1 Surface Irrigation		**$ 479,900**	**$ 658,050**	**$ 831,300**
	Sub total for scheme Option 2 Surface Irrigation		**$ 604,900**	**$ 815,050**	**$ 1,020,300**
	Sub total for scheme Option 3 Surface Irrigation		**$ 1,060,900**	**$ 1,423,050**	**$ 1,749,900**
	Sub total for scheme Option 1 Sub-surface Irrigation		**$ 623,900**	**$ 814,050**	**$ 1,023,300**
	Sub total for scheme Option 2 Sub-surface Irrigation		**$ 748,900**	**$ 971,050**	**$ 1,212,300**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 1,204,900**	**$ 1,579,050**	**$ 1,941,900**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Option 1 Surface Irrigation		$ 47,990	$ 65,805	$ 83,130
	Option 2 Surface Irrigation		$ 60,490	$ 81,505	$ 102,030
	Option 3 Surface Irrigation		$ 106,090	$ 142,305	$ 174,990
	Option 1 Sub-surface Irrigation		$ 62,390	$ 81,405	$ 102,330
	Option 2 Sub-surface Irrigation		$ 74,890	$ 97,105	$ 121,230
	Option 3 Sub-surface Irrigation		$ 120,490	$ 157,905	$ 194,190
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Option 1 Surface Irrigation		$ 23,995	$ 32,903	$ 41,565
	Option 2 Surface Irrigation		$ 30,245	$ 40,753	$ 51,015
	Option 3 Surface Irrigation		$ 53,045	$ 71,153	$ 87,495
	Option 1 Sub-surface Irrigation		$ 31,195	$ 40,703	$ 51,165
	Option 2 Sub-surface Irrigation		$ 37,445	$ 48,553	$ 60,615
	Option 3 Sub-surface Irrigation		$ 60,245	$ 78,953	$ 97,095
	Total for scheme Option 1Surface Irrigation		**$ 551,885**	**$ 756,758**	**$ 955,995**
	Total for scheme Option 2 Surface Irrigation		**$ 695,635**	**$ 937,308**	**$ 1,173,345**
	Total for scheme Option 3 Surface Irrigation		**$ 1,220,035**	**$ 1,636,508**	**$ 2,012,385**
	Total for scheme Option 1 Sub-surface Irrigation		**$ 717,485**	**$ 936,158**	**$ 1,176,795**
	Total for scheme Option 2 Sub-surface Irrigation		**$ 861,235**	**$ 1,116,708**	**$ 1,394,145**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 1,385,635**	**$ 1,815,908**	**$ 2,233,185**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B5 - Cost Estimate for Turf Farm (Hastings Point)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 19.16L/s @ 50m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 40,000	$ 50,000	$ 60,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	150mm PVC Rising Main	1,500	$ 105,000	$ 210,000	$ 300,000
	Sub total Item 1		**$ 230,000**	**$ 367,000**	**$ 489,000**
		50%	$ 115,000	$ 183,500	$ 244,500
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	11	$ 264,000	$ 352,000	$ 418,000
2.11	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.12	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.13	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.1		**$ 274,000**	**$ 365,000.00**	**$ 434,000**
2.2	Subsoil Irrigation	11	$ 396,000	$ 495,000	$ 594,000
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 406,000**	**$ 508,000.00**	**$ 610,000**
3	**Below Ground Storage (See Underground Tanks Worksheet)**	N/A	**$ 724,500**	**$ 966,000**	**$ 1,159,200**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 80,000	$ 96,000	$ 120,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 100,000**	**$ 120,000**	**$ 150,000**
	Sub Total without Irrigation		**$ 330,000**	**$ 487,000**	**$ 639,000**
	Sub total for scheme Option 1 & 2 Surface Irrigation		**$ 604,000**	**$ 852,000**	**$ 1,073,000**
	Sub total for scheme Option 3 Surface Irrigation		**$ 1,328,500**	**$ 1,818,000**	**$ 2,232,200**
	Sub total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 736,000**	**$ 995,000**	**$ 1,249,000**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 1,460,500**	**$ 1,961,000**	**$ 2,408,200**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Without Irrigation		$ 33,000	$ 48,700	$ 63,900
	Option 1 & 2 Surface Irrigation		$ 60,400	$ 85,200	$ 107,300
	Option 3 Surface Irrigation		$ 132,850	$ 181,800	$ 223,220
	Option 1 & 2 Sub-surface Irrigation		$ 73,600	$ 99,500	$ 124,900
	Option 3 Subsurface Irrigation		$ 146,050	$ 196,100	$ 240,820
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Without Irrigation		$ 30,200	$ 24,350	$ 31,950
	Option 1 & 2 Surface Irrigation		$ 16,500		
	Option 3 Surface Irrigation		$ 66,425	$ 90,900	$ 111,610
	Option 1 & 2 Sub-surface Irrigation		$ 36,800	$ 49,750	$ 62,450
	Option 3 Subsurface Irrigation		$ 73,025	$ 98,050	$ 120,410
	Total without Irrigation		**$ 393,200**	**$ 560,050**	**$ 734,850**
	Total for scheme Option 1 & 2 Surface Irrigation		**$ 680,900**	**$ 937,200**	**$ 1,180,300**
	Total for scheme Option 3 Surface Irrigation		**$ 1,527,775**	**$ 2,090,700**	**$ 2,567,030**
	Total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 846,400**	**$ 1,144,250**	**$ 1,436,350**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 1,679,575**	**$ 2,255,150**	**$ 2,769,430**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B6 - Cost Estimate for Combined Storage at Hastings Point

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 19.16L/s @ 50m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 40,000	$ 50,000	$ 60,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	150mm PVC Rising Main	1,500	$ 105,000	$ 210,000	$ 300,000
	Sub total Item 1		**$ 230,000**	**$ 367,000**	**$ 489,000**
		50%	$ 115,000	$ 183,500	$ 244,500
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation		$ 360,000	$ 450,000.00	$ 540,000
2.11	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.12	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.13	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.1		**$ 370,000**	**$ 463,000.00**	**$ 556,000**
2.2	Subsoil Irrigation		$ 540,000	$ 675,000	$ 810,000
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 550,000**	**$ 688,000.00**	**$ 826,000**
3	**Above Ground Storage (See Underground Tanks Worksheet)**	1	**1,228,000**	**$ 1,535,000**	**$ 1,842,000**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 80,000	$ 96,000	$ 120,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 100,000**	**$ 120,000**	**$ 150,000**
	Sub Total without Irrigation		**$ 1,558,000**	**$ 2,022,000**	**$ 2,481,000**
	Sub total for scheme Option 3 Surface Irrigation		**$ 1,928,000**	**$ 2,485,000**	**$ 3,037,000**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 2,108,000**	**$ 2,710,000**	**$ 3,307,000**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Without Irrigation		$ 155,800	$ 202,200	$ 248,100
	Option 3 Surface Irrigation		$ 192,800	$ 248,500	$ 303,700
	Option 3 Subsurface Irrigation		$ 210,800	$ 271,000	$ 330,700
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Without Irrigation		$ 77,900	$ 101,100	$ 124,050
	Option 3 Surface Irrigation		$ 96,400	$ 124,250	$ 151,850
	Option 3 Subsurface Irrigation		$ 105,400	$ 135,500	$ 165,350
	Total without Irrigation		**$ 1,791,700**	**$ 2,325,300**	**$ 2,853,150**
	Total for scheme Option 3 Surface Irrigation		**$ 2,217,200**	**$ 2,857,750**	**$ 3,492,550**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 2,424,200**	**$ 3,116,500**	**$ 3,803,050**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B7 - Cost Estimate for Ti Tree Plantation (Chinderah)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Feeder Mains**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 40,000	$ 50,000	$ 60,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	Extend 100mm rising main	500	$ 95,000	$ 125,000	$ 165,000
	Sub total Item 1		**$ 220,000**	**$ 282,000**	**$ 354,000**
		50%	$ 110,000	$ 141,000	$ 177,000
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	52.1	$ 1,250,400	$ 1,667,200	$ 1,979,800
2.2	Connection to Rising Main and Valving	4	$ 2,000	$ 2,500.00	$ 3,000
2.3	Control System	1	$ 1,000	$ 1,500.00	$ 2,000
	Sub total Item 2.1		**$ 1,253,400**	**$ 1,671,200.00**	**$ 1,984,800**
2.2	Subsoil Irrigation	52.1	$ 1,875,600	$ 2,344,500	$ 2,813,400
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 1,885,600**	**$ 2,357,500**	**$ 2,829,400**
3	**Below Ground Storage (See Underground Tanks Worksheet)**	N/A	**$ -**	**$ -**	**$ -**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 80,000	$ 96,000	$ 120,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 100,000**	**$ 120,000**	**$ 150,000**
	Sub Total New Irrigation		**$ 320,000**	**$ 402,000**	**$ 504,000**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Without Irrigation		$ 32,000	$ 40,200	$ 50,400
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Without Irrigation		$ 16,000	$ 20,100	$ 25,200
	Total Without Irrigation		**$ 368,000**	**$ 462,300**	**$ 579,600**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B8 - Cost Estimate for the Golf Course (Chinderah)

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main 76.7L/s @50m**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 10,000	$ 12,000	$ 14,000
1.2	Supply & installation of 2 pumps	1	$ 40,000	$ 50,000	$ 60,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 20,000	$ 25,000	$ 30,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 15,000	$ 20,000	$ 25,000
1.7	300mm PVC Rising Main	354	$ 67,260	$ 88,500	$ 116,820
	Sub total Item 1		**$ 192,260**	**$ 245,500**	**$ 305,820**
		50%	$ 96,130	$ 122,750	$ 152,910
2	**Irrigation Infrastructure**				
2.1	Pop-up Sprinkler Surface Irrigation	22.1	$ 530,400	$ 707,200.00	$ 839,800
2.11	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.12	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.13	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.1		**$ 540,400**	**$ 720,200.00**	**$ 855,800**
2.2	Subsoil Irrigation	22.1	$ 795,600	$ 994,500	$ 1,193,400
2.21	Flowmeter	1	$ 3,000	$ 4,000.00	$ 5,000
2.22	Connection to Rising Main and Valving	1	$ 5,000	$ 6,000.00	$ 7,000
2.23	Control System	1	$ 2,000	$ 3,000.00	$ 4,000
	Sub total Item 2.2		**$ 805,600**	**$ 1,007,500.00**	**$ 1,209,400**
3	**Below Ground Storage (See Underground Tanks Worksheet)**	N/A	**$ -**	**$ -**	**$ -**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 80,000	$ 96,000	$ 120,000
4.2	Site Cleanup, Demobilisation	1	$ 10,000	$ 12,000	$ 15,000
4.3	Commisioning & Defects	1	$ 10,000	$ 12,000	$ 15,000
	Sub total for Item 4		**$ 100,000**	**$ 120,000**	**$ 150,000**
	Sub Total without Irrigation		**$ 292,260**	**$ 365,500**	**$ 455,820**
	Sub total for scheme Option 1 & 2 Surface Irrigation		**$ 832,660**	**$ 1,085,700**	**$ 1,311,620**
	Sub total for scheme Option 3 Surface Irrigation		**$ 832,660**	**$ 1,085,700**	**$ 1,311,620**
	Sub total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 1,097,860**	**$ 1,373,000**	**$ 1,665,220**
	Sub total for scheme Option 3 Sub-surface Irrigation		**$ 1,097,860**	**$ 1,373,000**	**$ 1,665,220**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	Without Irrigation		$ 29,226	$ 36,550	$ 45,582
	Option 1 & 2 Surface Irrigation		$ 83,266	$ 108,570	$ 131,162
	Option 3 Surface Irrigation		$ 83,266	$ 108,570	$ 131,162
	Option 1 & 2 Sub-surface Irrigation		$ 109,786	$ 137,300	$ 166,522
	Option 3 Subsurface Irrigation		$ 109,786	$ 137,300	$ 166,522
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	Without Irrigation		$ 14,613	$ 18,275	$ 22,791
	Option 1 & 2 Surface Irrigation		$ 41,633	$ 54,285	$ 65,581
	Option 3 Surface Irrigation		$ 41,633	$ 54,285	$ 65,581
	Option 1 & 2 Sub-surface Irrigation		$ 54,893	$ 68,650	$ 83,261
	Option 3 Subsurface Irrigation		$ 54,893	$ 68,650	$ 83,261
	Total without Irrigation		**$ 336,099**	**$ 420,325**	**$ 524,193**
	Total for scheme Option 1 & 2 Surface Irrigation		**$ 957,559**	**$ 1,248,555**	**$ 1,508,363**
	Total for scheme Option 3 Surface Irrigation		**$ 957,559**	**$ 1,248,555**	**$ 1,508,363**
	Total for scheme Option 1 & 2 Sub-surface Irrigation		**$ 1,262,539**	**$ 1,578,950**	**$ 1,915,003**
	Total for scheme Option 3 Sub-surface Irrigation		**$ 1,262,539**	**$ 1,578,950**	**$ 1,915,003**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B9 - Cost Estimate for Uki Nursery

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Pump Station & Rising Main**				
1.1	Pump station insitu concrete slab (no pumphouse building)	1	$ 4,000	$ 6,000	$ 8,000
1.2	Supply & installation of 2 pumps	1	$ 5,000	$ 7,500	$ 10,000
1.3	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 7,500	$ 10,000	$ 12,500
1.4	Supply & Installation of Auto Backwash Filter, associated pipework, valves, fittings, etc	1	$ 5,000	$ 7,500	$ 10,000
1.5	Supply & Installation of switchboard (power distribution & metering)	1	$ 1,000	$ 1,500	$ 2,000
1.6	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 1,000	$ 1,500	$ 2,000
	Sub total Item 1		**$ 23,500**	**$ 34,000**	**$ 44,500**
2	**Irrigation Infrastructure - Already Installed**	0	**$ -**	**$ -**	**$ -**
3	**Below Ground Storage (not required as existing)**	0	**$ -**	**$ -**	**$ -**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 1,000	$ 1,200	$ 1,500
4.2	Site Cleanup, Demobilisation	1	$ 1,000	$ 1,200	$ 1,500
4.3	Commisioning & Defects	1	$ 1,500	$ 1,800	$ 2,250
	Sub total for Item 4		**$ 3,500**	**$ 4,200**	**$ 5,250**
	Sub total for scheme		**$ 27,000**	**$ 38,200**	**$ 49,750**
5	**Further Treatment (Lime Dosing and Filtration)**				
5.1	Lime Dosing and Filtration unit	1	**$ 35,000**	**$ 50,000**	**$ 75,000**
6	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	New Pump Station and rising main		$ 5,400	$ 5,730	$ 7,462.50
	New Pump Station and rising main and further treatment		$ 12,400	$ 13,230	$ 18,712.50
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	New Pump Station and rising main		$ 2,700	$ 3,820	$ 4,975
	New Pump Station and rising main and further treatment		$ 6,200	$ 8,820	$ 12,475.00
	Total for scheme New Pump Station plus Rising Mian		**$ 35,100**	**$ 47,750**	**$ 62,188**
	Total for scheme New Pump Station plus Rising Main and further treatment		**$ 80,600**	**$ 110,250**	**$ 155,938**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Summary Table

Table B10 - Cost Estimate for Tyalgum

Item	Description	Number of	Best Case	Medium Case	Worst Case
1	**Irrigation Feed Mains**				
1.1	Supply & installation of associated pipework, pipe supports, pump valves, fittings, etc	1	$ 20,000	$ 25,000	$ 30,000
1.2	Supply & Installation of switchboard (power distribution & metering)	1	$ 1,000	$ 1,500	$ 2,000
1.3	Electrical, Power Mains, pump cabling, isolators, general lighting & power outlets	1	$ 500	$ 1,000	$ 1,500
1.4	100mm PVC Rising Main	50	$ 2,250	$ 4,750	$ 7,550
	Sub total Item 1		**$ 23,750**	**$ 32,250**	**$ 41,050**
2	**Irrigation Infrastructure**				
2.1					
2.11	Pop-up Sprinkler Surface Irrigation	3.1	$ 74,400	$ 99,200.00	$ 117,800
2.12	Flowmeter	1	$ 1,500	$ 2,000.00	$ 2,500
2.13	Connection to Rising Main and Valving	4	$ 2,000	$ 2,500.00	$ 3,000
2.14	Control System	1	$ 1,000	$ 1,500.00	$ 2,000
	Sub total Item 2.1		**$ 78,900**	**$ 105,200.00**	**$ 125,300**
2.2	Subsoil Irrigation	3.1	$ 111,600	$ 139,500	$ 167,400
2.21	Flowmeter	1	$ 1,500	$ 2,000.00	$ 2,500
2.22	Connection to Rising Main and Valving	4	$ 2,000	$ 2,500.00	$ 3,000
2.23	Control System	1	$ 1,000	$ 1,500.00	$ 2,000
	Sub total Item 2.2		**$ 116,100**	**$ 145,500**	**$ 174,900**
3	**Below Ground Storage Not required**	1	**$ -**	**$ -**	**$ -**
4	**Preliminaries, Site Establishment, Cleanup and Commisioning**				
4.1	Preliminaries, Site Establishment	1	$ 1,000	$ 1,200	$ 1,500
4.2	Site Cleanup, Demobilisation	1	$ 1,000	$ 1,200	$ 1,500
4.3	Commisioning & Defects	1	$ 1,500	$ 1,800	$ 2,250
	Sub total for Item 4		**$ 3,500**	**$ 4,200**	**$ 5,250**
	Sub total for scheme New PS and Surface Irrigation		**$ 106,150**	**$ 141,650**	**$ 171,600**
	Sub total for scheme New PS and Subsurface Irrigation		**$ 143,350**	**$ 181,950**	**$ 221,200**
5	**Design and Administration Costs**				
6.1	Investigation, approvals, design, tender/contract documentation (10%)				
	New PS and Surface Irrigation		$ 10,615	$ 14,165	$ 17,160
	New PS and Subsurface Irrigation		$ 14,335	$ 18,195	$ 22,120
6.2	Tweed Shire contract admin. & supervision, corporate overheads (5%)				
	New PS and Surface Irrigation		$ 5,308	$ 7,083	$ 8,580
	New PS and Subsurface Irrigation		$ 7,168	$ 9,098	$ 11,060
	Total for scheme New PS and Surface Irrigation		**$ 122,073**	**$ 162,898**	**$ 197,340**
	Total for scheme New PS and Subsurface Irrigation		**$ 164,853**	**$ 209,243**	**$ 254,380**

Basis of Costs

1. Pump station costs based on other recent projects and supplier costs.
2. Pipe rates based on compiled data from MWH projects and water authorities.

The following rates have been used

Pipe Details	Best Case	Medium Case	Worst Case	Price from Vini	Tyco Water	Tycowater
ϕ300 uPVC / DICL	$ 190	$ 250	$ 330	$ 111	$ 93	$ 83
ϕ250 uPVC	$ 180	$ 240	$ 320	$ 72	$ 79	$ 62
ϕ200 uPVC	$ 90	$ 155	$ 230	$ 46	$ 50	$ 42
ϕ150 uPVC	$ 70	$ 140	$ 200	$ 28	$ 30	$ 21
ϕ100 uPVC	$ 50	$ 100	$ 156	$ 14	$ 15	$ 13
ϕ80 uPVC	$ 45	$ 95	$ 151	$ 8	$ 10	-

3.Typical contingencies of 20% have been applied to the medium case and more conservative contingencies of 50% have been applied for the worst case

4. Irrigation Infrastructure Costs

Irrigation System Installation Rates	$ / Hectare
Pop up Surface Spray	
Best Case	$ 24,000.00
Medium	$ 32,000.00
Worst	$ 38,000.00
Sub-Soil Irrigation	
Best Case	$ 36,000.00
Medium	$ 45,000.00
Worst	$ 54,000.00

Subsoil Irrigation Rates have been based on received quotes. This has been taken as the medium case.
A 20% increase and decrease has been applied for the best and worst case.

NOTE: For the purposes of this estimate and due to the fact that the reduction in pumping heads and pipe cost will be minimal Option 1 & 2 are the same. Also if 2 PS are required then the option is discounted on costs

Costs for Below Ground Storage Tanks

			Concrete Volume m3					
Location	Capacity Kl	Radius m	Floor Slab (400mm) (40mPa)	Roof Slab (600mm) (40mPa)	Walls (300mm) (40mPa)	Total Concr	Surrounds	Total Excav
Arkinstall Municipal Oval	580	9.6	116	174	36	326	224	1130
Memorial Garden	100	4.0	20	30	15	65	97	262
Barry Sheppard Oval	600	9.8	120	180	37	337	228	1165
Hastings Point Combined	1750	16.7	350	525	63	938	384	3072
Rugby Club	150	4.9	30	45	18	93	117	361
Turf Farm	1000	12.6	200	300	48	548	292	1840

Location	Capacity Kl	Excavation (Medium Ground) $80/m3	Dewatering $35/m2	Concrete Supply, inst. Re-inf, Formwork $1100/m3	Offsite Disposal of Spoil $25/m3	Geotech Inv. $	Tank Pumps, Valves & Fittings $	Under ground tanks Total $
Arkinstall Municipal Oval	580	$ 90,426	$ 10,150	$ 358,843	$ 22,656	$ 10,000	$ 100,000	$ 592,000
Memorial Garden	100	$ 20,965	$ 1,750	$ 71,544	$ 4,126	$ 10,000	$ 100,000	$ 208,000
Barry Sheppard Oval	600	$ 93,173	$ 10,500	$ 370,524	$ 23,421	$ 10,000	$ 100,000	$ 608,000
Hastings Point Combined	1750	$ 245,776	$ 30,625	$1,031,707	$ 67,198	$ 10,000	$ 150,000	$ 1,535,000
Rugby Club	150	$ 28,858	$ 2,625	$ 102,762	$ 6,085	$ 10,000	$ 100,000	$ 250,000
Turf Farm	1000	$ 147,176	$ 17,500	$ 602,316	$ 38,689	$ 10,000	$ 150,000	$ 966,000

Cost of Above Ground Storage

Location	Capacity Kl	Radius m	Floor Slab (400mm) (40mPa)	Roof Slab (600mm) (40mPa)	Walls (300mm) (40mPa)	Total Concr	Surrounds	Total Excav
Arkinstall Municipal Oval	580	9.6	116	174	36	326	224	116
Memorial Garden	100	4.0	20	30	15	65	97	20
Barry Sheppard Oval	600	9.8	120	180	37	337	228	120
Hastings Point Combined	1750	16.7	350	525	63	938	384	350
Rugby Club	150	4.9	30	45	18	93	117	30
Turf Farm	1000	12.6	200	300	48	548	292	200

Location	Capacity Kl	Excavation (Medium Ground) $80/m3	Dewatering $35/m2	Concrete Supply, inst. Re-inf, Formwork $1100/m3	Offsite Disposal of Spoil $25/m3	Geotech Inv. $	Tank Pumps, Valves & Fittings $	Above ground tanks Total $
Arkinstall Municipal Oval	580	$ 9,280	$ 10,150	$ 358,843	$ 2,900	$ 10,000	$ 100,000	$ 491,000
Memorial Garden	100	$ 1,600	$ 1,750	$ 71,544	$ 500	$ 10,000	$ 100,000	$ 185,000
Barry Sheppard Oval	600	$ 9,600	$ 10,500	$ 370,524	$ 3,000	$ 10,000	$ 100,000	$ 504,000
Hastings Point Combined	1750	$ 28,000	$ 30,625	$1,031,707	$ 8,750	$ 10,000	$ 150,000	$ 1,259,000
Rugby Club	150	$ 2,400	$ 2,625	$ 102,762	$ 750	$ 10,000	$ 100,000	$ 219,000
Turf Farm	1000	$ 16,000	$ 17,500	$ 602,316	$ 5,000	$ 10,000	$ 150,000	$ 801,000

Cost of Prefabricated Tanks

Location	Capacity Kl	Excavation (Medium Ground) $80/m3	Dewatering $35/m2	Tank Supply, inst. (Cost x 25% Inst.)	Offsite Disposal of Spoil $25/m3	Geotech Inv. $	Tank Pumps, Valves & Fittings $	Prefabricated Total $
Arkinstall Municipal Oval	580	$ 9,280	$ 10,150	$ 150,000	$ 2,900	$ 10,000	$ 100,000	$ 282,000
Barry Sheppard Oval	600	$ 9,600	$ 10,500	$ 156,250	$ 3,000	$ 10,000	$ 100,000	$ 289,000
Hastings Point Combined	1750	$ 28,000	$ 30,625	$ 306,250	$ 8,750	$ 10,000	$ 150,000	$ 534,000
Rugby Club	150	$ 2,400	$ 2,625	$ 68,750	$ 750	$ 10,000	$ 100,000	$ 185,000
Turf Farm	1000	$ 16,000	$ 17,500	$ 212,500	$ 5,000	$ 10,000	$ 150,000	$ 411,000

Costs for Below Ground Storage Tanks

			Concrete Volume m3					
Location	Capacity Kl	Radius m	Floor Slab (400mm) (40mPa)	Roof Slab (600mm) (40mPa)	Walls (300mm) (40mPa)	Total Concr	Surrounds	Total Excav
Arkinstall Municipal Oval	290	6.8	58	87	26	171	160	621
Memorial Gardens	50	2.8	10	15	11	36	71	156
Barry Sheppard Oval	300	6.9	60	90	26	176	163	639
Hastings Point Combined	875	11.8	175	263	44	482	274	1631
Rugby Club	75	3.5	15	23	13	51	85	210
Turf Farm	500	8.9	100	150	34	284	209	992

Location	Capacity Kl	Excavation (Medium Ground) $80/m3	Dewatering $35/m2	Concrete Supply, inst. Re-inf, Formwork $1100/m3	Offsite Disposal of Spoil $25/m3	Geotech Inv. $	Tank Pumps, Valves & Fittings $	Under ground tanks Total $
Arkinstall Municipal Oval	290	$ 49,685	$ 5,075	$ 187,673	$ 11,515	$ 10,000	$ 100,000	$ 364,000
Memorial Gardens	50	$ 12,498	$ 875	$ 39,198	$ 2,141	$ 10,000	$ 100,000	$ 165,000
Barry Sheppard Oval	300	$ 51,131	$ 5,250	$ 193,655	$ 11,901	$ 10,000	$ 100,000	$ 372,000
Hastings Point Combined	875	$ 130,456	$ 15,313	$ 530,187	$ 33,925	$ 10,000	$ 150,000	$ 870,000
Rugby Club	75	$ 16,837	$ 1,313	$ 55,577	$ 3,138	$ 10,000	$ 100,000	$ 187,000
Turf Farm	500	$ 79,376	$ 8,750	$ 311,993	$ 19,591	$ 10,000	$ 150,000	$ 580,000

Cost of Above Ground Storage

Location	Capacity Kl	Radius m	Floor Slab (400mm) (40mPa)	Roof Slab (600mm) (40mPa)	Walls (300mm) (40mPa)	Total Concr	Surrounds	Total Excav
Arkinstall Municipal Oval	290	6.8	58	87	26	171	160	58
Memorial Gardens	50	2.8	10	15	11	36	71	10
Barry Sheppard Oval	300	6.9	60	90	26	176	163	60
Hastings Point Combined	875	11.8	175	263	44	482	274	175
Rugby Club	75	3.5	15	23	13	51	85	15
Turf Farm	500	8.9	100	150	34	284	209	100

Location	Capacity Kl	Excavation (Medium Ground) $80/m3	Dewatering $35/m2	Concrete Supply, inst. Re-inf, Formwork $1100/m3	Offsite Disposal of Spoil $25/m3	Geotech Inv. $	Tank Pumps, Valves & Fittings $	Above ground tanks Total $
Arkinstall Municipal Oval	290	$ 4,640	$ 5,075	$ 187,673	$ 1,450	$ 10,000	$ 100,000	$ 309,000
Memorial Gardens	50	$ 800	$ 875	$ 39,198	$ 250	$ 10,000	$ 100,000	$ 151,000
Barry Sheppard Oval	300	$ 4,800	$ 5,250	$ 193,655	$ 1,500	$ 10,000	$ 100,000	$ 315,000
Hastings Point Combined	875	$ 14,000	$ 15,313	$ 530,187	$ 4,375	$ 10,000	$ 150,000	$ 724,000
Rugby Club	75	$ 1,200	$ 1,313	$ 55,577	$ 375	$ 10,000	$ 100,000	$ 168,000
Turf Farm	500	$ 8,000	$ 8,750	$ 311,993	$ 2,500	$ 10,000	$ 150,000	$ 491,000

Cost of Prefabricated Tanks

Location	Capacity Kl	Excavation (Medium Ground) $80/m3	Dewatering $35/m2	Tank Supply, inst. (Cost x 25% Inst.)	Offsite Disposal of Spoil $25/m3	Geotech Inv. $	Tank Pumps, Valves & Fittings $	Prefabricated Total $
Arkinstall Municipal Oval	290	$ 4,640	$ 5,075	$ 62,500	$ 1,450	$ 10,000	$ 100,000	$ 184,000
Memorial Gardens	50	$ 800	$ 875	$ 27,500	$ 250	$ 10,000	$ 100,000	$ 139,000
Barry Sheppard Oval	300	$ 4,800	$ 5,250	$ 68,750	$ 1,500	$ 10,000	$ 100,000	$ 190,000
Hastings Point Combined	875	$ 14,000	$ 15,313	$ 106,250	$ 4,375	$ 10,000	$ 150,000	$ 300,000
Rugby Club	75	$ 1,200	$ 1,313	$ 37,500	$ 375	$ 10,000	$ 100,000	$ 150,000
Turf Farm	500	$ 8,000	$ 8,750	$ 81,250	$ 2,500	$ 10,000	$ 150,000	$ 261,000

TSC Recycled Water Schemes O&M Costs for Options 1 & 3					
Equipment		Cost Calculation Basis	Sub totals $/Yr	Operating Costs $/Yr	Comments
Pump station	**Flow**	**Power Costs**			Pump KW Ratings
Arkinstall Municpal Park	40 l/s	50kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 7,200		>20 l/s = 20 KW Motors
		50kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 2,520	$ 9,720	20 < 50 = 50 KW Motors
					50 < 100 = 100 KW Motors
Tweed Heads Cemetary		20kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 2,880		50 < = 200 KW Motors
					All pumping rates are 4 hours a day split 50/50 between peak and off
		20kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 1,008	$ 3,888	peak .
Hasting Point Rugby Club	10 l/s	20kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 2,880		
		20kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 1,008	$ 3,888	
Barry Sheppard Oval & Pony Club	41 l/s	50kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 7,200		
		50kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 2,520	$ 9,720	
Turf Farm	40 l/s	50kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 7,200		
		50kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 2,520	$ 9,720	
Ti Tree Plantation	181 l/s	200kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 28,800		
		200kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 10,080	$ 38,880	
Chinderah Golf Course	77 l/s	100kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 14,400		
		100kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 5,040	$ 19,440	
Uki Nursery		20kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 2,880		
		20kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 1,008	$ 3,888	
Tyalgum		20kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 2,880		
		20kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 1,008	$ 3,888	
		Total pumping power cost/year =		$ 103,032	TSC would get a more competitive (bulk) power tariff than that assumed here, therefore power costs could be lower (by ~25%)
Labour O&M		(2 visits x 1hr x 35 wks) + (2 visits x 5hrs) x $62.50/hr =	$ 5,000	$ 45,000	2 major servicing visits per year, 35 regular checks during the year @ 9 Pumping Stations
Equipment replacement		2% of capital cost (~$157,000) =	$ 3,140	$ 28,260	2% of capital for PS civil, mechanical and Electrical works @ 9 Pumping Stations
Pipeline					
O& M		0.25% of capital =	$ 804,550	$ 2,011	0.25% of capital for pipeline, valve and fittings
TSC Storage Tanks					
O&M		0.25% of capital ($0) =	$ 572,000	$ 2,860	1 visit/yr per tank prior to irrigation season
Irrigation @ TSC Sites					
O&M Surface		15% of irrig.capex	$ 2,151,600	$ 322,740	
O&M Sub Surface		7.5% of irrig.capex	$ 2,994,000	$ 224,550	NOTE: It is believed the OPEX for the Subsurface will be less the Surface irrigation
		Total Surface Irrigation CAPEX		**$ 504,000**	
		Total Sub-surface Irrigation CAPEX		**$ 406,000**	

Arkinstall Municpal Park					
Equipment		Cost Calculation Basis	Sub totals $/Yr	Operating Costs $/Yr	Comments
Pump station	**Flow**	**Power Costs**			Pump KW Ratings
Arkinstall Municpal Park	40 l/s	50kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 7,200		>20 l/s = 20 KW Motors
		50kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 2,520	$ 9,720	20 < 50 = 50 KW Motors
Labour O&M		(2 visits x 1hr x 35 wks) + (2 visits x 5hrs) x $62.50/hr =		$ 5,000	2 major servicing visits per year, 35 regular checks during the year
Equipment replacement		2% of capital cost (~$157,000) =	$ 157,000	$ 3,140	2% of capital for PS civil, mechanical and Electrical works
Pipeline					
O& M		0.25% of capital =	$ 240,250	$ 601	0.25% of capital for pipeline, valve and fittings
TSC Storage Tanks					
O&M		0.25% of capital ($0) =	$ 364,000	$ 1,820	1 visit/yr per tank prior to irrigation season
Irrigation @ TSC Sites					
O&M Surface		**10% of irrig.capex**	$ 1,455,268	$ 145,527	
O&M Sub Surface		**8% of irrig.capex**	$ 1,628,688	$ 130,295	NOTE: It is believed the OPEX for the Subsurface will be less the Surface irrigation
		Total Surface Irrigation OPEX		**$ 165,807**	
		Total Sub-surface Irrigation OPEX		**$ 150,576**	

Barry Sheppard Oval					
Equipment		Cost Calculation Basis	Sub totals $/Yr	Operating Costs $/Yr	Comments
Pump station	**Flow**	**Power Costs**			Pump KW Ratings
Barry Sheppard Oval	40 l/s	50kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 7,200		>20 l/s = 20 KW Motors
		50kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 2,520	$ 9,720	20 < 50 = 50 KW Motors
Labour O&M		(2 visits x 1hr x 35 wks) + (2 visits x 5hrs) x $62.50/hr =		$ 5,000	2 major servicing visits per year, 35 regular checks during the year
Equipment replacement		2% of capital cost (~$157,000) =	$ 157,000	$ 3,140	2% of capital for PS civil, mechanical and Electrical works
Pipeline					
O& M		0.25% of capital =	$ 141,050	$ 353	0.25% of capital for pipeline, valve and fittings
TSC Storage Tanks					
O&M		0.25% of capital ($0) =	$ 608,000	$ 3,040	1 visit/yr per tank prior to irrigation season
Irrigation @ TSC Sites					
O&M Surface		**10% of irrig.capex**	$ 1,636,508	$ 163,651	
O&M Sub Surface		**8% of irrig.capex**	$ 1,815,908	$ 145,273	NOTE: It is believed the OPEX for the Subsurface will be less the Surface irrigation
		Total Surface Irrigation OPEX		**$ 184,903**	
		Total Sub-surface Irrigation OPEX		**$ 166,525**	

Bogangar Rugby Club					
Equipment		Cost Calculation Basis	Sub totals $/Yr	Operating Costs $/Yr	Comments
Pump station	**Flow**	**Power Costs**			Pump KW Ratings
Bogangar Rugby Club	40 l/s	50kW pump x 4hrs x 180 days x peak $0.2/kWhr =	$ 7,200		>20 l/s = 20 KW Motors
		50kW pump x 4hrs x 180 days x off-peak $0.07/kWhr =	$ 2,520	$ 9,720	20 < 50 = 50 KW Motors
Labour O&M		(2 visits x 1hr x 35 wks) + (2 visits x 5hrs) x $62.50/hr =		$ 5,000	2 major servicing visits per year, 35 regular checks during the year
Equipment replacement		2% of capital cost (~$157,000) =	$ 137,000	$ 3,140	2% of capital for PS civil, mechanical and Electrical works
Pipeline					
O& M		0.25% of capital =	$ 68,500	$ 171	0.25% of capital for pipeline, valve and fittings
TSC Storage Tanks					
O&M		0.25% of capital ($0) =	$ 250,000	$ 1,250	1 visit/yr per tank prior to irrigation season
Irrigation @ TSC Sites					
O&M Surface		**10% of irrig.capex**	$ 731,975	$ 73,198	
O&M Sub Surface		**8% of irrig.capex**	$ 776,825	$ 62,146	NOTE: It is believed the OPEX for the Subsurface will be less the Surface irrigation
		Total Surface Irrigation OPEX		**$ 92,479**	
		Total Sub-surface Irrigation OPEX		**$ 81,427**	

Kingscliff Recycled Water Scheme Stage 1
NPV ANALYSIS

PROJECT	Recycled Water Opportunities

24-Feb-06

ASSUMPTIONS	
Start of Project	2005
Length of Evaluation	20
Estimated Project Life (years)	
Discount rate	8%

OPTION SUMMARY

OPTION SUMMARY	*Surface NPV*	*Subsurface - NPV*
Arkinstall Park	-$3,249	-$3,258
Barry Sheppard Oval	-$3,637	-$3,617
Bogangar Rugby Club	-$1,732	-$1,658
TOTAL	-$8,618	-$8,533

NOTES:

1. Enter data in the Project Heading and Project Data box on this page only.
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4. Residual values, if applicable, should be calculated and included as income in the 25th year.

PROJECT	TSC Effluent Reuse Opportunities

Option 2	Arkinstall Park Surface Irrigation

File Name: A1014500

Date: 24-Feb-06

PROJECT DATA

Start of Project (financial year ending 30/6)	2006
Length of Evaluation (maximum 20 years)	20
Estimated Project Life	
Discount Rate (8% suggested)	8%
NPV	-$3,249

YEAR	COSTS ($,000s)				TOTAL COST	INCOME	NET CASH FLOW	PV 8%
	CAPITAL		RECURRENT					
	0	0	O & M	OTHER				
0	$1,455	$0	$166	$0	$1,621	$0	-$1,621	-$1,621
1	$0	$0	$166	$0	$166	$0	-$166	-$154
2	$0	$0	$166	$0	$166	$0	-$166	-$142
3	$0	$0	$166	$0	$166	$0	-$166	-$132
4	$0	$0	$166	$0	$166	$0	-$166	-$122
5	$0	$0	$166	$0	$166	$0	-$166	-$113
6	$0	$0	$166	$0	$166	$0	-$166	-$104
7	$0	$0	$166	$0	$166	$0	-$166	-$97
8	$0	$0	$166	$0	$166	$0	-$166	-$90
9	$0	$0	$166	$0	$166	$0	-$166	-$83
10	$0	$0	$166	$0	$166	$0	-$166	-$77
11	$0	$0	$166	$0	$166	$0	-$166	-$71
12	$0	$0	$166	$0	$166	$0	-$166	-$66
13	$0	$0	$166	$0	$166	$0	-$166	-$61
14	$0	$0	$166	$0	$166	$0	-$166	-$56
15	$0	$0	$166	$0	$166	$0	-$166	-$52
16	$0	$0	$166	$0	$166	$0	-$166	-$48
17	$0	$0	$166	$0	$166	$0	-$166	-$45
18	$0	$0	$166	$0	$166	$0	-$166	-$41
19	$0	$0	$166	$0	$166	$0	-$166	-$38
20	$0	$0	$166	$0	$166	$0	-$166	-$36
								-$3,249

NOTES:

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PROJECT	TSC Effluent Reuse Opportunities

Option 2	Arkinstall Park Subsurface Irrigation

File Name: A1014500

Date: 24-Feb-06

PROJECT DATA

Start of Project (financial year ending 30/6)	2006
Length of Evaluation (maximum 20 years)	20
Estimated Project Life	
Discount Rate (8% suggested)	8%
NPV	-$3,258

YEAR	COSTS ($,000s)				TOTAL COST	INCOME	NET CASH FLOW	PV 8%
	CAPITAL		RECURRENT					
	0	0	O & M	OTHER				
0	$1,629	$0	$151	$0	$1,779	$0	-$1,779	-$1,779
1	$0	$0	$151	$0	$151	$0	-$151	-$139
2	$0	$0	$151	$0	$151	$0	-$151	-$129
3	$0	$0	$151	$0	$151	$0	-$151	-$120
4	$0	$0	$151	$0	$151	$0	-$151	-$111
5	$0	$0	$151	$0	$151	$0	-$151	-$102
6	$0	$0	$151	$0	$151	$0	-$151	-$95
7	$0	$0	$151	$0	$151	$0	-$151	-$88
8	$0	$0	$151	$0	$151	$0	-$151	-$81
9	$0	$0	$151	$0	$151	$0	-$151	-$75
10	$0	$0	$151	$0	$151	$0	-$151	-$70
11	$0	$0	$151	$0	$151	$0	-$151	-$65
12	$0	$0	$151	$0	$151	$0	-$151	-$60
13	$0	$0	$151	$0	$151	$0	-$151	-$55
14	$0	$0	$151	$0	$151	$0	-$151	-$51
15	$0	$0	$151	$0	$151	$0	-$151	-$47
16	$0	$0	$151	$0	$151	$0	-$151	-$44
17	$0	$0	$151	$0	$151	$0	-$151	-$41
18	$0	$0	$151	$0	$151	$0	-$151	-$38
19	$0	$0	$151	$0	$151	$0	-$151	-$35
20	$0	$0	$151	$0	$151	$0	-$151	-$32
								-$3,258

NOTES:

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PROJECT	TSC Effluent Reuse Opportunities

Option 2	Barry Sheppard Oval Surface Irrigation

File Name: A1014500

Date: 24-Feb-06

PROJECT DATA

Start of Project (financial year ending 30/6)	2006
Length of Evaluation (maximum 20 years)	20
Estimated Project Life	
Discount Rate (8% suggested)	8%
NPV	-$3,637

YEAR	COSTS ($,000s)				TOTAL COST	INCOME	NET CASH FLOW	PV 8%
	CAPITAL		RECURRENT					
	0	0	O & M	OTHER				
0	$1,637	$0	$185	$0	$1,821	$0	-$1,821	-$1,821
1	$0	$0	$185	$0	$185	$0	-$185	-$171
2	$0	$0	$185	$0	$185	$0	-$185	-$159
3	$0	$0	$185	$0	$185	$0	-$185	-$147
4	$0	$0	$185	$0	$185	$0	-$185	-$136
5	$0	$0	$185	$0	$185	$0	-$185	-$126
6	$0	$0	$185	$0	$185	$0	-$185	-$117
7	$0	$0	$185	$0	$185	$0	-$185	-$108
8	$0	$0	$185	$0	$185	$0	-$185	-$100
9	$0	$0	$185	$0	$185	$0	-$185	-$92
10	$0	$0	$185	$0	$185	$0	-$185	-$86
11	$0	$0	$185	$0	$185	$0	-$185	-$79
12	$0	$0	$185	$0	$185	$0	-$185	-$73
13	$0	$0	$185	$0	$185	$0	-$185	-$68
14	$0	$0	$185	$0	$185	$0	-$185	-$63
15	$0	$0	$185	$0	$185	$0	-$185	-$58
16	$0	$0	$185	$0	$185	$0	-$185	-$54
17	$0	$0	$185	$0	$185	$0	-$185	-$50
18	$0	$0	$185	$0	$185	$0	-$185	-$46
19	$0	$0	$185	$0	$185	$0	-$185	-$43
20	$0	$0	$185	$0	$185	$0	-$185	-$40
								-$3,637

NOTES:

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4. Residual values, if applicable, should be calculated and included as income in the 25th year.

PROJECT	TSC Effluent Reuse Opportunities

Option 2	Barry Sheppard Oval Subsurface Irrigation

File Name: A1014500

Date: 24-Feb-06

PROJECT DATA

Start of Project (financial year ending 30/6)	2006
Length of Evaluation (maximum 20 years)	20
Estimated Project Life	
Discount Rate (8% suggested)	8%
NPV	-$3,617

YEAR	COSTS ($,000s)				TOTAL COST	INCOME	NET CASH FLOW	PV 8%
	CAPITAL		RECURRENT					
	0	0	O & M	OTHER				
0	$1,816	$0	$167	$0	$1,982	$0	-$1,982	-$1,982
1	$0	$0	$167	$0	$167	$0	-$167	-$154
2	$0	$0	$167	$0	$167	$0	-$167	-$143
3	$0	$0	$167	$0	$167	$0	-$167	-$132
4	$0	$0	$167	$0	$167	$0	-$167	-$122
5	$0	$0	$167	$0	$167	$0	-$167	-$113
6	$0	$0	$167	$0	$167	$0	-$167	-$105
7	$0	$0	$167	$0	$167	$0	-$167	-$97
8	$0	$0	$167	$0	$167	$0	-$167	-$90
9	$0	$0	$167	$0	$167	$0	-$167	-$83
10	$0	$0	$167	$0	$167	$0	-$167	-$77
11	$0	$0	$167	$0	$167	$0	-$167	-$71
12	$0	$0	$167	$0	$167	$0	-$167	-$66
13	$0	$0	$167	$0	$167	$0	-$167	-$61
14	$0	$0	$167	$0	$167	$0	-$167	-$57
15	$0	$0	$167	$0	$167	$0	-$167	-$52
16	$0	$0	$167	$0	$167	$0	-$167	-$49
17	$0	$0	$167	$0	$167	$0	-$167	-$45
18	$0	$0	$167	$0	$167	$0	-$167	-$42
19	$0	$0	$167	$0	$167	$0	-$167	-$39
20	$0	$0	$167	$0	$167	$0	-$167	-$36
								-$3,617

NOTES:

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4. Residual values, if applicable, should be calculated and included as income in the 25th year.

PROJECT	TSC Effluent Reuse Opportunities

Option 2	Bogangar Rugby Club Surface Irrigation

File Name: A1014500

Date: 24-Feb-06

PROJECT DATA

Start of Project (financial year ending 30/6)	2006
Length of Evaluation (maximum 20 years)	20
Estimated Project Life	
Discount Rate (8% suggested)	8%
NPV	-$1,732

YEAR	COSTS ($,000s)				TOTAL COST	INCOME	NET CASH FLOW	PV 8%
	CAPITAL		RECURRENT					
	0	0	O & M	OTHER				
0	$732	$0	$92	$0	$824	$0	-$824	-$824
1	$0	$0	$92	$0	$92	$0	-$92	-$86
2	$0	$0	$92	$0	$92	$0	-$92	-$79
3	$0	$0	$92	$0	$92	$0	-$92	-$73
4	$0	$0	$92	$0	$92	$0	-$92	-$68
5	$0	$0	$92	$0	$92	$0	-$92	-$63
6	$0	$0	$92	$0	$92	$0	-$92	-$58
7	$0	$0	$92	$0	$92	$0	-$92	-$54
8	$0	$0	$92	$0	$92	$0	-$92	-$50
9	$0	$0	$92	$0	$92	$0	-$92	-$46
10	$0	$0	$92	$0	$92	$0	-$92	-$43
11	$0	$0	$92	$0	$92	$0	-$92	-$40
12	$0	$0	$92	$0	$92	$0	-$92	-$37
13	$0	$0	$92	$0	$92	$0	-$92	-$34
14	$0	$0	$92	$0	$92	$0	-$92	-$31
15	$0	$0	$92	$0	$92	$0	-$92	-$29
16	$0	$0	$92	$0	$92	$0	-$92	-$27
17	$0	$0	$92	$0	$92	$0	-$92	-$25
18	$0	$0	$92	$0	$92	$0	-$92	-$23
19	$0	$0	$92	$0	$92	$0	-$92	-$21
20	$0	$0	$92	$0	$92	$0	-$92	-$20
								-$1,732

NOTES:

1. Enter data in the Project Heading and Project Data box on this page only.
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4. Residual values, if applicable, should be calculated and included as income in the 25th year.

PROJECT	TSC Effluent Reuse Opportunities

Option 2	Bogangar Rugby Club Subsurface Irrigation

File Name: A1014500

Date: 24-Feb-06

PROJECT DATA

Start of Project (financial year ending 30/6)	2006
Length of Evaluation (maximum 20 years)	20
Estimated Project Life	
Discount Rate (8% suggested)	8%
NPV	-$1,658

YEAR	COSTS ($,000s)				TOTAL COST	INCOME	NET CASH FLOW	PV 8%
	CAPITAL		RECURRENT					
	0	0	O & M	OTHER				
0	$777	$0	$81	$0	$858	$0	-$858	-$858
1	$0	$0	$81	$0	$81	$0	-$81	-$75
2	$0	$0	$81	$0	$81	$0	-$81	-$70
3	$0	$0	$81	$0	$81	$0	-$81	-$65
4	$0	$0	$81	$0	$81	$0	-$81	-$60
5	$0	$0	$81	$0	$81	$0	-$81	-$55
6	$0	$0	$81	$0	$81	$0	-$81	-$51
7	$0	$0	$81	$0	$81	$0	-$81	-$48
8	$0	$0	$81	$0	$81	$0	-$81	-$44
9	$0	$0	$81	$0	$81	$0	-$81	-$41
10	$0	$0	$81	$0	$81	$0	-$81	-$38
11	$0	$0	$81	$0	$81	$0	-$81	-$35
12	$0	$0	$81	$0	$81	$0	-$81	-$32
13	$0	$0	$81	$0	$81	$0	-$81	-$30
14	$0	$0	$81	$0	$81	$0	-$81	-$28
15	$0	$0	$81	$0	$81	$0	-$81	-$26
16	$0	$0	$81	$0	$81	$0	-$81	-$24
17	$0	$0	$81	$0	$81	$0	-$81	-$22
18	$0	$0	$81	$0	$81	$0	-$81	-$20
19	$0	$0	$81	$0	$81	$0	-$81	-$19
20	$0	$0	$81	$0	$81	$0	-$81	-$17
								-$1,658

Appendix H Subsequent Investigation and Design Phases

The following investigation and design phases are needed to progress the TSC Recycled water Opportunities project. Next steps are "flagged' here in recognition of their importance as part of the wider scope of work necessary for approval of the Development Application process of TSC.

H1 Separate Development Application for the Recycled Water Scheme

The EIS for the new Kingscliff STP (GHD, December 2002), **Section 4.2** refers to the need for the assessment of recycled water proposals under Part 4 of the EP&A Act 1979, whereby a separate Development Application is required for a recycled water proposal. This is distinct from the Development Application, which has already been approved for the new STP.

The Concept Design Study reported here is a starting point to support Tweed Shire Council's Development Application for the recycled water scheme.

H2 Management of Public Health

The irrigation layout and control systems will need to be designed to comply with NSW DEC guidelines as well as national guidelines for reclaimed water use including:
Environmental Guidelines Use of Effluent by Irrigation (DEC, NSW Oct 2004);
NSW Guidelines for Urban and Residential Use of Reclaimed Water (NSW Recycled Water Co-ordination Committee 1993), and
National Water Quality Management Strategy Guidelines for Sewerage Systems: Reclaimed Water (ARMCANZ, ANZECC, NH&MRC 2000).

The proposed irrigation method and control systems for the sporting ovals should be designed to ensure accurate watering rates and scheduling to ensure > 4 hour withholding period before public access and to minimise offsite spray drift. Watering on high use public areas will need to be restricted to overnight watering (eg. 2300 to 0300) to prevent exposure of humans to recycled water.

The detailed design should also incorporate a layout with appropriate setback distances and sprinkler systems with automatic wind direction and wind speed anemometer controls that are sensitive to wind drift impacts.

H3 Soil/Land Capability and Environmental Issues

The following environmental issues should be addressed to confirm the assumptions made in the Concept Design Study. These are normally analysed by field investigations (soil, geotechnical, hydrogeological) with the aid of modeling techniques and to support any Development Application:

A. Management of Nutrients

The ability of an area to assimilate the nutrients supplied (particularly nitrogen and phosphorus), is determined by soil characteristics, groundwater conditions and the type of vegetation to which the recycled water is applied.

The above parameters should be analysed so that the application is sustainable in the long-term and thus avoids site run-off, excessive seepage to groundwater, potential high watertables, waterlogging and salinity problems and resultant vegetation damage (particularly on the foreshore).

B. Soils and Geology

Recycled water re-use studies require accurate information and site-specific data as input parameters to effective impact assessment. Without such information the confidence of recommendations is diminished and can provide misleading and speculative conclusions.

Soil and geological conditions should be assessed for all sites to evaluate the land capability for long term recycled water irrigation, which may have been modified by existing development and onsite activities and to effectively assess them for water, nutrient and salinity balance modeling.

C. Groundwater Issues

Determining an appropriate application rate of the irrigated recycled water based on the characteristics of the soil and plants, and their ability to assimilate that volume over the long-term without adverse environmental impact, is critical to prevention of groundwater pollution and excessive watertable rise. In Kingscliff hinterland and foreshore areas, the watertable is only about 1-2m below natural ground surface. The unconfined upper aquifer is also brackish – influenced by sea water intrusion.

An irrigation-scheduling model can be designed to assess plant demands and minimise excessive seepage to groundwater as far as practicable, but assuring adequate leaching fraction to prevent salt accumulation in the root zone.

H4 Stakeholder and Social Issues

The areas to be used as part of the recycled water scheme are subject to regular public access, as they include:

Outdoor sporting venues (e.g. Arkinstall Municipal Oval, Barry Sheppard Oval and Round Mountain Pony Club.)

In addition, private customer sites also have public and member access, but with ability to restrict access to the site's opening times including to Chinderah Golf Course.

The various interests in these areas, include:
Stakeholder and community concerns (sporting groups, schools, etc.);
Native Title and Cultural Heritage issues (local indigenous communities);
Land use and tenure of existing developments (local developers eg. Gales Holdings).

Stakeholder and community liaison with the various groups who use the sporting facilities is an essential part of Council's Development Application process.

Appendix I Review Meeting Presentation

Effluent Reuse Scheme Opportunities

Presented to Tweed Shire Council

Presented by MWH Gold Coast

Date 8th February 2006

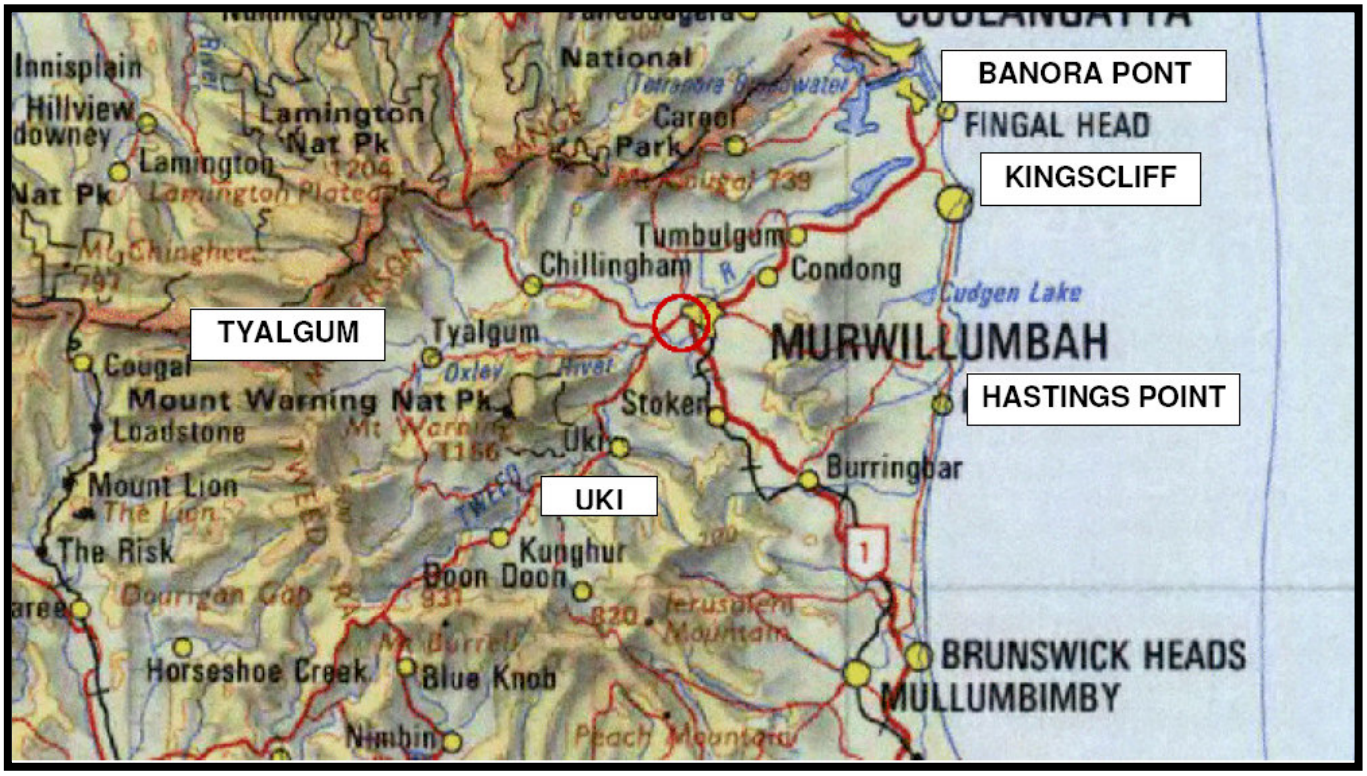
Workshop Objectives

- To Confirm Base Information
- Confirm project objectives and ensure that they are understood by all parties
  - Discharge of effluent (containing nutrients) to waterways will be reduced,
  - Beneficial effluent reuse to the local environment will be environmentally sustainable,
  - Demand on drinking water supplies will be reduced by substituting its use with increasing beneficial effluent reuse schemes,
  - Costs of water supply to the Shire will be contained,
  - The Shire's water and sensitive urban design strategy will be enhanced
- Prioritize the options
- Agree options for further development

Workshop Agenda

Approx. Timings	Wednesday 8th February 2006 TSC Reuse Opportunities Workshop
13.30	*Coffee for Start 13:15*
13:35	Introduction
13:40	Information Phase
14:45	*Coffee Break*
15:00	Discussion of Options
15:00	Options Evaluation and Decisisons
16:15	Action Plan and Programme
16:30	Feedback and Close

TSC Effluent Reuse Opportunities



Existing Performance

Source STP	Average Daily Flow (Ml/d)	Maximum Daily Flow (Ml/d)	Minimum Daily Flow (Ml/d)	Additional Treatment
Banora Point	12.0	69*	0.005 (This result is suspect - 5)	N
Hastings Point	2.5	11.7*	1.9	N
Kingscliff	2.1	15.7*	0.13 (This result is suspect - 0.5)	N
Uki	0.3	0.7*	0.2	Y
Tyalgum	0.5	0.3*	0.3	Y

* RAIN AFFECTED

Key Issues

- Subsurface or Surface Irrigation
- Controlled Public Space / Public Health
- Direct Irrigation, on site Pumping Station and Storage
- Final Effluent Outflows and Irrigation Demand

EPA - Use of Effluent by Irrigation

Appendix 1: Guidelines for the Use of Reclaimed Water from Municipal Sewage Treatment Plants

Table A1: Guidelines for treatment, disinfection and irrigation controls for the spray application of municipal sewage effluent

Type of reuse	Level of treatment	Effluent quality[1]	Effluent monitoring[2]	Controls
Urban (non-potable)				
Municipal with uncontrolled public access Irrigation open spaces, parks, sportsgrounds, dust suppression, construction sites	Tertiary and Pathogen reduction[5]	pH 6.5–8.5[7] ≤2 NTU[8] 1 mg/L Cl2 residual[10] or equivalent level of pathogen reduction Thermotolerant coliforms[3] <10 cfu/100mL[4]	pH weekly BOD weekly Turbidity continuous With disinfection system, e.g. Cl_2 Disinfection systems daily[6] Thermotolerant coliforms[3] weekly	Application rates limited to protect groundwater quality. Salinity should be considered for irrigation.
Municipal with controlled public access Irrigation open spaces, parks, sportsgrounds, dust suppression, construction sites, mines	Secondary and Pathogen reduction[5]	Thermotolerant coliforms[3] <1,000 cfu/100 mL[4]	pH monthly SS monthly Thermotolerant coliforms[3] weekly Disinfection systems daily[6]	Irrigation during times of no public access. Application rates limited to protect groundwater quality. Salinity should be considered for irrigation. Withholding period nominally 4 hours or until irrigated area is dry.
Agricultural				
Food production Raw human food crops in direct contact with effluent e.g. via sprays, irrigation of salad vegetables In NSW, NSW Health does not support the use of reclaimed water for spray irrigation of salad vegetables where the effluent is in contact with the edible part of the plant.	Tertiary and Pathogen reduction[5]	pH 6.5–8.5[7] ≤2 NTU[8] 1 mg/L Cl_2 residual[10] or equivalent level of disinfection Thermotolerant coliforms[3] <10 cfu/100 mL[4] <1 intestinal nematode egg or larva/L[9]	pH weekly Turbidity continuous Disinfection systems daily[6] Thermotolerant coliforms[3] weekly	Application rates limited to protect groundwater quality. Salinity should be considered. A minimum of 25 days ponding or equivalent treatment (e.g. sand filtration) for helminth control.

Irrigation System

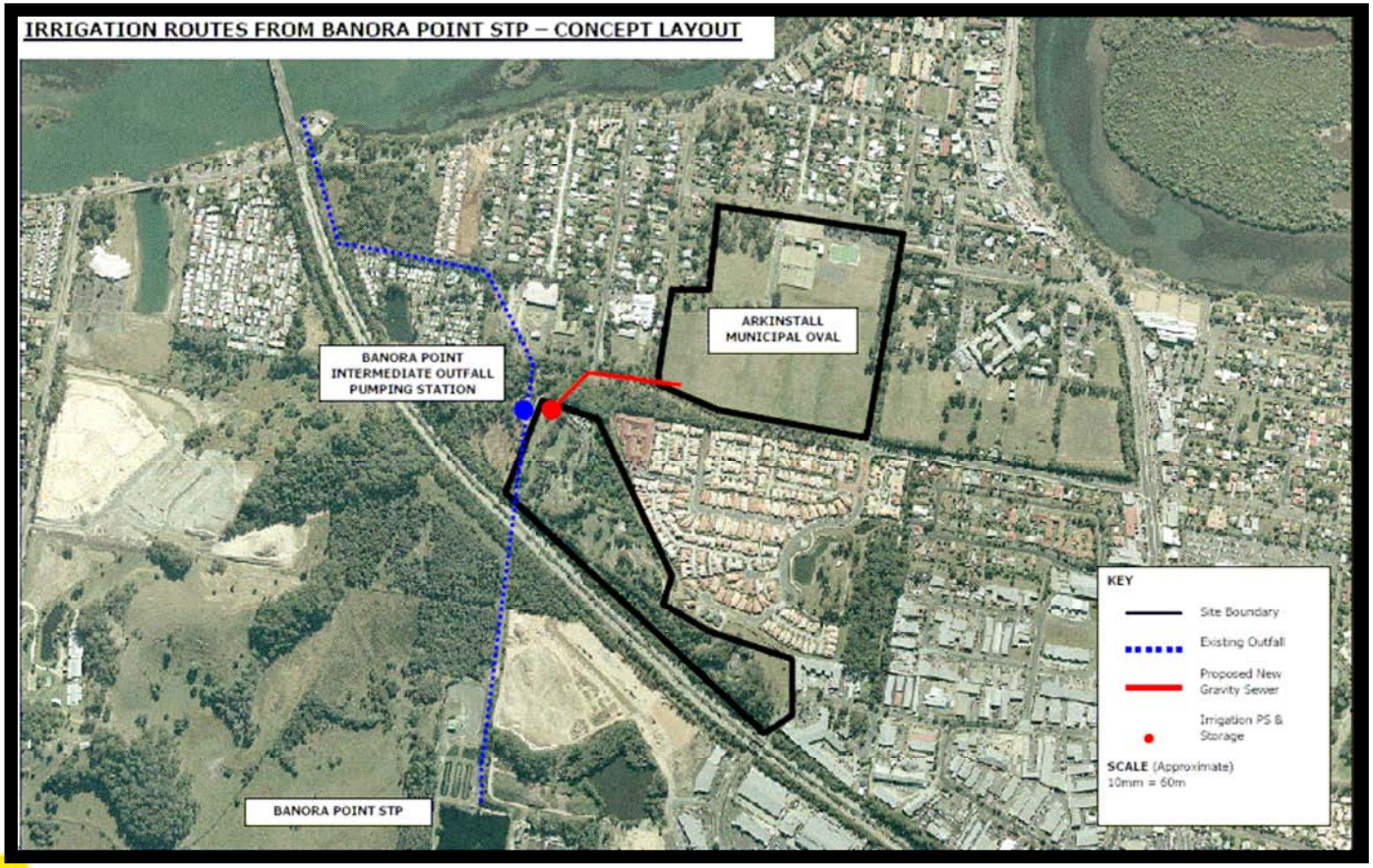
TYPE	ADVANTAGES	DISADVANTAGES
Surface	• Cheaper Installation Cost • Greater so less risk of Damage (i.e. Forking) • Uniform Coverage	• Stringent EPA Guideline • Public Health Risks • Larger Operation Costs • Constraints on irrigation times • Aerosol Drift
Subsurface	• Cheaper Operational Costs • No Public Health Risks • No constraints on irrigation times • Reduction in on Site Storage	• Less Uniform coverage • Risk of Damage(i.e. Forking) • Algae/Slime growth

Options

- Banora Point
- Hastings Point
- Kingscliff
- Uki
- Tyalgum

- Storage
- CAPEX
- OPEX
- Programme
- Conclusions

Banora Point



Banora Point - Arkinstall Park

Banora Point - Arkinstall Park

- The Banora Point Outfall Booster Pump Station is operated according to Ebb Tides
- Direct irrigation option is dependant on the tides
- Irrigation can only occur twice a day without storage
- Large area to irrigation and no guarantees required flows from works will coincide with irrigation times
- House Estates and Schools surround the park

Banora Point - Arkinstall Park

Surface Irrigation

- Irrigation required between 2300 and 0300 hours
- Full Days Storage Tank
- Irrigation timing is tide dependant (without Storage)

Subsurface

- Irrigation timing is tide dependant (without Storage)
- Irrigation 24/7
- 50% Storage Tank (Filled At each Tide)

Banora Point - Arkinstall Park

Preferred Option

- A connection will be made at the Banora Point Intermediate Pumping Station (PS). downstream of the outfall booster pumps.
- The head generated will feed the irrigation pumping station for Tweed Heads Crematorium and Memorial Gardens.
- PS when not irrigating will fill a storage tank at Arkinstall Park.
- Pumps within the storage tank will irrigate Arkinstall Park
- Subsurface irrigation.
- Irrigation will take place twice a day.
- The storage tank will need to be empty when the outfall main from Banora Point is operating to ensure that the tank can be refilled for the next irrigation.

Banora Point - Memorial Gardens

Banora Point - Memorial Gardens

- The Banora Point Outfall Booster Pump Station is operated according to Ebb Tides
- Direct irrigation option is dependent on the tides
- Irrigation can only occur twice a day without storage
- Large area to irrigation and no guarantees required flows from works will coincide with irrigation times
- Locked gates restrict public access between 1800 and 0730 hours
- Cemetery is Still Operational

Banora Point - Memorial Gardens

Surface Irrigation

- Irrigation required between 1900 and 0300 hours
- Full Days Storage Tank
- Irrigation timing is tide dependent (without Storage)

Subsurface

- Irrigation timing is tide dependent (without Storage)
- Irrigation 24/7(With Storage)
- 50% Storage Tank (Filled At each Tide)

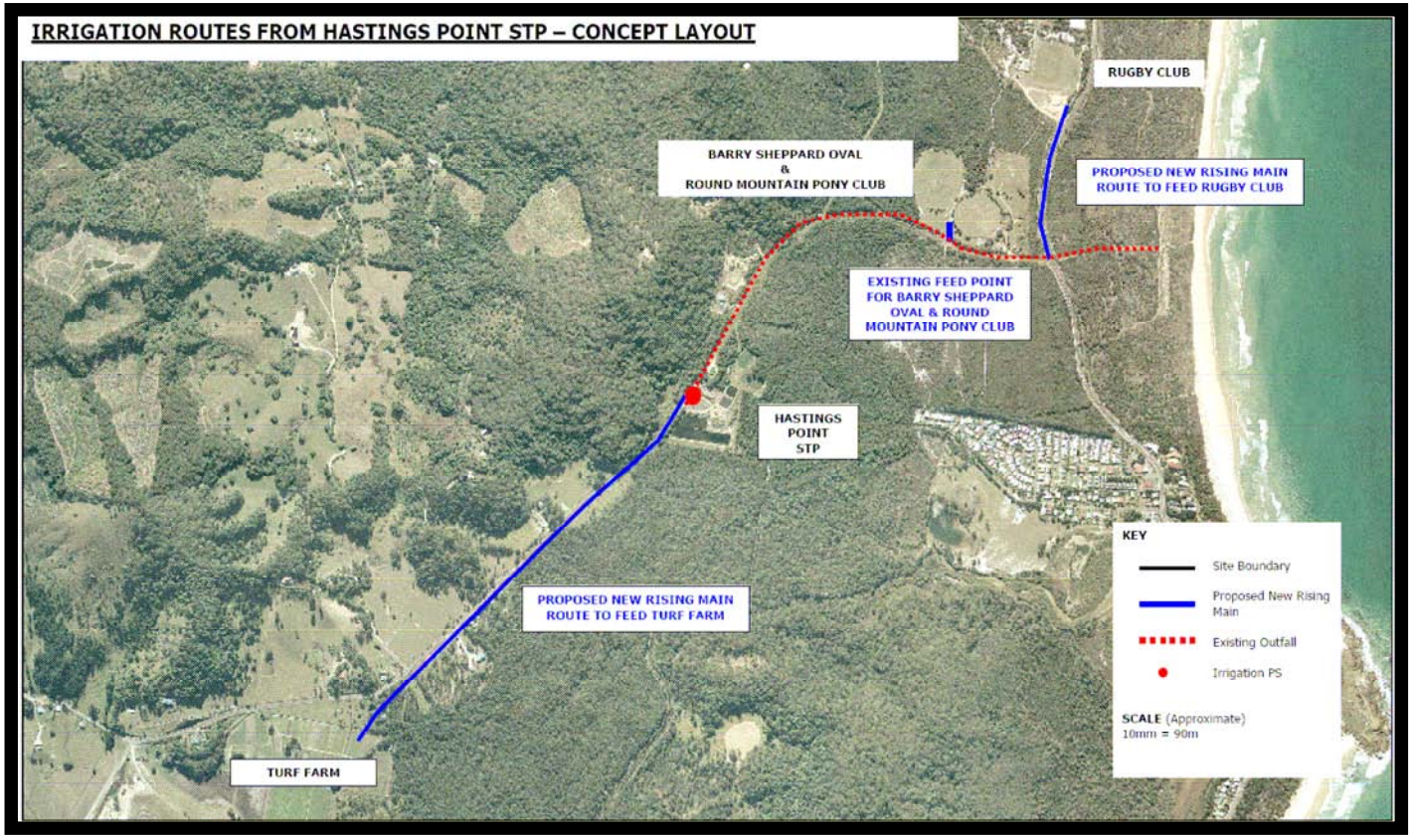
Banora Point - Memorial Gardens

BACK

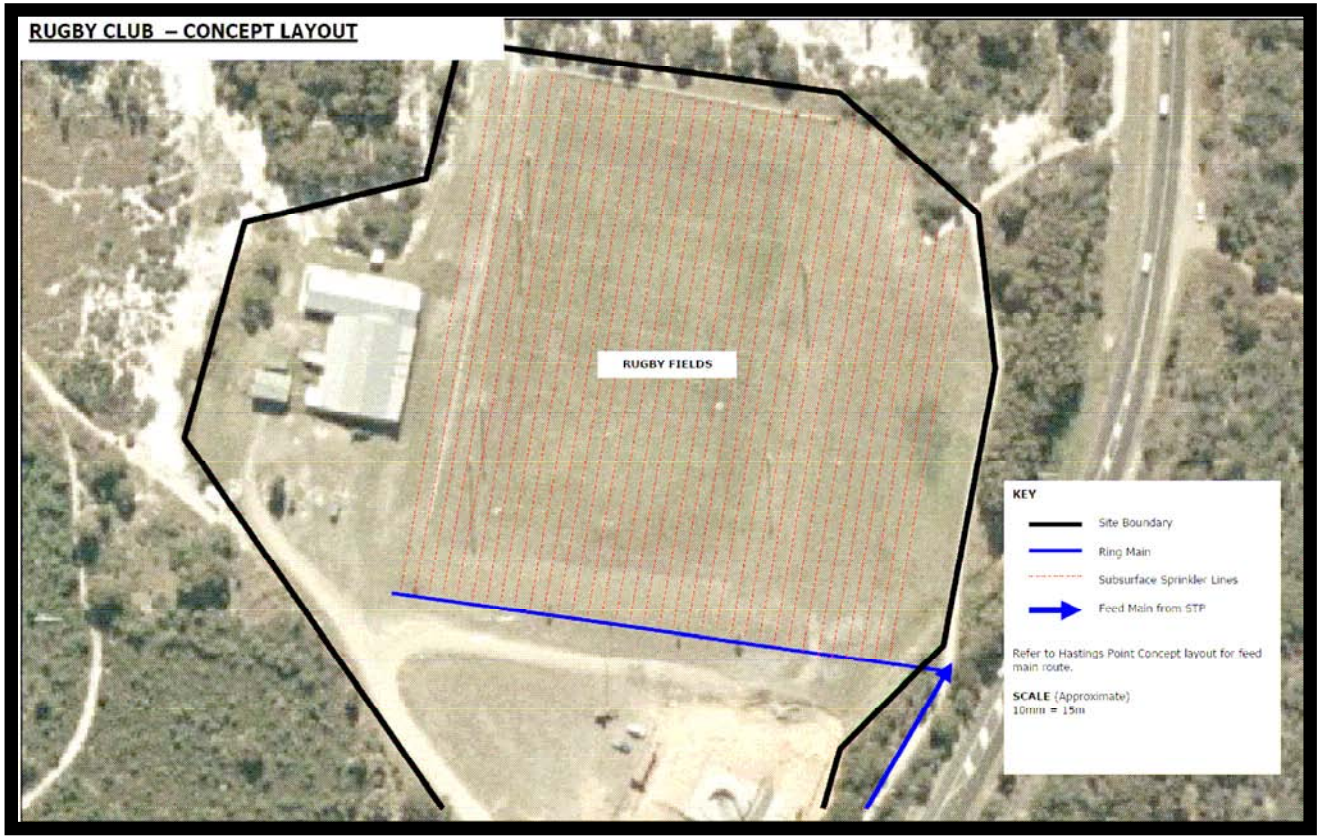
Preferred Option

- A connection will be made at the Banora Point Intermediate Pumping Station (PS). downstream of the outfall booster pumps.
- The head generated will feed the irrigation pumping station for Tweed Heads Crematorium and Memorial Gardens.
- This PS when irrigate the memorial gardens during the required hours of 1900 – 0300 hours.
- The flows will be controlled using water levels and valves with manual override.
- Storage of 100kL will be required for the daily irrigation.

Hastings Point



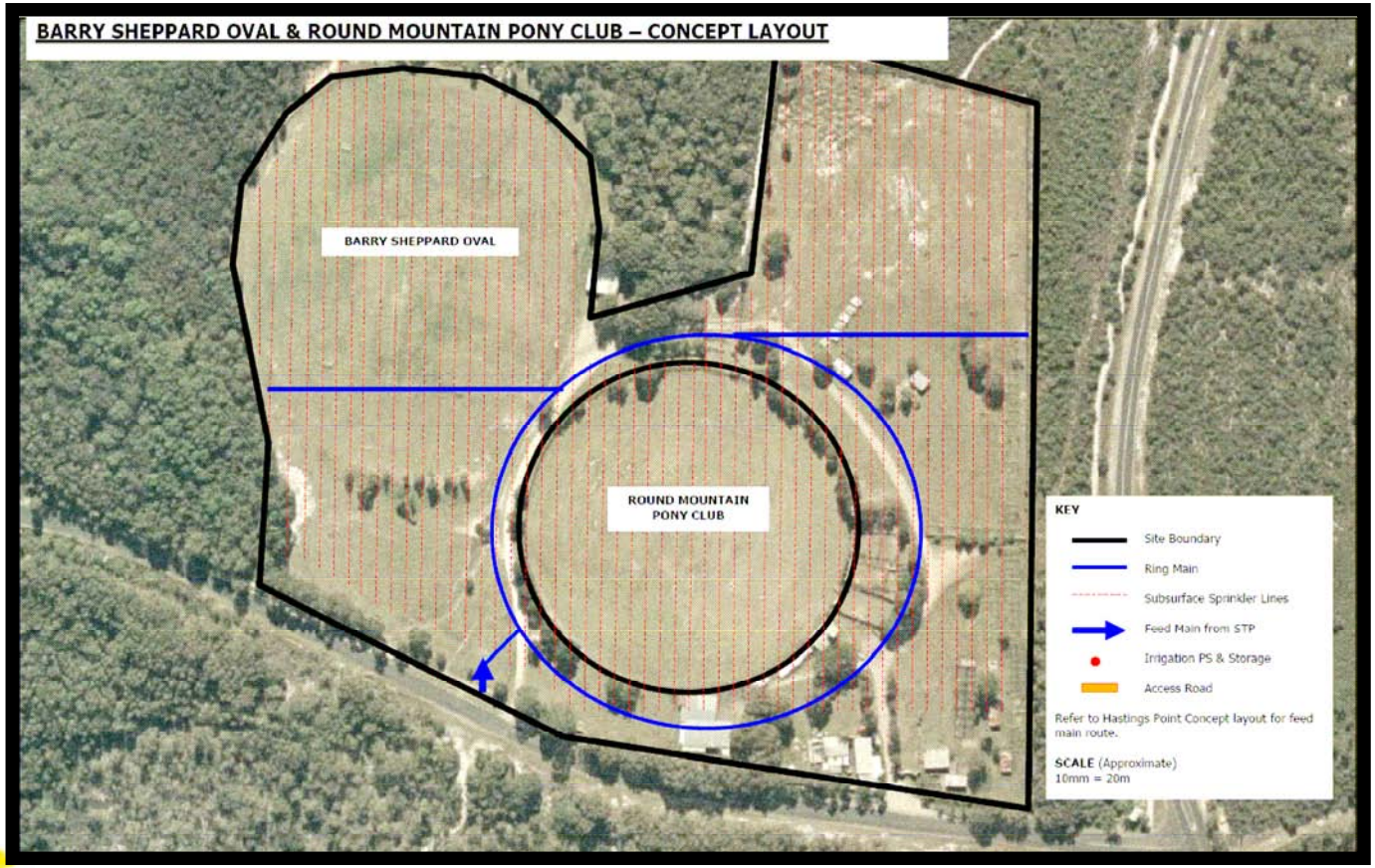
Hastings Point - Rugby Club



Hastings Point - Rugby Club

- It may be possible to provide the irrigation requirements directly from the existing outfall PS at Hastings Point by making modifications to the existing variable speed pumps.
- On site irrigation pump station fed using the existing pressurised outfall main.
- Irrigation requirement is small therefore no storage.
- Times of irrigation will need co-ordinating with the other proposed irrigation sites.

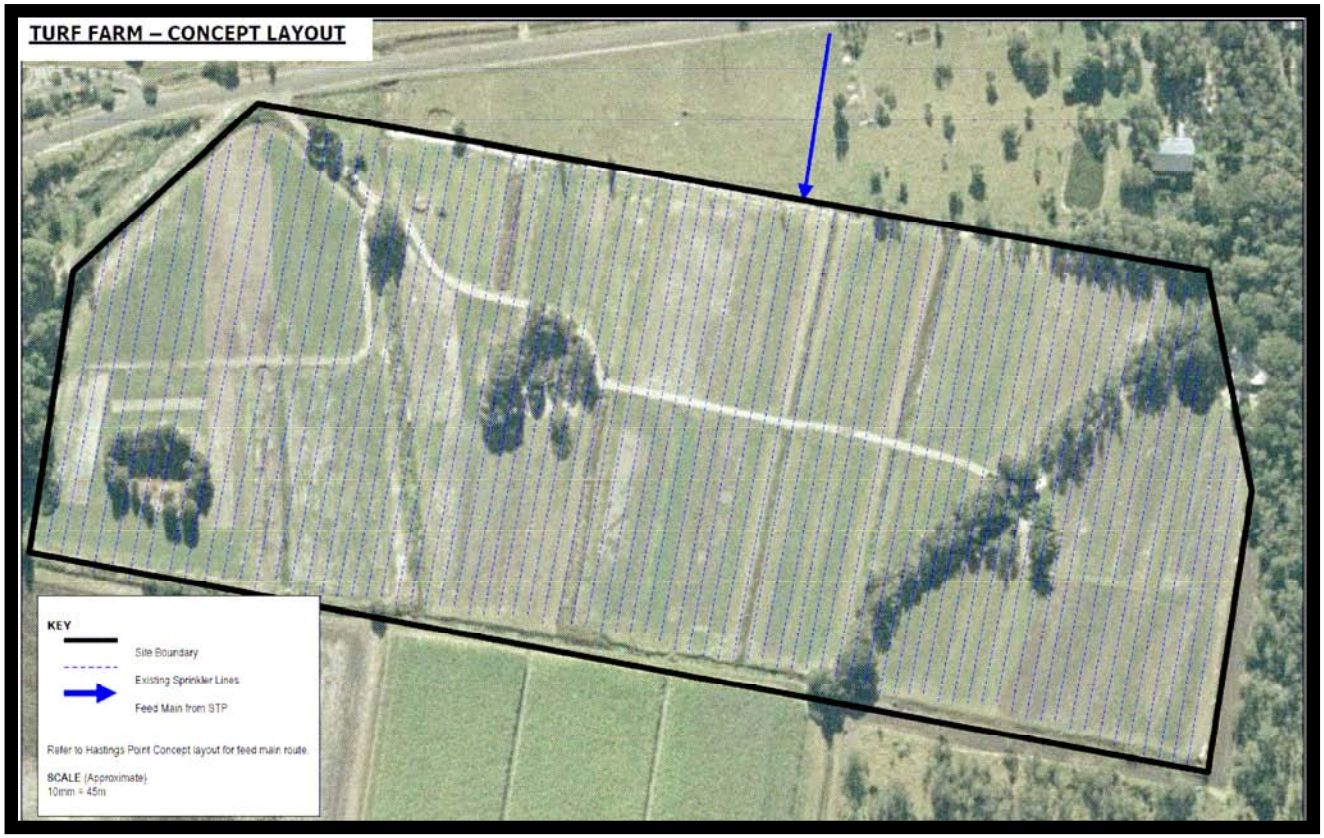
Hastings Point - Barry Sheppard Oval



Hastings Point - Barry Sheppard Oval

- Due to the large irrigation demand a direct pumping option does not appear viable.
- As the irrigation requirement is large on site storage will be required.
- Above ground sprinklers required a full day tank.
- Subsurface irrigation is implemented then the tank size can be reduced.
- The tank will be fed over a 24 hour period from the existing pressurised outfall main and have level control.
- Consideration must also be given to which site has preference i.e. the Pony Club or the Turf Farm.
- No amenities, housing estates, school; although controlled public access to the site during the irrigation times can not be guaranteed.

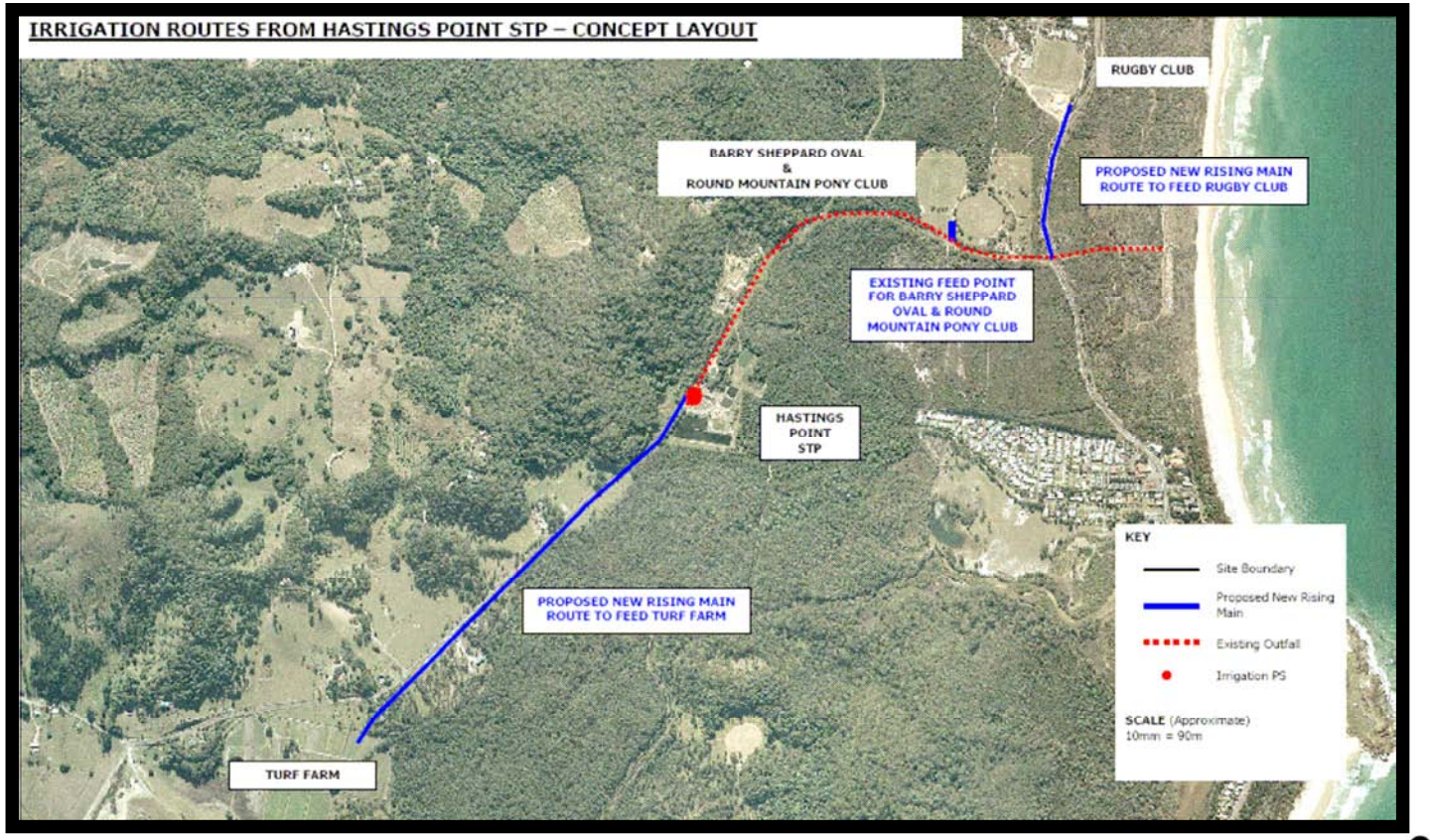
Hastings Point - Turf Farm



Hastings Point - Turf Farm

- Due to the large irrigation demand a direct pumping option does not appear viable.
- As the irrigation requirement is large, storage will be required.
- Landowner wished to use his above round irrigation system. The tank storage can still be reduce however as the land is privately owned and therefore public access is controlled so a reduced volume tank maybe a viable option.
- Having met with the Landowner a preference for any storage requirement to be site at the treatment works and directly fed has been expressed.
- Consideration must also be given to which site has preference i.e. the Pony Club or the Turf Farm.
- As there are no amenities, housing estates, school within the locality above ground sprinkler irrigation is acceptable.

Hastings Point - Combined



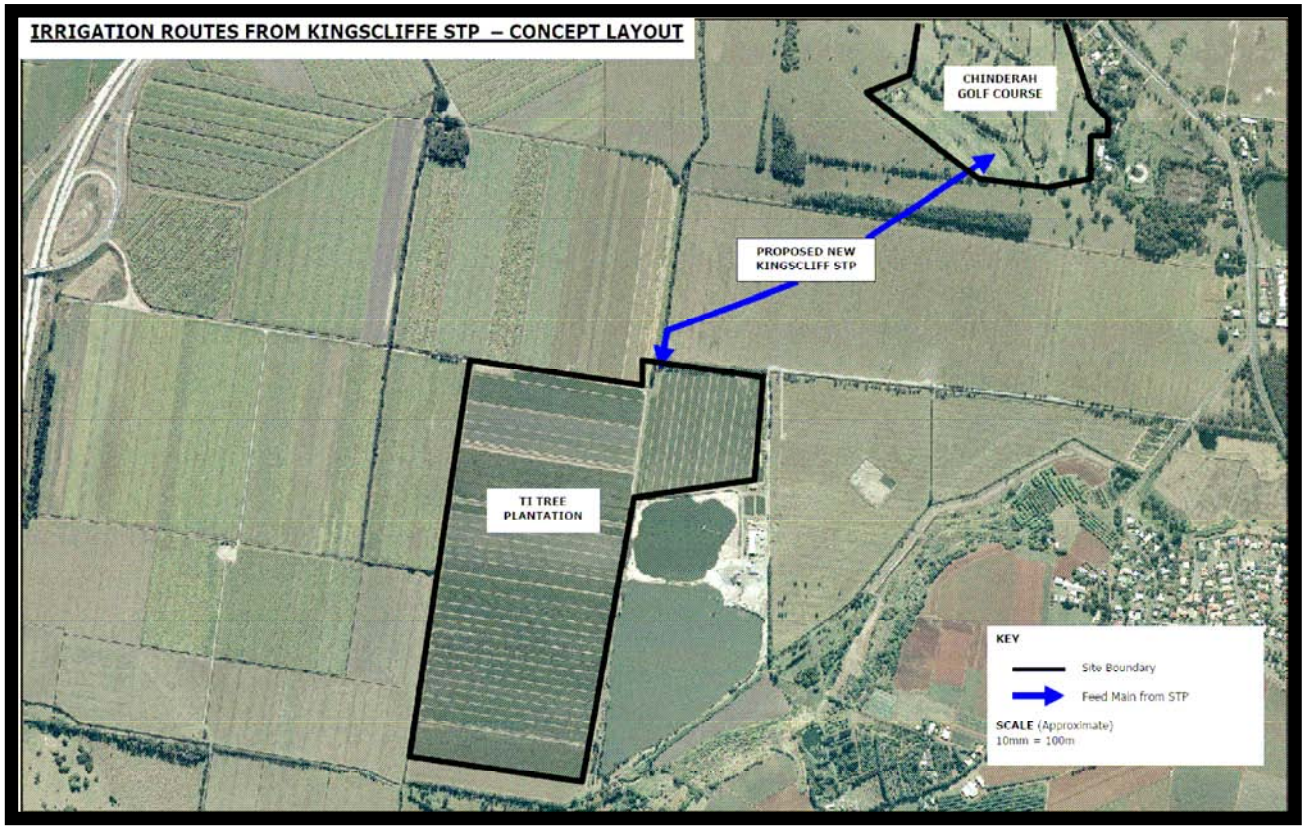
Hastings Point - Combined

BACK

Preferred Option

- All irrigation storage on site at Hastings Point STP.
- 1 irrigation pumping station would be required to directly feed all 3 sites and controlled so that only 1 site is operating at a time.
- An alternative to meet the irrigation requirements is to utilise the existing Final Effluent Lagoon at Hastings Point as the source for the irrigation.
- If no sites are irrigation then the outfall main will operate as normal.
- Subsurface irrigation will be employed so irrigation can occur at any time
- On site storage will be in 1.73ML, equating to 85% of the final effluent from the STP. (Assuming 1Ml.day to Turf farm)

Kingscliff


IRRIGATION ROUTES FROM KINGSCLIFFE STP – CONCEPT LAYOUT
CHINDERAH GOLF COURSE
PROPOSED NEW KINGSCLIFF STP
TI TREE PLANTATION
KEY
Site Boundary
Feed Main from STP
SCALE (Approximate)
10mm = 100m

Kingscliff - Ti Tree Plantation

Preferred Option

- The Ti Tree Plantation Land owner has expressed a desire not to have any final recycled water provided.

Kingscliff - Golf Course

- The Golf Course is building on site storage in the form of a Final Recycled water Lagoon. 6Ml storage lagoons located on the southern edge of the Gold Course.
- The new Kingscliff STP will provide 1.11Ml/day to the golf course.

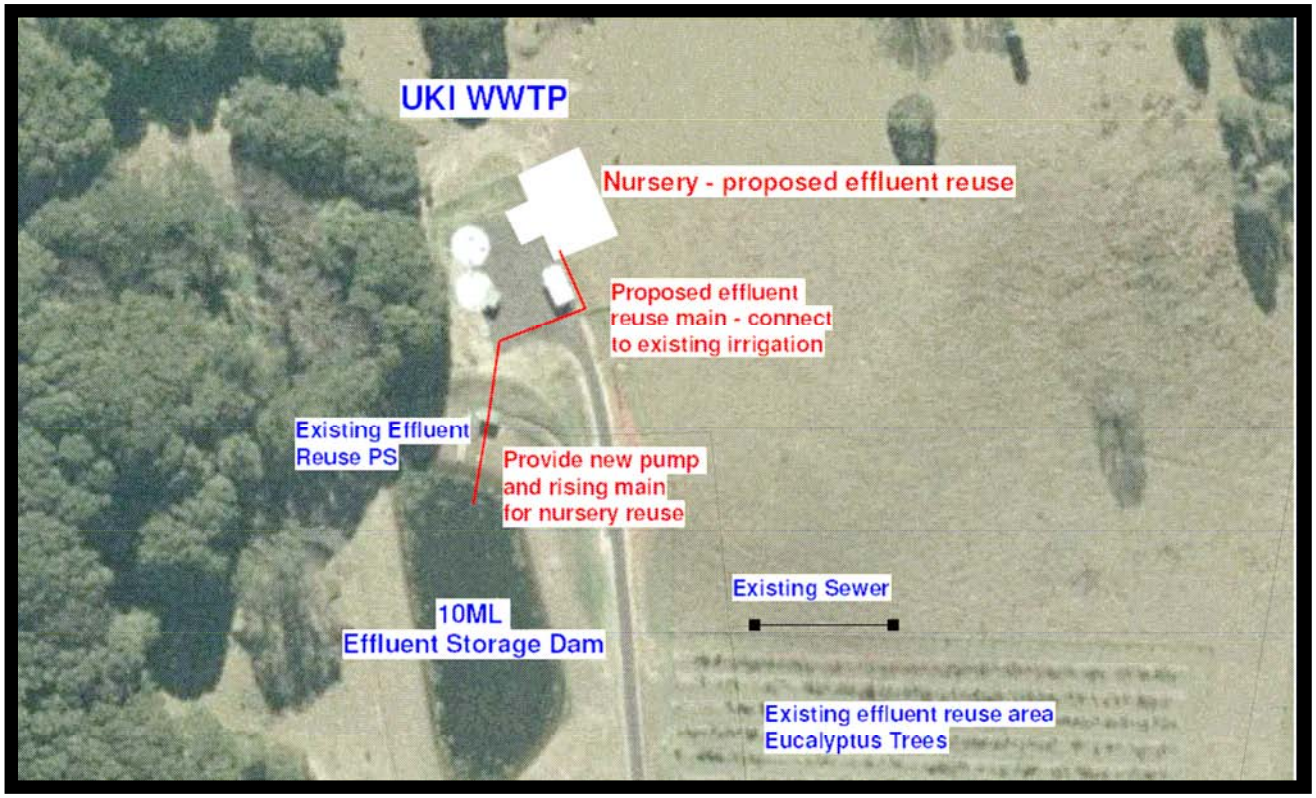
Kingscliff - Golf Course

BACK

Preferred Option

- As the solution stands the only option is to provide a pumping station and rising main to feed on site storage that will be constructed by the Golf Course Land owners. As there will be storage the PS can operate over a 24 hour period if required and therefore there should be no problems delivering the required volumes
- The golf course requires approximately 50% of the average annual flows leaving the STP.

Uki


UKI WWTP
Nursery - proposed effluent reuse
Proposed effluent
reuse main - connect
to existing irrigation
Existing Effluent
Reuse PS
Provide new pump
and rising main
for nursery reuse
Existing Sewer
10ML
Effluent Storage Dam
Existing effluent reuse area
Eucalyptus Trees

Uki - Nursery

- Uki STP has a 10ML recycled water storage dam on-site.
- Currently has an irrigation system in place utilising potable water. The Eucalyptus tree plantations that currently reuse the Uki STP recycled water are also on site.
- The levels of nitrogen, phosphorus and potassium can affect the health and growth of the immature plants.
- There is currently in place within the Uki treatment process methods of removing phosphorus via chemical dosing. If the dosing can be more tightly controlled then the levels of phosphorus may be brought under the desired levels, reducing the risk to the nursery. If this is not possible and the nursery plants cannot tolerate the excessive phosphorus, then additional treatment via further chemical dosing and removal of precipitate by a filter will be required.

BACK

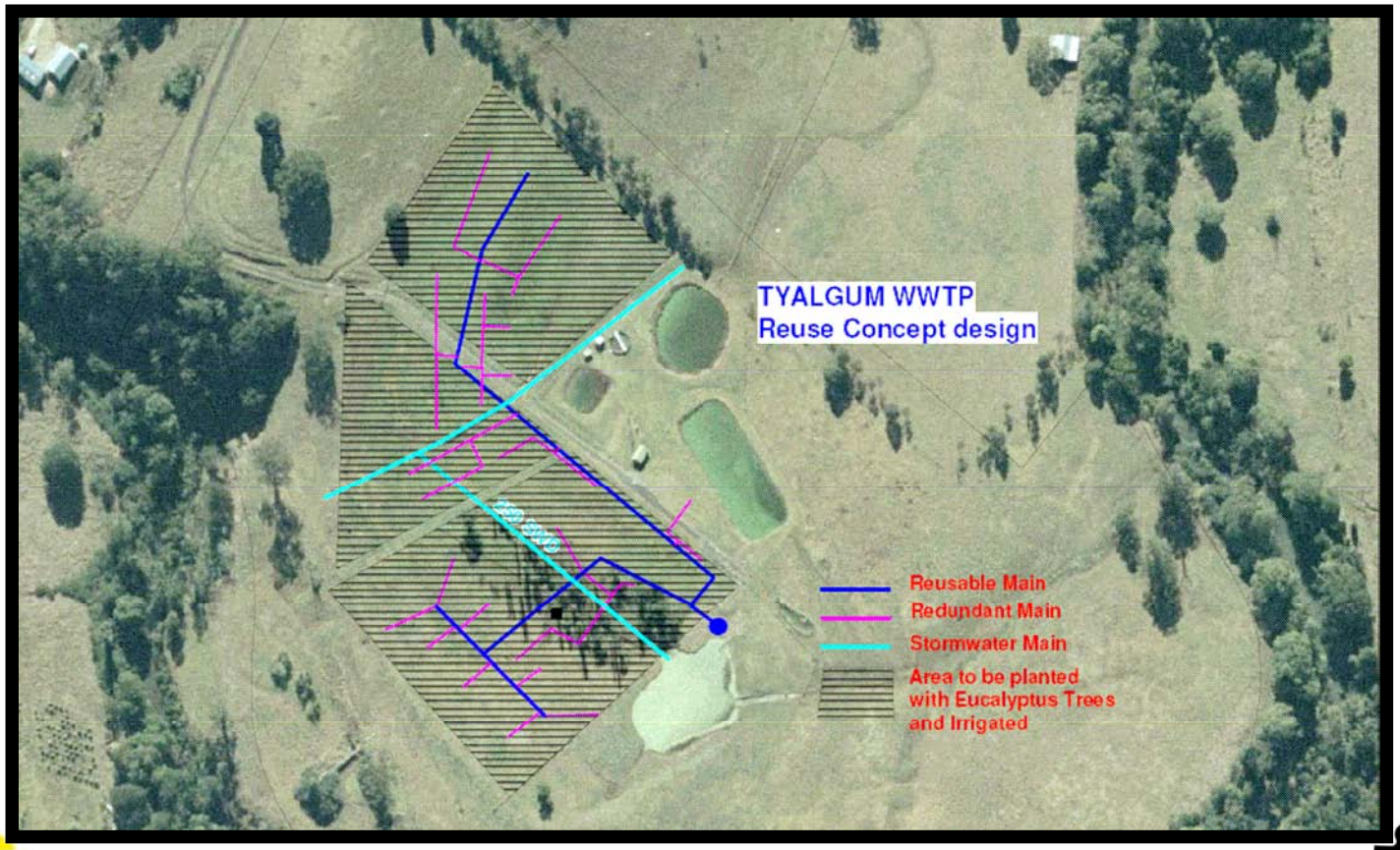
Uki - Nursery

- The existing irrigation feed pump station for the Eucalyptus Tree plantations is owned, operated and maintained by the Currumbin Wildlife Sanctuary.

Preferred Option

- Tweed Shire Council provide their own separate PS and rising main to supply recycled water to the current irrigation system at the nursery.

Tyalgum


TYALGUM WWTP
Reuse Concept design
Reusable Main
Redundant Main
Stormwater Main
Area to be planted with Eucalyptus Trees and Irrigated

Tyalgum - Eucalyptus Tree Plantation

- The existing recycled water pump station has pumps that operate at a duty point of 7.8 l/s at 37 m head.
- The existing pumps can be reused.
- It is noted that this is peak flow requirements and for the most part these flow rates for that length of time will not be required.,
- Calculations also have confirmed the available head from the pumps of 37m is also adequate.
- As the site for reuse is restricted to public access and the native trees proposed to be irrigated are not for human consumption, then the quality of the treated recycled water satisfies the EPA Guidelines: *Use of Effluent by Irrigation*.

BACK

Tyalgum - Eucalyptus Tree Plantation

- Existing recycled water irrigation scheme set up to irrigate surrounding open space paddocks.
- Existing on-site recycled water storage dam and recycled water PS feed a network of pipelines and a surface spray system of sprinklers that have a spray radius of 15m.

Preferred Option

- Reuse the on-site storage, PS and part of the existing pipeline network to feed a new irrigation system, designed to irrigate the new Eucalyptus tree plantations more efficiently, via sprinklers with only a 3m radius.

Storage

BACK

Recycled Water site:	Indicative Cost (supply & installation) ($K)	Construction Issues/Limitations
Arkinstall Municipal Oval	$ 364,000*	• Limit the tanks to 15m Diameter. This will reduce excavation depths to less then 4m • More extensive excavations • De-watering of excavations to deal with high watertables • Protection of concrete and associated below ground works from saline groundwater and acid sulphate soils • Water proofing of tanks to prevent saline groundwater infiltration • Higher geotechnical and structural concrete costs • Offsite soil cartage and disposal.
Memorial Garden	$ 208,000	

* Denotes that the option has Subsurface irrigation and therefore the storage tank has been reduce to ½ a days storage

Capital Costs

BACK

OPTION	Best Case	Medium Case	Worst Case
Banora Point			
Arkinstall Municipal Park	$ 1,225,000	$ 1,629,000	$ 2,041,000
Memorial Gardens	$ 374,000	$ 510,000	$ 639,000
Hastings Point			
Combined Storage	$ 2,424,000	$ 3,117,000	$ 3,803,000
Kingscliff			
Ti Tree Plantation	N/A	N/A	N/A
Golf Course	$ 336,000	$ 420,000	$ 524,000
Uki			
Nursery	$ 35,000	$ 48,000	$ 62,000
Tyalgum			
Nursery	$ 94,000	$ 120,000	$ 147,000
PROPOSED SOLUTION TOTAL COST	**$ 4,488,000**	**$ 5,844,000**	**$ 7,216,000**

Operational Costs

BACK

Operation	Description	Cost	Comment
Pumping Costs	Total pumping power cost/year =	$ 103,032	
Labour O&M	(2 visits x 1hr x 35 wks) + (2 visits x 5hrs) x $62.50/hr =	$ 45,000	TSC would get a more competitive (bulk) power tariff than that assumed here, therefore power costs could be lower (by ~25%)
Equipment replacement	2% of capital cost (~$157,000) =	$ 28,260	
Pipeline			2 major servicing visits per year, 35 regular checks during the year @ 9 Pumping Stations
O&M	0.25% of capital =	$ 2,011	2% of capital for PS civil, mechanical and Electrical works @ 9 Pumping Stations
TSC Storage Tanks			
O&M	0.25% of capital ($0) =	$ 2,860	0.25% of capital for pipeline, valve and fittings. Does not included for Hastings Point Combined Option if it is required.
Irrigation @ TSC Sites			
O&M Surface	15% of irrig.capex	$ 325,620	1 visit/yr per tank prior to irrigation season
O&M Sub Surface	7.5% of irrig.capex	$ 224,550	
	Total Surface Irrigation OPEX ($K)	**$ 507,000**	
	Total Sub-surface Irrigation OPEX ($K)	**$ 406,000**	

Further Investigations

- Recycled water demands for all customers.
- Construction Review by a TSC approved contractor
- Pipeline alignments will need to be walked by qualified environmental and archaeological/heritage specialists.
- Carry out water balance, nutrient and salt loading calculations for all proposed parks and reserves.
- Recycled water pumping system requirements should be verified based on review of irrigation water demands, pipeline routes and capacities from the investigations above.
- Further assessment of the need for a buffer storage at Kingscliff STP
- Detailed engineering, planning, environmental, vegetation, absorptive capacity of the soils, social and economic impact assessments.
- A review of the irrigation proposals in line with any other council department redevelopment plans

Construction Programme

- Estimated time to complete design is about 6–9 months.
- EPA and TSC Planning approvals are likely to take at least 3 months.
- Tendering typically takes 2-3 months, including evaluation and contract award.
- Construction should take at least 6–12 months but is heavily dependent on the structure of the contract. The timescale could be reduced if each site was individually tendered.
- TSC should allow at least 18-24 months for the planning, approval, detailed design and construction and commissioning phases to be completed.

BACK

Conclusions

- Subsurface irrigation is recommended for many of the proposed irrigation sites. It offers greater flexibility over irrigation times, removed the risks to public health, eliminates any need for additional treatment and can help reduced the storage tank requirements.
- Surface irrigation is recommended for the Tweed Heads Memorial Gardens due to the possibility of future graves being required
- Surface irrigation is also recommended for the Tyalgum STP irrigation, similar to the irrigation currently used on Eucalyptus Tree plantations at Uki STP. The nursery at Uki has an existing irrigation system that can be reused for the recycled water and requires a new pump station and rising main to feed

Appendix J Priority of Options

STP	Effluent Reuse Scheme	Preferred Rank
Banora Point	Arkinstall Park	high (PR)
	Memorial Gardens	high (PR)
Hastings Point	Rugby Club / Bogangar Football Field	high (needed)
	Pony Club & Barry Shephard Oval	low
	Commens Turf Farm	high (commercial)
	Combined	
Kingscliff	Chinderah Golf Course	medium - 2 years
	Ti-tree Plantation	gone
Uki	Native Plant Nursery	medium to low
Tyalgum	Tree Plantation	low