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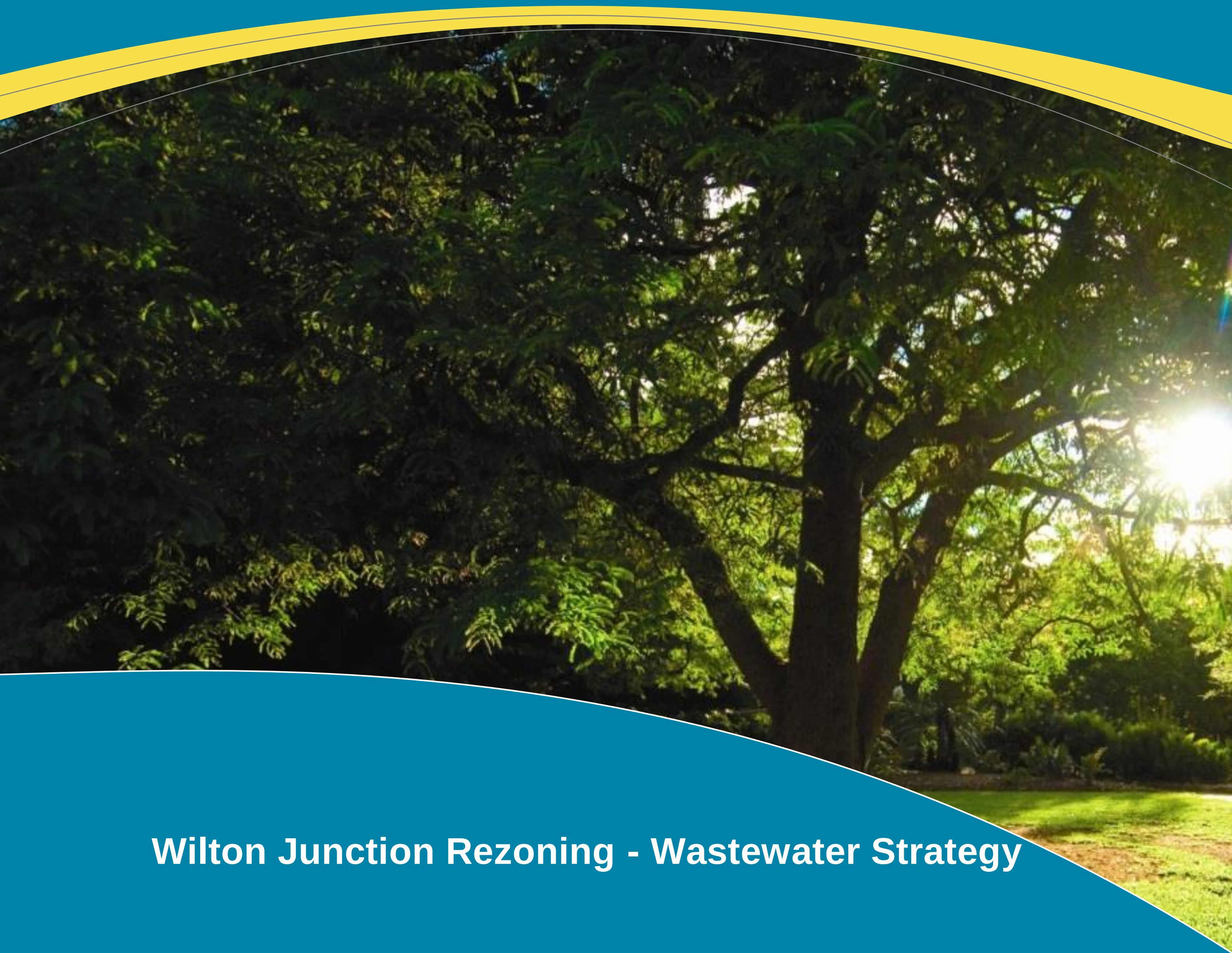

Wilton Junction Rezoning - Wastewater Strategy

Prepared for Wilton Landowners Group

June 2014

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REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file).			
			Prepared by	Checked by	Reviewed by	Approved by
1	5/7/2013	Draft Report	GA & BH		TD & CW	SP
2	2/8/2013	2nd Draft Report	GA & BH	TD	TD & CW	SP
3	29/10/13	Final	SP	AW	AW	SP
4	9/04/14	Final (updated npv, lifecycle cost memo)	SP	BB	BB	SP
5	10/06/14	Final (new figures)	SP	ED	SP	SP
6	19/06/14	Final (new landowners comments)	SP	ED	SP	SP

Executive Summary

The Wilton Rezoning Landowners Group, which includes Bradcorp, Lend Lease, Walker Corporation and Governors Hill Pty Ltd, have nominated land adjoining the Hume Highway and Picton Road intersection at Wilton to be rezoned as part of the Potential Homesites Program, a State Government initiative to address Sydney's housing supply shortfall. This proposed development is known as Wilton Junction, and sits within the Wollondilly Shire LGA.

MWH was engaged by the Wilton Rezoning Landowners Group to develop a high level wastewater servicing strategy to support the proposed Wilton Junction development rezoning.

The proposed Wilton Junction development is proposed to provide approximately 11,900 additional dwellings and 11,000 jobs in Wilton, including the Bingara Gorge development. A new town centre will be located near the junction of the Hume Highway and Picton Road and smaller neighbourhood centres will be created.

The Study Requirements (SRs) for the rezoning specify the need for a strategy and implementation plan detailing the staged delivery of infrastructure to service the initial and ultimate development. This report and supporting analysis addresses the SRs for the proposed Wilton Junction development and specifically recommends:

- A Membrane Bio-Reactor (MBR) wastewater treatment plant with tertiary media filters located near the existing Bingara Gorge STP.
- A pressure sewer network with individual pots and pumps installed on each property.

The project team undertook extensive stakeholder consultation with Sydney Water and the Environment Protection Authority during the development of the wastewater strategy, particularly regarding the criteria and approach to be adopted for the study.

The estimated capital cost of providing this wastewater servicing infrastructure is estimated at $47M for the STP and $173M for the wastewater network ($13.2M for Trunk Infrastructure, $28.4M for Reticulation Infrastructure and $131.6M for property works).

It is proposed that the above infrastructure would be delivered in a staged approach in order to align with the timeline for the delivery of the lots, as shown in Table 1 and Table 2.

Further detailed investigations are required to refine the wastewater strategy when the rezoning of Wilton Junction has been confirmed, including hydraulic modelling, septicity and odour modelling geotechnical and environmental impact assessments.

Table 1: Proposed Wastewater Network Assets

Stage	Dwellings Serviced	Assets Required	Cost Estimate ($M)
1	0 to 2,000	SPS 1 (60l/s @68m) & SPS 2 (183l/s @6m) + SPS 2 Storage	$3.2M
		Rising Mains: 2.8km of PE DN280 & 0.1km of PE DN400	$1.7M
		Gravity Mains: 0.2km of PE DN250, 3.6km of PE DN315 & 0.75km of PE DN355 pipe	$3.4M
		Reticulation Network: 14.9km of PE pipe (DN50 to DN200)	$2.5M
		Property Works:	$21.8M
2	2,000 to 7,200	SPS 3 (22l/s @81m), SPS 4 (45l/s @68m) & SPS 5 (75l/s @18m)	$2.8M
		Rising Mains: 1.8km of PE DN160, 1.5km of PE DN225 & 0.4km of PE DN315	$1.7M
		Gravity Mains: 2.35km of PE DN250 & 2.25km of PE DN315	$3.1M

Stage	Dwellings Serviced	Assets Required	Cost Estimate ($M)
		Reticulation Network: 38.8km of PE pipe (DN50 to DN200)	$6.4M
		Property Works	$49.3M
3	7,200 to 10,100	SPS 6 (62l/s @ 81m)	$1.4M
		Rising Mains: 3.8km of PE DN315	$2.4M
		Gravity Mains: 1.9km of PE DN250	$1.4M
		Reticulation Network: 70.8km of PE pipe (DN50 to DN200)	$11.7M
		Property Works	$60.5M
Total			**$173.3M**

Table 2: Proposed Wastewater Treatment Plant

Stage	Cumulative EP	Required By	Cost Estimate ($M)
1	0 to 4,500	Approx. 2018/19[1]	$12M
2	4,500 to 9,000	2022	$12M
3	9,000 to 18,000	2025	$7M
4	18,000 to 36,000	2030	$16M
Total			$47M

The identified strategy offers a cost-effective, staged approach to provide the wastewater services for the Wilton Junction development. The strategy:

- Provides an efficient and value for money solution
- Provides flexibility in allowing servicing of the four development fronts simultaneously and also allows for integration with the adjoining Bingara Gorge development.
- Significantly reduces the risk of environmental overflows from the network, by adopting a pressure sewer system and is more conducive to mine subsidence.
- Represents value for the government and developer as the future infrastructure has been sized according to Sydney Water’s latest design criteria.

Wilton Landowners Group

Wilton Junction Rezoning - Wastewater Strategy

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Appendix A Build Out Rate and Staging
Appendix B Design Criteria Technical Memo and Notes from Meetings with Sydney Water
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Abbreviations

ADWF	Average Dry Weather Flow
AHD	Australian Height Datum
BOD	Biochemical Oxygen Demand
CDU	Chemical Dosing Unit
COD	Chemical Oxygen Demand
DN	Nominal Diameter (of a pipe)
EP	Equivalent Person
EPA	Environment Protection Agency
HGL	Hydraulic Gradient Line
Ha	Hectare
kL	Kilolitre
km	Kilometre
kW	Kilowatt
L/s	Litres/second
LGA	Local Government Area
m	metre
m/s	metres per second
MBR	Membrane Bio-Reactor
MDP	Metropolitan Development Program
ML	Megalitre
MLD	Megalitres per day
NH3-N	Ammonia Nitrogen
O&M	Operation & Maintenance
OD	Outside Diameter (of a pipe)
PDWF	Peak Dry Weather Flow
PWWF	Peak Wet Weather Flow
RL	Reduced Level
RMS	Roads and Maritime Services
SCA	Sydney Catchment Authority
SEPP	State Environment Planning Policy
STP	Sewage Treatment Plant
SPS	Sewage Pumping Station
SWC	Sydney Water Corporation
TKN	Total Kjeldahl Nitrogen
Total P	Total Phosphorus
TSS	Total Suspended Solids
WSA	Water Services Association

1 Introduction

1.1 Background

In November 2011, the NSW Government initiated the Potential Housing Opportunities Program and invited landowners with suitably located substantial landholdings to nominate sites which might be able to deliver additional housing to address Sydney's housing supply shortfall. Walker Corporation, Governors Hill, Bradcorp and Lend Lease responded to the Program and nominated landholdings of more than 100ha in Wollondilly Shire, surrounding the Hume Highway-Picton Road intersection for consideration. This area has subsequently become known as Wilton Junction, and is the subject of this application.

Following a Wollondilly Shire Council resolution in May 2012, the four major landowners (collectively known as the Wilton Junction Landowners' Group) signed an agreement to work cooperatively with Council to prepare a high level Master Plan for Wilton Junction to deliver high quality new housing, jobs close to homes, supporting social and utilities infrastructure and services, and a range of complementary land uses.

A high level Master Plan and a Preliminary Infrastructure Requirements Report were considered by the Council on 17 December 2012, with Council resolving to give in-principle support to the proposal. Council also resolved to request that the rezoning be a state-driven process.

Subsequently, the NSW Government decided to coordinate the statutory planning process, led by the Department of Planning and Infrastructure (now the Department of Planning and Environment, DP&E). The Minister for Planning and Infrastructure (now the Minister for Planning and Environment) proposed to prepare a State Environmental Planning Policy (SEPP), as per Section 24 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), which identifies that a SEPP is an Environmental Planning Instrument, and Section 37 of the EP&A Act, which relates to the making of a SEPP for State or regional significant development. This was done with a view to rezone the land through an amendment to the Wollondilly Local Environmental Plan 2011 (LEP) to facilitate the early delivery of housing and infrastructure, linked to an agreed Infrastructure, Servicing and Staging Plan.

The Department of Planning and Infrastructure issued Study Requirements (SRs) to the Proponents (Walker Corporation, Bradcorp and Governors Hill) to guide the planning investigations for a new town at Wilton Junction. The SRs set the criteria for carrying out environmental investigations across the Study Area (excluding both Bingara Gorge and the existing Wilton village which will not be affected by any proposed amendments to their current zoning and planning provisions). The investigations examine the potential for the Wilton Junction Study Area to be rezoned under a SEPP.

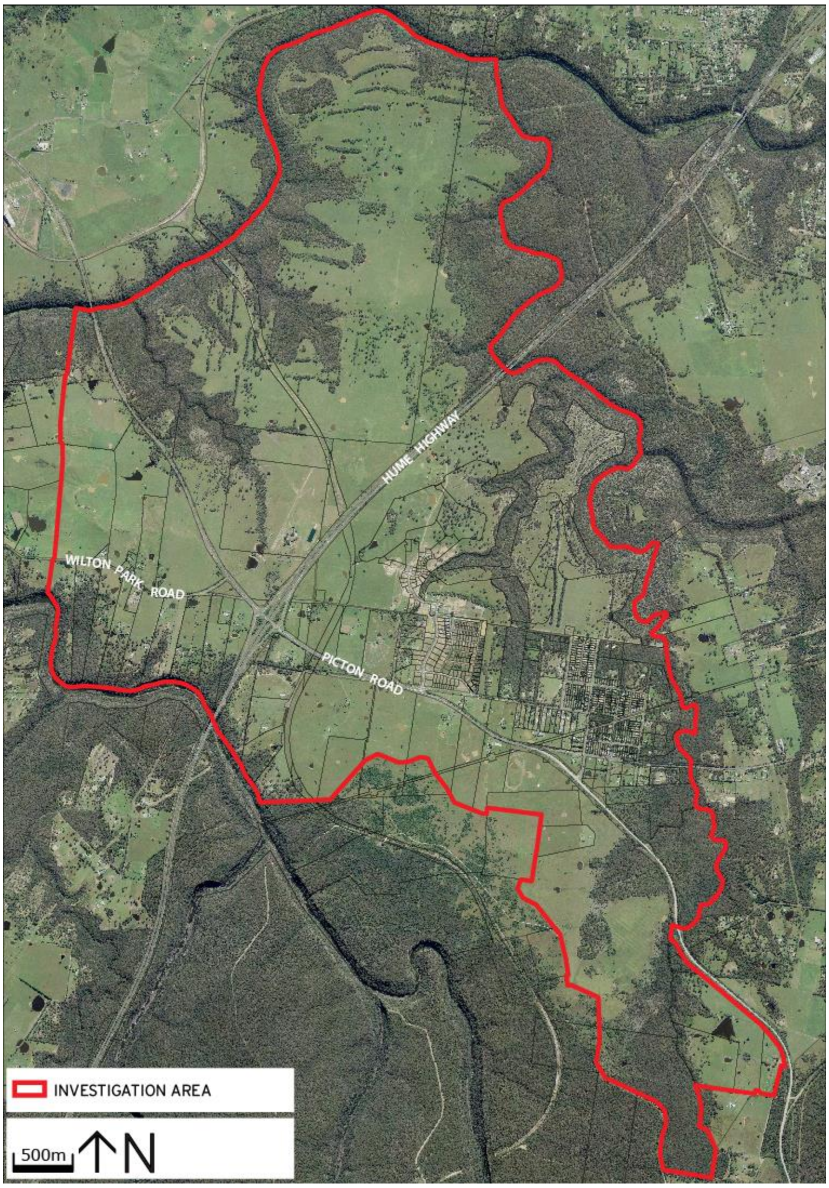
This report addresses the wastewater servicing requirements to meet the SRs for a new town at Wilton Junction.

1.2 Study Area

Wilton Junction is located within Wollondilly Shire Council and is approximately 80 km from Sydney Central Business District, and 30 km west of Wollongong. The study area includes the existing village of Wilton and the recently approved suburb of Bingara Gorge.

The area is strategically located around the Hume Highway-Picton Road interchange, and represents the next potential major town along this transport corridor south of Campbelltown–Macarthur. Moreover, Wilton Junction has the distinct advantage of a consolidated land ownership of more than 2,700ha in the control of recognised developers, with the resources and capability to expedite housing delivery, roll out enabling infrastructure, deliver social services and provide local employment.

Figure 1-1 : Study Area



1.3 Landownership

There are four major landowners within the Investigation Study Area:

- Bradcorp Pty Ltd (land at Wilton West)
- Walker Corporation (lands south of Picton Road and east of the Hume Highway)
- Governors Hill (land including the Wilton Aerodrome and lands on both sides of Picton Road west of the Hume Highway)
- Lend Lease (land to the north-west of the Hume Highway-Picton Road intersection; but is excluded from the study requirements)

The Investigation Study Area also includes land by other private owners (excluding land in Bingara Gorge and Wilton village) as outlined in Table 1-1 with a plan of the extent of ownership provided in Figure 1-2.

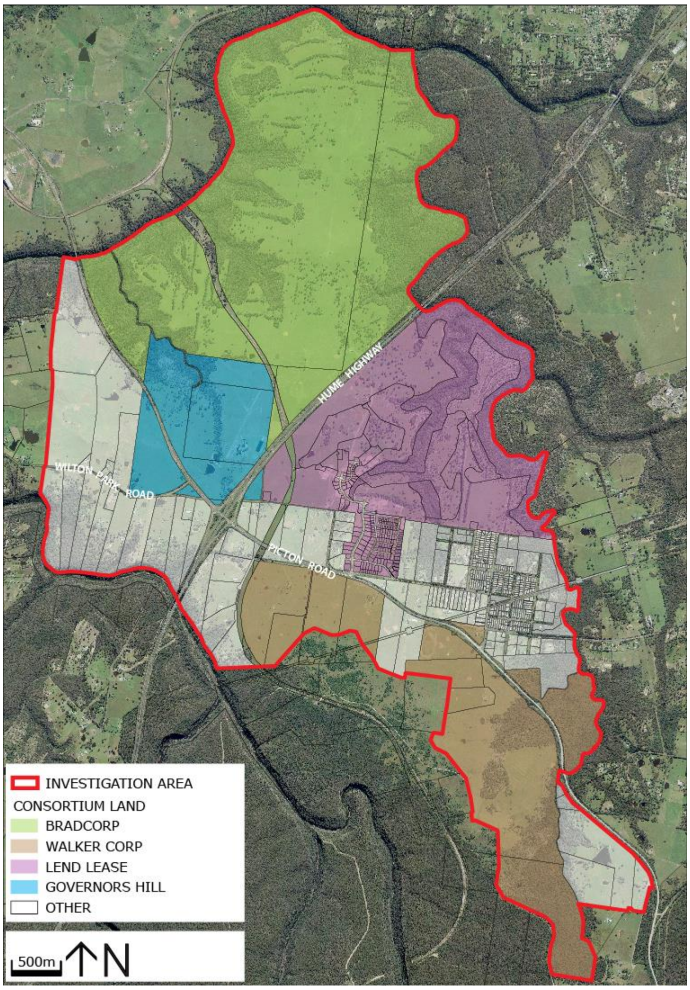
Table 1-1: Landownership Details

Landowner	Gross Area (Ha)	Net Developable Area (Ha)
Lend Lease	455	240
Bradcorp	872.40	458.70
Governors Hill	175.30	123.50
Walker Corporation	405.20	230.30
Other Landowners**	572.30	489.20
Total	**2,480.20**	**1,541.70**

** This comprises 113 other private landowners, excluding the new Bingara Gorge estate and the existing Wilton village which will not be affected by any proposed amendments to the existing Wollondilly Shire Council planning provisions.

For the purposes of this rezoning application, the Proponents include Walker Corporation, Governors Hill and Bradcorp. Lend Lease will continue with the planning and delivery of its Bingara Gorge community in Wilton, which is already zoned for residential development. Lend Lease is working with the Proponents of this rezoning application to plan and deliver the new town at Wilton Junction and its associated infrastructure.

Figure 1-2 : Land Ownership



1.4 Project Description

Vision for Wilton Junction

The Proponents have a vision for the proposed rezoning of land at Wilton Junction, which is:

"Wilton Junction is a new community cradled in a unique landscape characterised by bushland, rivers, creeks, lakes and ridges set against the backdrop of the Razorback Range. By design, the place and the lives of its people are intertwined with the bush

The community respects the location's rich bushland setting, engages with surrounding water features and embraces sustainability

Inclusive and welcoming of diversity, it's a place to nurture relationships, grow a family - to put down roots.

Founded on a 21st century interpretation of timeless "Garden City" principles, Wilton Junction combines the best features of our most loved country towns with the facilities, services and technologies found in Australia's most successful, edgy, and vibrant town centres

A safe place to visit – a healthy place to live – a great place to learn - a rewarding place to work – the local community takes pride in the strength of its cultural and civic life and the role of their town in Wollondilly Shire and the region."

Delivering the Vision and Project Description

This vision will be delivered through the creation of a new town with between 11,000 and 13,000 new homes and 11,000 jobs. Residential neighbourhoods will be created around green spaces providing a range of housing choice and facilitating healthy lifestyles options for all new residents. A new town, comprising of approximately 17ha, will be established within the north-west quadrant of the study area and will be surrounded by employment generating uses for business, bulky goods and light industry, comprising of approximately 120 - 130ha of land. Smaller neighbourhood centres will be created within the residential neighbourhoods to cater for convenient daily shopping choices. Community facilities and physical infrastructure will be provided facilitating the creation of a self-sustaining community. Existing significant environmental features and heritage items will be preserved commemorating the natural and historical setting of the study area.

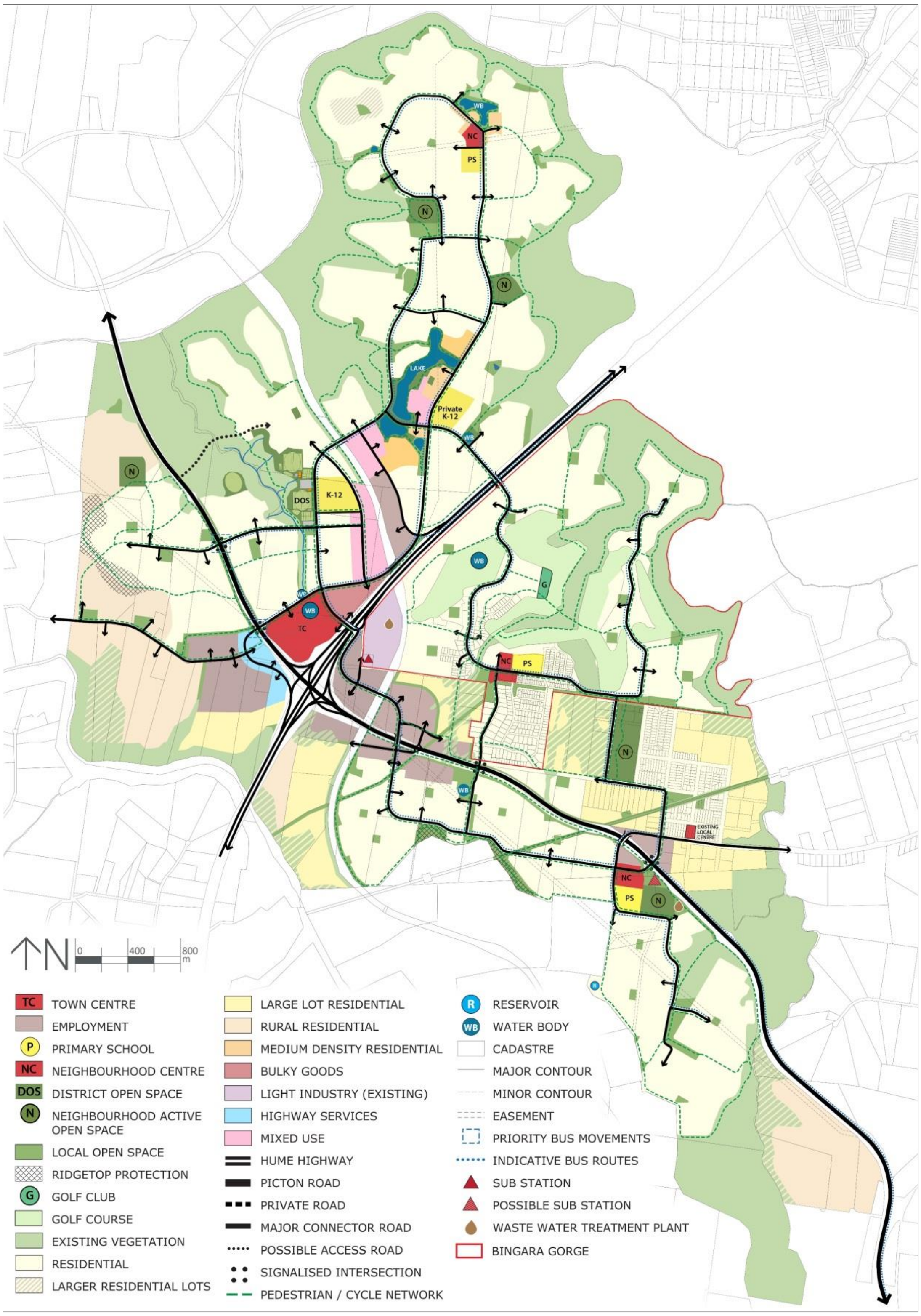
This report forms part of the studies required to be undertaken to meet the Study Requirements outlined by the Department of Planning and Infrastructure as part of the investigations for the release and rezoning of land at the junction of the Hume Highway and Picton Road through a SEPP. The study outcomes and report has also informed the development and preparation of a Master Plan for Wilton Junction.

The proposed Master Plan will be informed by the following key principles:

- **Employment and commercial drivers.** The delivery of approximately 11,000 jobs focused around a new town centre and in close proximity to the Hume Highway and Picton Road.
- **Housing.** Providing between 11,000 and 13,000 new dwellings across the precinct, inclusive of the 1,165 already approved at Bingara Gorge and the existing Wilton village.
- **Community facilities**. Provide a diverse range of high quality community facilities including a schools, library, community centre in a town centre and three neighbourhood centres across the precinct.
- **Environment**. Conserving ecological features and biodiversity and establishing a Trust to rehabilitate and manage approximately 614.5ha of bushland.
- **Place making.** Delivering high quality and connected network of streets, spaces and squares throughout the development.
- **Activity centres**. Focus on the delivery of a new town centre and three smaller neighbourhood centres with a diverse mix of retail, commerce, business and light industry.
- **Traffic and transport.** Providing strategic motorway and bus access to surrounding areas, legible movement throughout the development.

- **Infrastructure.** Integrated water, waste water and stormwater management systems and access to all other utilities including gas and NBN.

Figure 1-3 : The Wilton Junction Master Plan



1.5 Study Objectives and Scope

This report forms part of the studies required to be undertaken to meet the study requirements outlined by the Department of Planning and Infrastructure (DoPI) as part of the investigations for the release and rezoning through a State Environmental Planning Policy (SEPP).The study outcomes and report has also informed the development and preparation of a Master Plan for Wilton Junction. The particular study requirements for the provision of wastewater infrastructure involve:

Table 1-2: Study Requirements and Strategy Response

Study Requirements	Strategy Response
Preparing an Infrastructure, Servicing and Staging Plan in conjunction with relevant agencies to service the release areas with sewage treatment, effluent disposal and water reuse (if proposed); in a staged manner as well as a whole.	**Wastewater Network** – Two strategies, a gravity system and a pressure system has been assessed for the development using Sydney Water performance standards. Details of the assessment are provided in Section 5. **Wastewater Treatment –** The strategy has been developed in consultation with Sydney Water (SWC), EPA and DoPI. The strategy is based on an integrated approach that takes account of the treatment plant process and associated rain gardens and lake. Details of the effluent quality targets are provided in Appendix C. Details of the staging strategy are provided in Section 9.
Details of funding for staging and the entire cost of delivery of required infrastructure and the component and timing of funding proposed by Government.	**Wastewater Network** – Costing for the strategies are based on industry published documents. A staging and costing plan has been provided in Section 5 with details of costing provided in Appendix D. **Wastewater Treatment –** Costing for the strategies are based on industry published documents. A staging and costing plan has been provided in Section 5 with details of costing provided in Appendix D.

The study requirements have been addressed in the following scope of work to examine the wastewater network and treatment components of the study area.

<u>Wastewater Network</u>

The scope of this work includes:

- Develop a concept level layout of the wastewater network for a conventional gravity network and a pressure sewer system network
- Undertake a life cycle analysis for the 2 different network schemes
- Size wastewater network assets to SWC criteria and to meet SWC performance standards
- Prepare cost estimates
- Staging of wastewater network infrastructure

<u>Wastewater Treatment</u>

The scope of this work includes;

- Develop a concept level plan for the wastewater treatment plant to meet the effluent quality targets provided by the Effluent Management consultants (J. Wyndham Prince and VKL Consulting)

- Develop the treatment plant size and process block diagram
- Desktop review of the potential options for bio-solids treatment and beneficial reuse/disposal
- Review of potential impact on air quality from odour sources and potential mitigation requirements
- Staging of wastewater treatment infrastructure including interim local treatment

The approach of the treated effluent disposal strategy is to maximise land irrigation (such as playing fields and road verges) with the remainder going to a purpose built lake. The lake water body will contain highly treated effluent that allows secondary contact recreation. This water body will not contain any stormwater in order to control nutrient levels. The lake will discharge via a pipe system to proposed rain-gardens prior to discharging to an ephemeral gully. Here treated stormwater will mix with the effluent from the lake.

SWC and the EPA were extensively engaged on this approach during the course of this study. It is noted that the management of and disposal of treated effluent for Wilton Junction New Town is the subject of a separate study undertaken by J Wyndham Prince and VKL Consulting and that study provided the effluent quality targets for the high level design of the treatment plant.

1.6 Previous Studies

The previous wastewater studies completed on the Wilton Junction development include;

- “Wilton New Town Sewage Overview” – CH2MHill (October 2012). This study identified the preferred site to be alongside the existing Bingara Gorge STP and recommended an MBR treatment plant to treat effluent to a quality similar to that of Picton STP. The STP was estimated to cost $32M and gravity sewer network to cost $12M in capital expenditure.
- “Technical Memorandum 1, Sewage Overview” – CH2MHill (January 2013) - comments on costings. This was an addendum to the “Wilton New Town Sewage Overview” – CHM2Hill (October 2012) report to provide a breakdown of the network costs and additional background information on how the costs were derived. The breakdown of the network costs are;
    - West Wilton SPS - $6.3M. This includes an SPS of 220L/s at 100m head, 5.1km of DN450 rising main and 3.25km of trunk gravity mains (DN375 and DN450).
    - Central Wilton Trunk and SPS System - $3.1M. This includes an SPS of 100L/s at 20m head, 0.5km of DN300 rising main and 3.75km of trunk gravity mains (DN375 and DN450).
    - South West Wilton PS - $2.6M. This includes an SPS of 65L/s at 13m head, 0.5km of DN250 rising main and 4.0km of trunk gravity mains (DN200 and DN300).
- “Technical Memorandum 2, Sewage Overview” – CH2MHill (February 2013) - further advice on treatment. This was an addendum to the “Wilton New Town Sewage Overview” – CHM2Hill (October 2012) report to provide additional information on possible staging options.
- “Technical Memorandum - Wilton Junction Pre-design preliminary cost assessment for infrastructure required for disposal of treated effluent” - VKL (January 2013). This was a high level pre-design concept and cost estimate to provide the necessary infrastructure for effluent disposal.

2 Existing and Future Lot Projections

Within the Wilton Junction rezoning precinct is the township of Wilton with approximately 500 existing residential dwellings and the current Lend Lease development of Bingara Gorge. Bingara Gorge has development approval for 1,165 dwellings (with an allowance for up to 1,800 dwellings rezoned).

2.1 Existing Wastewater Servicing Arrangements

The Bingara Gorge development currently has a privately run Sewage Treatment Plant (STP) and pressure sewer network. The Bingara Gorge STP disposes of treated effluent by irrigation to a nearby golf course.

The existing dwellings in the village of Wilton are currently serviced by septic tanks and other on-site systems. It is proposed the Wilton village will be provided with a pressure sewerage scheme under Sydney Water's Priority Sewage Program (PSP) with flows transferred to Bingara Gorge STP.

2.2 Future Wilton Junction Development

The Wilton Junction development will provide for 11,900 new dwellings, including Bingara Gorge, as well as commercial and light industrial development. The development details are shown in Table 2-1.

A summary of the residential land area and proposed residential development yields for each of the Wilton Junction land owners is outlined in Table 2-2. The proposed annual residential production rate is detailed in Appendix A.

The total dwelling production at ultimate development is expected to be 11,900 of which 1,800 will come from the Bingara Gorge development. As explained further in Section 4, this study assumes that Bingara Gorge will be serviced by the Bingara STP, distribution network and effluent disposal system.

Table 2-1: Proposed Wilton Junction Residential Dwelling Allotment

Development Type	Units	Yield
Residential		
- Area to be Rezoned	Dwellings	10,100
- Bingara Gorge	Dwellings	1,800*
Total Wilton Junction	**Dwellings**	**11,900**
Commercial (Gross Area)	Hectares	54
Industrial (Gross Area)	Hectares	116
Primary Schools	Each	3
High School	Each	2

*The increase from 1,165 lots is subject to approval.

Table 2-2: Proposed Wilton Junction Residential Dwelling Allotment

Landowner	Gross Area (Ha)	Net Developable Area (Ha)	Potential Development Yield	Indicative Yield[1]
Lend Lease (Bingara Gorge)	455	240	1,500 - 2,000	1,800
Bradcorp	872.40	458.70	5,000 - 5,500	5,400
Governors Hill	175.30	123.50	500 - 1,000	1,000
Walker Corporation	405.20	230.30	2,500 - 3,000	2,500
Other Land	572.30	489.20	1,000 - 1,500	1,200
Total	**2,480.20**	**1,541.70**		**11,900**

Note: [1] The final yield for each landowner has not yet been determined.

3 Design and Performance Criteria

This section describes the criteria proposed to be adopted for the Wilton Junction development.

3.1 Wastewater Criteria

The wastewater flows are based on:

- SWC (28 September 2012) "Wastewater Network Growth Servicing Strategy – Criteria and Guideline 2012"
- Sewerage Code of Australia WSA 02-2002-2.2, Sydney Water Edition 1 – Version 3
- Pressure Sewerage Code of Australia WSA 07-2007-1.1.

The criteria and approach described in this section were documented in the Technical Memo "Water and Wastewater Demand Forecasts (14 May 2013)" with feedback provided by SWC on 21 May 2013 and 29 May 2013 (refer to Appendix B for these documents).

3.1.1 Occupancy Rate

The occupancy rate adopted for this study is based on the "Wilton Junction – Social Infrastructure Background Investigations Report" prepared by Elton Consulting and the "Wilton Junction – Population and Employment Land Need" by Macroplan Dimasi support the high level Master Plan. A check of 2011 census data for the Wollondilly LGA indicates there were 43,259 people and 15,455 private dwellings with a resulting occupancy rate of 2.8. Due to the strategic nature of the work, an increase of the occupancy rate will have minimal impact on the strategy. These will be further assessed during the next stage of the project.

3.1.2 Non-Residential Flow Allowance

The SWC document "Wastewater Network Growth Servicing Strategy – Criteria and Guideline 2012" provides the following guidance for non-domestic flows;

- Light Industrial: 75 EP/Ha
- Heavy Industrial: 150 EP/Ha
- Commercial: 75 EP/Ha

SWC has indicated that on recent planning studies, they have adopted a lower value for non-residential development (refer to "Water and Wastewater Demand Forecast Memo" – 14 May 2013 and Meeting Notes – 29 May 2011 in Appendix B). The following loading figures have been adopted for Commercial and Industrial development;

- Light Industrial: 40 EP/Ha
- Commercial: 40 EP/Ha

Based on these figures and Table 4-1, non-residential flows represent approximately 20% of the total flow.

3.1.3 Low Infiltration and Leak Tight Sewer Systems

To address the inflow and infiltration of stormwater into the sewer system, SWC is currently trialling "Low Infiltration" and "Leak Tight" sewers.

"Low Infiltration" sewers are characterised by:

- Construction material of Polypropylene (PP), Glass Reinforced Plastic (GRP) or Polyvinylchloride-Unplasticised (PVC-U) with rubber ring joints or solvent cement joints.
- Cast-in-situ manholes and the use of more maintenance shafts over standard manholes.
- Property connections a minimum of DN100mm size
- Private sewer connections should be at least 2m away from SWC sewers
- Overflow relief gully to be fitted with leak proof covers

- Additional acceptance testing and defects liability tests

"Leak Tight" sewers are characterised by:

- Construction material of fully welded Polyethylene (PE) pipes
- Electrofusion jointing of PE pipelines
- Property connections shall be a minimum of DN110mm in size

SWC is currently trialling leak-tight wastewater systems in two catchments and at this stage has found no evidence that this type of system should be adopted as the 'business as usual' wastewater scheme (refer to Meeting Notes – 29 May 2013 in Appendix B). Therefore a low-infiltration wastewater criteria has been considered as the gravity option in this study.

3.1.4 Containment Standard

For the gravity sewer option, SWC has suggested that the containment standard for the Picton network of 10 in 10 years should be adopted "as a starting point" for the Wilton Junction development (refer to Meeting Notes – 29 may 2013 in Appendix B). It is expected that adopting the design criteria set out in Table 3-1 will meet a containment standard of 10 in 10 years for the gravity option (but would need to be confirmed with extended period hydraulic modelling).

For a pressure sewer system, it is expected that there would be no wet weather overflows as the network is constructed from fully welded PE pipe and each service pot would contain emergency storage for 24 hours of Average Dry Weather Flow (ADWF).

3.2 Basis of Design

A summary of the design criteria for a "Low Infiltration" gravity sewer network is presented below in Table 3-1 whilst the design criteria for a "Pressure Sewer System" is presented in Table 3-2.

Table 3-1: Summary of Watewater Design and Performance Criteria for a "Low Infiltration" Gravity Sewer System

Item	Design Criteria	Units	Wastewater
Design Flows			
Single Dwelling Residential	Person	EP/dwelling	2.8
Light Industrial	EP	EP/Ha	40
Commercial	EP	EP/Ha	40
Design Flow	ADWF	l/s	150 L/person/day
Design Flow	Dry Weather Peaking Factor (d)		$d = 0.01(\log A)^4 - 0.19(\log A)^3 + 1.4(\log A)^2 - 4.66\log A + 7.57$ Where A is gross plan area of the development's catchment in hectares
Design Flow	PDWF	l/s	PDWF = d X ADWF
Design Flow for low infiltration sewers	PWWF	l/s	PWWF = 3 x PDWF
Pump Capacity Design			
Pump Station	Pump Capacity		2.5 x PDWF
Pump Station	Emergency Storage		4hrs x PDWF

Item	Design Criteria	Units	Wastewater
Pump Station	Maximum Pump Head	M	70m
Pipeline Design			
Gravity Main	Min Diameter	Mm	150
Rising Main	Min Velocity	m/s	0.75
Rising Main	Target Velocity	m/s	1.2 – 1.8
Rising Main	Max Velocity	m/s	2.5

Table 3-2: Summary of Watewater Design and Performance Criteria for a Pressure Sewer System

Item	Design Criteria	Units	Wastewater
Design Flows			
Single Dwelling Residential	Person	EP/dwelling	2.8
Light Industrial	EP	EP/Ha	40
Commercial	EP	EP/Ha	40
Design Flow	ADWF	l/s	150 L/person/day
Design Flow (Eone Method)	Pumps Operating	No. of Pumps	0.0306 x No. of Lots +4.8465
Design Flow	PDWF	l/s	No. of Pumps x 0.58l/s
On Property Pressure Pumps			
Grinder Pumps	Typical Flow	l/s	0.6
Grinder Pumps	Max Head	M	56
Grinder Pumps	Shut Off Head	M	80
Pressure Pipeline Design			
Reticulation Mains	Min Diameter	mm	DN50
Reticulation Mains	Min Velocity	m/s	0.6 (at least once per day)

4 Wastewater Flow Projection

The Lend Lease Bingara Gorge development is rezoned. This development is currently looking to increase their total yeirld from 1,165 to 1,800 dwellings and currently has approximately 200 occupied dwellings on the ground. At the time of writing this report Bingara Gorge is in the process of moving from a temporary Sewerage Treatment Plant (STP) to a full Membrane Bio-Reactor (MBR) through negotiation with the private operator.

For the wastewater scheme, it is has been assumed that all of the Bingara Gorge development as well as the existing Wilton township customers covered by the NSW Government's Priority Sewerage Program (PSP) will be serviced by the current (or upgraded) Bingara Gorge STP. Therefore, the projected wastewater flow and wastewater infrastructure detailed in this study is based on the remaining development area which is for 10,100 dwellings. However, it should be noted that one of the servicing options available to the rezoning proponents is to negotiate a commercial agreement with Lend Lease to integrate the wastewater networks and upgrade the Bingara Gorge STP to service the initial stages of development. This would reduce the overall flow to the proposed Wilton Junction STP as well as the size of the STP and associated costs.

The future dwelling production for the Wilton Junction development has been estimated on an area basis for non-residential land uses and actual dwelling yield estimates for residential. A summary of the forecast future wastewater EP for the Wilton Junction development and Average Dry Weather Flow (ADWF) is provided in Table 4-1 below.

Table 4-1: Base EP and ADWF Forecast

Category	Number	Rate	EP	ADWF (l/s)
Residential	10,100	2.8 EP/dwelling	28,560	49.6
Commercial	Approx. 54 Ha	40 EP/Ha	2,160	3.8
Light Industrial	Approx. 104 Ha[1]	40 EP/Ha	4,160	7.2
Schools	4,000	0.2 EP/student	800	1.4
Total			**35,680**	**62.0**

Note: [1] The total Industrial area in the development is approximately 116 ha but 12 ha of Industrial land is located in the Bingara Gorge development. Therefore only 104 ha is being considered in this wastewater study.

4.1 Gravity Sewer System Flow Projection

The forecast flows and design pumping station flows for a gravity sewer network are derived from data provided in Table 2-2, Table 3-1 and Table 4-1 and are presented in Table 4-2. The PDWF peaking factor has been calculated based on the gross catchment area for each pumping station.

Table 4-2: Gravity catchment forecast flows

Catchment	Gross Area (ha)	PDWF Factor (d)	EP	ADWF (l/s)	PDWF (l/s)	PWWF (l/s)	Pump Design Flow (l/s)	Comment
1	289	2.12	5,921	10.3	21.8	65.2	54.4	
2	212	2.21	4,462	7.8	17.1	51.3	42.7	
3	432	2.02	7,581	13.2	26.6	79.6	163.5	Includes flow from catchment 1&2

Catchment	Gross Area (ha)	PDWF Factor (d)	EP	ADWF (l/s)	PDWF (l/s)	PWWF (l/s)	Pump Design Flow (l/s)	Comment
4	230	2.18	2,503	4.3	9.5	28.3	23.7	
5	407	2.03	6,013	10.4	21.2	63.6	127.5	Includes flow from catchment 4&6
6	398	2.04	5,755	10.0	20.3	61.0	50.9	
7	165	2.29	3,477	6.0	13.8	41.5	34.57	
Total	**2,133**		**35,712**	**62.0**	**130.3**	**390.5**		

4.2 Pressure Sewer System Flows

The forecast flows for the pressure sewer system are derived from the data provided in Table 2-2, Table 3-2 and Table 4-1. A summary of the key system flow data is provided below in Table 4-3. For the pressure sewer system, the design flow does not vary on a catchment basis like the gravity system does.

Table 4-3: Base EP and ADWF Forecast for Pressure System

Catchments	Number of Lots	ADWF (l/s)	No.of House Pumps Operating	Design Flow (l/s)
21 catchments in total	10,100	62.0	413	248

5 Wastewater Network Servicing Options

From the previous CH2MHill Report "Wilton New Town – Sewerage Overview – October 2012", the proposed rezoning precinct has a preferred site identified for hosting the STP alongside the existing Bingara Gorge STP. This site is centrally located for the whole Wilton Junction developm ent and is alongside the Hume Hwy.

The development precinct has a general slope running from the south east to the north west where it falls towards the Nepean River. Elevations in the catchment range from RL 120m to RL 250m.

To transfer the flow to the STP, two high level network options were considered:

- Gravity Sewer Network based on "Low Infiltration" sewers
- Pressure Sewer System based on a single pot per property

5.1 Gravity Sewer Network

The gravity sewer network is divided into seven catchments and hence seven Sewage Pumping Stations (SPSs) have been considered. Trunk gravity mains (ranging in size from DN300mm to DN450mm) collect and transport the wastewater from the low fringes of the development to the SPSs. With development North of Picton Rd subject to mine subsidence, steeper grade sewers (in the order of at least 1.5% slope) are required to counter the potential impact of mine subsidence.

Taking into consideration the identified staging, the optimal configuration of the trunk gravity sewer network is provided in Figure 5-1 with a summary of the assets provided below in Table 5-1. Servicing of the main development areas in rezoning precinct is achieved by;

- The majority of the development in the South East gravitates towards the STP where a low head pumping station (SPS 5) is required to lift the flow to the STP. A pumping station will be required in the eastern extremity of the development (SPS 6) that will pump to a trunk gravity main running towards the SPS located near the STP.
- Development in the North requires a number of higher head pumping stations (SPS 1 and SPS 2) that pump to an intermediate pump station (SPS 3) prior to STP.
- Development in the West and North West requires two pumping stations (SPS 3 and 4) that pump directly to the STP.

Emergency Storage is based on capacity for four hours of Peak Dry Weather Flow (PDWF) at each SPS. Emergency storage is a risk mitigation measure used to reduce the likelihood of both dry weather and wet weather overflows.

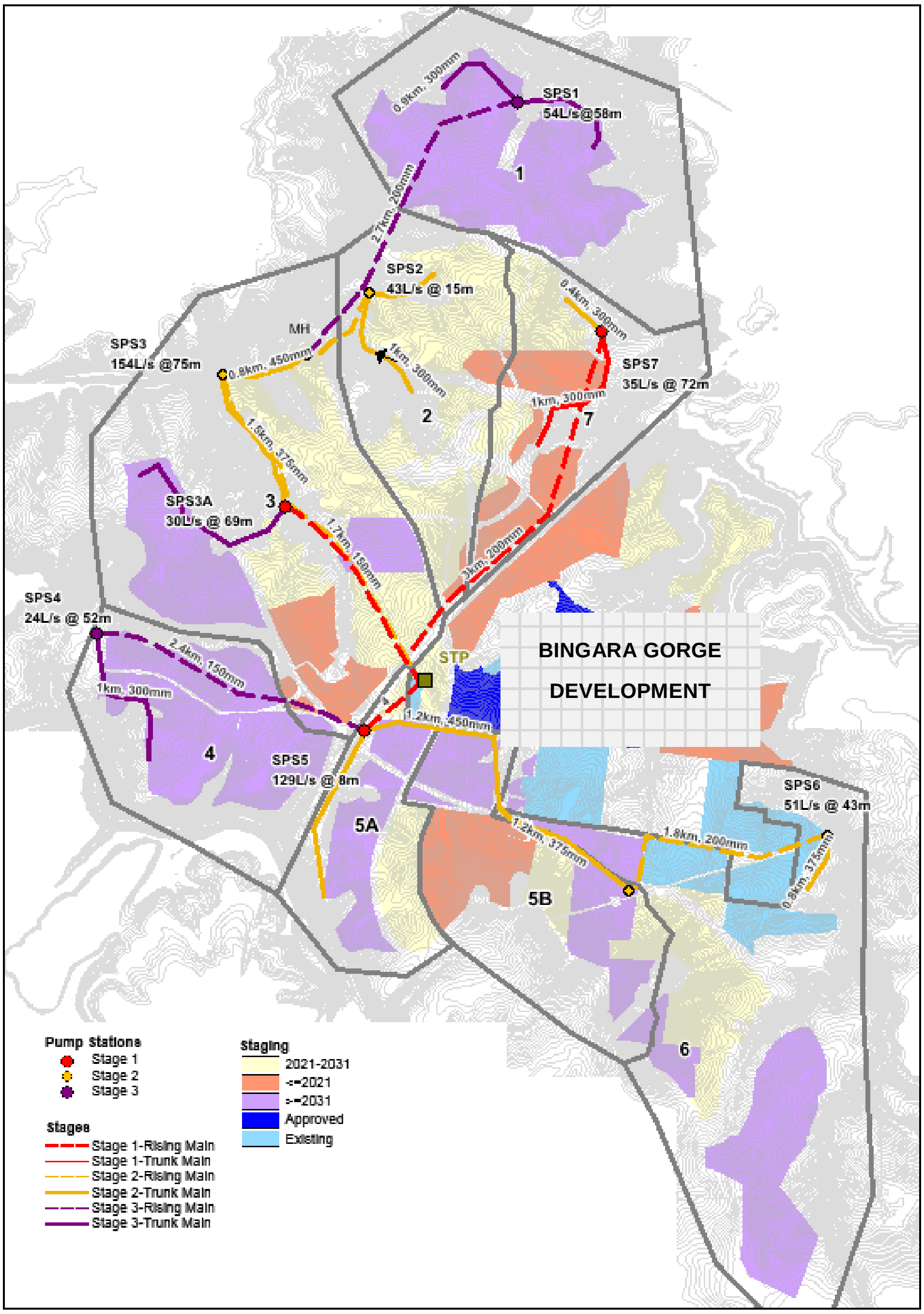
The reticulation infrastructure comprises of DN150 and DN225 gravity sewer pipes based on each residential lot requiring 18m of sewer pipeline and a 80:20 split of between DN150 andDN225.

Table 5-1: Trunk Gravity Sewer Assets Required

Assets	Cost
Trunk Infrastructure	
7 Permanent SPS's & 1 Temporary SPS	$10.6M
Emergency Storage	$8.4M
Rising Mains	$12.4M
Trunk Gravity Mains	$30.8M
Subtotal	**$62.2M**
Reticulation Infrastructure	
147km of DN150 gravity sewer pipe	$120.4M

Assets	Cost
37km of DN225 gravity sewer pipe	$40.0M
Subtotal	**$160.4M**
TOTAL	**$222.6M**
Cost per lot	**$21,800**

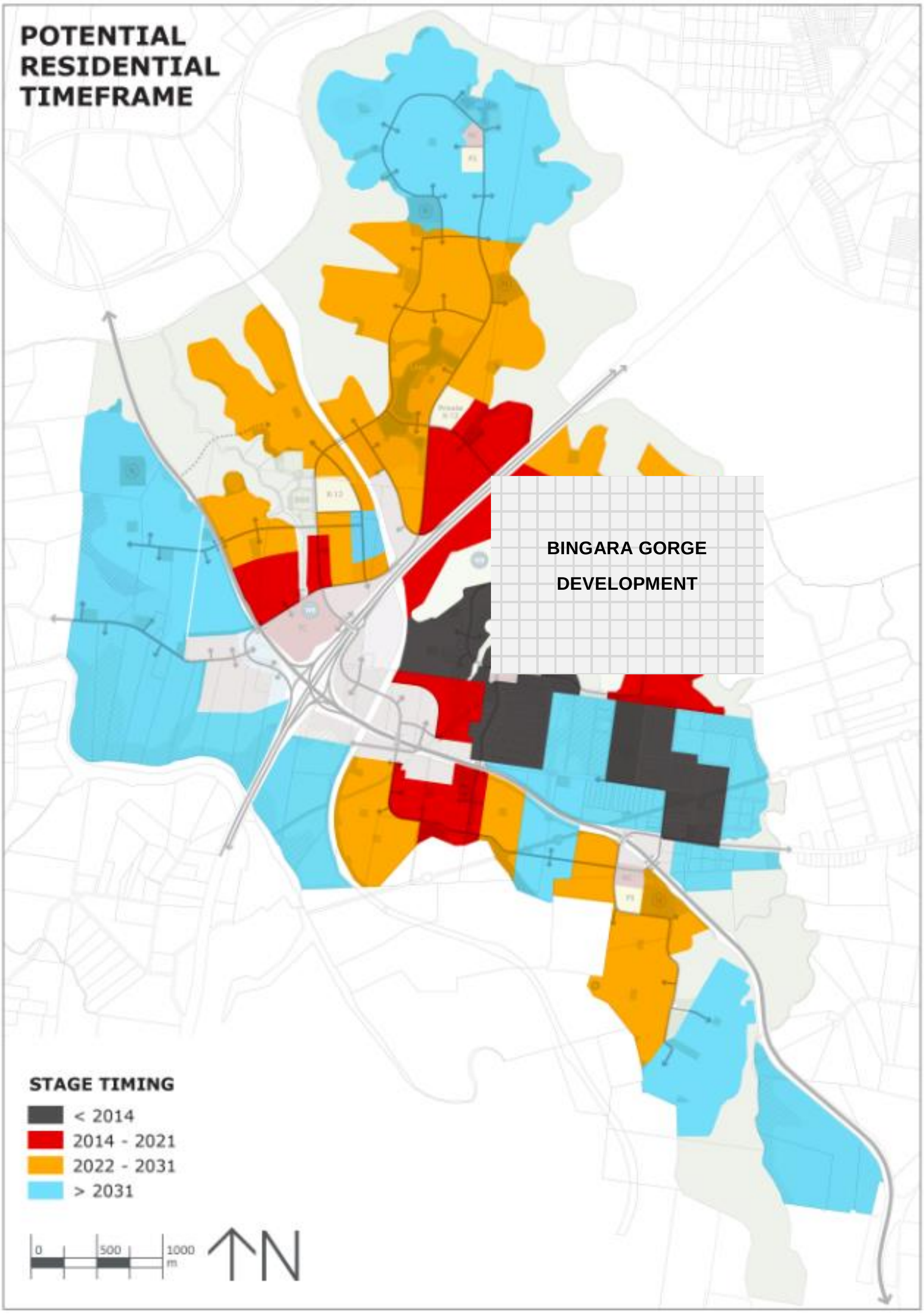
Figure 5-1 : Gravity Sewer Network

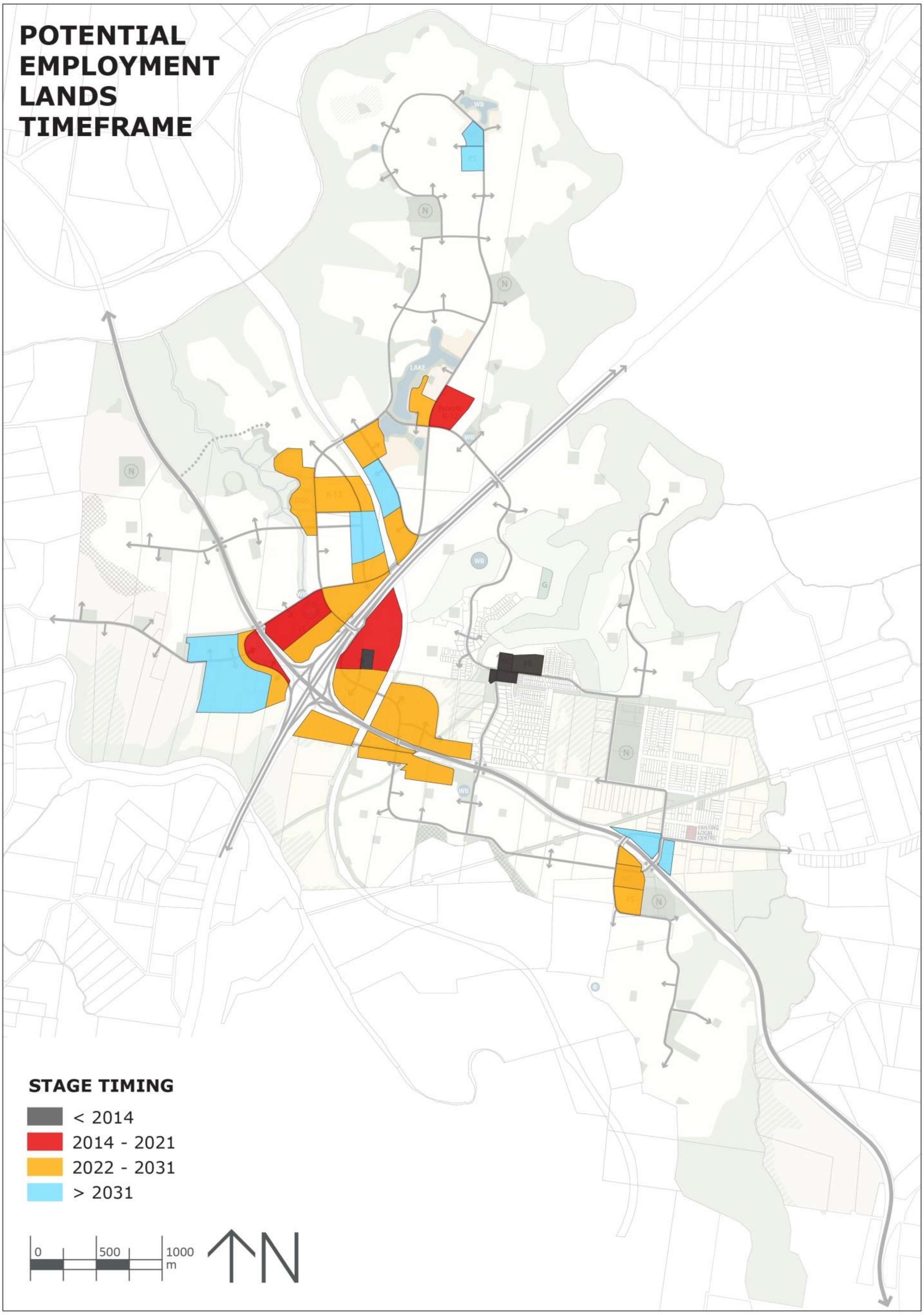


5.1.1 Staging of the Proposed Gravity Network

The wastewater gravity network was configured so that the delivery of the infrastructure would align with the delivery of lots on the ground. The staging plan developed by "Connor Holmes" proposes development on four fronts (including Bingara Gorge) to expedite the delivery of housing and jobs as presented below in Figure 5-2.

Figure 5-2 : Proposed Development Staging




POTENTIAL EMPLOYMENT LANDS TIMEFRAME
STAGE TIMING
< 2014
2014 - 2021
2022 - 2031
> 2031
0
500
1000 m
N

5.1.1.1 Stage 1 Development

Stage 1 covers the period up to 2021 and will service up to 2,000 dwellings (excluding the Bingara Gorge development). It is possible to service up to 200 dwellings with a pump-out arrangement for the initial servicing of each development area. This may be an effective servicing option if it proves difficult to install the sewage infrastructure in time for the initial stages of development.

The infrastructure required for Stage 1 is detailed in Table 5-2 below and involves;

- For Catchment 3, a temporary SPS (near Governors Hill land) is proposed prior to the main SPS for the catchment being installed in Stage 2. For the temporary pump station a diesel generator has been allowed for rather than emergency storage. It will be able to accommodate some of the Stage 2 development as well which is likely to mean that it will have a life of 10 years.
- Staging the SPS and rising main for Catchment 5 has been incorporated into this scheme to better align the infrastructure spend with lot development. This involves providing half the ultimate capacity in the first stage with the remaining in the second stage of development.
- A new SPS for catchment 7 will be installed for ultimate configuration.

Table 5-2: Stage 1 Trunk Infrastructure

Catchment	Assets	Cost	Timing
3 (interim)	SPS 3a: 30l/s@69m	$1.2M	2014 – 2021
	Rising Main: 1.7km of DN150	$0.9M	
	Trunk Gravity Mains:	N/A	
	Reticulation Mains:	$8.3M	
5 (initial)	SPS 5: 64l/s@12m	$1.9M	2014 – 2021
	Rising Main: 0.4km of DN200	$0.3M	
	Trunk Gravity Main:	N/A	
	Reticulation Mains	$11.6M	
7	SPS: 35l/s@72m	$2.1M	2014 - 2021
	Rising Main: 3.0km of DN200	$2.1M	
	Trunk Gravity Main: 1.0km of DN300	$2.1M	
	Reticulation Mains	$19.5M	
Total		**$50.0M**	

Note: The cost of the SPS includes emergency storage.

For the interim SPS there may be on opportunity to install a pre-fabricated package pump station

The apportionment of cost between the proponents is subject to commercial negotiations.

5.1.1.2 Stage 2 Development

Stage 2 covers the period from 2021 to 2031 and will be service up to 7,500 dwellings (excluding the Bingara Gorge development) The infrastructure required for Stage 2 is detailed in Table 5-3 and involves:

- The upgrade of SPS 5 to ultimate capacity and the duplication of the DN200 rising main.
- Replacement of the interim pump station for catchment SPS 3a with the ultimate SPS 3.
- A new SPS for catchment 6 that will be installed for ultimate configuration.

Table 5-3: Stage 2 Trunk Infrastructure

Catchment	Assets	Cost	Timing
2	SPS: 43l/s@15m	$2.2M	2021 - 2031
	Rising Main: 0.7km of DN200	$0.5M	
	Trunk Gravity Main: 1.5km of DN300	$2.9M	
	Reticulation Mains	$20.6M	
3	SPS: 164l/s@75m	$3.7M	2021 - 2031
	Rising Main: 2.9km of DN375	$3.8M	
	Trunk Gravity Main: 1.2km of DN300, 1.5km of DN375 & 0.8km of DN450	$5.6M	
	Reticulation Mains (Remaining after Stage 1)	$17.0M	
5 (upgrade)	SPS: Upgrade to 164l/s@8m	$0.9M	2021 - 2031
	Rising Main: 0.2km of DN200	$0.3M	
	Trunk Gravity Main: 1.3km of DN300, 1.2km of DN375 & 1.2km of DN450	$8.7M	
	Reticulation Mains (Remaining after Stage 1)	$11.5M	
6	SPS: 51l/s@43m	$2.5M	2021 - 2031
	Rising Main: 1.6km of DN200	$1.1M	
	Trunk Gravity Main: 0.8km of DN375	$1.9M	
	Reticulation Mains	$30.3M	
7	Trunk Gravity Main: 0.4km of DN300	$0.9M	2021 – 2031
Total		**$114.4M**	

Note: The cost of the SPS includes emergency storage.

The apportionment of cost between the proponents is subject to commercial negotiations.

5.1.1.3 Stage 3 Development

Stage 3 covers the period after 2031 and will be service the full 10,100 dwellings (excluding the Bingara Gorge development). The infrastructure required for Stage 3 is detailed in Table 5-4: Stage 3 Trunk InfrastructureTable 5-4 and involves:

- A new SPS for catchment 1 that will be installed for ultimate configuration.
- A new SPS for catchment 4 that will be installed for ultimate configuration.

Table 5-4: Stage 3 Trunk Infrastructure

Catchment	Assets	Timing	Timing
1	SPS: 54l/s@58m	$2.6M	After 2031
	Rising Main: 2.7km of DN200	$1.8M	
	Trunk Gravity Main: 1.9km of DN300	$4.0M	
	Reticulation Mains	$32.5M	
3	Trunk Gravity Main:	$2.6M	After 2031
4	SPS: 24l/s@52m	$1.8M	After 2031
	Rising Main: 2.4km of D150	$1.4M	
	Trunk Gravity Main: 1.0km of DN300	$2.1M	
	Reticulation Mains	$9.0M	
		$57.8M	

Note: The cost of the SPS includes emergency storage.

The apportionment of cost between the proponents is subject to commercial negotiations.

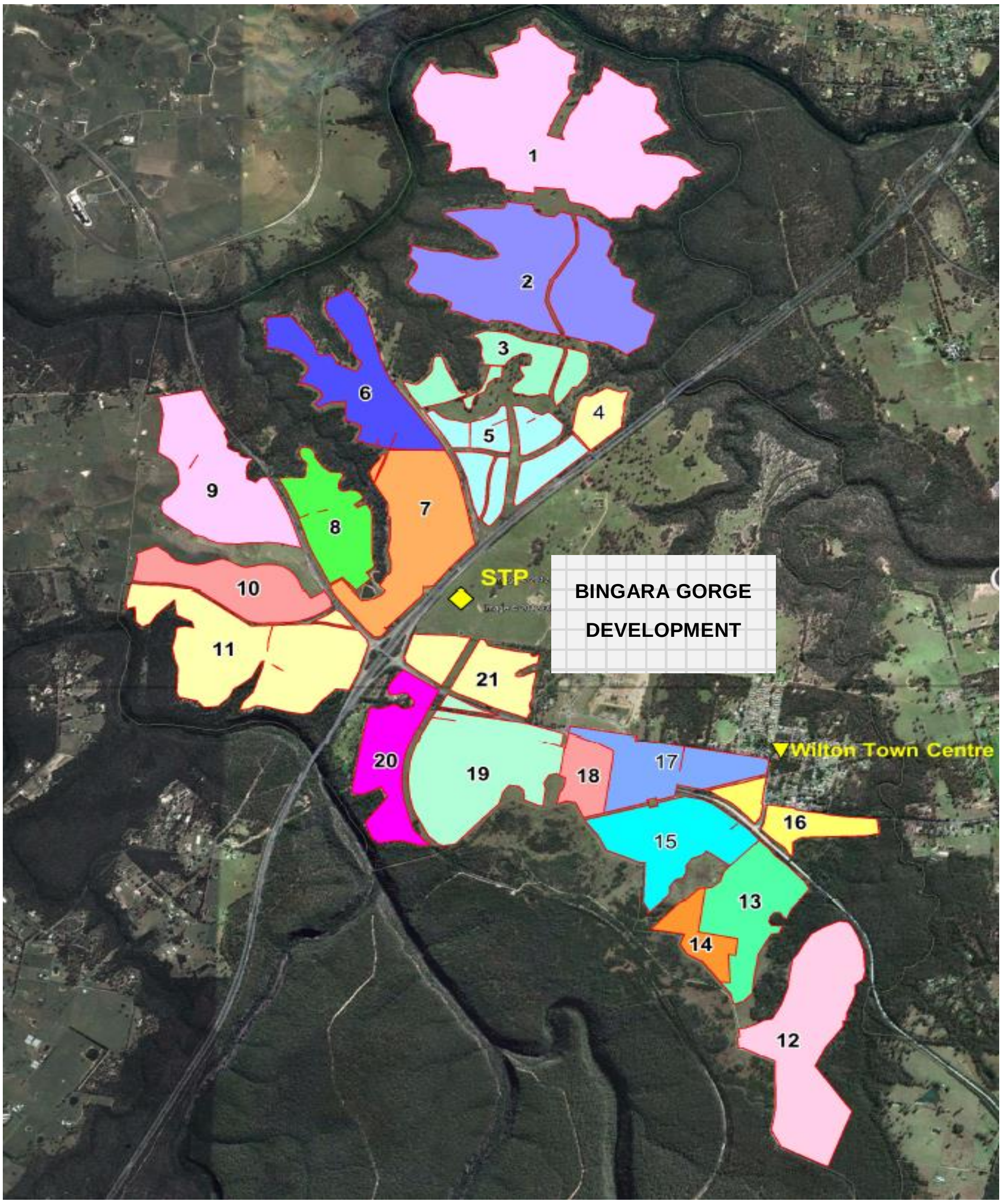
5.2 Pressure Sewer Network

The proposed sewerage reticulation system will comprise of multiple independent pressure sewer networks serving individual sub-catchments. Each residential property will be supplied with a collection tank and grinder pump, which will macerate the sewage and feed it into an on-property pressurised pipe. The pressurised pipe will then feed into a network of small diameter reticulation mains. The reticulation mains will discharge into either a pressure discharge structure where flows will gravitate to a SPS, or directly into a SPS, conveying flows to the discharge location at the STP.

The area was divided up into 21 sub-catchments which were based on a combination of topographical constraints (e.g. not exceeding a static head threshold of 40m) and development staging. The 21 sewer sub-catchments are displayed in Figure 5-3. The size and the number of lots in each sub-catchment determined the contributing flows and infrastructure required to convey flows ultimately to the proposed STP.

A limitation of a pressure sewer system is the max desirable head during normal operations of 56m. In the context of the proposed Wilton Junction development, this leads to additional transfer stations being required to overcome the static head differential resulting from the natural terrain.

Figure 5-3 : Pressure Sewer Network Catchments



5.2.1 Pressure Sewer Network Components

The pressure sewer network has three sections that broadly service the North, West and South-East of the rezoning precinct. The proposed pressure sewer network contains the following components;

- On Property Works - A collection tank of approximately 1.8 m deep and 0.7 m diameter installed on each property. A standard gravity property connection will run between the house and the collection tank. The pump operates within a typical operating volume between 32 and 100 litres dependant on the model and manufacturer. A buried boundary kit consisting of an isolation valve and check valve separates the property works with the reticulation mains. The collection tank is protected by an alarm system in the event of flow conditions outside normal operation. The alarm will typically be triggered based on certain levels inside the tank.
- Reticulation Network – The network is a complete pressure system comprising of Polyethylene pipe material (PE100, PN16) in various sizes depended on the design velocity of the network. Pipe sizes

will vary throughout the network, but are typically DN50 to DN200. All pipework is laid at minimum depth, since pressure sewer networkshave minimal dependency on grade.

- Gravity Mains – Gravity mains are located in the south of the catchment as the falling topography facilitates flow towards the treatment plant. A total of 10.1km of gravity mains are proposed for this scheme.
- Sewage Pumping Stations and Rising Mains – A total of six SPSs are expected to be required for this development with five of them being booster pump stations and one of them being a conventional wet well arrangement. The booster pump stations consist of centrifugal pumps with a small control chamber on the suction side of the pumps. The pumps would be controlled with an IICATS telemetry kiosk. The conventional wet well pump would consist of submersible pumps with IICATS telemetry kiosk and emergency storage. Odour Control Units (OCUs) may be required to mitigate against possible odours and septicity locally and downstream of the pumping station but have not been allowed for at this stage. It is recommended that septicity and odour modelling of the network be undertaken to .determine the optimum odour mitigation strategy. The footprint of each SPS would be approximately 10m x 20m.

A summary of the costs in provided below in Table 5-5.

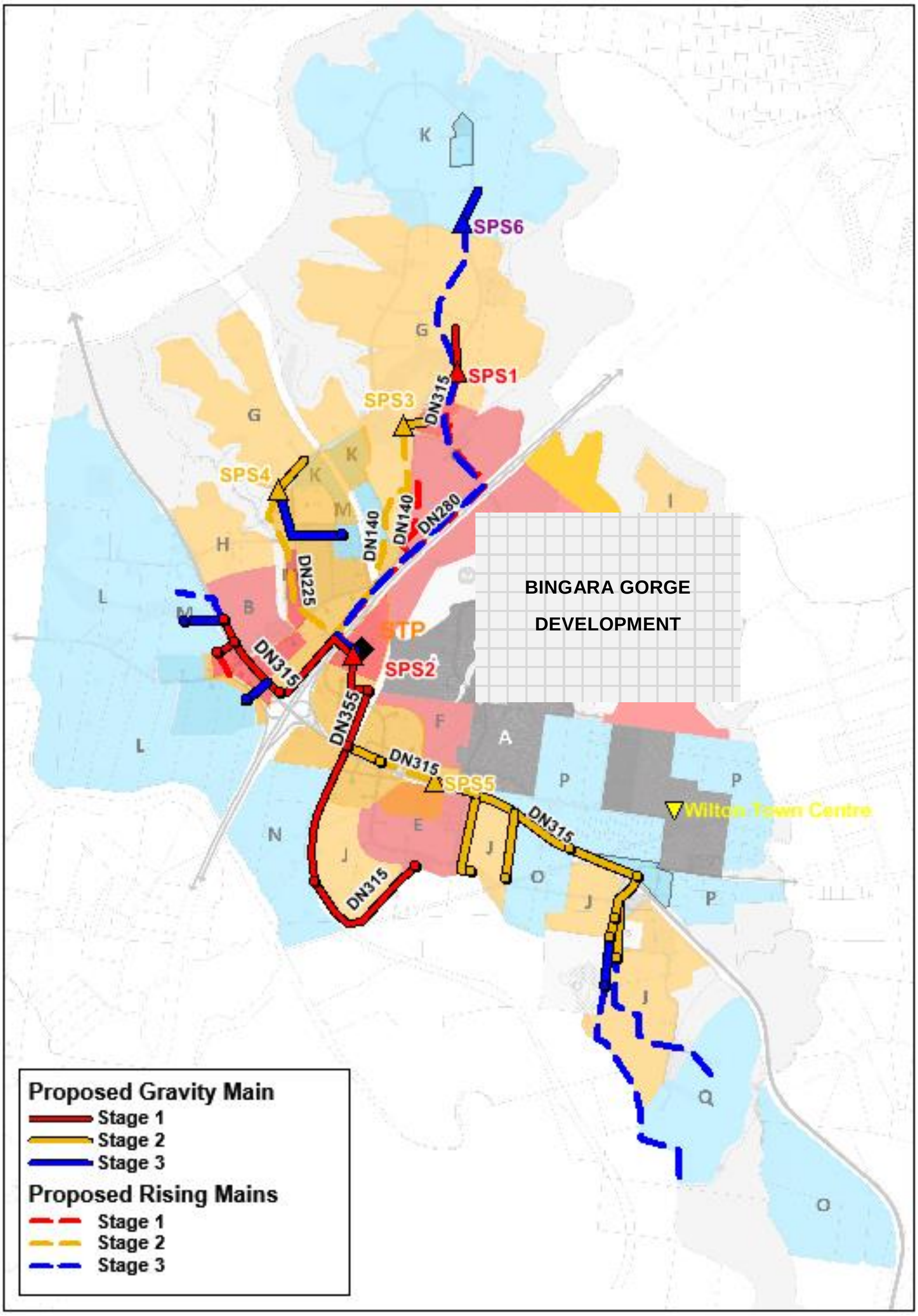
Table 5-5: Pressure Sewer Network

Assets	Cost
Trunk Infrastructure	
6 x SPSs (5 Boosters and 1 traditional wet well SPS)	$6.4M
Rising Mains	$5.8M
Storage	$1.0M
Subtotal	**$13.2M**
Reticulation Infrastructure	
Property Works	$131.6M
Reticulation Installation	$20.6M
Gravity Main	$7.8M
Subtotal	**$160.0M**
TOTAL	**$173.3M**
Cost per lot	**$17,000**

5.2.2 Staging of the Proposed Pressure Network

Similar to the proposed gravity network, the proposed wastewater pressure network has been configured so that the delivery of the infrastructure would align with the delivery of lots on the ground. Refer to Figure 5-4 for the staged asset layout for the pressure sewer network.

Figure 5-4 : Staged Pressure Sewer Network Infrastructure



5.2.2.1 Stage 1 Development

Stage 1 covers the period up to 2021 and will service up to 2,000 new dwellings. It is possible to service up to 200 lots with a pump-out arrangement for the initial servicing of each of the three landholder development fronts. This may be an effective servicing option if it proves difficult to install the sewage infrastructure in time for the initial stages of development.

The infrastructure required for Stage 1 is detailed in Table 5-6 below and involves;

- For the land in the North (Bradcorp) of the rezoning precinct, the trunk infrastructure required to service this is SPS 1 and a rising main to the STP. There would also be property pumps directly pumping into the rising main. SPS1 is not proposed to be staged and can service additional lots.
- For the land in the West (Governors Hill) of the rezoning precinct, the trunk infrastructure required to service this is PE DN315 trunk gravity main from the development to a lift station (SPS 2) located near the STP.
- For the land in the South-East (Walker Corp.) of the rezoning precinct, the trunk infrastructure required to service this is PE DN355 and DN315 trunk gravity mains from development to a lift station (SPS 2) located near the STP.

Table 5-6: Stage 1 Pressure Network Infrastructure

Assets	Cost	Timing
SPS 1 (60l/s @68m) & SPS 2 (183l/s @6m) + SPS 2 Storage	$3.2M	2014 – 2021
Rising Mains: 2.8km of PE DN280 & 0.1km of PE DN400	$1.7M	
Gravity Mains: 0.2km of PE DN250, 3.6km of PE DN315 & 0.75km of PE DN355 pipe	$3.4M	
Reticulation Network: 14.9km of PE pipe (DN50 to DN200)	$2.5M	
Property Works:	$21.8M	
Total	**$32.6M**	

Note: The apportionment of cost between the proponents is subject to commercial negotiations.

5.2.2.2 Stage 2 Development

Stage 2 covers the period from 2021 to 2031 and will service approximately 5,200 new dwellings. The infrastructure required to service Stage 2 is detailed below in Table 5-7 . The key pieces infrastructure required to service Stage 2 are;

- For the land in the North (predominantly Bradcorp), it is expected that some of the development will be able to connect into SPS 1 built in stage 1 and that SPS 3 and SPS 4 will need to be installed.
- For the land in the West (predominantly Governors Hill), it is expected that some of the development will be able to pump to the trunk gravity infrastructure (running alongside Picton Rd) built in the first stage of development and SPS 4.
- For the land in the South East (Walker Corp.), the trunk infrastructure required to service this is SPS 5 which will discharge into the trunk gravity infrastructure and SPS 2 built in stage 1.

Table 5-7: Stage 2 Pressure Network Infrastructure

Assets	Cost	Timing
SPS 3 (22l/s @81m), SPS 4 (45l/s @68m) & SPS 5 (75l/s @18m)	$2.8M	2021 – 2031
Rising Mains: 1.8km of PE DN160, 1.5km of PE DN225 & 0.4km of PE DN315	$1.7M	
Gravity Mains: 2.35km of PE DN250 & 2.25km of PE DN315	$3.1M	
Reticulation Network: 38.8km of PE pipe (DN50 to DN200)	$6.4M	
Property Works	$49.3M	
Total	**$63.3M**	

Note: The apportionment of cost between the proponents is subject to commercial negotiations.

5.3 Stage 3 Development

Stage 3 covers the period after 2031 and will service approximately 4,500 new dwellings. The infrastructure required to service Stage 2 is detailed below in Table 5-8. The key pieces of infrastructure required to service Stage 2 are;

- For the land in the North (predominantly Bradcorp) of the rezoning precinct, the trunk infrastructure required to service this is SPS 6.
- For the land in the West (Governors Hill and other developable land), connection to SPS 4 and the trunk gravity network along Picton Rd is required.
- For the land in the South East (Walker Corp and other developable land), connection into the trunk gravity network is required.

Table 5-8: Stage 3 Pressure Network Infrastructure

Assets	Cost	Timing
SPS 6 (62l/s @ 81m)	$1.4M	After 2031
Rising Mains: 3.8km of PE DN315	$2.4M	
Gravity Mains: 1.9km of PE DN250	$1.4M	
Reticulation Network: 70.8km of PE pipe (DN50 to DN200)	$11.7M	
Property Works	$60.5M	
Total	**$77.4M**	

Note: The apportionment of cost between the proponents is subject to commercial negotiations.

5.4 Comparison of Sewer Network Options

A Net Present Value (NPV) analysis was completed to compare the Low Infiltration Gravity Sewer network with the Pressure Sewer network.

This section also describes the basis and assumptions used for the cost estimates.

5.4.1 Cost Estimates

The cost estimates provided in this report are order of magnitude cost and are designed to be used for comparison purposes only. The cost estimates have been prepared using available cost estimating sources and MWH experience on similar projects, and are based on desktop assessments only. MWH warrants that reasonable skill, care and diligence was exercised in the preparation of these costs. However, MWH has no control over costs of labour, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or other factors likely to affect the probable cost of constructing the identified infrastructure. As such, MWH is unable to guarantee the accuracy of this cost estimate against the final outturn cost of the infrastructure and does not accept any liability in the event that actual costs are different from those indicated in our estimate.

Capital costs are order-of-cost estimates factored to year 2013 and the sources of capital cost estimates are;

- Sewage Pumping Stations - Factored rates from the "NSW Reference Rates Manual - Valuation of Water, Wastewater and Stormwater Assets, 2003".
- Sewer Rising Mains and Gravity Mains - Rawlinsons 2012 with 100% soft rock ground conditions assumed across the site. This was checked with industry feedback.
- Pressure Sewer – Based on MWH experience of Sydney Water's PSP, industry feedback and Rawlinsons 2012 (for reticulation and gravity mains).

The allowances presented in Table 5-9 reflect that generally a pressure sewer network will have less uncertainty in pre-construction activities (regulatory approvals, survey, design and project management) and during construction because the network layout does not require accurate invert levels and all pipe work can be laid at minimum depth, therefore reducing the risk of cost blow outs due to unforeseen ground conditions.

Table 5-9: Parameters for Construction Costs

Parameter	Gravity Network	Pressure Network
Survey, Design, Construction and Project Management	25%	15%
Contingency	30%	10%

5.4.2 NPV Analysis

The NPV Analysis was considered using a discount rate of 7.5% and Table 5-10 provides the parameters (annual % of capital value) that were adopted for the NPV analysis.

Table 5-10: Parameters for Operating and Maintenance Costs

Asset Type	Operating	Maintenance
SPS	0.7% + energy costs	1.8%
Pipelines	0.2%	0.4%
Storage structures	0.6%	0.5%
Pressure Sewers (On-property)	$20 per lot per year	$300 per lot per year
Pressure Sewers (Network)		$25 per lot per year

Table 5-11: Results of NPV Analysis forSewer Network (trunk and reticulation)

Scheme	Capital	O&M	NPV
Gravity	$222.6M	$25.2M	$90.9M
Pressure Sewer	$173.3M	$50.5M	$70.7M

A lifecycle cost assessment has been provided in Appendix D.

5.4.3 Conclusion

The conclusion from the NPV Analysis is that a pressure sewer system (assuming only soft rock ground conditions) is the lowest cost capital as well as the lowest NPV option.

A pressure sewer system also has the following benefits;

- Very unlikely to experience stormwater inflow or infiltration
- More conducive to mine subsidence
- Pipelines are kept to a minimal diameter and minimal depth and it is therefore unlikely to strike difficult ground conditions such as rock or water charged ground during construction.
- Significantly reduced potential for overflows due to reduced likelihood of root intrusions
- Power outages are unlikely to result in overflows as the system is designed with 24 hours of storage

It is therefore recommended that a pressure sewer system be considered to service this development. It is also recommended that the pressure sewer network be modelled at a later stage so that asset sizes can be optimised and all operational scenarios tested.

5.5 Mine Subsidence

The Illawarra Coal seam underlies the region at a considerable depth. Several collieries around Wilton currently extract coal, the nearest being Appin West Mine, 3 km to the north-east. All servicing options for Wilton Junction will be within one or more of the following mine subsidence districts:

- Bargo Mine Subsidence District
- Wilton Mine Subsidence District
- South Campbelltown Mine Subsidence District

All infrastructures associated with the servicing of the Wilton Junction development will need to accommodate the following requirements of the Mine Subsidence Board.

- Maximum vertical subsidence of 0.95m
- Maximum ground strains of 2.5mm/m
- Maximum tilt of 6mm/m
- Maximum radius of curvature of 5kms

6 Wastewater Treatment Design and Performance Criteria

This section describes the criteria that were adopted for the wastewater treatment components of the Wilton Junction Rezoning Wastewater Strategy.

The high level wastewater treatment design presented in this report is for the sole use of the Proponents for the sole purposes of supporting the rezoning application and feeding into Infrastructure Plans for State and Local Infrastructure Contribution Plans.

MWH has prepared this document on the basis of the information that is available. Where this document expressly refers to information from third party sources, MWH has not verified the full accuracy of the information.

6.1 Wastewater Treatment Criteria

6.1.1 Projected Population and Flows

The design flows presented in Section 3.2 and flow projections presented in Section 4 will apply to the wastewater treatment plant.

6.1.2 Influent Quality

As the Wilton Junction development will be a greenfield development site, no data is available for the actual characterisation of the influent for the wastewater treatment plant.

Consistent with the approach adopted in the *Wilton New Town Sewerage Overview* (CH2MHill, 2012), it has been assumed that trade waste loads generated within the Wilton Junction development would be strictly controlled at the source, so that the loads treated at the wastewater treatment facility would be within the domestic range.

The influent quality adopted in CH2MHill (2012) was defined in terms of contaminant concentration. When contaminant concentrations are used to characterise influent quality, contaminant mass loads are dependent on the hydraulic load adopted. For domestic wastewater, the mass loads of key contaminants are generally not dependent on the hydraulic loads, so contaminant concentrations will be higher for schemes with low per capita flows and lower for traditional schemes with higher per capita flows. Inappropriate selection of contaminant concentrations can lead to over or underestimating the contaminant mass loads.

For the purpose of this study, the influent quality was determined based on per capita mass loads for key contaminants in order to decouple the hydraulic load and the mass loads of key contaminants.

The hydraulic load and contaminant concentrations adopted in the CH2MHill (2012) Report were used to calculate the corresponding mass loads for key contaminants. These values were compared to reported typical Australian values and values MWH had previously observed for other domestic wastewater schemes in New South Wales.

In general, the contaminant loads calculated using the concentrations and hydraulic load presented in the CH2MHill (2012) Report, were lower than those typically observed in domestic wastewater schemes. When the contaminant loads were calculated adopting hydraulic load typical for a traditional wastewater scheme (i.e. 210/EP/day), the calculated contaminant loads were consistent with typical reported values and values observed on other projects.

The compared values are presented in Table 6-1, along with the contaminant loads that were adopted for this study. The adopted loads were selected based on the assumption that the development will not contain dual reticulation.

Table 6-1: Comparison of Per Captia Contaminant Mass Loads (g/EP/day)

Parameter	Reported Typical Values[1]	Previous Experience[2]	CH2MHill Report[3]	CH2MHill Report[4]	Adopted Values
BOD	55 to 60	54 to 60	44.25	62	60
COD	125 to 135	110 to 130	93	130	120
TSS	60 to 70	40 to 75	45	63	70
TKN	11.5 to 13.5	9 to 13.5	9	12.6	13.5
NH3-N	N/A	6 to 11	6.6	9.2	10.8
Total P	2.1 to 2.4	2.5 to 2.7	1.65	2.3	2.7

1. Griffiths P. (1997) ", "Achievable Effluent Quality from Biological Nutrient Reduction Systems under Australian Conditions – Modelling and Full Scale Operating Experience", BNR3 Conference Proceedings, Brisbane, Australia.
2. Based on MWH's previous experience with domestic wastewater schemes in New South Wales.
3. Calculated using hydraulic load and concentrations reported in CH2MHill (2012) Report.
4. Calculated using concentrations reported in CH2MHill (2012) Report and adopted a hydraulic load typical for a traditional scheme (i.e. 210L/EP/day).

The adopted contaminant loads are justified as follows:

- BOD: Data from other NSW plants shows 54 to 60 g /EP/day therefore a conservative approach has been taken.
- COD: Examination of data from other NSW STP's shows a COD:TKN ratio of 8 to 10.5. Adopting a COD:TKN ratio of 8.9 and a TKN load of 13.5g/EP/day provides a conservative COD load.
- SS: This can vary widely in plants depending on the layout of the sewer system and actions undertaken upstream of the STP (e.g. chemical dosing to control septicity). A nominal load has been adopted.
- TKN: A conservative value adopted based on examination of influent data from other NSW STP's.
- NH3-N: A conservative value adopted based on examination of influent data from other NSW STP's.
- TP: A conservative value adopted based on examination of influent data from other NSW STP's.

Table 6-2 presents the calculated concentration of key contaminants, based on a hydraulic load of 150L/EP/day (refer to Section 3.1) and the contaminant mass loads adopted in Table 6-1.

Table 6-2: Influent Contaminant Concentrations

Parameter	Units	Value
BOD	mg/L	400
COD	mg/L	800
TSS	mg/L	467
TKN	mg/L	90
NH3-N	mg/L	72
Total P	mg/L	20

6.1.3 Effluent Quality Requirements

The effluent quality requirements for the wastewater treatment plant were defined by J Wyndham Prince and VKL in their report "Water Cycle Management Strategy" dated June 2013. Ultimate and interim effluent quality targets were **summarised in a Technical Note by J Wyndham Prince. These are summarised in Table 6-3 and Table 6-4 respectively**, while the technical note associated with the supply of these effluent quality targets is contained in Appendix C.

Table 6-3: Ultimate Effluent Quality Targets

Parameter	Units	Value
Total N	mg/L	6 (mean)
Total P	mg/L	0.1 (mean)
Sodium	ppm	<1200
E.coli	cfu/100mL	1000
Enterococci	cfu/100mL	230
pH		6.5
TDS	mg/L	700

Table 6-4: Interim Effluent Quality Targets

Parameter	Units	Utilise Excess Bingara Gorge Capacity	Centralised Interim Solution	Decentralised Interim Solution
Total N	mg/L	Effluent quality will be dictated by Bingara Gorge STP design and any agreements entered into with Lend Lease &/or the STP's operators.	6 (mean)	6 to 10
Total P	mg/L		0.1 (mean)	1 to 5
Sodium	ppm		<1200	<1200
E.coli	cfu/100mL		1000	1000
Enterococci	cfu/100mL		230	N/A
pH			6.5	6.5 to 8.5
TDS	mg/L		700	700

Although J Wyndham Prince provided Total N and Total P targets expressed as means, for the purpose of this study we have assumed that the data is normally distributed, and therefore it is appropriate to assume that the mean equals the median (i.e. 50%ile).

It is noted that the proposed TDS limit is not consistent with the stipulated sodium limit of 1,200 ppm. It is assumed that the sodium limit will need to be considerably lower (e.g. at 300 mg/L) in order for TDS to be under 700 mg/L.

6.1.4 Biosolids Requirements

The Protection of the Environment Operations (Waste) Regulation 2005 deals with the waste related aspects of the Protection of the Environment Operations Act 1997. The Regulation deals with the way waste is managed in terms of storage and transportation along with record keeping requirements and fees to be paid at waste treatment facilities. The Biosolids Exemption 2008 provides the provisions to allow the reuse of Biosolids for land and thermal applications.

The NSW EPA released Environmental Guidelines: Use and Disposal of Biosolids Products in 1997. This document, referred to as the Biosolids Guidelines (NSW EPA, 1997), outlines the requirements for biosolids treatment and the potential uses of treated biosolids. The guidelines give classification to biosolids and determine what form of reuse the biosolids can have. Classification is given in terms of an allowed usage, within the categories outlined in Table 6-5.

Table 6-5: Contaminant Acceptance Concentration Thresholds

Contaminant	Grade A[1] (mg/kg)[3]	Grade B[2] (mg/kg)[3]	Grade C[3] (mg/kg)[3]	Grade D (mg/kg)[3]
Arsenic	20	20	20	30
Cadmium	3	5	20	32
Chromium (total)	100	250	500	600
Copper	100	375	2,000	2,000
Lead	150	150	420	500
Mercury	1	4	15	19
Nickel	60	125	270	300
Selenium	5	8	50	90
Zinc	200	700	2,500	3,500
DDT/DDD/DDE	0.5	0.5	1.00	1.00
Aldrin	0.02	0.2	0.5	1.00
Dieldrin	0.02	0.2	0.5	1.00
Chlordane	0.02	0.2	0.5	1.00
Heptachlor	0.02	0.2	0.5	1.00
HCB	0.02	0.2	0.5	1.00
Lindane	0.02	0.2	0.5	1.00
BHC	0.02	0.2	0.5	1.00
PCBs	0.3	0.3	1.00	1.00
*Contaminant acceptance concentrations are not mean values.				

Source: NSW EPA, 1997, Table 3-1.

Notes:

1. The Grade A threshold for cadmium is under review. Subject to the outcome of this review, the standard for cadmium would be revised and then may become the same as the maximum allowable soil concentration for agricultural land, namely 1 mg/kg.
2. The Grade B threshold levels are under review.
3. Values are expressed on dry weight basis.

According to the Biosolids Guidelines (NSW EPA, 1997), biosolids grading is based on a 'contaminant grade' and a 'stabilisation grade'. The contaminant grading relates to the concentration of specified heavy metals and organic chemicals that may be present. The concentrations defining the contaminant grading are called contaminant acceptance concentration thresholds and are shown in Table 6-5. These thresholds are not to be compared with the average concentration of a sample, but with a value derived from the average and standard deviation of the measured concentrations by means of a procedure set out in the Biosolids Guidelines.

The stabilisation grade relates to the extent of pathogen reduction in the solids and the potential for the solids to generate odour or attract vectors (i.e. flies and other insects). The higher the grading, the more freely the solids can be used.

In brief, the three stabilisation grades are summarised as follows:

- **Stabilisation Grade A** - biosolids that have been subject to high temperature or high pH/high temperature processes to achieve a high degree of pathogen and volatile solids reduction (e.g. lime stabilisation, composting or hydrolysis process).
- **Stabilisation Grade B** - biosolids that have passed through a process such as digestion to achieve a high degree of pathogen and volatile solids reduction.
- **Stabilisation Grade C** - biosolids not meeting the above requirements.

The allowable uses for biosolids based on the Biosolids Guidelines quality grading criteria are presented in Table 6-6.

Table 6-6: Classification of Biosolids Products

Biosolids Classification	**Allowable Land Application Use**	**Minimum Quality Grades**	
		Contaminant Grade	Stabilisation Grade
Unrestricted Use	Home lawns and gardens Public contact sites Urban landscaping Agricultural Forestry Soil and site rehabilitation Landfill disposal Surface land disposal [2]	A	A
Restricted Use 1	Public contact sites Urban landscaping Agricultural Forestry Soil and site rehabilitation Landfill disposal Surface land disposal [2]	B	A

Biosolids Classification	Allowable Land Application Use	Minimum Quality Grades	
		Contaminant Grade	Stabilisation Grade
Restricted Use 2	Agricultural	C	B
	Forestry		
	Soil and site rehabilitation		
	Landfill disposal		
	Surface land disposal [2]		
Restricted Use 3	Forestry	D	B
	Soil and site rehabilitation		
	Landfill disposal		
	Surface land disposal [2]		
Not Suitable for Use	Landfill disposal	E [1]	C [1]
	Surface land disposal [2]		

Source: NSW EPA, 1997, Table 3-6.

Notes:

1. Biosolids products which are not contaminant or stabilisation graded are automatically classified Not Suitable for Use.

2. To be applied within the boundaries of sewage treatment plant site.

The wastewater treatment plant will be designed to achieve stabilisation Grade B, although the interim solutions may only achieve stabilisation Grade C. By achieving stabilisation Grade B, the biosolids will be able to be used for the applications corresponding to Biosolids Classification Restricted Use 2 (refer to Table 6-6), assuming contaminant Grade C is achieved. It has been assumed that there will be no major contaminants in the catchment and any trade waste will be effectively managed. Contaminant Grade C will be achieved without the need for additional treatment.

6.1.5 Air Quality

Specification of odour levels or threshold for compliance can be complex and somewhat site-dependent. The most exposed existing (or likely future) off-site sensitive receptor at which compliance will be assessed will need to be defined. Usually this requires a detailed assessment of emissions rates, prevailing site environmental conditions (e.g. wind direction) and identification of odour receptors surrounding the site. It is recommended that such an odour assessment, with associated modelling, be undertaken prior to, or at least concurrent with, subsequent design phases. In this manner, designs or proposed designs, can be compared against odour control requirements.

7 Wastewater Treatment Options Review

7.1 Introduction

This section includes a review of potential treatment processes, followed by the selection of an appropriate treatment train to produce a high level design that is capable of achieving the effluent quality requirements outlined in Section 6.1.3.

It is noted that this review is focused mostly on the process option for secondary treatment. The review conducted represents a high level review based on available information on the drivers for the project. The review does not constitute a detailed option assessment, nor is it an outcome of multi-criteria assessment.

No consideration of preliminary treatment requirements (i.e. screens and grit removal) have been provided within this section, however preliminary treatment is included in the design. For preliminary treatment, it has been assumed that generic facilities will be required, unless an individual treatment process has other specific requirements (i.e. improved screenings capture are required for membrane bioreactor treatment).

7.2 Activated Sludge Process Configuration

There are several different activated sludge configurations which offer different levels of complexity and levels of treatment. The different options, and their relative merits are discussed in this section.

A number of intermittent and continuous flow (both compartmentalised and non-compartmentalised) secondary treatment processes have been evaluated to identify the most appropriate option to be considered for the high level design. These configurations are listed in Table 7-1.

Table 7-1: Potential Secondary Treatment Configurations

Intermittent Processes	Compartmentalised Processes	Non Compartmentalised Processes
Intermittently Decanted Aerated Lagoons Sequencing Batch Reactor BioDeNitro™ / BioDeniPho™ [1]	Modified Lutzack-Ettinger 4-Stage Bardenpho Reactor 5-Stage Bardenpho Reactor Johannesburg Modified UCT	Oxidation Ditch

While the configurations vary in terms of the number and order of zones, all configurations include aerobic zones for nitrification and anoxic zones for denitrification. The compartmentalised configurations vary only in recycles and placement of zones, which are used to control the local levels of nitrate and dissolved oxygen within the different zones of the bioreactor.

The low effluent concentration requirement for Total P of 0.1 mg/L (50%ile) indicates that enhanced biological phosphorous (bio-P) treatment alone will not be able to provide sufficient removal. To ensure the Total P effluent target is achieved, enhanced bio-P treatment would need to be combined with an additional chemically based phosphorous removal step.

As chemically based phosphorus removal will be required to achieve the effluent Total P requirement, the selection of treatment configuration for the plant will be governed by nitrogen removal. For this

[1] Proprietary systems designed by Veolia

reason, the Bardenpho process is considered more suitable than the Johannesburg and Modified UCT processes. The Johannesburg and Modified UCT processes are geared towards improved enhanced bio-P removal at the detriment of nitrogen removal.

Potential secondary treatment configurations for the local treatment options are presented in Section 7.2.1 to 7.2.5. Each option that requires tertiary filtration to achieve the required effluent quality is highlighted, and filter details, including potential chemical dosing requirements, are discussed. The preferred treatment configuration is then presented in Section 8.

7.2.1 Sequencing Batch Reactor Process

7.2.1.1 Technology Review

Sequencing Batch Reactor (SBR) technology has been available for nearly 80 years and has been developed into a patented process offered by European and American companies. The term SBR has been widely adopted throughout the water industry, and is currently used universally for the various versions of variable volume systems by a range of abbreviations including; IDEAL, ICEAS, IDAL and SBR itself.

The numerous types of SBR configurations are based upon a combination of influent feed arrangements (rapid fill, batch fill and continuous fill) and batching configurations (full batch, semi batch and sequence operated). For example, the IDAL is a continuous fill and sequence operated reactor.
The SBR technology offers the following advantages which have led to the technology becoming widely accepted in the water industry:

- Applicability to simple automation.
- SBR operation can be modified to allow control over bacterial species that causes filamentous bulking and nutrient removal.
- Ability to select robust microbial communities that maintain high performance during period of shock loads.
- Minimum operator intervention required and less physical space needs.

SBR's can be designed to withstand high peak hourly flows with no, or minimal loss, of effluent quality. The ability to control the feed to the reactor provides the SBR with an advantage over the IDAL process, which has no control over the feed flow. With the SBR process the feed to the reactor can be stopped during the settlement and/or the decant phase. This could be significant in preventing the potential risk of ammonia and soluble phosphorous breakthrough during the diurnal peak load to the reactors. Consequently the SBR would require large process tanks to cater for the increased cycle storage volume required when compared to the IDAL process. SBR configuration also requires a minimum of two reactors to ensure the mode can be sustained when one is off-line.

7.2.1.2 Achieving the Required Effluent Nutrient Quality

Operating without any tertiary treatment facilities the SBR process is not expected to be able to achieve the Total P effluent targets (0.1 mg/L 50%ile). The Total P effluent criteria can be addressed through chemical addition of alum, or iron salts using a 2-point dosing strategy.

The intermittent process will achieve denitrification through a primary anoxic zone, and therefore, although some simultaneous nitrification / denitrification will occur in the settle phase, complete denitrification is not achievable in this process.

It is predicted that an external carbon source will be required in order to achieve the required Total N requirement. The SBR configuration does not allow for an optimised dose of this external carbon unless a tertiary denitrifying filter is included.

7.2.2 Intermittently Decanted Aerated Lagoon Process

7.2.2.1 Technology Review

The IDAL process carries out nitrification, denitrification, settlement and decanting stages all in one tank. Nitrification, denitrification is achieved through intermittent operation of the aeration system. An IDAL is a continuous feed process and therefore does not have automated valves controlling the feed flow to the individual reactors. Therefore, as with the SBR process full denitrification is not achieved.

It is well documented that IDAL reactors are resilient to process upsets as the microbiology operates in the endogenous phase resulting in a stable population base of microorganisms. In addition, the use of large combined react-settle basins offers a strong buffering to hydraulic and toxic shock loads, although if a pressure sewer system was adopted, the requirement for variability due to hydraulic shock is minimal.

IDAL's have the ability to handle high PWWF to ADWF ratios, negating the need for storm tanks of bypasses to disinfection facilities, thus ensuring all are subjected to biological treatment. Typically flows less than 3 times ADWF are fully treated through normal, aeration, settle and decant cycle times. Flows between 3 times ADWF and up to 6 to 7 times ADWF are stabilised via a 'wet weather cycle' mode where a reduced aeration cycle occurs in the IDAL.

Flows in excess of 6 to 7 ADWF are treated via a solids contact process in a 'storm mode' cycle. In storm mode the decanters are maintained in a raised position enabling the IDAL to operate as a high rate sedimentation tank (whilst minimising the carryover of biomass). Screened effluent will enter the anoxic selector zone where contact stabilisation will occur prior to flows entering the main IDAL reactor where solids will settle.

Short circuiting during the decant phase is a common problem with IDAL reactors. This can occur due to the difference in influent sewage temperature and basin temperature. Incoming warmer sewage to the reactor can rise to the surface and essentially 'skid' along the surface to the decanter. Short circuiting can potentially cause ammonia breakthrough during the decant phase (concentrations of in excess of 2 mg/L have previously been experienced at other operational facilities). To alleviate this concern SBR technology would be required (allowing an intermittent fill process) to ensure compliance with the effluent Total N requirement.

It is noted that IDAL are commonly employed by Sydney Water for its inland wastewater treatment plants.

7.2.2.2 Achieving the Required Effluent Nutrient Quality

Operating the IDAL process without any tertiary treatment (as with the SBR) is not expected to be able to achieve the expected Total P effluent targets (0.1 mg/L 50%ile). However, the Total P effluent criteria can be partially addressed through chemical addition of alum and/or iron salts in a 2-point dosing strategy. Tertiary denitrification filters and associated chemical dosing may be required to achieve the expected Total N effluent target (6mg/L, 50%ile).

7.2.3 BioDeNitro™ & BioDeniPho™ Process

7.2.3.1 Technology Review

The BioDeNitro™ process comprises two activated sludge tanks and final settling clarifier. The two tanks are interconnected and operate alternatively, but with the continuous feed and discharge of sewage. One tank operates in the anoxic phase while the interconnecting tank operates in the aerobic phase. The process can be broken down into Phases A to D (as shown in Figure 7-1).

In Phase A raw sewage is introduced into the first anoxic tank for denitrification. As raw sewage continuously enters the tank, a corresponding volume of water and activated sludge leaves tank 2 and flows to tank 1. In tank 1 oxygen is introduced (aerobic conditions) leading to a biological degradation of the remaining organic matter and a conversion of the wastewater's ammonia content to nitrate (nitrification). In this, and the following phase, the treated wastewater flows from tank 1 to the final settling tank.

Phase B is a brief intermediary phase where the wastewater is transferred / fed to tank 1 into which oxygen is introduced (aerobic conditions). Oxygen is also introduced into tank 2 in this phase. The purpose of this phase is to reduce the content of ammonia in tank 2 before the wastewater is discharged from this tank.

Phases C & D correspond to the phases of A and B, except for the fact that the wastewater influent, effluent, and the process conditions in the tanks are interchanged. Once phase D is completed, the operation cycle starts again.

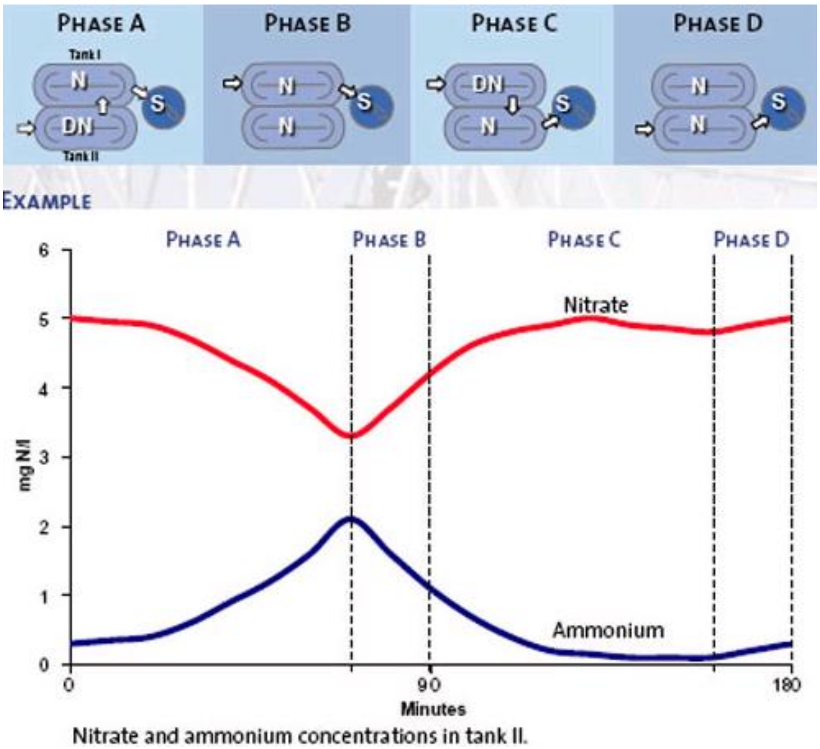


Figure 7-1 BioDeNitro™ Process (www.veoliawaterst.com)

To achieve optimum process performance the two tanks (1 & 2) must operate in intermittent series, however, if one tank is out of service the facility remains to keep one tank in operation thus maintaining a degree of process performance.

Typically only one clarification unit is provided with this proprietary process as, unless sludge scrapers require replacement, the unit is rarely out of service. Should the clarifier require significant maintenance (i.e. due to structural failure) then other options such as effluent storage dams will be required.

The BioDeNiPho™ process is an extension of the BioDeNitro™ process with an anaerobic zone included upstream of the anoxic zone. This facilitates biological phosphorus removal.

7.2.3.2 Achieving the Required Effluent Nutrient Quality

The BioDeNiPho™ process (including clarification) is capable of achieving close to full denitrification. However, its operation without any tertiary treatment facilities is not expected to be able to achieve the expected Total P effluent targets (0.1 mg/L 50%ile). The Total P effluent criteria could be addressed through chemical addition of alum, and/or iron salts, in conjunction with tertiary filtration.

7.2.4 Oxidation Ditch Process

7.2.4.1 Technology Review

The oxidation ditch process consists of a ring shaped channel. Screened wastewater enters the ditch where it is mixed with the activated sludge and circulated around the ditch by either the action of the mechanical surface aerators at a velocity to maintain the sewage and sludge solids in suspension or a combination of fine bubble diffused aeration and large impeller slow speed mixers.

Mixed liquor is continuously recirculated around the ditch in varying anoxic and aerobic fractions before being displaced over the outlet weirs by the incoming sewage to clarification tanks. Settled activated sludge is pumped back to the ditch while the clarified effluent is discharged.

Oxidation ditches typically operate in the extended aeration mode with long hydraulic residence and solids retention times. Mixed liquor from the oxidation tank enters clarification tanks prior to any treatment through tertiary treatment processes.

7.2.4.2 Achieving the Required Effluent Nutrient Quality

It is expected that the oxidation ditch process (together with clarification, substrate and chemical P removal dosing) will be able to achieve close to full denitrification. If the process is designed and operated adequately then the secondary effluent Total N quality can be expected to be in the range of 1.0 to 5.0 mg/L (50%ile), which is less than the effluent Total N target.

Operating without, any tertiary treatment facilities the oxidation ditch process is not expected to be able to continuously achieve the Total P effluent target (0.1 mg/L 50%ile). However, the Total P effluent criteria can be addressed through chemical addition of alum and/or iron salts (together with filtration).

The oxidation ditch type process is inherently robust. If a pressure sewer network is adopted, lower than typical flow variations could be expected which would create the advantage of improved DO control throughout the oxidation ditches (between anoxic /aerobic zones). It is expected that this would assist in achieving simultaneous nitrification/denitrification. However, oxidation ditches require very large volumes and out of all of the options considered, this option is likely to have one of the highest capital cost.

7.2.5 4 Stage Bardenpho Process

7.2.5.1 Technology Review

The four stage Bardenpho process uses both carbon in the wastewater and carbon from endogenous respiration to achieve denitrification. The influent initially enters a primary anoxic zone where it is mixed with a recycle stream from the end of the primary aerobic zone and return activated sludge (RAS).

The effluent then enters the primary aerobic zone where nitrification takes place. Part of the effluent from the primary aerobic zone is recycled to the head of the primary anoxic zone for denitrification utilising the carbon source in the influent sewage.

Flow then enters the secondary anoxic zone where carbon from endogenous respiration is utilised for denitrification. The effluent then enters the secondary aeration zone (or re-aeration zone) which is a relatively small zone used to nitrify any remaining ammonia which has been released due to cell lysis in the secondary anoxic zone. This re-aeration zone also ensures a positive dissolved oxygen concentration is maintained prior to flows entering clarification tanks. Membrane bioreactors can also be utilised in the process with some modification to manage dissolved oxygen, should available space be of concern. Return activated sludge (RAS) is recycled to the head of the primary anoxic zone

The four stage Bardenpho reactor has two separate denitrification zones targeted at achieving low effluent total nitrogen concentrations using the secondary anoxic zone to achieve total denitrification. This two stage process offers a more reliable and robust design to achieve stringent effluent nitrogen concentrations when compared to other typical processes such:

- Modified Ludzak Ettinger (MLE) process.
- Modified UCT process.
- Johannesburg process.

It also allows for optimisation of external carbon dosing required to achieve these low total nitrogen limits, by allowing the carbon source to be dosed into the secondary anoxic zone where there is little or no carbon from the domestic sewage.

It is noted that the Modified UCT process is geared towards enhanced biological phosphorous removal at the expense of nitrogen removal.

7.2.5.2 Achieving the Required Effluent Nutrient Quality

The four stage Bardenpho process is theoretically capable of full denitrification. The denitrification capability of the process is directly proportional to the influent biodegradable COD concentration and the position and sizes of the anoxic reactors. Adequate selection of the internal mixed liquor recycles and anoxic zone volumes, together with the potential for substrate dosing, can ensure that complete denitrification should be achievable. Online monitoring and process control can facilitate in ensuring effective operation.

Depending upon raw sewage characteristics the four stage Bardenpho process is expected to be able to achieve the expected Total N effluent target median of 6.0 mg/L. As the four stage process is not geared towards targeting biological P removal, chemical dosing assistance is expected to be required together with tertiary filtration.

The five stage process is a modification of the four stage process incorporating an anaerobic zone for biological phosphorous removal. Influent sewage and RAS are subsequently mixed in the anaerobic zone. This five stage process, although capable of achieving stringent effluent TN requirements, has not been considered any further in this strategic study. The advantage it provides, in terms of biological phosphorous removal, is expected to be outweighed by the additional substrate (i.e. carbon dosing) requirement and large reactor volume. Essentially the selection of either the four or five stage process is a trade-off between;

- the costs of chemical dosing (alum or ferric salts) to provide chemical phosphorous removal;
- the costs of additional substrate dosing (i.e. methanol) to account for the additional carbon requirements when completing biological phosphorous removal and;
- Operational complexity

The choice of biological or chemical phosphorus removal is therefore specific to the influent characteristics, size of the plant and effluent requirement for the plant. It is noted that biological phosphorus removal will minimise the chemical to be used, and could be useful if the effluent TDS target is tight.

7.2.6 Selected Configuration

The four stage Bardenpho has been selected for the nominal design. As discussed in Section 7.2.5 the four stage Bardenpho configuration reactor has two separate denitrification zones targeted at achieving low effluent total nitrogen concentrations. This two stage process offers a more reliable and robust design to achieve low effluent nitrogen concentrations, when compared to other typical (i.e. MLE configuration etc) and available processes (i.e. IDAL, SBR). Although the oxidation ditch type process provides a robust design, difficulties in controlling DO throughout the zones (especially during high flow periods) can lead to reduced control of effluent quality whilst the Bardenpho process is theoretically capable of fully controlled denitrification.

For the purposes of the nominal design, the four stage Bardenpho process was selected over the five stage Bardenpho process as it is anticipated that the costs of carbon dosing will outweigh the benefits of biological phosphorous removal. As the four stage process is not geared towards targeting biological P removal, chemical dosing assistance (ferric chloride / aluminium sulphate) is expected to be required in the bioreactors with a second dose prior to the tertiary filters.

Substrate dosing (in the form of acetic acid) is expected to be required to ensure full denitrification occurs in the process (either in the secondary or tertiary stages). Additional chemical dosing in the form of sodium hypochlorite for re-use water is also expected to be required together with sodium hydroxide for provision of supplemental alkalinity.

This review of activated sludge configurations was done explicitly for the purpose of selecting a nominal design to include in the rezoning application. Prior to progressing the design of the wastewater treatment plant, a more detailed review should be undertaken to enable a complete comparison, including whole of life costing's, of different activated sludge configurations. This is best conducted via a multi-criteria assessment (MCA) where the stakeholders are engaged to develop the preferred treatment solution for the project.

7.3 Conventional vs Membrane Activated Sludge Plant

A conventional activated sludge plant will include a bioreactor followed by clarifiers. In membrane bioreactors (MBRs), the concept is to 'amalgamate' an activated sludge reactor with a membrane filtration plant to produce a hybrid reactor-separation step that does not require an intermediate secondary clarifier.

Membrane bioreactors (MBR) developed overseas in the 1990s (especially Canada, Japan & United Kingdom) and there are now several applications for domestic/ municipal wastewater treatment in Australia, ranging from around 100 to 150,000 EP in size.

A summary of advantages and disadvantages of MBR systems over conventional activated sludge plants is given in Table 7-2.

Table 7-2: Advantages and Disadvantages of Membrane Bioreactor Systems

Advantages	
Effluent Quality	Excellent Suspended Solids Removal. Effluent turbidity is generally 0.2NTU (95th%ile) and 0.5NTU (max).
Area Reduction	Ability to operate at higher MLSS concentrations (i.e. 8,000-10,000 mg/L) provides size reductions of basins by factors of 1/3 to 1/4.
Process Performance	Excellent solids separation improves overall treatment performance and reliability.
Construction Costs	Construction costs are becoming comparable with conventional activated sludge plants due to decreasing membrane costs and increasing concrete and steel costs.
Disadvantages	
Fine Screening	Strict fine screening requirement. 0.5 – 2mm fine screening with pre-screening.
Energy Consumption	Relatively higher energy consumption due to: • the need to agitate the membrane by air, • low alpha factor for biological aeration due to the high MLSS concentration, • additional pumping, • higher RAS rates.
Hydraulics	Limited flexibility for handling high flows, Potential of membrane fouling limiting plant hydraulic flows.

Due to site constraints, the Proponents have advised that the high level design be based on an activated sludge process that will involve a membrane bioreactor. In general the process is significantly more compact than conventional biological systems, with a potentially better effluent quality than a conventional activated sludge process (with clarifiers). As solids separation does not require floc formation and settling, the bioreactor can operate at very high levels of MLSS (mixed liquor suspended solids), generally in the order of 6,000 to 10,000 mg/L with an average of 8000 mg/L.

This higher MLSS concentration results in a smaller reactor size and footprint and a long SRT, leading to a corresponding reduction in biological sludge production. The membrane separation as mentioned above also has the advantage of good particulate removal and effective disinfection through physical particle exclusion by size at the dynamic membrane surface.

Although a membrane bioreactor has been included in the high level design, the selection of a membrane bioreactor, over a conventional activated sludge process, should be reviewed in conjunction with any future reviews of the activated sludge configuration.

7.4 Tertiary Treatment

To mitigate the risk of exceedance of the effluent Total P requirement, tertiary filtration will be provided downstream of the membrane bio-reactor, such that a 2-point dosing strategy could be employed to remove phosphorous down to the low level of 0.1mg/L (50%ile).

For the purpose of this report, media filtration is considered. There are two generic alternatives for media filtration. Conventional downflow filters and upflow continuously backwashing filters.

Downflow filters operate in a conventional downflow filtration mode, and consist of underdrain supported gravel and sand. Facilities for backwashing and air scouring are provided. Individual filter cells are briefly taken out of service at regular intervals for a short backwashing cycle.

Upflow continuous backwash filters operate in an upflow mode. A sand bed is slowly drawn downward into an airlift system which scours the media and conveys it back to the top of the bed. Backwashing takes place continuously at a relatively low rate. The filter remains continuously in service.

The selection of the most appropriate tertiary filtration technology to be considered for the high level design is not a critical requirement as the relative costs of the filters will not drive the decision at this stage. However, further discussion can be provided on the appropriate type of filtration technology.

The need for tertiary filtration to facilitate solids removal in order to achieve an effluent Total P of 0.1mg/L (50%ile) impacts upon the type of filtration devices that are appropriate. The literature (C deBarbadillo et al, 2005) reports that continuously backwashing filters can achieve an effluent TSS concentration of 5 mg/L. Data is not presented in the literature to support a percentile for this requirement, however, on this basis their performance has been assumed to be inadequate for inclusion in this study.

Downflow filters, which operate in a conventional filtration mode, are inherently capable of achieving improved TSS concentrations due to lower levels of bed disruption (especially with deep beds).

There are some concerns about TSS break through with these types of filters (after any conventional backwashing) if only one stage of filtration is used.

However, from a review of current applications, adequately designed downflow filters with conventional backwashing, are not anticipated to cause disruptions to effluent quality.

For the purpose of developing a nominal design, downflow tertiary filtration has been adopted. During subsequent design stages, tertiary filtration requirements should be considered in conjunction with the secondary treatment, to ensure adequate filtration is provided.

7.5 Chemical Dosing

The significant chemical dosing requirements for the Wilton Junction wastewater treatment plant are expected to consist of the following:

- Substrate dosing to provide an additional carbon source for denitrification;
- Supplemental alkalinity dosing to the bioreactors;
- Alum or iron salts to facilitate chemical phosphorous removal;
- Sodium hypochlorite for the disinfection of onsite re-use water;
- Carbon dioxide or acid dosing for pH correction.

A summary discussion of each of the chemical requirements is presented in Section 7.5.1 to 7.5.4.

7.5.1 Carbon Dosing

Supplemental carbon is required to facilitate denitrification (approximately 8.6 mg COD is expected to be required per mg of nitrate nitrogen denitrified). This has been discussed as a potential requirement throughout Section 7.2 to ensure full denitrification. The dosing point is expected to be in the secondary treatment bioreactors. The ideal carbon source has the following properties:

- Inexpensive;
- Commercially available;
- Safe to handle;
- Liquid phase;
- Free of nitrogen and phosphorus;
- Low cell yield.

The most commonly utilised chemicals for sources of substrate include methanol, denatured ethanol and acetic acid. In addition, in particular locations, spent deicing fluids (ethylene glycol and propylene glycol), molasses, and brewery waste have been used to facilitate denitrification.

One of the largest concerns relating the selection of a carbon source relate to the need for transport, storage and handling of potentially dangerous goods. Methanol (99%) and denatured ethanol (93%) are combustible, flammable liquids (Package Class II) that have stringent requirements for transportation, storage and fire safety. Delivery of a diluted product may, in certain instances, mitigate the need for the provision of stringent storage and handling requirements. For example, a 24 percent (by weight) solution of denatured ethanol requires no special requirements. However, the use of a diluted product does increase volume of delivered chemical. Use of a 24% denatured ethanol solution requires three times the volume of product relative to a 93% solution.

Acetic acid (75% by weight) is a corrosive, combustible liquid (Packaging Class II) that has less stringent requirements for transport, storage and handling than methanol or denatured ethanol but nevertheless is an acid that can cause severe burns to the skin, eyes and respiratory tract, and must therefore be handled with care. Acetic acid also emits a distinctive powerful odour and indoor storage will necessitate the provision of adequate ventilation of the storage area.

Other forms of carbon such as ethylene glycol and propylene glycol are often nonhazardous fluids, however their use depends on their availability.

It is also worth noting that glycol and acetate (from acetic acid) are readily utilised by almost all denitrifying heterotrophs and do not require the development of a particular group of organisms to assimilate the substrate. In contrast, the use of methanol and ethanol requires the development of a specialised group of methylotrophs that facilitate assimilation of methanol. The methylotrophs have a relatively low specific growth rate and are particularly sensitive to temperature. Thus, a significant acclimatisation period is often associated with methanol prior to the development of optimum process performance. Furthermore, should the supply of methanol be interrupted for any reason for a sustained period, process performance is inhibited until the system becomes fully acclimated on restoration of supplemental carbon addition.

Based on the preceding discussion, for the purpose of developing a high level design, acetic acid has been selected as the supplemental carbon source for denitrification. It is recommended that the supplemental carbon source is considered in further details throughout any future design stages.

7.5.2 Alkalinity Dosing

In order to ensure sufficient alkalinity is present in the bioreactor to facilitate adequate biological performance, a supplemental alkalinity source is expected to be required. The addition of metal salts (i.e. ferric chloride) to the bioreactor will create an additional alkalinity demand which needs to be accounted for on top of any deficiencies associated with the potential for low alkalinity in the incoming sewage.

Although alkalinity can be provided in numerous different forms (i.e. magnesium hydroxide, lime etc), sodium hydroxide has been included for this high level design. For the sizes of the plant being considered in this study it is inappropriate to allow for lime batching and dosing facilities, however, the inclusion of magnesium hydroxide could prove beneficial in assisting any potential odour control facilities. It is recommended that the alkalinity source be considered in further detail throughout any future design stages.

7.5.3 Chemical Phosphorus Removal Dosing

Given that the treated wastewater requirements for Total P require compliance with a limit of 0.1 mg/L on a 50 percentile basis, there is a considerable risk of failure of the Total P requirement unless adequate dosing of alum or iron salt are exercised.

Under such circumstances, it is prudent to allow for a two-stage alum or iron salt dosing system that provides superior process control and allows polishing of treated wastewater.

In systems, where combined nitrogen and phosphorus removal is required to low levels, inhibition of the denitrification process has been reported as a result of low phosphorus concentration (measured as ortho-phosphate). It has been shown that the threshold requirement of phosphorus (as ortho-P) is approximately 0.01 g ortho-phosphate (as P) per g nitrate nitrogen. In order to ensure no nutrient limitation occurs it is essential that sufficient ortho-phosphate is present in the secondary treatment effluent.

In the high level design, a second stage of filtration, in addition to the membranes in the bioreactor, has been included for phosphorus removal. Two stage dosing would still be required, however instead of dosing to the filters the second dosing point will be to the second stage filters. The requirement for this should be further investigated with actual data from similar plants in detailed design.

For the purposes of the strategic study, the high level design has allowed for ferric salt dosing into the bioreactor and aluminium sulphate dosing for tertiary polishing as appropriate for chemical P removal. Further detailed chemical selection is recommended to be completed as part of any future design stages to ensure investigations into potential sludge production, bioreactor sizing and chemical storage facility requirements are completed.

Dosing into the bioreactor has to be done carefully. There are conditions that will result in no precipitation if the chemistry is not correct. It is also possible to over dose.

7.5.4 pH Correction Dosing

The effluent discharged from the wastewater treatment plant is required to have a pH of 6.5. It is anticipated that the pH of the effluent will be greater than 6.5, therefore to ensure this water quality target is achieved, either acid or Carbon Dioxide will need to be dosed downstream of the tertiary filters in order to reduce the effluent's pH.

For the purpose of this high level design, carbon dioxide has been selected for pH correction dosing, however, it is recommended that the chemical selected for pH dosing be considered in further detail throughout any future design stages.

7.6 Disinfection

Taking into consideration the processes already selected for the wastewater treatment plant (i.e. four-stage Bardenpho membrane bioreactor with tertiary filtration) and the wastewater treatment plant effluent quality targets, refer to Section 6.1.3, it is not envisaged that additional disinfection will be required for the primary process stream.

In order to provide service water for on-site use, if required, a portion of the flow will be taken from the permeate tank, chlorinated and stored on-site. Service water applications will include washdown water and filter backwash water.

The *Australian Guidelines for Water Recycling: Managing Health & Environmental Risks* (NRMMC, EPHC & AHMC, 2006) advocates a risk based approach for the planning and design of water recycling schemes. This approach includes the use of a risk assessment to determine the treatment and non-treatment risk mitigation measures required for a water recycling scheme in order to ensure that the treated effluent produced is fit for its intended use. A risk assessment will be undertaken for this scheme at the Development Application stage. Additional disinfection processes may need to be incorporated into the wastewater treatment plant design to address the outcomes of the risk assessment. This may increase wastewater treatment plants cost and land requirement.

7.7 Biosolids Management

The primary objectives for biosolids treatment are to:

- Stabilise sludge;
- Reduce pathogens; and
- Reduce water content.

A range of treatment technologies can be applied to achieve these objectives. In considering biosolids management, the preferred approach is to tailor the products to the "market", whilst understanding the regulatory requirements currently in place.

Waste activated sludge (WAS) from the bioreactors will be wasted to a WAS thickener. The thickened WAS will be digested in an aerobic digester prior to being dewatered and transported off site.

These processes, in conjunction with the other proposed wastewater treatment processes (i.e. membrane bioreactor) will ensure biosolids produced achieve stabilisation Grade B. It is assumed that Contaminant Grade C will be achieved without the need for additional treatment, so the biosolids could be used for the following end uses:

- Agriculture;
- Forestry;
- Soil and site rehabilitation;
- Landfill disposal;
- Surface land disposal (to be applied within the boundaries of the sewage treatment plant site).

7.8 Odour Control

Once the process and site selection has taken place, it is recommended that odour modelling is completed to establish the odour control requirements.

Odour modelling will also play a crucial role in determining a suitable buffer zone for surrounding the wastewater treatment plant. While no odour modelling has been undertaken as part of this Rezoning Application, odour modelling was completed as part of a previous study undertaken by CH2MHill (2005) for a proposed wastewater treatment plant to service 1,165 dwellings (i.e. 2,330 EP) and to be located adjacent to the site proposed in the *Wilton New Town Sewerage Overview* (CH2MHill, 2012). This study considered a buffer zone of 250m to be appropriate.

It is anticipated that odour control will need to be in place at the treatment plant with the provision of covers to minimise fugitive emission from odorous areas. The covered areas will need to be extracted with the extracted air undergoing odour treatment leading to discharge via a stack.

In addition, it is prudent to allow for a buffer zone (area to be determined based on odour dispersion modelling) to manage potential odour complaints during abnormal operation of the treatment plant. Design of the odour control system will need to comply with the requirements of the NSW EPA.

8 Wastewater Treatment Nominal Design

This section provides a high level wastewater treatment plant design for the Wilton Junction Development, based on the outcomes of the Wastewater Treatment Options Review in Section 7.

The nominal design consists of the following process elements for the ultimate plant:

- 2 No coarse (6mm) screens and associated ancillary equipment.
- 2 No grit chambers and associated ancillary equipment.
- 1 No wet weather storage.
- 2 No fine screens (1mm) and associated ancillary equipment.
- 2 No balance tank.
- 4 No four stage Bardenpho bioreactors and ancillary equipment.
- 4 No membrane tanks and ancillary equipment.
- 2 No permeate storage tanks.
- 4 No Tertiary media filters and associated ancillary equipment.
- 1 No sludge feed balance tank.
- 1 No sludge thickener and associated ancillary equipment
- 1 No aerobic digester and associated ancillary equipment
- 1 No sludge dewatering process (i.e. belt filter press or centrifuge) and associated ancillary equipment
- Chemical dosing facilities including:
    - Acetic acid.
    - Magnesium hydroxide.
    - Ferric chloride.
    - Carbon dioxide.
    - Sodium hypochlorite.
    - Citric acid.
    - Polymer.
- Service water system.
- Odour control facilities.

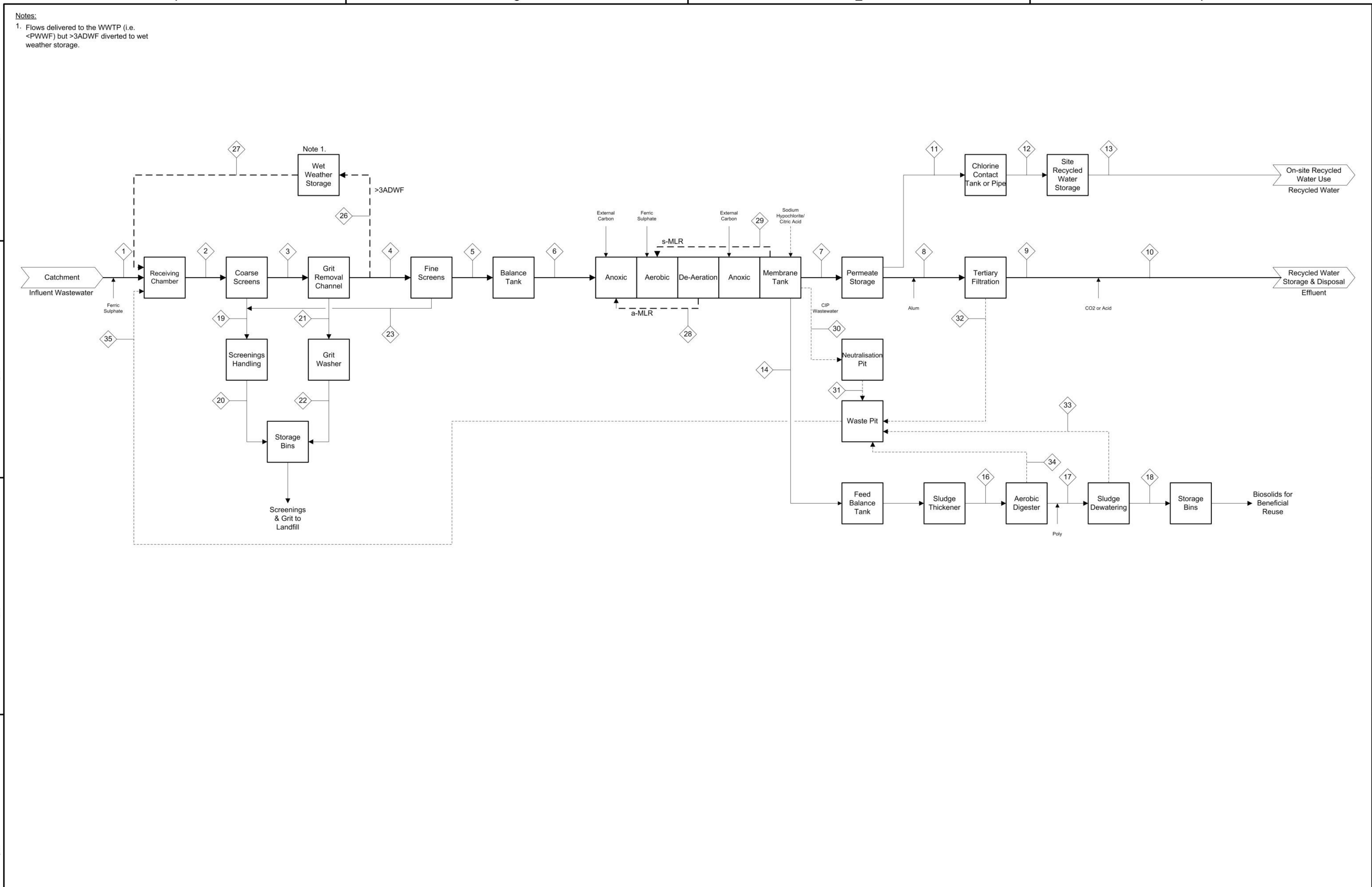
A block flow diagram of the high level design is presented in Figure 8-1. Taking into consideration the wastewater treatment design and performance criteria outlined in Section 6 and the high level design presented in this section of the report, the footprint of the wastewater treatment plant, excluding the wet weather storage, is estimated to be 80m x 120m. This estimate has been produced for the sole purposes of supporting the rezoning application and feeding into Infrastructure Plans for State and Local Infrastructure Contribution Plans. Any changes to the wastewater treatment plant design and performance criteria (e.g. adjustments to the effluent quality requirements) may impact on both the nominal design and the land requirements.

A pressure sewer scheme is the preferred wastewater network for this development and as such is expected to have no wet weather inflow or infiltration. Therefore no wet weather storage is expected to be needed at this wastewater treatment plant.

As the wastewater treatment plant will be part of a water recycling scheme, the wastewater treatment plant should be design taking into consideration the requirements of the *Australian Guidelines for Water Recycling: Managing Health & Environmental Risks* (NRMMC, EPHC & AHMC, 2006). These Guidelines advocate a risk based approach for the planning and design of water recycling schemes. This approach includes the use of a risk assessment to determine the treatment and non-treatment risk mitigation measures required for a water recycling scheme in order to ensure that the recycled water produced is fit for its intended use. To date, a risk assessment has not been undertaken for this water recycling scheme, and will be completed at Development Application stage. As well as informing the design of the wastewater treatment plant, the risk assessment will inform operational and monitoring requirements, along with procedures for managing planned and unplanned events. For example, the risks associated with non-conforming effluent quality could be addressed by continuous monitoring of the effluent quality with a procedure in place for diverting the effluent to an alternative location (e.g. the head of the wastewater treatment plant or an alternative storage) during periods of non-conformance.

At the next stage, the risk assessment may result in changes in the treatment plant design, e.g. additional disinfection processes may be required. This may impact on the cost and footprint requirements of the treatment plant.

Figure 8-1 : Wastewater Treatment Plant Nominal Design Block Flow Diagram



REV	DATE	BY	DESCRIPTION

DRAWN: BJH
CHECKED:
APPROVED:
DRAWING STATUS:

LEGEND:
- Primary Process Stream
- Primary Process Bypass/Return Stream
- Secondary Process Stream
- Secondary Process Bypass/Return Stream

PROJECT: Wilton Junction Rezoning Precinct
TITLE: Wastewater Treatment (Ultimate) Block Flow Diagram

DWG NO: BFD-001
REV: Draft
SHEET: 1 of 1
SCALE: NTS
JOB NO: 83501113
SIZE: A3

File: D:\BJH\Current Work\Wilton\

9 Staging Strategy

This section identifies opportunities for staging the construction of the wastewater treatment plant based on the nominal design presented in Section 8 and the build out rates presented in Appendix A.

A staging strategy was selected for the high level design, and for each Stage, capital cost estimates, were developed to provide an indication of the upfront capital spend required and the total capital cost for the wastewater treatment plant. These capital cost estimates were developed for the sole purpose of supporting the rezoning application and feeding into Infrastructure Plans for State and Local Infrastructure Contribution Plans.

The opportunities for staging and the capital cost estimates have both been developed taking into consideration the wastewater treatment design and performance criteria identified in Section 6. Any changes to these criteria (e.g. adjustments to the effluent quality requirements) may impact on both the staging opportunities and capital cost of the wastewater treatment plant.

It is noted that an alternative interim treatment option is to have 3 separate temporary package treatment plants situated on each developers land to service the first stage of development.

9.1 Overview

The construction of the wastewater treatment plant could be expanded under a staged growth strategy to meet the growing needs of the community over time.

The design of the wastewater treatment plant has been based on equivalent population (EP) estimates for residential and non-residential sewage flow contributions. The ultimate development has been designed for 36,000 EP, providing an allowance for non-residential flows in the order of 7,120 EP.

Taking into consideration the high level design proposed in Section 8 and the build out rates adopted in Appendix A, a potential wastewater treatment staging strategy has been presented in Table 9-1 and is described in Figure 9-1 to Figure 9-5.

Table 9-1: Wastewater Treatment Staging Strategy

Development Stage	Cumulative EP	ADWF (ML/d)	Required By	Commence Design
Interim Solution	Up to *X*			
Stage 1a	*X* to 2,250	0.34	Depend on *X*	
Stage 1b	2,250 to 4,500	0.68	2020/2021	2018/2019
Stage 2	4,500 to 9,000	1.35	2022	2020
Stage 3	9,000 to 18,000	2.70	2025	2023
Stage 4	18,000 to 36,000	5.40	2030	2028

The staging strategy for the wastewater treatment plant includes an interim solution of tankering sewage from the development. This will involve the use of tanker trucks to dispose of sewage, prior to the construction of the wastewater treatment plant. It is anticipated that this solution will cease prior to 950 EP, and is likely to be within the range of 400 EP to 700 EP, although the duration of tankering will depend on the following:

- the pace of development; and;
- the need to provide a minimum amount of sewage to support a biological process at the wastewater treatment plant.

It is noted that construction and commissioning for each stage will take approximately 12 to 18 months, with additional time required to allow for design.

The five stage approach outlined in Table 9-1 is based on the assumption that there is a significant time gap between each of the wastewater treatment plant stages. Depending on the tankering duration, it may be beneficial to combine Stage 1a and Stage 1b as a single stage.

The preferred bioreactor strategy could be:

- Stage 1a/1b: 1 small bioreactor (with 2 small membrane tanks)
- Stage 2: 2 small bioreactors (with 4 small membrane tanks)
- Stage 3: 2 small and 1 large bioreactors (with 4 small and 2 larger membrane tanks)
- Stage 4: 2 small and 2 large bioreactors (with 4 small and 4 larger membrane tanks)

Figure 9-1 : Wastewater Treatment Block Flow Diagram – Stage 1a

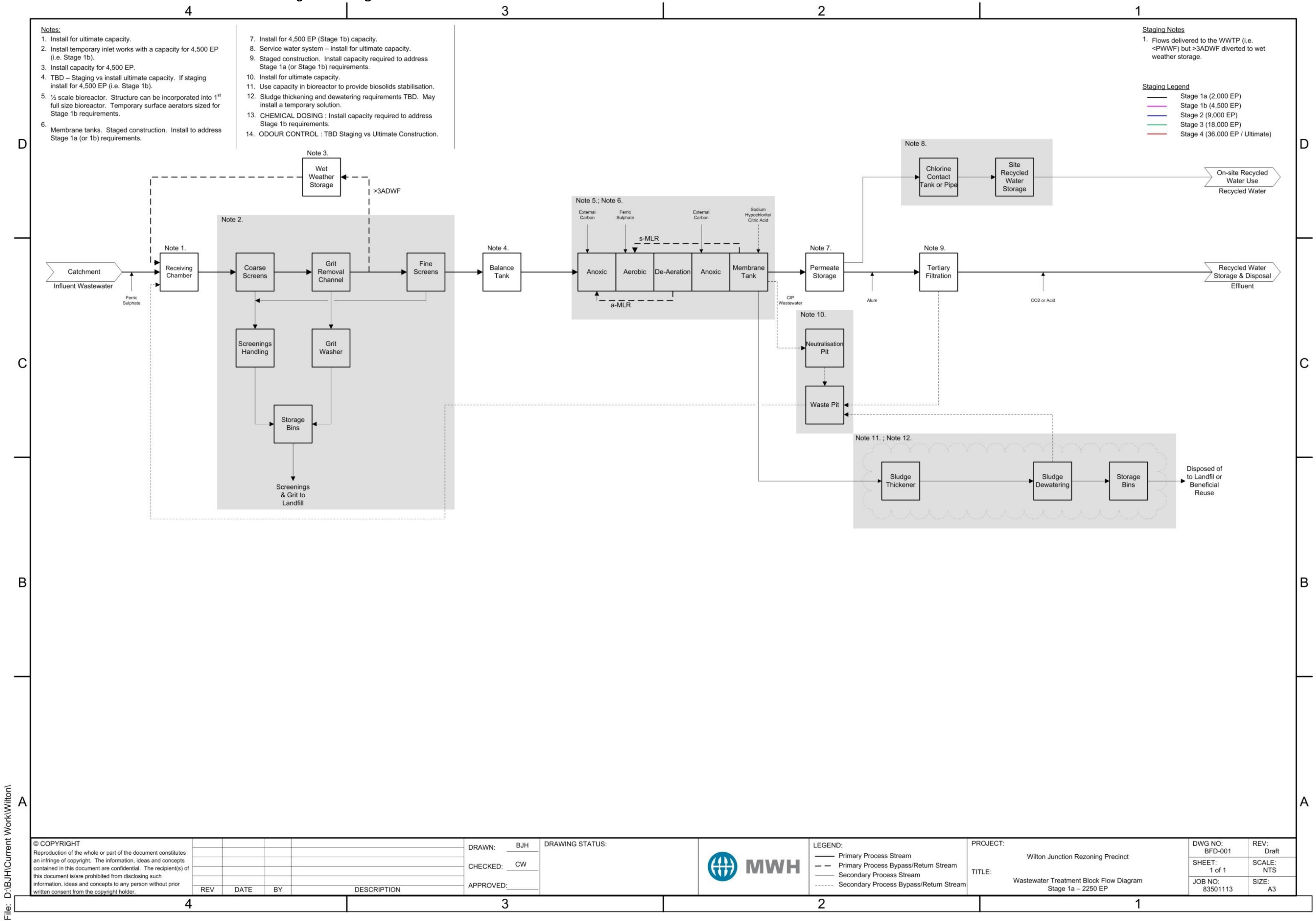


Figure 9-2 : Wastewater Treatment Block Flow Diagram – Stage 1b

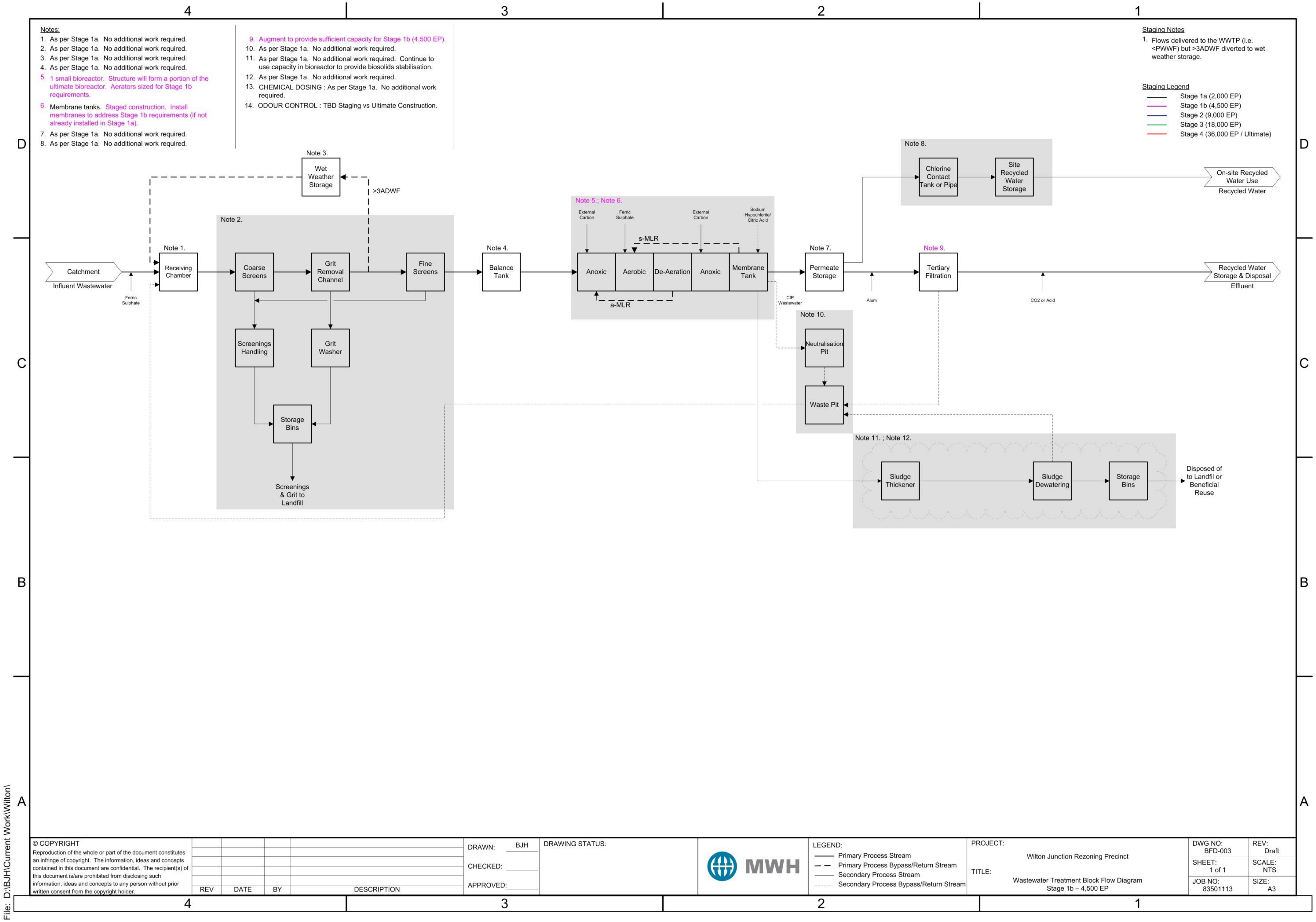


Figure 9-3 : Wastewater Treatment Block Flow Diagram – Stage 2

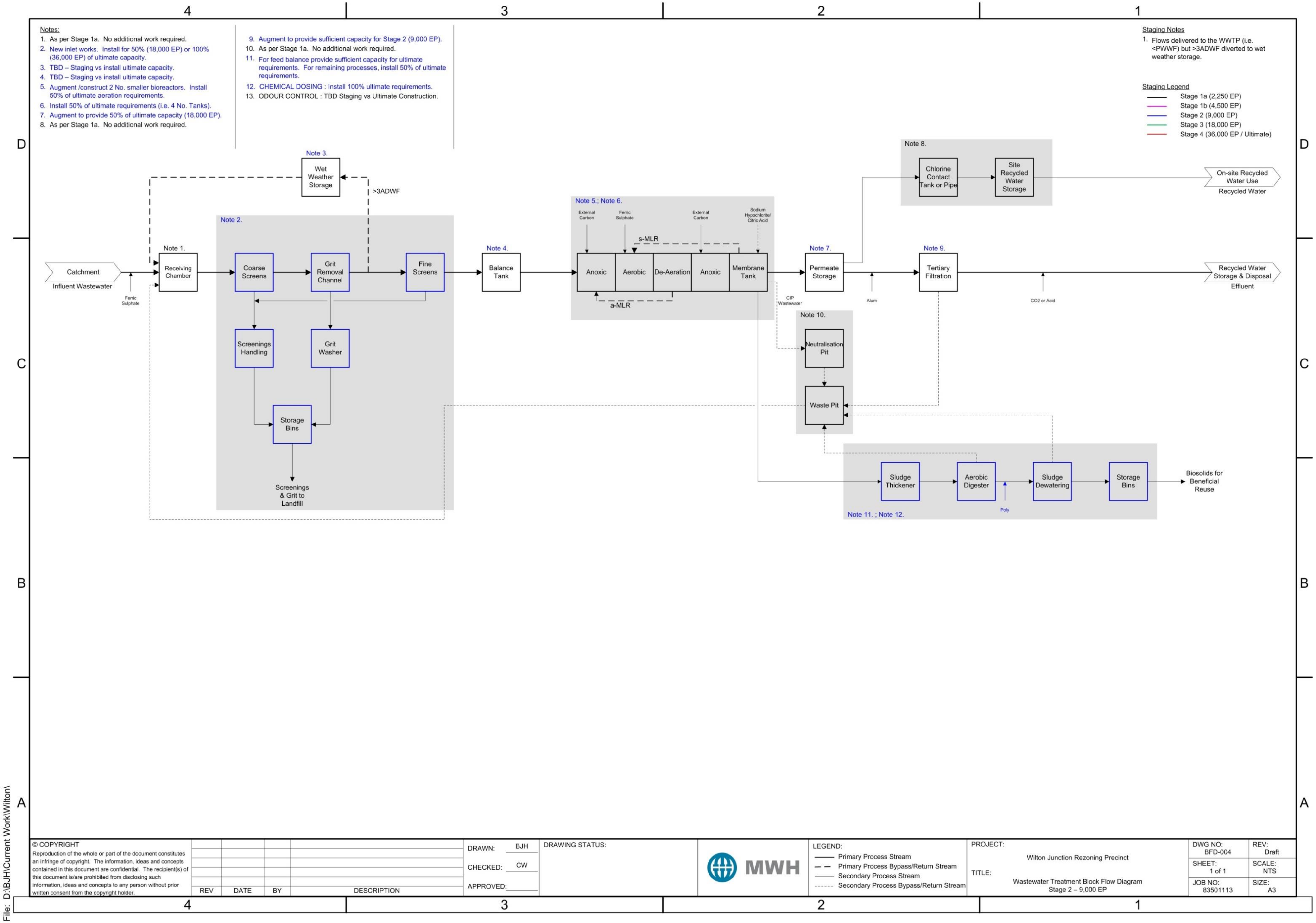


Figure 9-4 : Wastewater Treatment Block Flow Diagram Stage 3

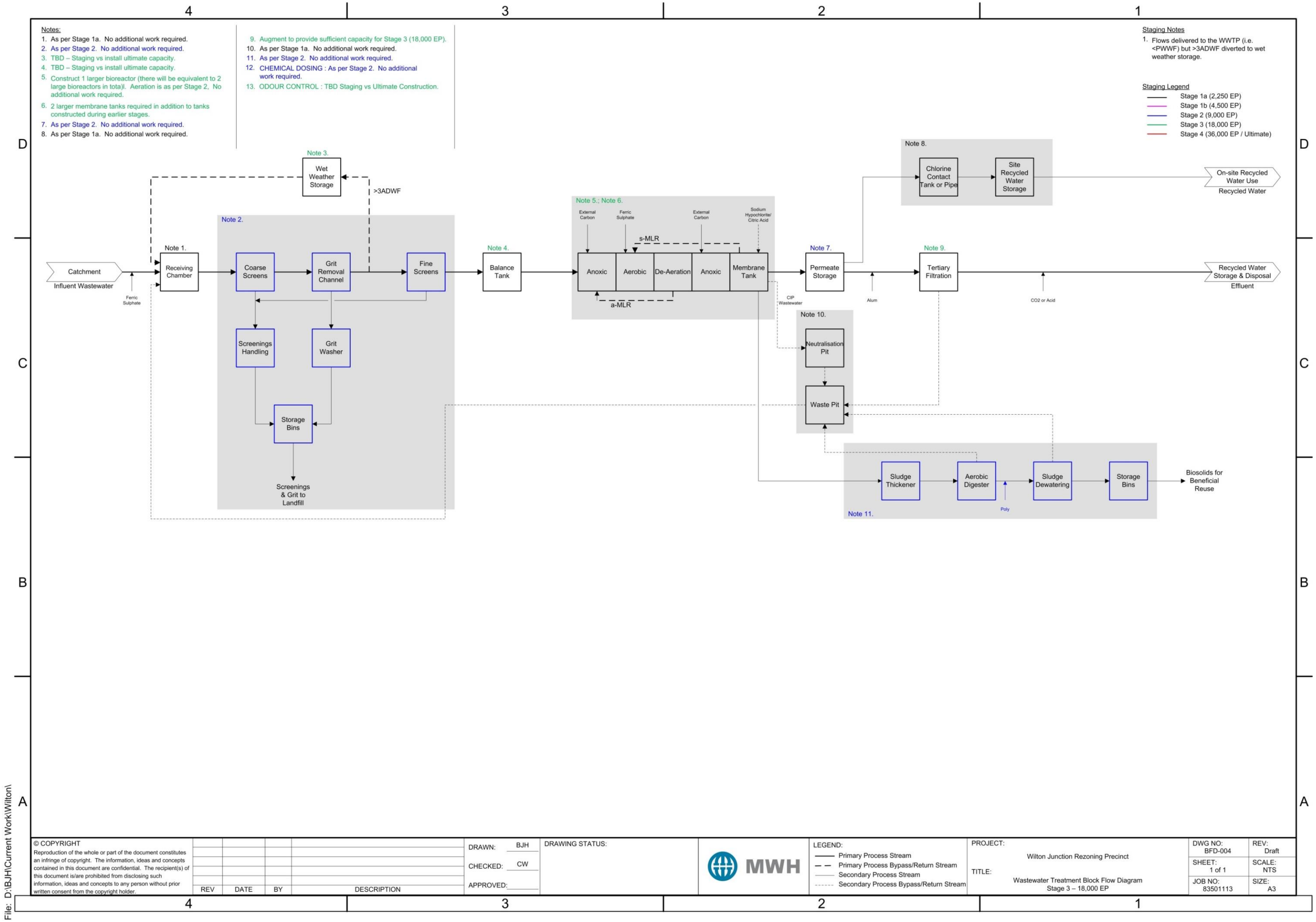
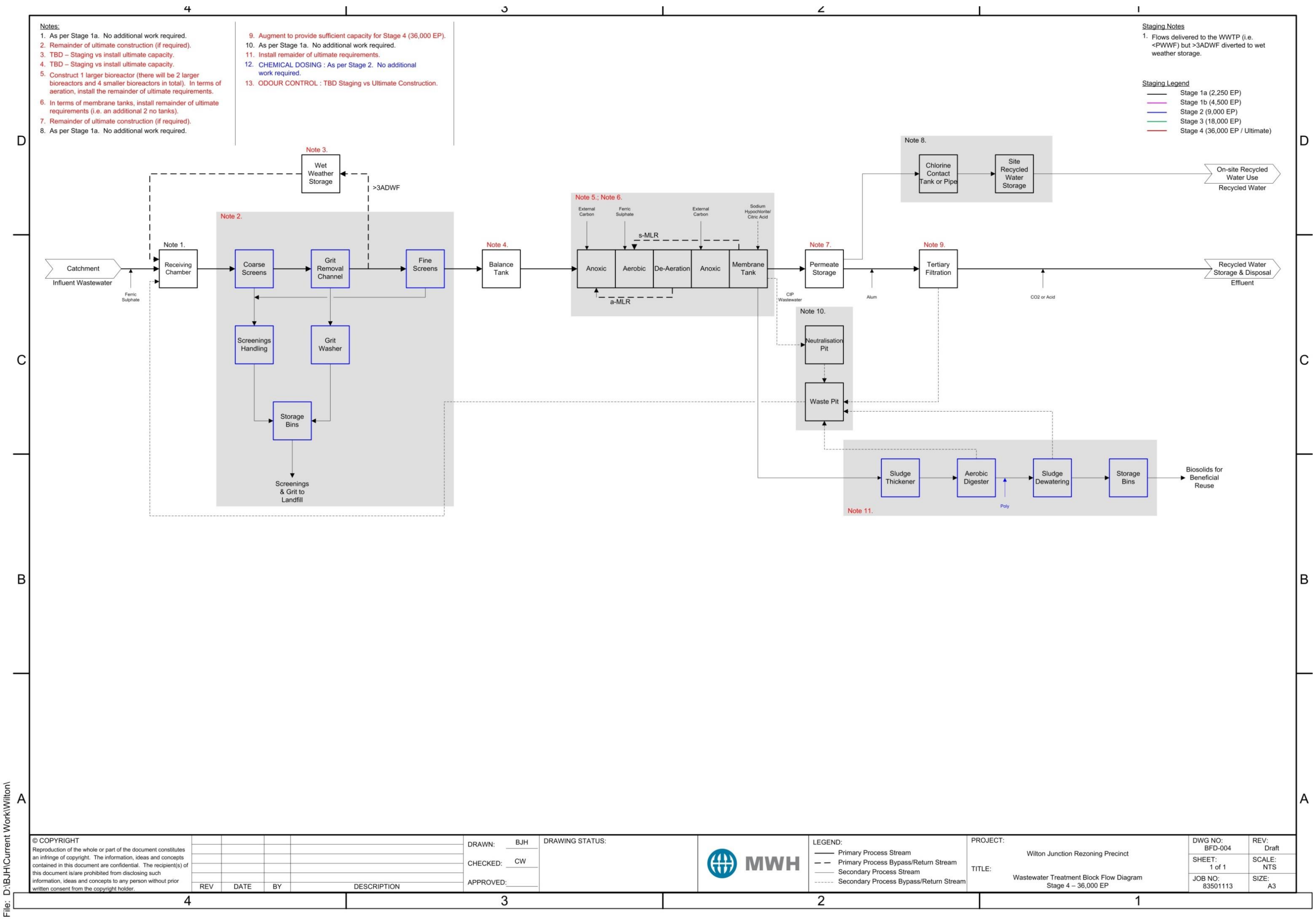


Figure 9-5: Wastewater Treatment Block Flow Diagram – Stage 4



9.2 Capital Costs

A planning level cost estimate has been developed for the nominal design presented in Section 8. This cost estimate includes all works associated with the wastewater treatment plant, including civil, mechanical and electrical components, including construction preliminaries. However, the cost estimate excludes costs associated with the wet weather storage.

For the purpose of developing the cost estimate, Stage 1a and Stage 1b were combined into one stage, and the staged approach presented in Section 9.1 was further refined to include the assumptions outlined in Table 9-2.

Table 9-2: Assumptions for Cost Estimates

Category	Staging Approach
Inlet Works	Temporary inlet works for Stage 1. 100% of ultimate inlet works is installed in Stage 2.
Balance Tanks	50% Balance Tank Capacity installed in Stage 1. Remaining capacity installed in Stage 4.
Bioreactor	Bioreactor #1 installed in Stage 1. A new bioreactor is constructed in Stage 2. In Stage 3 an additional larger bioreactor is added. In Stage 4, one additional larger bioreactor is added.
Permeate Storage	50% Permeate Storage installed in Stage 1. Remaining capacity installed in Stage 4.
Tertiary Filter	Filtration installation is staged.
Solids Handling	50% installed in Stage 2 and remaining 50% installed in Stage 4.
Chemicals	Temporary solution for Stage 1. 100% installed in Stage 2.
On-site Recycled Water	100% installed in Stage 1.
Odour Control	Nominal fee allocated for odour management.

The estimate has been developed using reference costing from similar facilities based upon our experience in wastewater treatment plant design, construction and commissioning and have been developed with the following general exclusions:

- Civil and earth works excluded tunnelling, rock breaking and rock removal.
- Ground remediation.
- Land purchase.
- Planning and building consents/permits.
- Environmental impact studies.

The capital cost estimates for each of the stages are as follows:

- Stage 1 - $12 million.
- Stage 2 - $12 million.
- Stage 3 - $7 million.
- Stage 4 - $16 million.

This includes the following allowances for:

- Contingency (25%);
- Construction Management (4%);
- Design (6%).

Please note that the treatment plant design may change after the risk assessment has been completed and this may impact on the wastewater treatment plant cost. Also the pace of the development may impact on the staging approach.

10 Preferred Wastewater Servicing Strategy

The recommended wastewater strategy to service the Wilton Junction development is for a pressure sewer system network and an MBR treatment plant with tertiary media filters.

One of the servicing options available to the proponents is to negotiate a commercial agreement with Lend Lease to integrate the wastewater networks and upgrade the Bingara Gorge STP to service the initial stages of development. This would reduce the overall flow to the proposed Wilton Junction STP as well as the size of the STP and associated costs.

10.1 Staging Plan and Cost Apportionment

The Proponents' preference is for Sydney Water to be the servicing authority. The Proponents propose that waste water services be delivered in a staged manner based on commercial terms with Sydney Water in accordance with Sydney Water's current published policy (Sydney Water – "Policy: Funding Infrastructure to service growth" and "Precinct Acceleration Protocol Funding – Guidelines for applications of commercial principles").

In the event that the Government decides that Sydney Water is not the servicing authority, the Proponents are able to deliver waste water infrastructure through a competitive tender process with the private sector who are registered WICA providers.

Importantly, the approach imposes **no additional cost to NSW Government.**

The staging, costs and proportion of developer land contributing to each catchment is detailed in the sections below. Assuming that Sydney Water would be the wastewater network owner and operator, the cost apportionment between developers and Sydney Water for at least the trunk assets is based on the following;

- Permanent SPSs and Rising Mains would be fully funded by Sydney Water
- Pressure Sewer Reticulation Network infrastructure would be funded by the Proponents for minimum sized mains (PE DN50mm) with upsizing costs being funded by Sydney Water. The cost for a minimum reticulation main (DN50mm) is expected to $55/m.
- Trunk Gravity mains would be funded by the Proponents for minimum sized mains (DN150mm) with upsizing costs being funded by Sydney Water. The cost for a minimum gravity main (DN150mm) is expected to $257/m.
- Proponents would be responsible for all property works including the pots, pumps and the discharge line to the property boundary kit.

The staging plan for this development is to service initial development (in the order of 150 to 250 lots) with a pump out tanker arrangement. This is primarily to provide a minimum amount of sewage to support a biological wastewater treatment plant and to assist in the timely delivery of housing within the development.

The staged implementation and cost apportionment of the trunk wastewater network assets is provided in Table 10-1 below.

Table 10-1: Staging Plan and Cost Apportionment for Network Assets

Stage	Dwellings Serviced	Assets Required	Cost Estimate ($M)	Sydney Water Funded ($M)	Proponents Funded ($M)
1	0 to 2,000	Pump Stations	$3.2M	$3.2M	0
		Rising Mains	$1.7M	$1.7M	0
		Trunk Gravity Mains	$3.4M	$1.9M	$1.5M
		Reticulation Mains	$2.5M	$1.5M	$1.0M

Stage	Dwellings Serviced	Assets Required	Cost Estimate ($M)	Sydney Water Funded ($M)	Proponents Funded ($M)
		Property Works	$21.8M	0	$21.8M
2	2,000 to 7,200	Pump Stations	$2.8M	$2.8M	0
		Rising Mains	$1.7M	$1.7M	0
		Trunk Gravity Mains	$3.1M	$1.7M	$1.4M
		Reticulation Mains	$6.4M	$3.6M	$2.8M
		Property Works	$49.3M	0	$49.3M
3	7,200 to 10,100	Pump Stations	$1.4M	$1.4M	0
		Rising Mains	$2.4M	$2.4M	0
		Trunk Gravity Mains	$1.4M	$0.8M	$0.6M
		Reticulation Mains	$11.7M	$6.6M	$5.1M
		Property Works	$60.5M	0	$60.5M
Total			**$ 173.3M**	**$29.3M**	**$144.0M**

The staged implementation of the STP is provided below in Table 10-2.

Table 10-2: Staging Plan for STP Assets

Stage	Cumulative EP	Required By	Cost Estimate ($M)
1	0 to 4,500	Approx. 2018/19[1]	$12M
2	4,500 to 9,000	2022	$12M
3	9,000 to 18,000	2025	$7M
4	18,000 to 36,000	2030	$16M
Total			**$47M**

Note: [1] Dependent on duration of tankering arrangement.

The identified strategy offers a cost-effective, staged infrastructure plan to provide the wastewater services for the Wilton Junction development. The strategy:

- Provides the most efficient and cost-effective scheme
- Provides flexibility in allowing servicing of the four development fronts simultaneously and also allows for integration with the adjoining Bingara Gorge development.
- By adopting a pressure sewer system, provides a scheme that will significantly reduce the risk of environmental overflows from the network
- Represents value for the government and developer as the future infrastructure has been sized according to Sydney Water's latest design criteria.

11 References

The following is a list of documents that have been referenced for this study:

- ABS website 2011 Census – *Wollondilly LGA "Quickstats"*
- *"Wilton New Town Sewage Overview" – CH2MHill (October 2012)*
- Sydney Water Supplement (28 September 2012) *"Wastewater Network Growth Servicing Strategy – Criteria and Guideline 2012"*
- Sewerage Code of Australia *WSA 02-2002-2.2, Sydney Water Edition 1 – Version 3*
- Pressure Sewerage Code of Australia *WSA 07-2007-1.1.*
- Rawlinsons, Edition 30, 2012
- Ministry of Energy and Utilities, NSW Reference Rates Manual - Valuation of Water, Wastewater and Stormwater Assets, 2003
- Elton Consulting, Wilton Junction New Town - High Level Infrastructure Business Case, 2012
- CH2MHill (2005). *Statement of Environment Effects : STP and Effluent Reuse Scheme – Wilton Parklands Development.*
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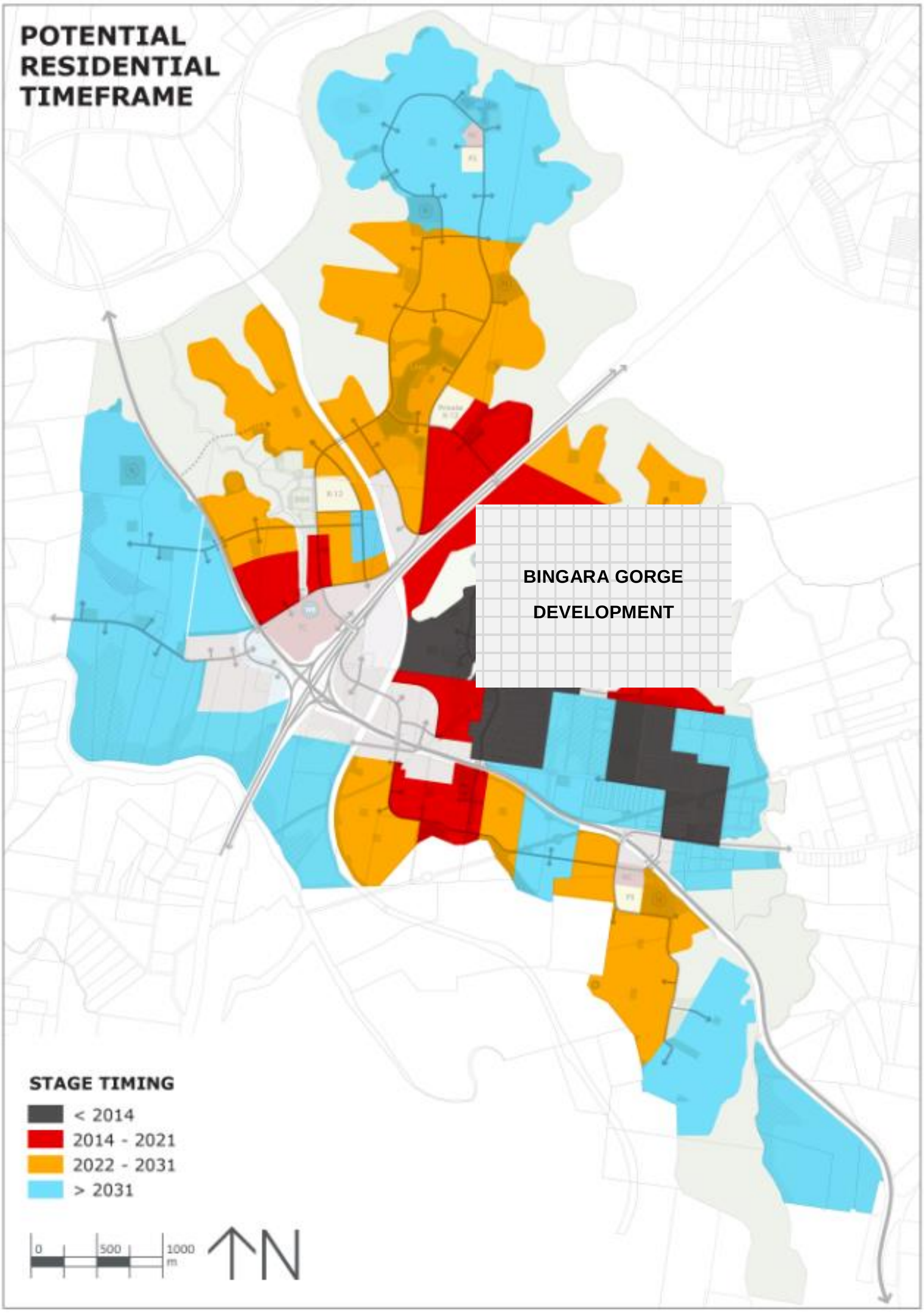
- deBarbadillo, C., Rectanus, R., Lambert, S., Parker, D., Wells, J., and R. Willey, 2005, *Evaluating Denitrification Filters*, *Water Environment Federation*, June 2005.
- Natural Resources Management Ministerial Council, Environmental Protection and Heritage Council & Australia Health Ministers' Conference (NRMMC, EPHC & AHMC). (2006) *Australian Guidelines for Water Recycling : Managing Health & Environmental Risks (Phase 1)* Canberra.
- New South Wales Environment Protection Authority (NSW EPA) (1997) *Environmental Guidelines: Use and Disposal of Biosolids Products*, Sydney.
- Griffiths, P. (1997) "Achievable Effluent Quality from Biological Nutrient Reduction Systems under Australian Conditions – Modelling and Full Scale Operating Experience", Proceedings of BNR3 Conference, Brisbane, Australia.

Appendix A Build Out Rate and Staging

WILTON JUNCTION BUILD OUT RATE

Year	Annual Allotment Production	Cumulative Allotment Production	Annual Dwelling Production	Cumulative Dwelling Production
2007	-	-	-	-
2008	20	20	-	-
2009	40	60	-	-
2010	60	120	20	20
2011	80	200	40	60
2012	100	300	60	120
2013	120	420	80	200
2014	220	640	100	300
2015	270	910	120	420
2016	320	1,230	220	640
2017	370	1,600	270	910
2018	420	2,020	320	1,230
2019	470	2,490	370	1,600
2020	520	3,010	420	2,020
2021	520	3,530	470	2,490
2022	520	4,050	520	3,010
2023	520	4,570	520	3,530
2024	520	5,090	520	4,050
2025	520	5,610	520	4,570
2026	520	6,130	520	5,090
2027	550	6,680	520	5,610
2028	550	7,230	520	6,130
2029	550	7,780	550	6,680
2030	550	8,330	550	7,230
2031	550	8,880	550	7,780
2032	550	9,430	550	8,330
2033	450	9,880	550	8,880
2034	450	10,330	550	9,430
2035	450	10,780	450	9,880
2036	450	11,230	450	10,330
2037	350	11,580	450	10,780
2038	200	11,780	450	11,230
2039	120	11,900	350	11,580
2040			200	11,780
2041			120	11,900
Total	**11,900**	**11,900**	**11,900**	**11,900**

WILTON JUNCTION DEVELOPMENT STAGING



Appendix B Design Criteria Technical Memo and Notes from Meetings with Sydney Water

Appendix C Effluent Quality Targets

Appendix D Cost Estimates

Appendix E NPV Analysis