9. Water Management Strategy

9.1 Water Management

Management Objective - To ensure that the surface and groundwater resources are not adversely impacted and where possible principles of reuse and recycling are applied.

Groundwater in the Upper Collie basin is fully allocated due to high demand from the coal-based industries, particularly power generation. Perdaman estimates that for the purposes of plant operation, an annual water license allocation of 12 GL per annum is required. To meet this demand, Perdaman has applied to the Department of Water for a 5C surface water allocation from Wellington Dam, a surface water source approximately 35 kms west of the proposed site.

The Department of Water has, in principle, agreed to license Perdaman to extract 12 GL pa of water on the provision that Perdaman develops a water strategy that identifies and addresses:

- Site water balance;
- Water supply demand;
- Prioritised supply options;
- Contingency supply options;
- Supply triggers and adaptive management;
- On-site storage management;
- Wastewater streams, wastewater treatment and wastewater disposal;
- Water use efficiency plans; and
- Potential Impacts on Water Resources.

This section outlines the proposed Water Management Strategy for the Project. Further details are provided in Appendix C.

9.1.1 Key Issues

The surface and groundwater resources of the Upper Collie catchment have been under availability and quality pressure for years, as a result of land clearing and water extraction and use by coal based industrial activities. Counterbalancing the allocation pressures on groundwater is the underutilisation of the Wellington Dam surface water source, as a result of salinity and the need to utilise costly desalination processes to treat this water for use.

By 1977, approximately 25 % of the Upper Collie Catchment had been cleared, in part for agriculture, both annual agriculture and perennial system (pine plantations). Extensive clearing occurred in the eastern area of the catchment to accommodate the broadacre farming systems and resulted in rising groundwater and dryland salinity. Salinity levels in waterways and tributaries of the Collie River, including the East Branch, reached concentrations up to 1,990 mg/L leading to an increase in salinity in Wellington Dam. Salinity readings of up to 1,100 mg/L have been recorded in Wellington Dam in the past. To manage salinity levels in Wellington Dam for the purposes of irrigation water supply, the Water Corporation annually flushes water from the lower dam into downstream streams and in due course out to sea.

Dewatering in the Collie Basin for the purpose of open cut coal mining and groundwater abstraction to supply cooling water to power generators and other plant operations has led to the drawdown of the basins aquifers, reducing water levels in summer pools along the east and south branch of the Collie River. Mine voids have become reservoirs for dewater. The dewatering and groundwater extraction activities have changed the water balance in this catchment.

New industries looking to become established in the Coal basin must consider alternatives to groundwater extraction for water supply and undertake treatment to reduce raw water salinity to levels acceptable for industrial processing. Perdaman will be addressing these key issues by securing a primary surface water supply that will be treated at the plant using desalination technologies in order that the required water quality is achieved for the various process uses in the plant.

9.1.2 Water Requirements

Analysis of the proposed plant operations anticipates that the supply/demand requirements will be approximately 36 ML/day on a 24 hour cycle. The urea plant will operate for 330 days pa, thereby consuming 330 x 36 = 11.9 GL of water annually.

The plant will operate on a constant load basis, however a variance of plus/minus 10% is expected because of the changes in the ambient environment (humidity, temperature). Water requirements will not increase in the future.

The following wastewater streams (liquid effluent) will be produced from the plant and operations:

- Wastewater from pre-treatment of raw supply water;
- Wastewater (brine return and reject water) from the water treatment/desalination plant;
- Process wastewater (including cooling tower blowdown and process blowdown water from the Gasifier water bath);
- Wastewater from the demineralisation plant;
- Domestic wastewater (greywater and blackwater); and
- Site stormwater runoff.

9.1.3 Water Balance

Estimates of the Plant water balance are subject to the outcomes of the detailed design process yet to be undertaken by Perdaman. An indicative water balance is provided below (Figure 52).

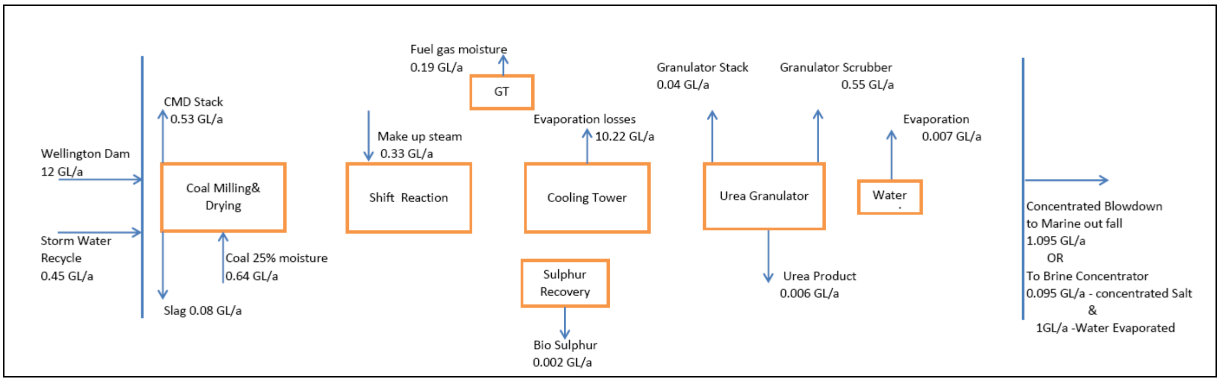

Figure 52 Plant Water Balance

Estimated water inputs and losses to the plant are detailed in Table 76.

Table 76 Estimated Water Balance Figures

Water Source/Loss	In Gl/a	Out Gl/a	Comment
Coal 24.5% moisture	0.64		2.63 Mtpa coal
Wellington dam	12		Assigned quantity
Mine dewatering	0		Assumption
Stormwater recycle	0.45		Estimated site area x 700 mm/a
Urea synthesis water			accounted for internally
Evaporation - main CT		10.22	Estimate on heat duty
Marine outfall		1.095	Assumption 365 d/a (3 Ml/d)
Slag		0.08	25% moisture
CMD stack		0.53	24.5% to 5% assumption
Granulator stack		0.04	98% dry in feed
Granulator scrubber		0.55	70 tph
Shift reaction		0.33	CO to 3%
Urea product		0.006	0.27% in product
Sulphur		0.002	15% moisture
Sludge			
CO2 compression			Assume nil
Process strippers		0.05	Estimate only
Fuel gas moisture		0.19	23.6 tph assumed
water holding ponds		0.007	Estimate only - 220 mm/a net evaporation

9.1.4 Key elements

The primary Site uses within the Perdaman Urea Plant site are identified in Table 77.

Table 77 Primary Site uses within the Perdaman Urea Production Plant site

Primary land use	Key elements	
Syngas Block	» Coal storage and preparation	» Gasification
	» Shift (syngas is adjusted to maximise hydrogen production)	» Acid gas clean-up and sulphur recovery
Product Block	» Ammonia synthesis	» Urea synthesis
	» Urea granulation	» Product storage and rail car loading
Utility Block	» Air separation	» Power generation
	» Water treatment	» Cooling water
	» Flare	» Fire fighting facilities
	» Other utilities	
Infrastructure and Logistics	» Administration buildings	» Operations control room
	» Maintenance workshops	» Parts and materials warehousing
	» Plant Security	

9.2 Water Demand

The Perdaman Urea plant requires water for the following primary water demands:

- Closed circuit cooling water make-up (evaporation, blowdown and drift losses);
- Process water make-up;
- Demineralised water make-up (for steam/condensate losses); and
- Potable and fire water use.

A secure continuous supply of water is critical to the urea manufacturing process. A total annual supply of 12 GL/annum over the design operating period of 25 years is currently estimated.

The quality of available water resources will also impact upon the quantity required, as treatment of water will be required to varying degrees dependent on the various process water requirements.

9.2.1 Process Water Requirements

The estimated water demand and water quality requirements for Process water (including internal power generation) are outlined in Table 78. The primary demand will be for cooling water.

Table 78 Estimated water demand and water quality requirements for Process water

Water Demand	Unit	Cooling water	Process water	Demineralised[26]
Water Quantity	GL/a	9.5	1.4	0.5
Water Quality				
pH at 25°C		6.5 to 8.5	6.5 to 8.5	6 to 8
TDS	mg/L	< 200	200 to 500	
Total hardness	ppm	< 200		
Calcium hardness	ppm	< 120		
SiO2	ppm	< 20	< 2	< 0.02
Chloride	ppm	80 - 200	< 0.1	
Iron	ppm	< 1	< 1	
Turbidity	NTU	< 5		
Conductivity	m-mho/cm			< 1.0
Dissolved Oxygen	ppb			1.01 (exit aerator)
Chlorine	ppm			< 0.1
Mineral	ppm			< 0.01
Pressure	bar (g)			TBC
Temperature	°C before pre-heating			30

9.2.2 Potable Water Requirements

Potable water is required for staff amenities and safety showers, office and administration. Potable water will be generated on-site at the water treatment plant. Options for water use efficiencies will be identified through a Water Use Efficiency Plan. Water use efficiencies may reduce the demand for potable water through options which may include reuse of stormwater for toilet flushing.

Plant staff estimated to peak at 80 people per day. Based on an estimated water usage of between 36 and 54 kL/person/year this equates to a total potable water demand of between 2.88 and 4.32 ML/year.

9.2.3 Fire Water Requirements

Fire water supply water will be obtained from the water supply for the Plant. The required water quality for fire water is comparable to the cooling water quality outlined in Table 78. Fire water will be stored in a purpose designed tank within the Process site.

[26] Other parameters may be specified by the technology provider

9.2.4 Construction Water Requirements

Water will be required during the construction phase of both the Plant as well as the water supply pipeline between Wellington Dam and the Site. Water will be required for both construction purposes (industrial grade) and human use (potable water). Perdaman propose to access existing potable water infrastructure adjacent to the site for construction phase water supply.

9.3 Water Supply Options

Surface water resources will be the primary water supply for the Plant, unless other water supply options are made available by the Department of Water that will assist in the strategic management of water in the basin.

A number of different surface water supply sources have been identified within the Upper Collie catchment as a result of the intensive study of the catchment in recent years.

This section discusses the identified water supply sources, the prioritised water supply strategy and the contingency supply options. The prioritised water supply strategy has been developed with the aim of providing security of supply, with the contingency supply options identified to ensure continuity of water supply in the event of a primary water source becoming unavailable.

The water supply options considered are classified as one or both of the following:

- *Primary water supply* – a source(s) which will usually supply the major proportion of water demand.
- *Supplementary water supply* – alternative water source(s) which will be utilised to supplement the primary water supply to provide security of supply, while providing additional benefits through strategic improvements to water resource management.

The intention of the supplementary water supply options is to utilise identified alternative water supply options when available in order to minimise the demand on the primary water resource. The supplementary water supplies would be mixed with the primary source to provide an acceptable feed water quality or may be used exclusively during short term failure of, or shortfall in, supply from the primary source(s).

9.3.1 Wellington Reservoir

Wellington Reservoir is the largest surface water catchment in the southwest of Western Australia. The 2007 report Water Source Options in the Collie-Wellington Basin (DoW 2007d) identified that the dam is under utilised due to its high salinity level.

Wellington Reservoir has a capacity of 186 GL, of which 85 GL is currently allocated (DoW 2007d). The allocation of water in 2007 from Wellington Reservoir is shown in Figure 53.

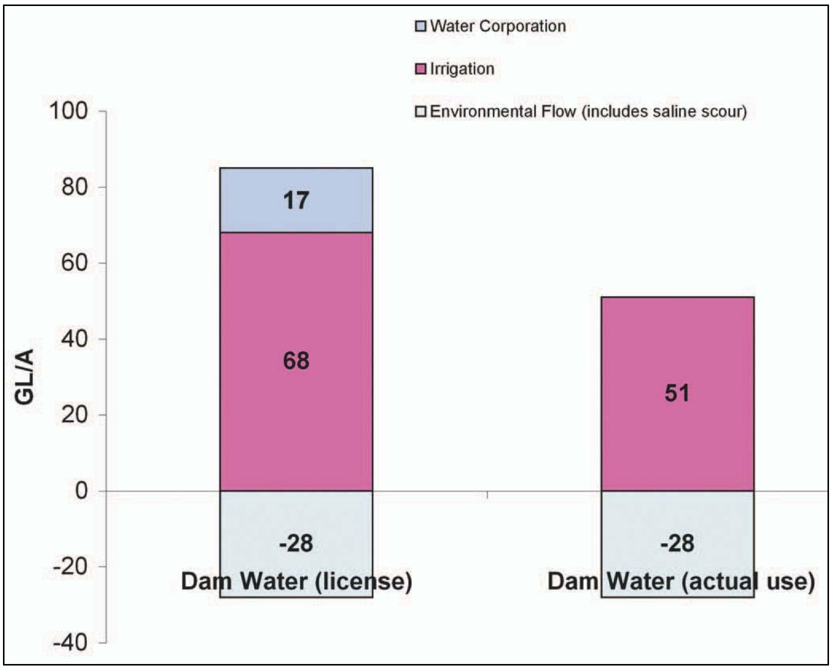

Figure 53 Allocation of water from Wellington Dam (Source: DoW 2007d)

Surface water from the Wellington Reservoir is considered the primary water supply source for the Plant. Perdaman has submitted a Surface Water Licence application to source a 12 GL/a allocation of water from the Wellington Reservoir. This allocation would be subject to reduction on a year-to-year basis by the Department of Water, in the event of lower than planned runoff into the reservoir in any year.

Perdaman intend to use this water source as the primary water supply to ensure security of supply. Supplementary water will be sourced from alternative identified sources when available to minimise the demand on the surface water resource, as well as to provide strategic improvements to the water resources of the Collie region.

Infrastructure Requirements

Pipeline infrastructure will be required to convey water from Wellington Reservoir to the Site. A Water Corporation owned pumpstation exists at Wellington Dam, connected to a pipeline between Wellington Dam and Harris Dam, passing to the north of Collie. The Water Corporation currently utilises the pipeline to convey potable water from Harris Dam to the townships of Collie and Allanson. Perdaman is currently in discussions regarding the possible use or purchase of the pumpstation and section of pipeline between Wellington Dam and Allanson. To supply water from the Wellington Reservoir to the Plant will require the following investment in infrastructure:

» New pumps at the Wellington Dam; and

» A new pipeline to supply water from either Wellington Reservoir or Allanson township to the Site (depending on the outcome of discussions with Water Corporation).

Perdaman intends to construct a dedicated water supply pipeline at ground level in the existing pipeline easement between Wellington Dam and Collie north, then within an existing Western Power 132 kV transmission line corridor from the point of intersection with the water corridor, to the Site). Management of the potential impacts of the establishment of this infrastructure on water resources are addressed within Section 9.10.

9.3.2 Dewatering from Mining Operations

Mining operation within the Collie Coal Basin typically result in a dewatering requirement to ensure safe mining operations. Due to the generally high quality of the mine dewatering, there is high demand for its use by power stations within the Collie Coal Basin. Of the 22 to 37 GL/a predicted to be produced by mine dewatering in 2010 (DoW 2007d), 20 GL is allocated to power stations leaving 2 to 17 GL available for other uses. The Plant forecast requirement of approximately 2.6 Mt/a of coal implies there will be potential availability of mine dewatering from proposed coal mining operations.

The volume of dewatering from mining operations associated with the mining of coal specifically for the Plant would not meet the water demand of the plant. Furthermore, one of the key objectives outlined in the *Draft Upper Collie management plan* (DoW 2007c) identifies that "*No further use of dewatering water for industrial purposes (including power generation) will be permitted*" (Objective 9).

Perdaman considers that within the context of strategic water resource management of the Upper Collie catchment, it is preferable to use surplus mine dewatering, in excess of current demand by power stations, when available instead of surface water from the Wellington Reservoir.

The majority of water from mine dewatering operations is produced in advance of commencement of mining activities in a new pit. The amount of water produced from this activity is highly variable from year-to-year and as such water from mining operations should be considered a supplementary water supply.

9.3.3 Desalination of Collie Diversion Project Water

Diversion of early winter season saline streamflow from the Collie River East Branch and storage within a disused mine void is an option being considered by the Department of Water to reduce the salinity of water within the Wellington Dam to potable levels (DoW 2007d). To reduce the quantity of saline water flow into the Wellington Reservoir, the DoW intends to pre-treat the diverted and stored water to meet marine discharge requirements, then dispose of the pre-treated water via the Verve Energy marine discharge pipeline.

There is potential for Perdaman to take the pre-treated diversion water and desalinate the water for use (or alternatively take desalinated water if available) on the Plant and the company has submitted a formal offer to this effect to DoW. The DoW identify that diversion of approximately 6 GL of stream flows has the potential to produce approximately 3-4 GL of potable water following treatment using desalination processes.

9.3.4 Recycled Wastewater and Stormwater

Wastewater will be generated continuously at the site during urea manufacturing operations. The wastewater sources include, but are not limited to, the following:

- Effluent generated from the treatment of water supply sources;
- Effluent generated from the processing plant; and
- Greywater and blackwater generated from the offices and other business operations.

The estimated volume of water that may be generated from stormwater run-off is in the order of 0.45 GL/a. Stormwater in Western Australia is primarily only available in winter, and there is a significant shortfall in the water required to meet the demand of the plant. This water supply option should therefore be considered a supplementary water source.

9.4 Prioritised Water Supply Strategy

9.4.1 Water Supply Strategy Principles

The prioritised water supply strategy has been developed with regard to the known water resources issues within the Upper Collie catchment, as well as the policies and provisions outlined in the *Draft Upper Collie Water Management Plan* (DoW, 2007). It has also been developed with consideration to the various demands for water resources within the region.

The prioritised water supply strategy has also been developed with regard to:

» The requirement for a reliable supply being maintained;

» The reliability of the identified water supply options;

» Fit for purpose supply; and

» Low winter rainfall years.

The proposed water supply strategy principles are:

» Reliance on water from Wellington Reservoir as a sole water supply option only when supplementary water sources are unavailable;

» Maximise plant water use efficiencies to reduce demand on water sources;

» Utilise mine water as a primary water source when available; and

» Utilise diversion water from the Collie River East Branch when available.

9.4.2 Prioritised Water Supply Strategy

Perdaman proposes to prioritise the water supply strategy to minimise the take of potential potable water from the Upper Collie catchment (i.e. Wellington Reservoir). Given the comparatively high supply volumes required, and the uncertainty at this time around availability of other water resources within the catchment, security of supply has been sought through the application for a Surface Water Licence for a 12 GL/a allocation. The prioritised 12 GL/a water supply strategy includes reduced water demands based on water reuse of and water use efficiencies.

The prioritised water supply strategy is outlined below:

Priority 1: Primary water supply from the Wellington reservoir through securing a Surface Water Licence.

Priority 2: Supplementary water supply from mine dewatering abstractions from coal mining operations when available.

Priority 3: Potential for supplementary water supply from desalination of Collie Diversion Project Water if available.

Priority 4: Additional water from Wellington Reservoir, if required, through a trading arrangement with Harvey Water.

The supply of water from the identified sources is subject to a number of commercial agreements and management decisions, including commercial supply from Harvey Water, and access to the other sources through allocation agreement with the DoW.

The prioritised water supply strategy will require the upgrading and installation of infrastructure for the purposes of transporting water supply sources to the site, treatment and storage of water, and disposal of wastewater.

9.4.3 Contingency Water Supply Strategy

The contingency options for water supply are an important issue to address due to the reliance of the supply strategy on surface water sources and the impacts of climate change on the availability and security of surface water resources for the duration of the plant.

The Department of Water consider that the supply of water from the Wellington Reservoir has < 85% reliability (DoW, 2007c). Perdaman has applied for a 12 GL/a allocation from Wellington Reservoir, however, other supply sources are also being sought by Perdaman in order to ensure continued and reliable supply of water to the Plant. These contingent sources include:

- Trading arrangement with Harvey Water;
- Dewatering from mining operations;
- Desalinated diversion water from the Collie River East Branch;
- Treated water supplied by any water utility that may be established; and
- Purchase of potable water from Harris Dam.

9.4.4 Adaptive Management and Trigger Points for Change in Water Supply

The reliance of the water supply strategy on surface water sources introduces a degree of uncertainty into the long-term security of supply. The prioritised water supply strategy recognises the uncertainty of surface water resources due to the impacts of climate change, and proposes to minimise the use of water from Wellington Reservoir when alternate supplementary water sources are available (Section 9.4).

Adaptive management of the water supply strategy requires that the water supply options are regularly reviewed with regard to the availability of water resources and in the context of the *Draft Upper Collie water management plan* (DoW 2007c).

The review process is intended to identify the current and future availability of supplementary water sources to augment the primary water source from Wellington Reservoir. These supplementary water sources should be brought online at the earliest convenience to minimise demand on the Wellington Reservoir water resources.

Trigger points for changes in the ranking of water supply options would occur if:

- A review identifies a surplus supply of mine dewatering water in excess of that required by the power stations. In these instances the mine dewatering would become a primary water supply for the plant for the available period.

» The review identifies that diversion water from the Collie River East Branch is available for desalination. In these instances the diversion water would be used to supplement the available primary water supply sources.

» The review identifies that supply shortfalls are forecast to occur from the prioritised water supply options within a five year period. In this instance Perdaman will have a period of about five years to identify and develop alternative secure water supply options.

9.5 Water Quality and Treatment

9.5.1 Water Quality

The quality of the identified surface water supply options (Section 9.3) is variable (Table 79). In particular the Total Dissolved Solids, sodium and chloride concentration levels differ between the main water supply sources identified due to the differing salinity of the water resources.

Table 79 Quality of Raw Supply Water

Parameter	Unit	Wellington Reservoir[27]	Mine Dewatering[28]	Desalination of Collie Diversion Project water[29]
pH		6.5 to 7.8	5 – 6	NA
Total Dissolved Solids	mg/L	950	450 – 750	4500 – 6000
Total Suspended Solids	mg/L	0.5 – 2	NA	NA
Dissolved Oxygen	mg/L	8 – 10	NA	7 – 9
Sodium	mg/L	220 – 270	100 – 200	1000 – 1200
Potassium	mg/L	2 – 3	5 – 8	~ 300
Calcium	mg/L	22 – 26	3 – 5	80 – 120
Magnesium	mg/L	55 – 60	15 – 20	~ 300
Iron	mg/L	0.06 – 2	2 – 10	0.1 – 0.5
Manganese	mg/L	0.02 – 0.7	0.1 – 0.4	0.2 – 0.4
Chloride	mg/L	500 – 550	200 – 400	2200 – 2800
Sulphate	mg/L	32 – 38	10 – 30	~ 300
Bicarbonate	mg/L	20 – 25	5 – 10	NA
Silica	mg/L	1.5 – 2.0	10 – 12	3 – 5
Phosphate (PO_4-P)	mg/L	0.005	NA	< 0.01
Nitrate (NO_3-N)	mg/L	0.1 – 0.6	0.1	NA

[27] Based on data primarily for the period 2005-2009.

[28] Based on limited available data.

[29] Based on limited available data

Arsenic	mg/L	< 0.001	< 0.01	< 0.001
Cadmium	mg/L	< 0.001	NA	0.004
Chromium	mg/L	< 0.001	NA	< 0.001
Cobalt	mg/L	< 0.01	< 0.01	0.05
Copper	mg/L	< 0.001	0.01 – 0.04	0.001
Lead	mg/L	< 0.001	< 0.001	0.001
Mercury	mg/L	< 0.0001	< 0.0001	NA
Nickel	mg/L	< 0.001	< 0.03	0.03
Vanadium	mg/L	< 0.001	< 0.002	< 0.001
Zinc	mg/L	< 0.002 – 0.003	0.06 – 0.12	0.07

9.5.2 Water Treatment

Treatment of the supply water is required to remove contaminants and ensure the water meets the water quality for the required end use. Pre-treatment of raw source water will be required prior to treatment in a water treatment plant for meet fit-for-purpose standards for industrial (plant and fire water) and human use (potable). Different levels of treatment will be required depending on the water source due to the variable water quality.

9.6 On-site Storage

9.6.1 Liquid Storage

Water storages are required for a range of purposes including:

- Storage of supply water (process water, potable water, fire water);
- Storage of treated water;
- Storage of effluent;
- Storage of chemicals.

To wastewater treatment ponds will be constructed to provide a contingency should the Verve wastewater pipeline not accept PCF wastewater for a period of time due to possible problems with the pipe that requires repair. Both ponds will be lined with an impervious material and have the capacity to store 21 ML of water, the equivalent of seven days wastewater supply.

Pond one will initially receive wastewater generated at the Site. This water will be transferred to Pond 2 once it has been treated. Pond 2 water will be tested for water quality prior to its disposal to the waste water pipeline.

Storages will be constructed in compliance with Australian Standards and associated Government planning and building regulations. Regular monitoring and maintenance checks will be undertaken to ensure no loss of water to the environment.

Wastewater effluent and other potential contaminants (e.g. chemicals, hydrocarbons) will be stored in tanks constructed within a secondary containment of sufficient volume to prevent losses to ground if a minor or major spill occurs.

9.6.2 Solids Storage

The Perdaman Urea Plant will require storage for solids for input into the processing plant (mined coal) and storage of solids generated from the urea production process. Solids generated from the production process include the urea product, sulphur recovered from the coal as well as solid waste products.

The urea product will be stored in a purpose built sealed storage facility prior to transport via rail to the Bunbury Port for export. Any solid waste generated will also be stored in purpose built storage facilities prior to recycling (preferred) or disposal at a suitably licensed landfill.

The conceptual water flow for the site is outlined in Figure 54. The conceptual water flow diagram identifies the requirement for pre-treatment of water due to the variable water quality of the various water supply sources identified (Section 9.5), followed by further treatment in a water treatment plant to meet process water and other water requirements. The conceptual water flow for the site also identifies a range of wastewater streams, which will require further treatment prior to disposal.

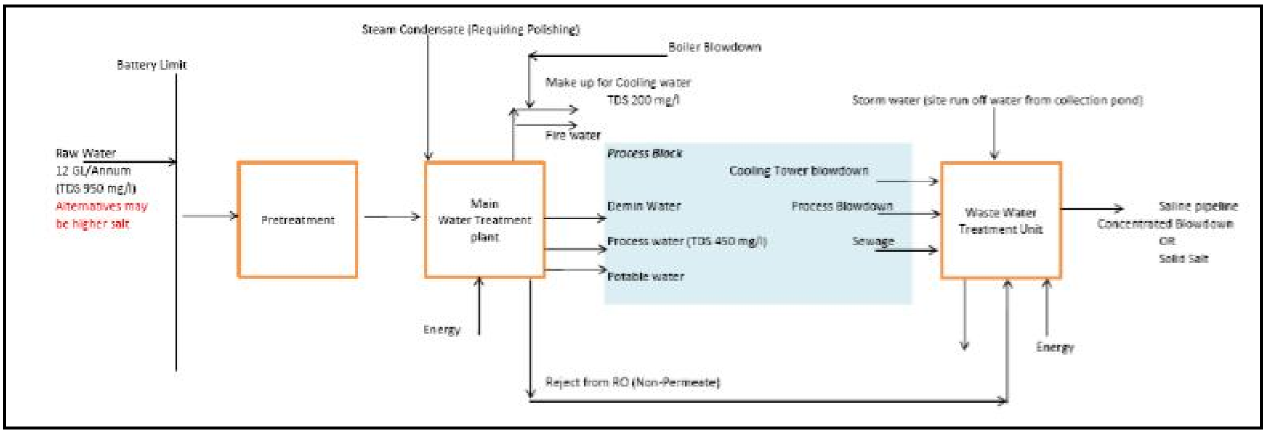

Figure 54 Conceptual water flow diagram for the Perdaman Urea plant site

9.7 Wastewater Streams

The following wastewater streams (liquid effluent) will be produced from the plant and operations:

- Wastewater from pre-treatment of raw supply water;
- Wastewater (brine return and reject water) from the water treatment/desalination plant;
- Process wastewater (including cooling tower blowdown and process blowdown water from the Gasifier water bath);
- Wastewater from the demineralisation plant;
- Domestic wastewater (greywater and blackwater); and
- Site stormwater runoff.

Effluent is produced from the process plant primarily from the cooling water blowdown and process blowdown from the Gasification Unit.

In the cooling water circuit the water is evaporated to remove heat resulting in a concentration of the residual water salts. Chemicals such as biocides are also added to control the quality of the water. A blowdown of the cooling tower is required to control salt levels, with a typical blowdown salt concentration of approximately 2500 mg/L TDS from an initial concentration of 200 mg/L TDS.

Wastewater from the Gasifier water bath is expected to contain 200 ppm of nitrogen as NH_4-N/NH_3-N.

Stormwater is site runoff, mainly from roads and other hard surfaces. Stormwater is generally considered a wastewater and can contain relatively high concentrations of contaminants including nutrients, hydrocarbons, metals and pathogens. The lack of barriers to exposure and the inability to control raw water quality make it a difficult option for direct reuse, requiring a high level of treatment.

It is standard engineering practice in design and operation of manufacturing facilities to provide containment bunding around areas of the plant where stormwater runoff may contain traces of oil and other contaminants. This practice will be used on the Urea plant, with stormwater from bunded areas conveyed to the wastewater treatment plant for treatment and potential water recycling. Cleaner stormwater from the remainder of the Plant will be collected and contained on site. Options for the reuse of this water within the plant will be explored within a Water Use Efficiency Plan.

Stormwater management at the site will be designed to comply with the *Shotts Industrial Estate District Water Management Strategy* (GHD in production) and the Department of Waters Water Quality Protection Note *Stormwater management at industrial sites* (DoW 2006).

9.8 Disposal Options

Some of the wastewater streams produced by the process plant will be reused or internally pre-treated and recycled for use within the process plant. This is described further in Sections 9.10.1 and 9.10.2. The remaining wastewater streams will be collected for treatment on-site in a Wastewater Treatment Plant prior to disposal.

9.8.1 Verve Energy Pipeline

The Verve Energy pipeline runs to the coast from the Verve Energy saline WTP and discharges to the ocean approximately 800 m offshore north of the Leschenault Estuary. The current discharge capacity of the pipeline and the licence conditions for the quality of discharge water are outlined in Table 80. Table 68 also identifies the existing quantity and quality of water that is discharged via the Verve pipeline.

Discharge of wastewater from the Perdaman site will comply with the EPA marine discharge licence conditions for the Verve Energy pipeline (EPA 1177, January 2005). The current capacity and licence condition for quality of the brine discharged through the Verve Energy pipeline will define the required water quality and quantity (and final treatment requirements) of the final discharge from the Perdaman site. The wastewater will therefore be treated as necessary within the on-site Wastewater Treatment Plant in order to comply with the licence conditions, and to satisfy the requirements of the EPA.

Verve Energy is currently awaiting the outcomes of an investigation commissioned to identify options for rectification of leakage problems with the marine discharge pipeline. The outcomes of this investigation will determine options for access to pipeline for the purposes of disposing of wastewater from the Perdaman site.

Table 80 Verve Energy pipeline discharge capacity and water quality

Parameter	Unit	Limit
Discharge Volume	GL/yr	2.4 – 2.8
EPA Licence Conditions[30]		
pH		6.5 to 8.5
Total Dissolved Solids	mg/L	< 32,000
Total Suspended Solids	mg/L	<50 for 90% samples
Dissolved Oxygen	mg/L	>5
Sodium	mg/L	<10,500
Potassium	mg/L	<280
Calcium	mg/L	<400
Magnesium	mg/L	<1,400
Iron	mg/L	<5
Manganese	mg/L	<5
Chloride	mg/L	<19,000
Sulphate	mg/L	<2,450
Bicarbonate	mg/L	<140
Silica	mg/L	<100
Phosphate (PO_4-P)	mg/L	<2
Nitrate (NO_3-N)	mg/L	<5
Arsenic	mg/L	<0.1
Cadmium	mg/L	<0.02
Chromium	mg/L	<0.1
Cobalt	mg/L	<0.1
Copper	mg/L	<0.25
Lead	mg/L	<0.1
Mercury	mg/L	<0.002
Nickel	mg/L	<0.3

[30] EPA 1177, January 2005

Parameter	Unit	Limit
Vanadium	mg/L	<1
Zinc	mg/L	<0.5

9.8.2 Brine Concentration

Should disposal of wastewater via the Verve Energy ocean outfall pipeline not be feasible, Perdaman propose to concentrate the brine wastewater stream using a brine concentrator and waste heat from the Perdaman plant. The concentrate from the concentrator would be mixed with flyash that would be imported by road from nearby power stations, if required, to absorb further excess water. Cement would then be added to 'solidify' the mix and render any waste contaminants immobile, in accordance with Australian Standard Leachate Protocols. The fixated concentrate waste will be disposed of using road transport to a suitably licensed landfill operated by third parties.

A general outline of the wastewater pre-treatment and brine concentration process follows:

» Wastewater generated on site from cooling tower blowdown and other sources will be treated through a wastewater treatment plant designed to concentrate the salts and recover as much water as possible. The treatment train would typically involve the use of a reverse osmosis (RO) plant to undertake the initial concentration followed by a brine concentrator to further concentrate the salts, followed by mixing of the residual concentrate with cement in a suitable mixer and stockpiling of the mixed residual solid for testing and then disposal to a third party licensed landfill.

» The estimated quantity of salt for disposal will be approximately 15,000-18,000 t/a, subject to the water treatment technology. It should be noted that >75 % of the salts will derive from the saline raw water from Wellington Dam. Hence the quantity of salt is dependent on the salinity of the water as received from the Dam. The salts coming from the gasification is the product of neutralisation of waste water with caustic and HCL and primarily consist of sodium chloride.

» The RO plant is a membrane process whereby feed water is converted into two streams. The stream that passes through the membrane is called the permeate stream which is high quality water with very low salt content. The other stream is the reject stream which retains the majority of salts and is more concentrated than the feed stream.

» The brine concentrator employs thermal energy to further concentrate the salts in the reverse osmosis reject stream. After passing through the brine concentrator, up to 99% of the feed water is converted to near pure water with the remaining flow being rejected as a very concentrated brine solution. Due to the high energy usage of the brine evaporator, utilising an RO plant to undertake the initial concentration is the most energy efficient process. The concentrated brine reject from the brine concentrator is typically a small flow which can readily be stockpiled for off-site transport and disposal. Product water from both the RO plant and brine concentrator can be reused in the process as cooling tower makeup water or other uses.

» Brine concentrators typically utilise electrical energy to drive a mechanical vapour compressor. It may also be feasible to use waste heat as the energy source for the brine evaporator if this is available on site in sufficient quantity and reliability.

9.9 Potential Impacts on Water Resources

Operation of the Perdaman Urea plant has the potential to affect the quality of surface water and groundwater resources in the following ways:

- Sediment and water run-off to nearby water bodies during construction activities of the plant and the pipeline from Wellington Dam;
- Leakage from wastewater, effluent and chemical storage tanks;
- Discharge of wastewater with concentration of parameters in excess of the license conditions;
- Contamination from hydrocarbons and other chemicals used on site; and
- Contamination from run-off from coal, urea and solid waste storage.

While there are no surface water bodies within the Perdaman site boundary, run-off from the site has the potential to flow into adjacent water bodies. The creek line located to the west of the site flows to Stockton Lake, with flow from the lake to the Collie River South Branch ultimately flowing to Wellington Reservoir.

9.10 Management of Impacts

The management of potential impacts will be undertaken with regard to the management objectives of water resources within the Upper Collie catchment and with recognition of the need to:

- Restore ground water levels within the Collie Coal Basin;
- Improve the quality of the water in the Wellington Reservoir; and
- Protect the existing ecological, social and cultural values at a low level of risk.

A number of management plans and management strategies will be developed at various stages of the project to minimise the impact on water resources. Monitoring plans will be prepared and implemented for many of these management strategies to monitor the impact of the plant, and to assist in adaptive management of the project. These plans and strategies are described below.

Construction Phase Environmental Management Plans will be prepared to manage the impacts of construction phases of the plant and the pipeline on the environment, including water resources. The plans will include erosion and sediment control, as well as management of surface water run-off during construction activities. The plans will also include induction and training programs for construction staff.

A Local Water Management Strategy (LWMS) will be prepared in support of the Structure Plan for the site, as required under the state government planning framework *Better Urban Water Management* (WAPC 2008). The LWMS will provide detailed information relating to objectives for total water cycle management, pre and post development water balance, potable and non-potable water use, water sources and infrastructure requirements for water supply, wastewater and stormwater management (including quantification of storage and detention areas), and surface water and groundwater management (including monitoring programme design, implementation and reporting). The LWMS will be consistent with the strategies and objectives of the *Shotts Industrial Estate District Water Management Strategy* (DWMS) currently under preparation for Landcorp as part of its responsibilities in relation to the zoning amendments required to create Shotts Industrial Estate, which includes the Perdaman site.

A Wetland Management Plan will be prepared for the wetland adjacent to the southern boundary of the site. The Wetland Management Plan will identify the existing environmental features and ecological values of the wetland, and outline management, monitoring commitments and implementation actions required.

Perdaman will invest and commit to water use efficient technologies to minimise waste and maximise water use throughout the site. The water use efficiency objectives of the Perdaman Urea plant include:

» To recover and reuse stormwater within the site provided it meets fit for purpose water quality requirements;

» To recover and recycle condensed steam instead of allowing it to escape to drainage systems

» To recycle wastewater produced through the urea production process on-site provided it meets fit for purpose water quality requirements; and

» To ensure that water storage areas are covered/enclosed to reduce evaporative losses.

9.10.1 Water Reuse

Water will be re-used throughout the Urea plant production process including:

» Process water from the Urea stream, will be treated to Boiler Feed Water (BFW) quality and will be recycled back into the BFW circuit;

» The Boiler blowdown water will be reused as cooling water makeup;

» The steam condensate from the steam traps will be recovered and reused after polishing treatment to the desired quality; and

» The steam condensate from the condensers will be polished and reused in the BFW circuit.

9.10.2 Water Recycling

The following wastewater streams will be treated to a standard that is fit-for-purpose for use within the Urea plant:

» The blowdown water from the Cooling Tower;

» The domestic grey water;

» The blowdown water from the Gasifier water bath;

» Site stormwater runoff; and

» Reject water from the desalination units.

Options for the reuse and recycling of stormwater for purposes such as toilet flushing will also be explored to reduce the demand for potable water.

9.11 Water Use Efficiency Commitments

It is recognised that key water savings will be made through use of efficient technologies, reuse of water and use of recycled water within the plant. Commitments within this aspect include:

» Aim to reuse water that is fit for purpose to result in 20% improvement in water use efficiency as per the *Draft Upper Collie water management plan*;

» Aim to recycle treated wastewater to provide water that is fit for purpose to result in 20% improvement in water use efficiency as per the *Draft Upper Collie water management plan*; and

» Development of a Water Use Efficiency Management Plan as per the *Draft Upper Collie water management plan* (DoW 2007c) and the new State Government water efficiency measures (*Water Agencies (Water Use) By-laws 2007).*

Some of the aspects that may be included within the Water Use Efficiency Plan are:

» Measurement, monitoring and reporting of water use;

» Use of water efficient appliances;

» Use of waterless or water efficient fittings;

» Education programs for staff; and

» Prioritisation of outdoor areas and landscaping measures.

9.11.1 Liquid wastewater

Plant wastewater streams will be continuously monitored. The wastewater will be stored in a pond Lined with impermeable material.

Stormwater will be monitored prior to discharge (if not recycled) to ensure it meets the water quality of the receiving environment. Monitoring parameters will include total suspended solids, ph, turbidity, total hydrocarbons and volume.

9.11.2 On-site liquid storages

On-site liquid storage areas will be subject to regular inspections to ensure that there are no leakages and that they comply with regulations.

9.11.3 Marine discharge disposal

All treated wastewater discharged into the Verve Energy marine discharge pipeline will be continuously monitored for discharge volume, turbidity, total dissolved solids (calculated from electrical conductivity) and dissolved oxygen as required per the EPA licence conditions (EPA 1177, January 2005). Other regular monitoring stipulated in the licence conditions will also be undertaken by Perdaman, prior to discharge to the marine discharge pipeline, as outlined in Table 81.

Table 81 Verve Energy marine discharge pipeline monitoring commitments

Monitoring Site	Frequency	Parameter
Wastewater discharge pond outlet	Continuously (when flowing) reported as weekly averages and annual total volume discharged	Discharge volume, turbidity, total dissolved solids(calculated from electrical conductivity), dissolved oxygen
	Weekly	pH. Temperature, total suspended solids

Monitoring Site	Frequency	Parameter
	Monthly	Phosphate-phosphorous, Nitrate-nitrogen, Total Petroleum Hydrocarbons (TPH)
	Quarterly (nominally November, February, May and August)	Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Silica, Arsenic, Cadmium, Chromium, Cobalt, Copper, Lead, Mercury, Nickel, Vanadium and Zinc

9.11.4 Surface and ground water

Perdaman will prepare and implement water quality monitoring of the surface water bodies located adjacent to the site and groundwater. These monitoring commitments will include monitoring during the pre-development and operational phases. These monitoring programs will be developed and outlined within the Local Water Management Strategy.

9.12 PCF Commitments

Perdaman commit to ensuring that all design and strategies proposed in this Water Management Strategy comply with Australian Standards and relevant guidelines and guidance from the Department of Water and other government agencies where appropriate. The next stages for water management of the development include preparation of a number of management strategies and management plans including:

» A Local Water Management Strategy to support the site Structure Plan;

» A Water Use Efficiency Plan to outline the water use efficiency technologies, as well as the water reuse and water recycling commitments for the site;

» Construction Environmental Management Plan for both the Urea Plant and the Wellington Dam to Perdaman pipeline to minimise the impact of the construction phase on the surrounding environment; and

» A Wetland Management Plan to outline the management and monitoring of adjacent wetlands.