5 Water Resources

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5.1 Surface Water

Summary

Potential surface water impacts have been considered both for the proposed Coke and Power Plant at Stanwell and the wharf at Fisherman's Landing on the Curtis Coast. A wide range of information was used in the assessment including meteorological, topographical, hydrological and water quality data plus a number of independent reports and observations made during an inspection of the project site. The relative importance of potential impacts was assessed with reference to this information and the proposed works at both sites.

The proposed development site at Stanwell is within the Neerkol Creek catchment, an ephemeral creek system influenced by agricultural and industrial practices. Stanwell Power Station (SPS) currently discharges combined power station blowdown and stormwater into Quarry Creek, a tributary of Neerkol Creek, on a continual basis. This has led to more consistent overall flow conditions. Flood event data within the catchment is limited but a significant flood event is known to have occurred in 2003. Water chemistry is variable and biological indicators suggest that water quality is generally poor, characterised by high salinity and some nutrient enrichment. However, the creek does support some local ecosystems and there are a number of licensed abstractions, largely for agricultural purposes.

The Curtis Coast area is a significant marine environment with importance to the Great Barrier Reef lagoon. Fisherman's Landing is currently used by a number of industries for import/export. There is a relative lack of definitive studies of water quality at the proposed development site which means assessment has been difficult. However, information reviewed suggests that water quality is generally relatively unpolluted. As outlined in Section 4 - Climate, storm surges pose a potential flood risk along the coast in this area.

During construction (more significantly at the project site than at Fisherman's Landing), potential impacts are largely from mobilisation of sediments into surface water bodies. These will be addressed by utilising the existing drainage infrastructure and implementing additional environmental management practices in accordance with industry standards. No natural surface water bodies are present on site and only minor amounts of potential pollutants such as fuel oil will be required.

During operations, stockpiling of coal and coke at both Stanwell and Fisherman's Landing has the potential to introduce particulates into local water bodies. Dust suppression and water management structures will be implemented at both sites to limit the generation and mobilisation of these potential pollutants. The volume of waste water will be limited through good environmental management, including bunding of areas prone to contaminant spillage and separation of clean runoff from potentially dirty runoff. The Project will require a considerable water supply, largely for Power Plant cooling and coke quenching purposes. This is proposed to be sourced from some of the available resource in the Fitzroy Basin either through existing or new water allocations.

The sustainability of water use will be addressed through water re-use options as far as possible. Some minor impacts on the flow regime of local creeks may be caused under certain plant configuration

scenarios due to releases of water from the Power Plant. Given the proximity of downstream water users and the ephemeral nature of much of the local water environment, unchecked discharges from the Project could potentially comprise a large proportion of the flow in the creek for most of the year. Therefore, the design strategy for surface water management at the Project focuses on minimising the amount of potential contaminants present in runoff (e.g. coke and coal dust, oil and chemicals) and installation of infrastructure to contain and treat this runoff.

5.1.1 Description of Environmental Values

Environmental impacts to the surface water environment at the two sites (Stanwell and Fisherman's Landing) have been assessed with reference to existing drainage conditions and water quality. This included investigations of on-site drainage patterns, the wider catchment context (including downstream water users) and flow regimes in the major creek systems adjacent to the site including flooding issues. Water quality was summarised from available data in terms of physical, biological and chemical parameters.

Catchment Context

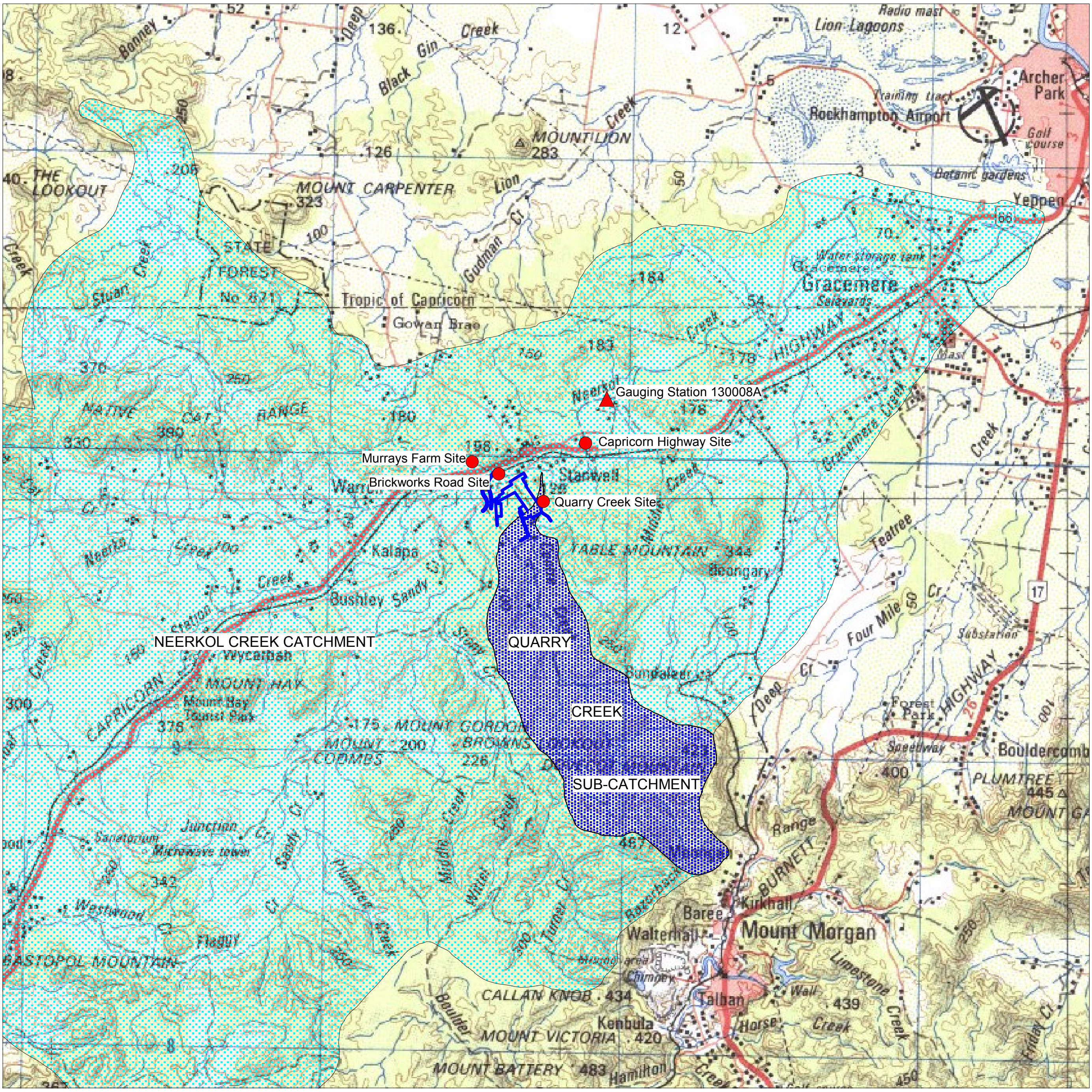
Stanwell

The project site is located in Fitzroy Shire within the Neerkol Creek catchment, a sub-catchment of the Fitzroy River (Figure 5.1). The overall catchment size is approximately 625 km^2 including Westwood in the west, the northern side of the Razorback Range in the south and part of the Native Cat range to the north-west. The catchment comprises Stony Creek, Stuart Creek, Sandy Creek, Flaggy Creek, Plumtree Creek, Middle Creek, Wittel Creek, Turner Creek and Quarry Creek. The Fitzroy River flows into the Pacific Ocean downstream of Rockhampton, approximately 50 km to the east of the site. The Fitzroy River drains a catchment area of over 140,000 km^2, and has three major tributaries: the Isaac; McKenzie; and Dawson Rivers.

A sub-tropical humid climate is characteristic of both the Rockhampton and Gladstone regions, with wet summer periods generally between December and March, and dry winters generally between June and September. Climatic data for both sites is discussed in Section 4 - Climate.

Land use in the catchment is characterised largely by agricultural land (grazing and cropping). Sandstone quarrying occurs in the area with some gravel quarrying having occurred in the past. Industry is mainly limited to the SPS and some light industry (truck wreckers, saleyards). The Capricorn Highway and railway follow a route adjacent to Neerkol Creek.

A narrow band of riparian vegetation exists along Quarry and Neerkol Creeks with a discontinuous canopy and patches of modified or rank grassland associated with agriculture. Otherwise, there has been extensive clearing around the creeks. Instream aquatic habitats also exist with dense aquatic vegetation supporting a range of fauna species (Section 6 – Nature Conservation). Artificial dams have been installed in the area and generally do not have fringing vegetation but do support a specific suite of water



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LEGEND

- Neerkol Creek Catchment.
- Quarry Creek Subcatchment.
- Monitoring Locations.
- Neerkol Creek Gauging Station 130008A.
- Proposed Coke and Power Plant

Source: Australian 1:250000 Topographic Series, Rockhampton SF56-13

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AND POWER PLANT PROJECT
ENVIRONMENTAL IMPACT STATEMENT

REGIONAL DRAINAGE AND SURFACE WATER MONITORING LOCATIONS

Drawn: VH	Approved: JMcD	Date: 06-01-06
Job No: **42625626**	File No: 42625626-g-010b.wor	

Figure: **5.1**

Rev:B

A4

birds (Section 6 - Nature Conservation). The channel geomorphology is characterised by high, steep, irregular planar and locally benched bank slopes and low flood-prone terraces.

Fisherman's Landing

Facilities for loading of coke will be situated on the wharf at Fisherman's Landing, approximately 11 km north of Gladstone. The wharf will be built on existing reclaimed land in Port Curtis, so there are no natural watercourses at this location. Port Curtis provides access to a major industrial port area servicing several heavy industries such as alumina refining and aluminium smelting, power generation, cement and chemical production and major coal exports. Mangroves, mud flats and seagrass beds fringe its large natural harbour. Part of the estuary and several offshore islands are included in the Great Barrier Reef Marine Park (Section 3 – Land Characteristics).

Existing Drainage Conditions

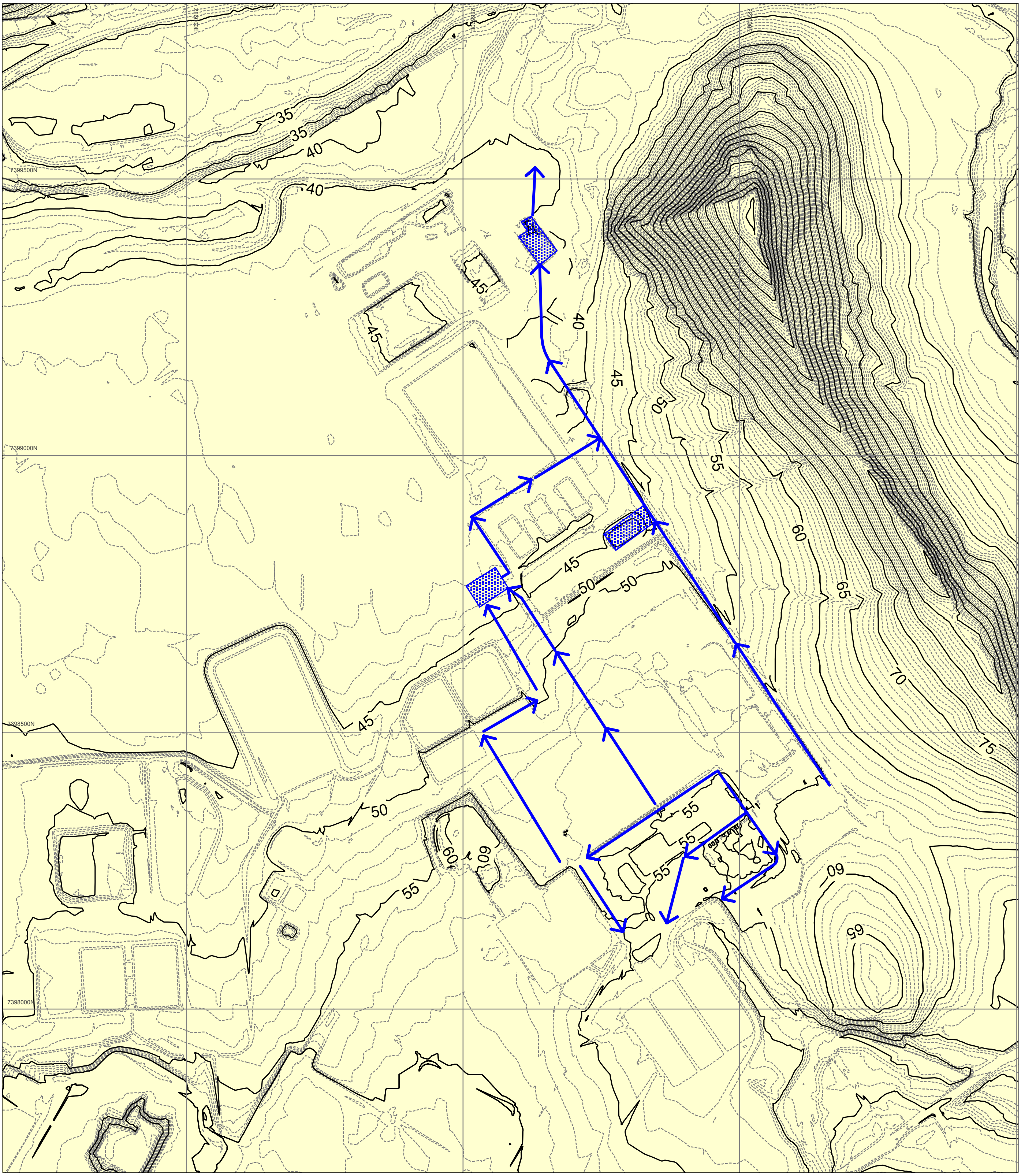
Stanwell

The topography of the project site at Stanwell was significantly altered during preliminary works for the former AMC project (Dames & Moore, 1999). The site has been extensively cleared and a range of water management structures were put in place. Drainage channels were excavated to convey surface runoff around, and away from, construction areas. Major channels drain from the south-eastern end of the site (adjacent to the security cabin and car park) along the south-western and north-eastern site boundaries into two sedimentation dams/holding ponds (Figure 5.2). The overflow from both sedimentation dams drain towards a 'lagoon' area located to the north of the project site. From here, runoff naturally drains to further ephemeral billabongs in an area of natural bushland outside the AMC site boundary. Flow from the sedimentation dams into the lagoon area has only been observed two to three times over the past 12 months and, on these occasions, the flow rate was very low and is not believed to have discharged into the adjacent creek system.

Surface runoff from the far south-eastern portion of the site flows south towards a three-stage surface water buffer pond system called the Northern Storm Water Dam (NSWD). These ponds also receive cooling tower blowdown from SPS and 'clean' stormwater (i.e. from the cooling tower platform, roads, roofs and most open areas) from the northern side of SPS.

Quarry Creek, to the south-east of the development site, intersects Neerkol Creek approximately 1 km to the east of Flagstaff Hill. SPS is licensed by the Queensland Environmental Protection Agency (EPA) to discharge 18 ML/day into Quarry Creek via the NSWD. However, the SPS currently only discharges 3-5 ML/day. This discharge has formed a significant component of the overall flow regime in the area since 1993 when the first unit of SPS was commissioned.

As Quarry Creek is naturally ephemeral, there is typically no flow upstream of the NSWD discharge point in the creek during dry or low rainfall conditions, and little or no ponding is present within the upstream sections the creek, as observed during the site visit undertaken for the Project. Although the creek is ephemeral, there are some larger billabongs downstream of the discharge point, and during periods of low



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Scale 1:10 000 (A4)
Horizontal Datum GDA94 Zone 56

LEGEND

- Drainage Channel and Flow Direction
- Settling Ponds
- —60— Major Contour and Value (mAHD)
- - - - Minor Contour

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ENVIRONMENTAL IMPACT STATEMENT

EXISTING TOPOGRAPHY AND STORMWATER MANAGEMENT FEATURES - STANWELL

Drawn: VH	Approved: JMcD	Date: 06-01-06
Job No: **42625626**	File No: 42625626-g-051.wor	

Figure: **5.2**

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A4

rainfall, flow is considered to be entirely due to the discharge from SPS. This water also accounts for the majority of flow in Neerkol Creek, otherwise characterised by intermittent pools observed along the route of the Capricorn Highway. These pools are fed by runoff from the surrounding highlands and perched groundwater, and are typical of the permanent freshwater lagoons in the area. The creek system ultimately flows into a wetland area called Gracemere Lagoons from where it discharges to the Fitzroy River.

The Department of Natural Resources and Mines (DNRM) records stream flow in Neerkol Creek at gauging station 130008A, located 1.8 km downstream of the confluence with Quarry Creek (Figure 5.1). Analysis of the data indicates large seasonal variations in flow. Notable high flows (mean monthly flow greater than 500 ML/day) occurred between December 1990 and February 1991, in January 1996 and in February 2003. Table 5.1.1 presents mean monthly flows for Neerkol Creek. To account for the variability of climate between 'wet' and 'dry' periods, data for whole years only between 1 June 1987 and 31 May 2004 have been included. On average, mean monthly flows are significantly higher between December and February than for the rest of the year.

Table 5.1.1 Mean Monthly Flows between June 1987 and May 2004 for Neerkol Creek at Gauging Station 130008A

Month	Mean Monthly Flows (m^3s^{-1})	Mean Monthly Flows (ML/day)
January	2.2	190
February	2.1	183
March	0.7	56
April	0.2	18
May	0.4	38
June	0.1	10
July	0.1	6
August	0.1	6
September	0.0	4
October	0.1	5
November	0.3	27
December	3.5	303

Long periods of very low flow (less than 0.01 m^3s^{-1} on average) were recorded in Neerkol Creek prior to the commencement of the SPS discharge in 1993. Since November 1993, average monthly flow below 0.01 m^3s^{-1} has not been recorded. The DNRM have confirmed that for long periods in the year, flows in the creek are entirely dependent on SPS discharge. This discharge is therefore considered to have improved the sustainability and reliability of flows in Neerkol Creek.

The geology of the creek systems is characterised by Quaternary alluvium comprising clay, silt, sand and gravel beds (Section 3 – Land Characteristics). The presence of these soils subjects the banks to scour, undercutting and associated instability. However, despite local clearing activities, significant stands of riparian vegetation are still present within, and immediately adjacent to, the incised channels of both Neerkol and Quarry Creeks. Further information on the physical integrity of soils in the local area is presented in Section 3 – Land Characteristics.

Fisherman's Landing

Local drainage in the Comalco wharf area is directed mostly towards a settlement/evaporation pond in the south-eastern corner of the wharf (Figure 3.5). This area receives 'first-flush' runoff from the Comalco wharf site, located to the west of the proposed coke stockpile area. A bunding system on the reclaim area has been installed to manage runoff from the area. Otherwise, the site currently consists largely of bare earth with few drainage structures or water management infrastructure. Rainfall that is not contained on the reclaim area by the bunding or in the Comalco pond will discharge to Port Curtis, either via seepage through the reclaim or as direct runoff.

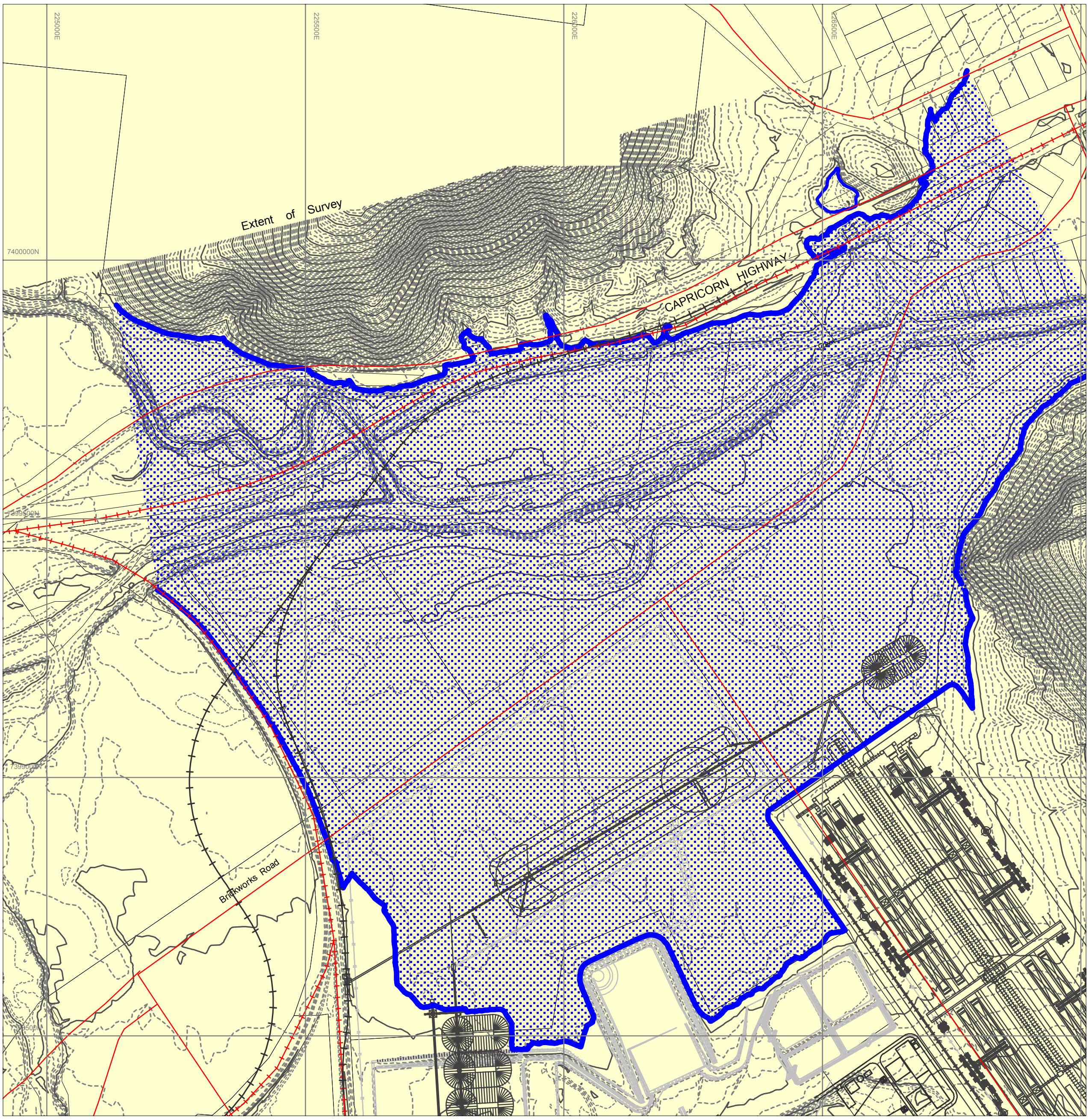
Flooding

Stanwell

It is understood that specific information on flood levels, flow rates and inundated areas for Neerkol Creek in the vicinity of the project site has not previously been recorded and local government and the DNRM rely largely on local anecdotal information. A substantial flood event occurred in February 2003 causing the loss of construction equipment located on the banks of Quarry Creek during activities associated with the AMC development, although more detailed information on the extent, levels and recurrence interval of this flood was not available. Substantial flows appear to be of short duration and flow is very low or nothing for the majority of the year.

A preliminary flood risk assessment on Neerkol Creek adjacent to the northern boundary of the project site was carried out using an industry-standard software package (HEC-RAS, U.S. Army Corps of Engineers). Cross sections for Neerkol Creek adjacent to the project site were developed from contour data for the site and surrounding area. These were input to a steady-state hydraulic model in HEC-RAS with other data (Manning's roughness, location of levees and channels) derived from site observations. Both 100-year and 50-year Average Recurrence Interval (ARI) flow rates for the site were calculated from flood frequency analysis of Neerkol Creek gauging station data (Station Number 130008A) and adjusted to the catchment area at the site. Similar analysis for Quarry Creek was not possible due to the lack of suitable data.

The results of this preliminary modelling suggest that during a 100-year ARI flood, Neerkol Creek would reach a height of approximately 44.5 m AHD adjacent to the site. During a 50-year ARI flood, Neerkol Creek would reach a height of approximately 43 m AHD. The model also suggests that a small floodplain, located to the west of the site, could be an important storage area in the event of major flooding. Figure 5.3 shows the outline 100-year ARI flood levels. The potential impacts of flooding are discussed below. The maximum flow in Neerkol Creek for the February 2003 event was approximately 1,625 m^3s^{-1}. Flood frequency analysis suggests this would be between a 10 and 20-year event.



LEGEND

Indicative 100-year Average Recurrence (Inferred Flood Plain)

Proposed Coke and Power Plant

Existing Stanwell Power Station

Road

Railway

N

0 200 400m

Scale 1:12 500 (A4)

Horizontal Datum GDA94 Zone 56

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100-YEAR AVERAGE RECURRENCE FLOODPLAIN

Drawn: VH	Approved: JMcD	Date: 06-01-06	Figure: **5.3**	Rev:C
Job No: **42625626**	File No: 42625626-g-014c.wor			**A4**

Fisherman's Landing

A storm surge is an increase in local water level to a height markedly above the predicted tide level, and is usually caused by a combination of low barometric pressure and cyclonic wind fields coinciding with a high spring tide. Under these conditions storm surges can cause widespread flooding of adjacent low-lying coastal areas.

Between 1949 and 1992, there have been at least eight separate storm surge events that have occurred at Gladstone. Of these, about a quarter resulted in storm tide levels reaching above the highest astronomical tide level. The Callenmondah area, the Barney Point port area and the Boyne Island area have the greatest level of risk in terms of storm tide inundation (AGSO Geoscience Australia, 2001). Storm surge levels have been predicted by Blain *et. al.* (1980), and these estimates are summarised in Table 5.1.2.

Table 5.1.2 Predicted Storm Surge Levels for Gladstone Harbour

Return Period	1:20 Years		1:50 Years		1:100 Years		1:500 Years	
Location	**m AHD**	**m HAT**	**m AHD**	**m HAT**	**m AHD**	**m HAT**	**m AHD**	**m HAT**
Fisherman's Landing	+2.74	+0.32	+3.10	+0.68	+3.37	+0.95	+4.00	+1.58
Targinie Creek	+2.70	+0.28	+3.15	+0.73	+3.32	+0.90	+3.94	+1.52
Auckland Point	+2.62	+0.20	+2.96	+0.54	+3.22	+0.80	+3.82	+1.40

Source: Blain *et. al.* (1980)

Potential flooding issues at the Fisherman's Landing site are considered to be associated with storm surges and tidal inundation. The region's key tidal data for Port Curtis are presented in Table 5.1.3. Aerial photographs and vegetation mapping indicates the tidal inundation area across the coastal plain is highly variable relative to the tide level.

Table 5.1.3 Tide Levels at Gladstone (Standard Port)

Tidal Plane	Tide Levels at Gladstone (Standard Port) (m AHD)
Highest Astronomical Tide (HAT)	2.42
Lowest Astronomical Tide (LAT)	-2.27
Mean High Water Spring (MHWS)	1.64
Mean Low Water Spring (MLWS)	-1.60
Mean High Water Neap (MHWN)	0.79
Mean Low Water Neap (MLWN)	-0.75

Source: Queensland Transport (2004)

The nominal level for the reclaimed land upon which the loading bays and stockpile will be located, is approximately 5.9 m AHD and is unlikely to be affected by storm surges.

Water Quality

Screening Criteria

Existing chemical water quality of the site and local watercourses has largely been compared with ANZECC/ARMCANZ Guidelines (ANZECC and ARMCANZ, 2000) for lowland river aquatic ecosystems, livestock (beef cattle) watering and irrigation of crops to establish existing environmental values. For chloride and sodium, the values presented are the ANZECC guidelines for sensitive crops (lower values) and tolerant crops (higher values). Tolerant crops are able to tolerate concentrations above those shown and no upper limits for these crops are specified by the guidelines. Abstraction from the creeks for irrigation or stock watering is only likely when there is sufficient water available. Under these circumstances, the volume of water present is likely to provide dilution of potential contaminants. However, water quality monitoring was carried out under varying flow conditions and may not indicate the suitability of water for these purposes.

Draft Queensland Water Quality Guidelines (EPA, 2005a) are also used to review water quality data and generally have priority over ANZECC guidelines. However, with the exceptions of Electrical Conductivity (EC) (calculated value for Fitzroy Central region), total nitrogen and total phosphorus, there are no Queensland-specific guidelines for the majority of indicators monitored. Both guidelines recommend pH values of 6.5 to 8 for aquatic ecosystems. For some monitoring locations, a substantial amount of discrete data has been provided. Overall baseline water quality has, therefore, been discussed by comparing median values and the range of values between the 20^{th} and 80^{th} percentiles with the screening criteria.

Stanwell

Water quality in both Neerkol and Quarry Creeks has been monitored regularly by SCL as part of a wider environmental monitoring program. A range of water quality data for January 1999 to August 2005 was provided for locations within both creeks as follows (Figure 5.1):

- The NSWD discharge into a small tributary of Quarry Creek;
- Neerkol Creek adjacent to Brickworks Road (upstream of the confluence with Quarry Creek and therefore not influenced by the SPS discharge);
- Neerkol Creek adjacent to Capricorn Highway (downstream of the confluence with Quarry Creek);
- Monitoring location MP3 (upstream of the NSWD discharge);
- Neerkol Creek adjacent to Murray’s Farm (upstream of the confluence with Quarry Creek); and
- Quarry Creek (downstream of the NSWD discharge).

Table 5.1.4 presents selected surface water monitoring results, relevant to the discussion of water quality presented in this section.

Table 5.1.4 Selected Stanwell Power Station Water Quality Monitoring Data (1999-2005) for Various Sites

Indicator	QLD EPA/ANZECC Guidelines[1]			Upstream of SPS Discharge								Nthern Stm Wtr Dam Dis.				Downstream of SPS Discharge							
				Murrays Neerkol Creek				Brickworks Road								Quarry Creek				Capricorn Highway			
	Aquatic Ecosystems	Stock Watering	Irrigation	Number of Samples	Median	20%ile	80%ile	Number of Samples	Median	20%ile	80%ile	Number of Samples	Median	20%ile	80%ile	Number of Samples	Median	20%ile	80%ile	Number of Samples	Median	20%ile	80%ile
Field Conductivity (µS/cm)	340	NR	NR	7	2,120	358	4,896	74	3,625	2,044	4,538	333	1,857	1,707	1,960	42	1,928	1,765	2,010	81	2,024	1,807	2,140
Conductivity @ 25°C (µS/cm)	340	NR	VAR[2]	7	1,394	339	4,846	75	3,705	2,033	4,458	346	1,890	1,764	1,968	45	1,948	1,818	2,014	83	2,019	1,837	2,130
Field pH	6.5-8.0	NR	6.5-9	6	7.8	7.7	7.8	73	7.5	7.3	7.8	341	8.6	8.3	8.8	43	7.6	7.4	7.9	80	7.6	7.4	7.9
pH @ 25°C	6.5-8.0	NR	6.5-9	7	7.7	7.5	8.0	75	7.8	7.5	7.9	346	8.7	8.4	8.8	45	7.9	7.7	8.2	84	7.8	7.6	8.1
p Alkalinity (mg/L)	NR	NR	NR	7	0	0	0	71	0	0	0	339	9	2.76	16.44	43	0	0	0	80	0	0	0
m- Alkalinity (mg/L)	NR	NR	NR	7	173.7	104.5	285.74	75	194	119.02	277.06	346	137.25	128.8	146.1	45	150.4	139.38	156.16	84	185.5	174.58	198.84
Temperature (°C)	NR	NR	NR	6	24.0	19.5	24.8	73	24.2	18.6	27.6	344	25.4	20.5	28.0	40	25.2	19.4	28.1	80	23.8	18.7	27.1
Total Hardness (mg/L)	NR	NR	NR	7	381	102	1331	75	1034	576	1247	323	442	405	476	40	451	425	488	78	507	460	534
Turbidity (NTU)	50	NR	NR	6	16.0	6.0	33.0	74	5.4	2.4	11.4	343	3.8	1.5	7.9	43	5.3	1.5	9.1	82	4.1	1.1	9.7
Total Suspended Solids (mg/L)	NR	NR	NR	7	15	10	48	74	10	5	18	345	6	3	10	44	7	4	24	83	6	2	18
Dissolved Oxygen (mg/L)	NR	NR	NR	3	4.8	2.6	9.5	74	5.7	3.4	7.9	340	7.7	6.1	9.2	41	5.2	3.9	7.4	82	4.4	2.4	6.1
T.D.S (calc) (mg/L)	NR	4,000	NR	6	1,019	286	3,085	74	2,006	1,070	2,496	319	1,262	1,174	1,335	40	1,273	1,190	1,339	77	1,308	1,197	1,369
Total Phosphorus (mg/L)	0.05	NR	0.05	0	-	-	-	40	**0.09**	0.05	0.58	78	**0.55**	0.26	0.99	27	**0.40**	0.27	0.44	75	**0.30**	0.18	0.79
Total Nitrogen (mg/L)	0.5	NR	5	0	-	-	-	70	0.47	0.36	1.00	74	2.25	1.46	3.48	28	1.75	1.24	2.50	76	1.10	0.89	1.70
Chloride (mg/L)	NR	NR	175-700	7	324	36	1,452	75	**1,093**	508	1,482	345	317	279	344	45	312	261	344	84	363	319	393
Total Fluoride (mg/L)	NR	NR	1,000	0	-	-	-	58	0.2	0.1	0.2	0	-	-	-	0	-	-	-	66	0.6	0.5	0.8
Magnesium (mg/L as Mg)	NR	NR	NR	7	47	10	165	75	125	63	156	323	45	37	50	40	48	41	53	78	54	44	59
Potassium (mg/L)	NR	NR	NR	7	6	4	7	75	5	4	6	345	27	22	33	45	29	25	33	84	20	17	23
Silica (mg/L)	NR	NR	NR	7	18	11	22	74	19	13	25	344	85	62	119	45	64	55	80	83	54	44	70
Sodium (mg/L)	NR	NR	115-460	7	127	28	512	75	373	195	469	346	221	200	235	45	229	207	240	84	237	218	250
Sulfate (mg/L)	NR	1,000	NR	7	34	10	71	75	33	18	47	344	334	288	389	45	354	313	433	84	311	256	346
Soluble Aluminium (µg/L)	55	NR	5000	2	65	38	92	0	-	-	-	0	-	-	-	2	8	4	12	0	-	-	-
Soluble Barium (µg/L)	NR	NR	NR	1	26	26	26	63	270	140	356	68	250	210	300	0	-	-	-	68	184.5	160	206
Soluble Cadmium (µg/L)	0.2	10	100	3	0.16	0.11	5.34	12	0.18	0.07	4.52	9	0.08	0.05	5.80	4	0.06	0.06	0.07	15	0.15	0.06	4.24
Soluble Chromium (µg/L)[3,4]	4.9	1,000	100	0	-	-	-	15	12.0	4.7	23.4	20	4.2	2.4	7.1	15	4.3	2.2	11.0	19	12.0	4.4	25.6
Soluble Copper (µg/L)[3]	7.3	1,000	200	4	3.5	2.3	3.9	45	1.4	1.0	3.5	78	6.2	3.9	11.0	37	6.1	4.1	10.0	70	2.5	1.6	4.1
Soluble Iron (µg/L)	NR	NR	200	3	180	110	240	15	150	32	322	10	28	22	70	24	61	35	107	32	61	35	108
Soluble Manganese (µg/L)	1,900	NR	2,000	5	39	39	45	51	120	33	370	25	13	8	19	30	29	15	98	59	73	28	159
Cyanobacteria cells/ml	NR	11,500	NR	0	-	-	-	0	-	-	-	84	1,950	49	14,712	31	0	0	1,110	65	80	0	1,390

Notes: [1] EPA (2005a) guidelines given for pH, total nitrogen, total phosphorus and EC. ANZECC/ARMCANZ (2000) default trigger values for lowland river aquatic ecosystems, livestock (beef cattle) watering and irrigation of general crops given for all other indicators where relevant.
[2] Guideline values of EC for irrigation of crops are highly variable dependent on a range of factors including type of crop.
[3] Trigger values corrected for median water hardness.
[4] Trigger value for CrVI.
Exceedance of the guideline criteria (upland river aquatic ecosystems) shown as shaded cells, exceedance of irrigation upper limits shown in **bold**. There was no exceedance of stock watering criteria for median values.
NR = No values recommended.

High salinity runoff occurs with the first flush of rainfall after a dry period. As rainfall continues, salinity will decrease due to dilution from increased runoff volume. After rainfall ceases, water becomes isolated in billabongs along the course of local creeks where salinity gradually rises due to evaporation and the influence of groundwater as an increasingly large component of water in the system. Increasing salinity in the overall catchment is potentially a result of agricultural practices and land clearing. This promotes increased erosion and mobilisation of salts as a result. Without vegetation to reduce the watertable level, naturally occurring groundwater is also brought closer to the surface and into contact with surface water bodies.

Neerkol Creek and several of its tributaries are naturally very saline as supported by the monitoring data. EC values are above EPA guidelines for Fitzroy central region at all locations with large variations between the 20^{th} and 80^{th} percentiles. The highest values are found on Neerkol Creek at Brickworks Road (upstream of the NSWD discharge) and the lowest are from the point of NSWD discharge.

As would be expected, due to the relationship with EC, Total Dissolved Solids (TDS) are also elevated at a number of sites, however, concentrations are at a suitable level for stock watering and the NSWD discharge is within the limits prescribed under the terms of SPS’s environmental authority. Elevated chloride levels were detected at a number of sites, particularly Brickworks Road upstream of SPS’s discharge, and are likely to be naturally occurring. Sulphate levels are also slightly elevated, though not above any of the screening criteria used.

All sites are slightly alkaline. The highest median pH values are at the NSWD discharge (8.6-8.7) but are within the range prescribed by the environmental authority. With respect to pH and SPS’s environmental authority conditions, the EPA pH guidelines have not been exceeded at any of the locations downstream of the discharge on Neerkol Creek or Quarry Creek. Values for pH do not have a wide variance.

Dissolved Oxygen (DO), Total Suspended Solids (TSS) and turbidity are all within guideline criteria. Total phosphorus is above guideline criteria upstream of the NSWD discharge. Total phosphorus and total nitrogen are above screening criteria downstream of the NSWD, as is the NSWD discharge water which contributes to flow at the downstream sites. As land use in the catchment is largely characterised by agriculture, the use of fertilisers and high erosion rates from farmland are also likely to be significant contributors to the elevated nutrients. However, monitored concentrations of DO and turbidity are not above screening criteria at any location and do not indicate significantly eutrophic conditions.

Soluble aluminium was detected at elevated concentrations at the monitoring location adjacent to Murray’s Farm on Neerkol Creek (upstream of the NSWD discharge). Relatively little additional data for aluminium was available, although monitoring on Quarry Creek indicated that levels there were below screening criteria. Chromium was also detected at concentrations above ANZECC (2000) guidelines for lowland freshwater ecosystems on Neerkol Creek, both upstream and downstream of the confluence with Quarry Creek. However, as the screening criteria are for CrVI only and the laboratory analysis presented made no distinction between chromium species, this may not be an accurate representation of environmental risk. Cadmium, copper and iron concentrations show marked variation between the 20^{th} and 80^{th} percentiles at most sites. However, median values are all below screening criteria. The concentrations of metals are likely to be naturally occurring as a result of the regional geological conditions and are considered to be limited in bioavailable forms, due to the generally alkaline nature of the catchment.

Water quality samples in Neerkol Creek were also collected by DNRM between October 1987 and May 2002 at Station Number 130008A, located downstream of the SPS discharge and currently owned by SPS. As the hydrological regime was significantly altered by the commencement of continuous discharge from SPS in 1993, only data after this date is considered to be representative of current conditions and are summarised in Table 5.1.5.

Table 5.1.5 DNRM Water Quality Data for Neerkol Creek (Station Number 130008A)

Indicator	QLD EPA/ANZECC Guidelines[1]			Station Number 130008A		
	Aquatic Ecosystems	Stock Watering	Irrigation	Median	20%ile	80%ile
Field Conductivity (µS/cm)	340	NR	NR	2,094	1,560	2,182
Conductivity @ 25°C (µS/cm)	340	NR	VAR[2]	2,098	1,445	2,185
Field pH	6.5-8.0	NR	6.5-9	7.7	7.4	8.0
pH @ 25°C	6.5-8.0	NR	6.5-9	7.8	7.7	8.2
Temperature (°C)	NR	NR	NR	23.5	17.9	27.7
Hardness as CaCO3 (mg/L)	NR	NR	NR	544	363	569
Turbidity (NTU)	50	NR	NR	0.8	0.5	1.5
Total Suspended Solids (mg/L)	NR	NR	NR	5.0	2.6	9.0
Dissolved Oxygen (mg/L)	NR	NR	NR	7.5	4.0	10.1
T.D.S (calc) (mg/L)	NR	4,000	NR	1241	864	1318
Total Phosphorus (mg/L)	0.05	NR	0.05	0.025	0.018	0.068
Nitrate as NO3 (mg/L)	0.06	400	NR	1.3	0.6	1.7
Chloride (mg/L)	NR	NR	175-700	389	254	412
Total Fluoride (mg/L)	NR	NR	1000	0.31	0.24	0.42
Potassium (mg/L)	NR	NR	NR	11.0	6.5	13.1
Silica (mg/L)	NR	NR	NR	23.9	14.8	30.4
Sodium (mg/L)	NR	NR	115-460	233.1	160.6	248.7
Sulfate (mg/L)	NR	1,000	NR	305.8	158.5	336.5
Soluble Aluminium (µg/L)	55	1,000	5	0	0	4
Soluble Copper (µg/L)[3]	7.3	1	0.2	10	10	26
Soluble Iron (µg/L)	NR	NR	0.2	10	4	16
Soluble Manganese (µg/L)	1,900	NR	2	0	0	0

Notes: [1] EPA (2005a) guidelines given for pH, total nitrogen, total phosphorus and EC. ANZECC/ARMCANZ (2000) default trigger values for lowland river aquatic ecosystems, livestock (beef cattle) watering and irrigation of general crops given for all other indicators where relevant.
[2] Guideline values of EC for irrigation of crops are highly variable dependent on a range of factors including type of crop.
[3] Trigger values corrected for median water hardness.
Exceedance of the guideline criteria (upland river aquatic ecosystems) shown as shaded cells, exceedance of irrigation upper limits shown in bold. There was no exceedance of stock watering criteria for median values.
NR = No values recommended.

DNRM's monitoring data suggests that Neerkol Creek does not meet EPA (2005a) guidelines for EC or ANZECC (2000) aquatic ecosystems water quality guidelines for pH, nitrate and copper. The creek is generally suitable for stock watering and irrigation of most crops under the ANZECC guidelines (ANZECC, 2000).

In situ continuous pH and EC monitoring have also been carried out at this site from December 1994 to the present. The mean pH of this data is 8.1 and mean EC is 1,973 µS/cm. Both of these values exceed screening criteria for aquatic ecosystems. However, DNRM have advised that these results should be used with caution as the probes were serviced only once every three to four months (P. Voltz, DNRM. pers. comm. 21/06/05) and monitoring probes can be seriously affected by algal growth which interferes with the meter readings. Notwithstanding the above, the EC of Neerkol Creek reflects the background salinity of this catchment (refer Table 5.1.4).

The most recent analysis of monitoring data was reported in 2001 (Waste Solutions Australia, 2001) and found no exceedances of the SPS environmental authority conditions recorded between 1999 and 2000 (the period of monitoring covered by the report). The data reviewed for this EIS suggests that discharges from the NSWD continue to be within the licence conditions for the prescribed parameters. The report also stated that salinity levels downstream of the NSWD discharge had slightly decreased since the commencement of SPS discharge. However, sulphate concentrations at the Capricorn Highway site were reported to have increased by more than five times the pre-1993 level. Sulphate tends to remain in solution and does not precipitate out or undergo other reactions to remove it from solution if the water is not reducing and is under-saturated with gypsum. It is therefore a useful indicator of how far discharges originating from SPS travel within the overall catchment. At Fairy Bower Road, a monitoring location approximately 15 km downstream from SPS, sulphate levels exceeded the baseline by greater than three times on one occasion, indicating the possibility for discharge to reach several kilometres downstream of the discharge point. Elevated sulphate levels in an anoxic environment such as a stagnant billabong can lead to the growth of sulphate-reducing bacteria that produce hydrogen sulphide as a waste product.

Both Neerkol and Quarry Creeks are characterised by abundant aquatic plant species, macro invertebrates and aquatic vertebrates including turtles (Section 6 – Nature Conservation). A change in aquatic ecology has been noted since SPS commenced operations in 1993. The most obvious impact of this continuous flow has been an increase in exotic weed growth (especially Para Grass) along the creek. As the local streams pass through chiefly agricultural landscapes, they are also subject to other outside modification processes, including clearing of riparian habitats and cattle degradation. Aquatic ecology is characterised by low SIGNAL2 (aquatic macroinvertebrate index) scores indicating that water quality is generally poor. However, the larger aquatic species that were observed are considered relatively robust to these conditions. Further information is presented in Section 6 – Nature Conservation.

Fisherman's Landing

The wharf at Fisherman's Landing extends more than 2 km from the natural coastline into the narrows of Port Curtis. Water quality at Port Curtis is critical due to the proximity of the Great Barrier Reef World Heritage Area and coastal marine parks. Due to the area's importance, the "Curtis Coast Regional Coastal Management Plan" (Curtis Coast Plan) (EPA, 2003a) has been drafted by the EPA to direct the implementation of the “State Coastal Management Plan – Queensland’s Coastal Policy” (EPA, 2001). This indicates that water quality must be maintained at a standard that supports and maintains coastal ecosystems. Furthermore, release of contaminants must be eliminated wherever possible. The narrows around Fisherman’s Landing are considered by the Curtis Coast Plan to be a near pristine system that has experienced minimal impacts and are vulnerable to effects from contaminated stormwater runoff. Suspended solids are a major source of pollutants particularly from bare earth surfaces and can impact on local seagrass beds and marine biodiversity.

The Curtis Coast Plan also states that water quality monitoring at Port Curtis is undertaken by a range of organisations and is not well co-ordinated or integrated into decision making. Relatively little water quality data is available. Monitoring around Fisherman’s Landing was carried out over a period of 12 months for the Stuart Oil Shale Project EIS (Southern Pacific Petroleum, 2002). Although raw data was not available, summary graphs indicated that water was slightly alkaline (at a pH of approximately 8) and suspended solids were found to be generally between 20 mg/L and 100 mg/L. DO was found to be generally within the guideline trigger values (draft EPA Water Quality Guidelines for Central East Coast Mid-Estuarine Waters - 2005a). A range of metals (aluminium, arsenic, barium, boron, cadmium, copper, iron, lead, mercury, nickel and zinc) were analysed and all were found to be below ANZECC (2000) trigger values for marine waters, with the exception of copper and nickel which had been detected at concentrations slightly greater than the respective trigger values on more than one occasion. An elevated concentration of cyanide was detected on one occasion but the median value would be below screening criteria. Total nitrogen and total phosphorus were found to be generally below draft EPA Water Quality Guidelines (2005a) with the exception of one sample for each parameter that had been detected slightly above respective trigger values. Ammoniacal nitrogen was found to be highly variable and appeared to be at a concentration greater than screening criteria on several monitoring rounds.

Surface Water Abstractions

There are 21 surface water abstractions within the Neerkol Creek catchment currently licensed to 16 parties by DNRM. Of these: 13 are for irrigation purposes only; one for domestic supply only; three for domestic supply and stock watering; four for domestic supply, stock watering and irrigation; and one for irrigation and amenities. One further licence in the Neerkol Creek catchment for irrigation purposes expired on 30 June 2005, although it is possible that this has now been renewed. Within the wider catchment context, one licence is registered in each of the Stuart Creek and Sandy Creek catchments for irrigation. Licence conditions for abstractions from these watercourses do not specify the volume of water permitted for extraction but specifies the area in hectares that the licensee is entitled to irrigate. The total volume extracted from each creek in any year is therefore largely dependent on the availability of water and the crop to be irrigated.

Existing Environmental Authorities

Stanwell

The EPA has issued an environmental authority to regulate the environmental aspects of the operations of SPS. These include operating a sewage treatment works, operating a municipal water treatment plant, waste disposal, chemicals manufacture, processing and mixing, crude oil and petroleum product storage and power generation.

Schedule C of the environmental authority relates to water and states that all practicable measures to prevent or minimise the release of contaminants to waters must be carried out. A number of dams (e.g. drains reclaim dam, effluent dam, coal stockpile runoff ponds) are located on site for water management and these are specified as being suitable for the release of potentially contaminated water. Discharges from the site into the water environment outside the site boundary are only permitted from the NSWD to an unnamed tributary of Quarry Creek. A number of monitoring locations for surface water quality are described and limits for a range of water quality parameters including pH, suspended solids, DO and TDS are specified (Table 5.1.6). With regards to volume of discharge water, Schedule C states that this must not exceed 18 ML/day.

Table 5.1.6 Release Water Quality Characteristic Limits from NSWD as Defined in SPS Environmental Authority

Indicator	Discharge Limit in Environmental Authority
pH	6.5-9.6
Total Dissolved Solids (mg/L)	1,450
Total Suspended Solids (mg/L)	100
Dissolved Oxygen (mg/L)	2[1]
Total Chloride (mg/L)	400
Total Residual Oxidant (as Cl) (mg/L)	0.05

Notes: [1] Minimum value.

Schedule D of the environmental authority covers stormwater management, specifically with regards to potential contaminant releases caused by rainfall. With the exception of runoff into the drains reclaim dam, coal stockpile runoff ponds and runoff from a former landfill site, all activities must be carried out by such practicable means to prevent or minimise the contact of rainfall or stormwater runoff with wastes or other contaminants and prevent the release of contaminated runoff from the site.

Fisherman's Landing

Environmentally Relevant Activities (ERAs) at Fisherman's Landing, including stockpiling, loading or unloading goods in bulk and regulated waste transport from/to the wharf are also regulated by the EPA through an environmental authority held by the Central Queensland Port Authority (CQPA). The conditions state that, as holder of the environmental authority, CQPA must take all reasonable and practicable measures to prevent and/or to minimise the likelihood of environmental harm being caused and must install all measures, plant and equipment necessary to ensure compliance with the conditions of the environmental authority. Schedule 1C of the environmental authority states that contaminants must not be released from the site to any waters or the bed and banks of any waters and there must be no release of stormwater runoff that has been in contact with any contaminants at the site to any waters, roadside gutter or stormwater drain. Under Schedule 3C, the holder of the environmental authority is also responsible for checking stormwater drains for slicks, scums or other evidence of discolouration on a monthly basis and making determinations of total oil and grease concentrations for the released waters if they exist. Release of contaminants to waters is regulated by the limits specified in Table 5.1.7.

Table 5.1.7 Release Water Quality Characteristic Limits in CQPA Environmental Authority

Indicator	Discharge Limit	Monitoring Frequency
Dissolved Oxygen (mg/L)	2 [1]	Upon discharge (up to 4 times/year)
Suspended Solids (mg/L)	Port Curtis +10%	Upon discharge (up to 4 times/year)
pH	6.5-8.5	Upon discharge (up to 4 times/year)
Oil and Grease (mg/L)	10	Upon discharge (up to 4 times/year)

Notes: [1] Minimum value.

Further conditions relate to determining the presence of *Escherichia coli* in the marina and monitoring of mangrove colonisation adjacent to intertidal port developments. Activities associated with the Project will be required to comply with the conditions of CQPA's environmental authority.

Summary of Environmental Values

In line with the *Environmental Protection (Water) Policy 1997* (*EPP (Water)*), environmental values for all Queensland waters must be identified in order that they be protected and/or enhanced. These include the biological integrity of the aquatic ecosystem and recreational, drinking water supply, agricultural and/or industrial uses. Specific environmental values for Neerkol Creek are not defined within the *EPP (Water)* and there are no detailed local plans relating to environmental values for the catchment.

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The biological status of Neerkol and Quarry Creeks is considered to be poor as indicated by macroinvertebrate scoring (Section 6 – Nature Conservation). High salinity is evidenced by elevated EC concentrations above ANZECC guidelines (2000) for lowland freshwater ecosystems. However, this is considered to be a natural occurrence. Monitoring data also suggests that there are elevated concentrations of nutrients both upstream and downstream of the site which have the potential to promote eutrophic conditions, although there are other indicators such as DO and cyanobacteria which suggest eutrophication is not an issue at present. Abundant exotic aquatic flora (principally Para Grass) is present in the catchment. The reasons for the spread of this species are complex and are probably attributable to a number of causes.

Recreational values of local watercourses are considered to be very limited. Neither Quarry nor Neerkol Creeks are navigable and few locations are suitable for swimming. Although recreational fishing has been observed on Neerkol Creek, none of the large species commonly associated with angling are present or have been observed in the past. There are no direct abstractions from natural surface water bodies in the local area for industrial purposes. Most local residents obtain the majority of their water supply from rainwater harvesting but eight abstraction licenses define domestic supply as a use for creek water. However, existing flows are considered to have insufficient chemical quality to be used for drinking water without significant treatment. The issue of supply security also precludes more widespread use for this purpose. Abstractions from Neerkol Creek for agricultural purposes are extensive, largely for irrigation and stock-watering. Existing chemical water quality suggests that Neerkol Creek is largely suitable for these purposes.

Fisherman's Landing

Water quality in the narrows at the Fisherman's Landing site is described in the Curtis Coast Plan (EPA, 2003a) as being a near pristine system within the narrows around Port Curtis and has experienced minimal impacts. This water has considerable ecological and recreational value and is vulnerable to effects from contaminated stormwater runoff.

5.1.2 Potential Impacts and Mitigation Measures

Stanwell - Construction Phase

Sediment/Contaminant Mobilisation

Sediment mobilised during construction activities may enter surface water runoff during rainfall events and discharge to watercourses leading to deleterious effects on water quality and aquatic habitats. A discussion of the erosion potential of soils at the project site and methods to mitigate the effects of erosion is presented in Section 3 – Land Characteristics. However, the potential for overland flow and sediment mobilisation at this site is limited by shallow gradients. Water management structures have already been established for the majority of the project area to convey flow without exacerbating erosive potential and to prevent sediment mobilisation off-site. These include excavated drainage lines and settlement/evaporation ponds which will be upgraded for this Project.

Sediment exposed or generated during construction and/or plant operation may also be blown by wind into surface water bodies and potentially dry up wet areas. However, development at the project site will be at least 500 m from the nearest natural surface water body, which should adequately reduce the risks presented by wind-blown sediments.

The site has already been largely cleared of vegetation, exposing soil to wind and rain. Upon completion of the Project, the majority of the site will be covered by hardstand which will stabilise the soil and reduce erosive potential. Areas not required for essential plant functions will be re-vegetated post-construction.

On-site soil investigations found limited potential for significant contamination. Measures to mitigate environmental impacts from the mobilisation of soil contamination are outlined in Section 16 – Environmental Management Plan. The overall potential significance of these impacts is considered to be low.

Pollution Effects

Potential sources for on-site pollution during the construction phase predominantly comprise diesel and other petroleum-based fuels and lubricants used by excavation and construction machinery.

The SPS system has capacity to treat additional sewage effluent from the Project operational phase workforce, however, it is not presently known whether it will be sufficient to deal with the sewage volumes associated with the construction workforce. If the capacity is insufficient for this purpose, alternative arrangements including temporary toilet facilities will be provided. All waste produced in temporary facilities will be removed off-site for appropriate disposal. However, leakage of on-site sanitation may also cause effluent to be mobilised into surface waters with a direct impact on water quality. Limited volumes of potential contaminants and sanitary facilities will be required on-site and the risk of leakage is low.

Bunded storage areas for fuels and dangerous goods required for construction equipment will be provided with spill cleanup kits in accordance with Australian Standards (AS1940 and AS3780). All transfers of fuels and chemicals will be controlled and managed to prevent spillage outside bunded areas. Any pollution, mobilised in surface runoff, will be contained within the construction phase drainage network and will, therefore, ultimately enter the existing settlement/evaporation ponds where it can be contained and cleaned up. The significance of this impact is considered to be low.

Works Adjacent to/within Drainage Lines

Infilling on-site surface water bodies or drainage lines can lead to potential loss of water storage and can cause shallow waterlogging and/or destroy ecological habitats. However, no development will occur within 500 m of any natural water bodies or the likely floodplain. Construction activities that will affect existing drainage channels and control measures will only be carried out after suitable stormwater management infrastructure has been implemented on-site. No other natural surface water features have been identified on-site. The significance of this impact is considered to be low.

Increase in Impermeable Area

The construction of the Project will add to the overall proportion of impervious surface in the area. During the construction phase, soil compaction and digging up of permeable areas may also lead to an increase in impermeable surface area contributing to higher flow rates. Excessive increases in peak runoff can lead to increased flood risk and mobilise sediment, causing a negative impact on downstream receiving waters. However, the site has been mostly cleared of vegetation and the drainage measures already established mean that the majority of rainfall flows as relatively rapid runoff into the sediment dams established during preparatory works for the former AMC project. Overflows from these ponds are expected on average once in every 10 years. Within the context of the overall catchment area, this will have a very low impact on the overall flow regime.

Stanwell - Operational Phase

Pollution Effects

The major contaminants of concern at the project site are coal and coke particulates. These can enter surface runoff after rainfall or be mobilised into surface water bodies as wind-blown dust. Although typically Australian coals are considered to have generally low levels of toxic trace elements in comparison with coals from other countries, heavy metals may be associated with coal dust and therefore could be present in stormwater drainage from many areas of the plant. Other notable toxicants present in coal, particularly found in ash residue, include a range of Polynuclear Aromatic Hydrocarbons (PAHs), which are burned off during the coking process and are not present in coke.

Due to elevated dust levels, which may be blown from the stockpiles into surface runoff, the quality of discharge from the Coke Plant and stockpiles will not be of sufficient quality to be routed directly to surface water. Upon completion of Project construction, drains from coke plant areas will discharge to settlement/evaporation ponds. Pond design will comprise a range of measures, including weirs and deep water pools, to filter inflowing water and contain and precipitate out sediments and contaminants. Drainage from the Power Plant will also be directed to settling ponds with excess water discharged off-site. Water modelling has been undertaken for the coke plant catchment and various pond design and water re-use scenarios, tested against 66 years of historic rainfall data from the area. As a result of the modelling, the proposed water management systems discussed for the Coke Plant have been developed (Appendix F).

All ponds will be provided with a Design Storage Allowance (DSA) providing spare capacity above the normal operating water level to contain rainfall events and wave action without discharge to the environment. In the event of overflows resulting from storm events, the volume of rainfall would dilute the sediment content and salinity of overflow water. The overflow water from the ponds would also be from relatively sediment-free due to the decant water originating from the pond surface. Water entering the coke plant settlement/evaporation ponds will be predominantly disposed of by evaporation or re-used on site. Climate data for the local area (Section 4 - Climate) suggests advantageous conditions for the evaporation of water.

As coal and coke dust may also be blown by wind into surface water bodies, dust suppression measures including irrigation of the coal and coke stockpiles will be implemented. The stockpiles are also located at least 500 m from the nearest natural surface water body (Neerkol Creek to the north) which is considered to provide an adequate buffer.

Sewage from the Project will be treated within the existing SPS sewerage system or via site-specific treatment options. Other potential aqueous waste streams will include stormwater and runoff from chemical and hydrocarbon storage areas and process and maintenance and oil-filled transformer yard areas, water used for fire fighting activities, cooling water blowdown from the Power Plant, blowdown from the HRSGs, and water from coke quenching.

Waste water management infrastructure and procedures at both the Coke Plant and Power Plant will significantly reduce the risk of pollution. All areas where spills or leaks of contaminants may occur will be bunded in accordance with relevant Australian Standards and connected to oil separators where appropriate. No discharges to the wider environment will occur without waste water having been inspected and tested. Where contamination is identified, the waste water will be treated on-site or removed off-site for disposal at a licensed facility. Bunded areas and waste water collection pits will be isolated from surface runoff to prevent excessive volumes of waste production.

Some of the water from the settlement/evaporation ponds will be used for dust suppression at the coal and coke stockpiles. The rate of water used for dust suppression will be managed to reduce the potential for runoff from the stockpiles. Water from the settlement/evaporation ponds may also be used in a dilute form in coke quenching depending on water quality constraints.

Although it is possible that cooling water blowdown from the Power Plant will be re-used in the quench process, it is also possible that some or all of the blowdown will need to be discharged into Quarry Creek via settling ponds at a maximum rate of approximately 1.8 ML/day (Stage 1) increasing to 3.7 ML/day (Stage 2). These discharge rates will vary under adverse conditions such as hot weather and during times when raw water is of a substandard quality. Blowdown from the Power Plant will be of a similar quality to that from SPS and is likely to be characterised by elevated salinity, suspended solids and some slightly elevated metals. The blowdown will be directed to on-site settling ponds with similar surface water buffer pond configurations to the NSWD. It is assumed that similar discharge constraints would be imposed on the discharge from the Power Plant to those currently designated in the SPS environmental authority to protect downstream water quality. Any quench water that does not evaporate during spraying onto the hot coke will be continually recycled back into the quenching process and replenished through the raw water supply to provide dilution of salt content build-up resulting from continued re-use.

Given the proximity of downstream water users and the ephemeral nature of much of the local water environment, unchecked discharges from the Project could potentially comprise a large proportion of the flow in the creek for most of the year. This has guided the design strategy for surface water management at the Project towards minimising the amount of potential contaminants present in runoff (e.g. coke and coal dust, oil and chemicals) and installing infrastructure to contain and treat it. Appropriate procedures to further reduce the risks will also be implemented and are outlined in the Surface Water and Erosion Management Plan (Section 16 – Environmental Management Plan).

Flooding

Both the Coke Plant and Power Plant will be located above approximately 51 m AHD on raised ground. The largest flood event simulated using the outline hydraulic model was a 100-year ARI flood. Hydraulic modelling suggests that the water level during such an event would be approximately 44.5 m AHD. The main plant areas are therefore unlikely to be significantly affected by flooding. Although the layout of the site is yet to be finalised, it is likely that the settlement/evaporation ponds would be located at an elevation lower than the 100-year ARI flood level. However, these ponds will be designed such that they spill on average once every 10 years when modelled using 66 years of historical rainfall data collected from the area. Inundation of the ponds during a major flood would not therefore increase the risk of pollution incidents relative to those posed by design overflows. A 100-year ARI flood would provide significant dilution of any potential pollutants. Further assessment of the structural integrity of the settlement/evaporation pond walls in relation to extreme weather events will be made during the detailed design stage. All ponds will be designed in accordance with relevant engineering standards, including the "Soil Erosion and Sediment Control Guidelines for Queensland" (Institution of Engineers Australia (IEAust), 1996).

Appropriate flood risk alleviation measures such as a flood berm or raising of the entire stockpile area would be required to offset potential operational, environmental and health and safety risks from flooding at the coke stockpile. The coal stockpile is likely to be located well above the likely 100-year ARI floodplain. Any raising of land around the Coke Plant and stockpiles may have the affect of reducing the overall volume storage of the functional 100-year ARI floodplain with a potential consequence of increasing flood risk elsewhere in the catchment. Further assessment of flood risk in the area will be undertaken during detailed design and finalising the site layout.

Water Use

Optimal heat supply from the Coke Plant for the efficient operation of the associated Power Plant will be achieved when the Coke Plant is at full Stage 2 production. Consequently, the construction of the Power Plant is likely to coincide with the Stage 2 construction of the Coke Plant. However, further consideration of detailed design, economic and supply scenarios may result in the Power Plant being constructed and commissioned earlier than Stage 2 of the Coke Plant. Several different configurations for water use at the Project are possible, each with a different water requirement. The water use scenarios are based on the use of water cooling by the Power Plant, although investigations into the possible use of air cooling in the Power Plant are being conducted. Whilst air cooling will save on raw water requirements for the Power Plant, the production of blowdown water from the Power Plant will be limited. It should also be noted that the downside arising from the use of air cooling is a reduction in the efficiency of the Power Plant which will impact on its overall feasibility. Should water cooling be used, the largest single water use would be for the power plant cooling system (approximately 6,675 ML/year during Stage 2 with an additional 10% contingency allowance).

Other significant water uses are for coke quenching, the power plant steam cycle and dust suppression at the coal and coke stockpiles (Table 5.1.8). The maximum annual water use would be for Stage 2 production with the Power Plant fully operational. This would be approximately 10,740 ML/year. Stage 2 production at the Coke Plant without the Power Plant would require approximately 2,994 ML/year. Therefore, the maximum expected requirement for raw water importation is 10,740 ML/year. This assumes no implementation of re-use or recycling practices.

Water for make-up to the power plant steam cycle must be of a demineralised quality to prevent scaling of plant equipment and will be recycled within the process. A demineralised water supply will either be provided from the SPS water treatment plant at the site boundary or from a stand-alone demineralised water plant to be constructed. As occurs at the SPS, if both potable and demineralised water are prepared on site with new stand alone facilities, potable water can be derived from the demineralised water plant pre-treatment water prior to it undergoing demineralisation.

In order to reduce the Project’s consumptive use of water transferred from outside the Neerkol Creek catchment, minimise the volume of potentially contaminated discharges and enhance sustainability, opportunities for water re-use and recycling will be explored and implemented wherever possible. Dust suppression water demand will be in the order of 211.8 ML/year, however, some of this demand will be sourced from the coke plant settlement/evaporation ponds whenever there is sufficient water available. Dust suppression requirements able to be supplied from the settlement/evaporation ponds have been modelled at 67 ML/year (Stage 1) and 120 ML/year (Stage 2). The use of settlement/evaporation pond water has the potential to reduce water importation demand for dust suppression to 91.8 ML/year (Stage 2).

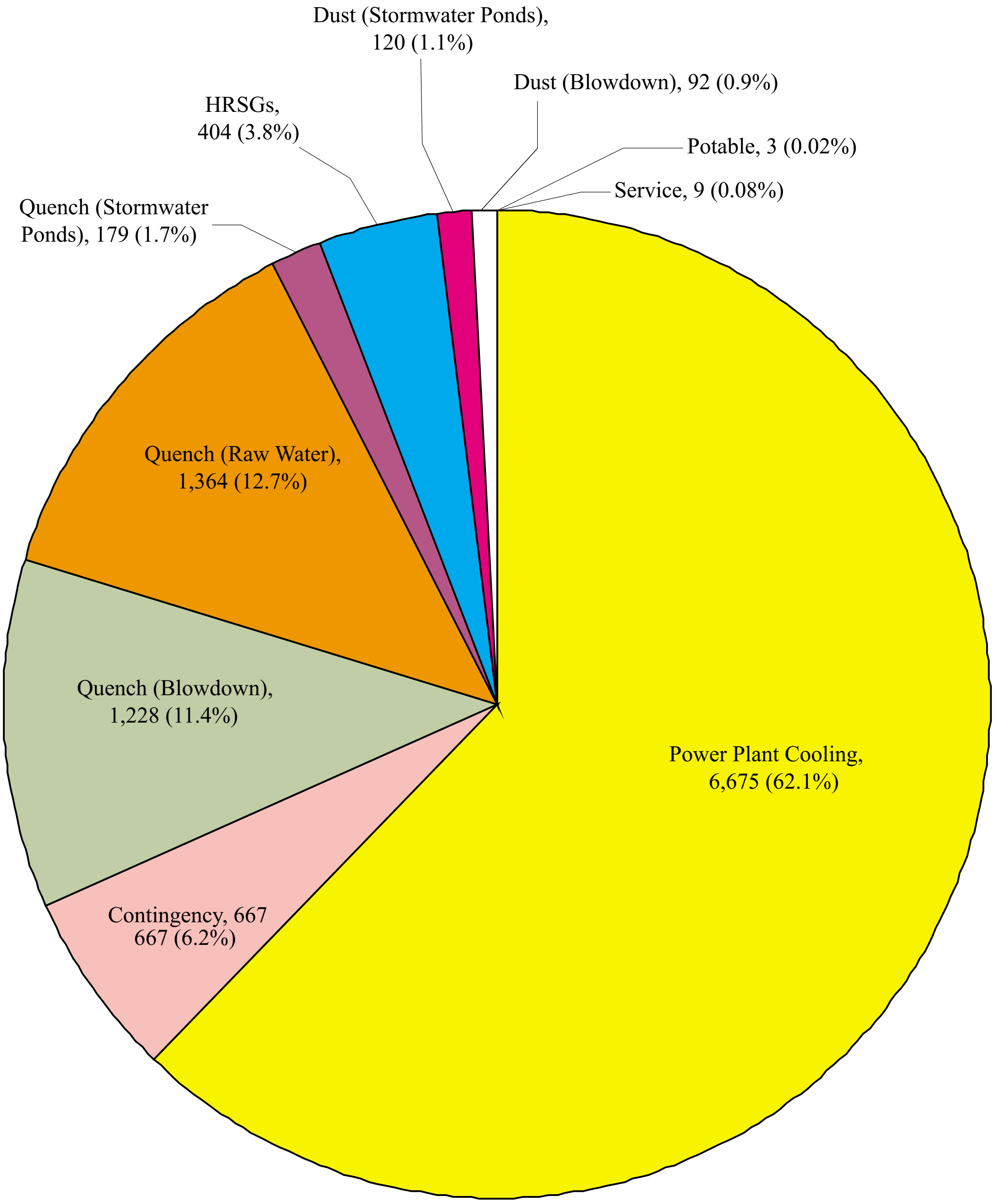
Provided that dust suppression needs are met, if there is additional water in the coke plant settlement/evaporation ponds then up to 10% of the Coke Plant's daily quench requirement for water may be obtained from this source as well, should the stormwater be of suitable quality for this purpose. However, rainfall is highly variable in this area and during some periods the volume of water supplied may be much lower. Modelling carried out using daily rainfall data between 1939 and 2005 suggests that as a long-term average approximately 6-7% of the total average quench demand could be derived from the settlement/evaporation ponds which would amount to 96 ML/year (Stage 1) increasing to 179 ML/year (Stage 2).

A further potential source of water re-use is the blowdown from the Power Plant's steam cycle (269.1 ML/year) and cooling processes (958.8 ML/year), which will become available during Stage 2 of the Project. Dependent on blowdown characteristics and quality restrictions for quenching purposes, it is possible that up to 100% of blowdown from the Power Plant (1,227.9 ML/year) could be used for quenching (Table 5.1.8). Based on the modelled figures for long term average availability of stormwater for quenching in the coke plant settlement/evaporation ponds (179 ML/year) and 100% re-use of blowdown for quenching, for Stage 2 of the Project including construction of the Power Plant (1,227.9 ML/year), it is possible that raw water needs for quenching may be reduced by approximately 1,406.9 ML/year. Table 5.1.8 and Figure 5.4 presents a breakdown of water use for this scenario. It is also possible that up to 10% (220 ML) of the available SPS blowdown may be used for quenching.

If the SPS blowdown water is able to be used in conjunction with power plant blowdown and available stormwater from the settlement/evaporation ponds, a total reduction in the demand on raw water importation in the order of 1,626.9 ML/year may be achieved. Additionally, the use of settlement/evaporation pond water for dust suppression may further reduce the demand on raw water by 120 ML/year, resulting in a total potential reduction in demand for raw water of 1,746.9 ML/year. This reuse scenario equates to 16% of the total site water requirement.

As the production of blowdown water will vary depending on operational factors, these are planning estimates only. As the quenching and blowdown processes are both continuous and the quenching demand is higher than available blowdown supply, no evaporative losses between blowdown water sourcing and delivery to the quenching process have been included in these calculations. In addition, the amount of blowdown water available for re-use will depend on the volume required to maintain environmental and irrigator abstraction flows in the Quarry Creek/Neerkol Creek systems. Detailed water system modelling will be undertaken as plant designs are further developed and will be continuously revised during the operational phase.

Of the potential options available for raw water supply, uses that do not increase the overall burden on the Fitzroy Basin would be the most sustainable, reliable and environmentally friendly. The "Fitzroy Basin Resource Operations Plan" (ROP) (DNRM, 2004) is the chief implementation tool of the "Fitzroy Basin Water Resource Plan" (DNRM, 1999) as defined by the Queensland *Water Act 2000*. This seeks to



STANWELL CORPORATION LIMITED / QUEENSLAND COKE & ENERGY	QUEENSLAND COKE AND POWER PLANT PROJECT ENVIRONMENTAL IMPACT STATEMENT			**BREAKDOWN OF WATER USE (ML/year) FOR COKE AND POWER PLANT PROJECT (STAGE 2)**
URS	Drawn: VH	Approved: JMcD	Date: 06-01-06	Figure: **5.4** Rev. A
	Job No.: **42625626**	File No. 42625626-g-052.cdr		A4

manage water in an integrated and sustainable way to achieve a balance between the needs of current water users, further water-related development in the area and environmental flows needed for aquatic ecosystems. Existing water allocations licensed by DNRM are already part of the ROP and therefore represent relatively secure, sustainable options.

SPS currently has an allocation of 24 GL/year from the Fitzroy River, approximately 30 km upstream of the Rockhampton Barrage but typically draws 2.01 GL on average per annum, with the amount being used varying each year depending on climatic factors and SPS plant availability. Some of SPS's unused allocation may be made available to the Coke Plant, although this is yet to be confirmed. The existing raw water supply may not be able to accommodate the peak instantaneous demand requirements of both the Coke Plant and SPS simultaneously, as the existing water supply pipeline has an effective maximum pumping capacity of 27 GL per annum and the Stanwell Water Supply Dam has a storage capacity of 1.9 GL. Other options for obtaining existing water allocations would include water trading arrangements with existing users such as Rockhampton City Council.

The "Fitzroy Basin Water Resource Plan" (FBWRP) (Fitzroy Basin Association, 2004a) indicates that up to 300,000 ML of unallocated mean annual diversion may still be available from the Fitzroy Basin. However, obtaining a new allocation from DNRM will be dependent on a number of factors including the type of allocation (water harvesting or direct diversion from the river), timescales for the release of allocations, security of supply and cost. Many of the potential options are likely to involve the construction of significant infrastructure and will be subject to relevant assessments and licensing/application processes. For example, a supply from the Fitzroy River upstream of the Rockhampton Barrage to the Stanwell Water Supply Dam may require a new pipeline and an increase in dam capacity. To meet the objectives of the FBWRP, the Project must also demonstrate that water use will be managed as efficiently as possible. Opportunities for stormwater to be retained and reused within the provisions of the overland flow amendment of the FBWRP may be a favourable aspect of this Project. However, it is not clear whether retaining a portion of the Project's stormwater in the settlement/evaporation ponds would be permitted where it would otherwise cause potential environmental harm.

Changes in Flow Regime

There are a number of scenarios under which flows from the site will be altered in comparison with the current baseline situation. If blowdown from the Power Plant is not re-used for quenching, this water would be discharged to Quarry Creek via settling ponds. This could lead to an increase in creek flow of between approximately 657 ML/year and 1,350 ML/year. There is also the possibility that a portion of SPS's combined stormwater and blowdown discharge to Quarry Creek will be re-used for coke quenching. If 10% of this discharge is re-used, then flows to Quarry Creek would be reduced by approximately 180 ML/year. It is unlikely that this water would be used without the Power Plant blowdown being re-used as well.

Should blowdown from the Power Plant be discharged to Quarry Creek, this would be continuous at a rate of between approximately 1.8 ML/day (Stage 1) and 3.7 ML/day (Stage 2). This would likely be less than that currently discharged from SPS (3-5 ML/day). A combined discharge from SPS and the Power

Plant would be very unlikely to exceed the maximum flow rate authorised under SPS's Environmental Authority (18 ML/day).

The Neerkol Creek catchment is considered to be reliant on continuous discharge from SPS for a large proportion of its flow through the majority of the year. Downstream water users and environmental flows are likely to be impacted by any consumptive re-use of SPS's discharge to Quarry Creek. If proposed water re-use from SPS's discharge is approximately 10%, then the impact may be relatively minor. Although this may mean that overall the loading of some chemical constituents to the creeks is reduced, water quality may deteriorate due to lower dilution and through-flow in stagnant ponds along the course of local creeks. If creeks are more vulnerable to drying out and salinity is more concentrated, this may impact on the ecology of the area. It is unlikely that Para Grass, a hardy species, would be significantly affected by changes in flow.

Any increase in flows associated with additional blowdown from the Power Plant is also likely to be relatively minor but may lead to a larger and more reliable downstream water flow regime. Any additional discharge will probably need to be of a similar standard to that from SPS at present. As such, the impact on water quality would be low. It is likely that additional flows would have a relatively minor impact on aquatic biology.

The settlement/evaporation ponds are designed to discharge to the environment on average only once in 10 years when modelled against 66 years of historical rainfall data for the area. Water balance modelling suggests that between approximately 290 ML/year (Stage 1) and 450 ML/year (Stage 2) will be lost as evaporation directly from the ponds and from use as dust suppression. This water would otherwise run off and into Neerkol Creek. Direct evaporative losses at the stockpiles and main coke plant area would be very similar to the losses that would occur from bare earth in the pre-existing situation. The average annual volume of water discharging to the creek as overflows from the ponds would be between approximately 2.4 ML/year (Stage 1) and 3.8 ML/year (Stage 2) though flows are likely to be highly irregular from year to year and these quantities would depend on the amount of re-use on site.

Within the context of the overall catchment however, due to the ephemeral nature of the flow regime, the reduction in flow caused by the coke plant settlement/evaporation ponds would be of minor significance. Any noticeable reduction in flows would only occur during rainfall events, when the remainder of the catchment would also be contributing to flow. Furthermore, pond design must be considered in view of the potential for pollution to occur. More frequent overflows from the settlement/evaporation ponds may lead to a greater and more concentrated load of potential contaminants being discharged into the creek. If blowdown from the Power Plant is discharged to Quarry Creek then this may offset any reductions in flow in the overall catchment

Runoff velocities are likely to be high in the event of overflows and measures will be taken at the drainage outfall to the creek and/or within the drainage system to ensure these flows do not create erosion or bed instability. An increase in continuous flow associated with the power plant blowdown may also have a minor impact on increasing erosion within the creek channel. However, the increase would not be more than the current average daily discharge from SPS. In addition, fluvial geomorphology in these local creeks will be shaped mostly by large flow events occurring after heavy rain. It is unlikely that an increase in continuous flow generated by the Project would significantly impact the morphology of local watercourses or riparian vegetation over the likely timeframe of the Project. Furthermore, the abundant aquatic flora along both Quarry and Neerkol Creeks will act to slow flow velocities, allowing water to be taken up by vegetation and seepage to groundwater.

Fisherman's Landing - Construction Phase

Sediment/Contaminant Mobilisation

Earthmoving activities at Fisherman's Landing have already been largely completed. Further construction works including the installation of conveyors and coke stockpile hardstand area are unlikely to significantly increase the risk of sediment and contaminant mobilisation. As the site currently consists of bare earth, construction of the hardstand for the coke stockpile will stabilise the soil and reduce erosion from this area.

Pollution Effects

Due to the near pristine condition of Port Curtis around the Fisherman's Landing wharf, discharges of pollutants must be restricted as far as practicable. Potential sources for on-site pollution during the construction phase predominantly comprise diesel and other petroleum-based fuels and lubricants used by excavation and construction machinery. However, as construction activities will be limited it is unlikely that significant amounts of potential contaminants will be present. If concrete is to be made up on-site, appropriate measures will be taken to safeguard against wind blowing cement or sediments into the sea. Temporary toilet facilities will be provided for construction staff and all waste produced be removed off-site for appropriate disposal. Limited volumes of potential contaminants and sanitary facilities will be required on site and the risk of leakage is low.

Bunded storage areas for fuels and dangerous goods required for construction equipment will be provided with spill cleanup kits in accordance with Australian Standards (AS 1940 and AS 3780). All transfers of fuels and chemicals will be controlled and managed to prevent spillage outside bunded areas. Any pollution mobilised in surface runoff will be contained within the construction phase drainage network and will, therefore, ultimately enter settlement/evaporation ponds where it will be contained and cleaned up.

Fisherman's Landing - Operational Phase

Pollution Effects

Pollutants of major concern within Port Curtis include suspended solids, as these can impact on local seagrass beds and marine biodiversity. Although the majority of fine coke material will be removed from the coke product at the project site, the coke stockpile at the wharf is a potential source of fine particulates. Measures will be taken to limit the mobilisation of coke particulates, including dust suppression and routing surface runoff from the stockpiles into a settlement/evaporation pond. The pond will be designed to spill on average once every 10 years. Rainfall events of the nature that would lead to an overflow would provide substantial dilution within site runoff. There would also be much greater rainwater input directly into Port Curtis at the same time. Site operations at Fisherman's Landing are unlikely to produce significant amounts of other potential pollutants.

Flooding

The wharf at Fisherman's Landing is constructed at a height of approximately 5.9 m AHD. This is at least 3.4 m above the highest astronomical tide and 1.9 m above the predicted 500-year ARI storm surge level. It is extremely unlikely, therefore, that the site will be affected by an extreme flood event.

Management and Mitigation Strategies

Objectives for the management and mitigation of potential impacts to surface water include to:

- Investigate and implement practical water recycling options to minimise demand on regional water resources; and
- Protect the integrity of local and regional catchments through site water management planning and implementation.

The Project will utilise water in a number of partially consumptive processes and produce a range of aqueous waste streams with varying quality characteristics. The Project water requirements will include the following:

- Power plant steam cycle (demineralised water);
- Power plant cooling system;
- Quench water for dousing hot coke output;
- Dust suppression at the coke and coal stockpiles;
- Service water for washdown and other miscellaneous uses;
- Fire system make-up water; and
- Potable water for the Project workforce.

The Project will involve a two-stage development, with a Stage 1 design capacity of approximately 1.6 Mtpa of dry coke expanded to a total of 3.2 Mtpa during Stage 2. To allow an assessment of environmental impacts and sustainability issues associated with the various options for configuration of the Project, both stages of development have been considered. The timing of construction of the Power Plant will be scheduled in accordance with the ability of the Coke Plant to provide the heat inputs to effectively operate the Power Plant. As such, the Coke Plant will be in operation without the Power Plant component of the Project for at least some part of Stage 1. Table 5.1.8 summarises the estimated water inputs and outputs for both stages of the Project.

Table 5.1.8 Water Balance for the Project

Description	Stage 1		Stage 2	
	In (ML/year)	Out (ML/year)	In (ML/year)	Out (ML/year)
Power Plant Steam Cycle				
Make-up to Condenser	201.8		403.6	
Blowdown		-201.8		-403.6
Power Plant Cooling System				
Make-up	3,337.5		6,675.0	
Evaporation and Drift		-2,858.1		-5,716.2
Blowdown		-479.4		-958.8
Contingency	333.7	-333.7	667.4	-667.4
Sub-Total Power Plant	***3,873.0***	***-3,873.0***	***7,746.0***	***-7,746.0***
Coke Production				
Quenching	1,385.2	-1,385.2	2,770.4	-2,770.4
Other				
Dust Suppression[1]	106.3	-106.3	211.8	-211.8
Service Water	4.3		8.6	
Potable Water	3.0		3.0	
Service Water Evaporation and Drainage		-4.3		-8.6
Sewage		-3.0		-3.0
Sub-Total Coke Plant	***1,498.8***	***-1,498.8***	***2,993.8***	***-2,993.8***
Total - Coke Plant and Power Plant	**5,371.8**	**-5,371.8**	**10,739.8**	**-10,739.8**

Notes: [1] Value calculated using conceptual stormwater management model.

Impacts to the surface water environment can be minimised by reducing volumes to be managed through re-use and recycling of water in the Coke Plant and Power Plant. Opportunities for water re-use are highly dependent on the final configuration of the Project. The power plant steam cycle operates in a closed loop with only a small amount being blown down from HRSGs and replaced in the cycle using demineralised water sourced from either SPS or an independent water treatment facility. The power plant cooling water should be able to be recycled through the steam cycle multiple times prior to salt build-up precluding further recycling. The number of cycles will depend on the input water quality which is seasonally variable, the propensity for fouling, and any discharge water quality limits (if discharging off-site) or quality requirements for reuse as quench water for the Coke Plant.

It is possible that quench water for the Coke Plant may be partially sourced from this blowdown and from stormwater (see below). This will be a partially consumptive water use as a lot of the quench water will evaporate as part of the quenching process. The ability to use the power plant blowdown water as quench water will be determined partly by the quality of water required in the quench process particularly with respect to the concentration of TDS and the effect it has on the final coke product.

On-site stormwater re-use will also be possible and relatively clean runoff from undeveloped areas will be separated from potentially contaminated runoff as much as practicable. Due to the potential for contaminants in runoff from the coal and coke stockpiles and the coke plant operational areas, stormwater runoff from these areas will be contained and managed to limit off-site discharge. Potentially contaminated stormwater will be isolated from ‘clean’ water by siting the stockpiles and main coke plant infrastructure on hardstand with drainage channels around these areas. This will prevent both the overspill of potentially contaminated ‘dirty’ runoff and the ingress of runoff from the surrounding undeveloped areas onto the hardstand. The contaminated water drainage channels will flow into a series of settlement/evaporation ponds, constructed with either a compacted earthen base or synthetic liner to prevent seepage. The pond system will be designed and managed such that overflow will occur on average once every 10 years. Although the primary function of the system will be to capture runoff and allow water to evaporate, it will also be re-used for dust suppression at the stockpiles and possibly for coke quenching. A conceptual stormwater management plan, outlining further details of the settlement/evaporation pond system, is presented as Appendix F.

Volumes of stormwater runoff from the Power Plant will be comparatively minor in the scheme of the project site and is not anticipated to be significantly contaminated with coke and coal particulates. Power plant runoff will be directed to buffer ponds and re-used for coke quenching or discharged to Quarry Creek if the water quality is sufficient to meet discharge limits.

Notwithstanding the water recycling options available, the majority of inputs to the Project are proposed to be met through raw water supply. Plans for sourcing this water may include one, or a combination, of the following options:

- Utilisation of SPS’s existing unused allocation;
- Negotiation of an increase in SPS’s allocation, sourced from Eden Bann Weir on the Fitzroy River, with DNRM;
- Negotiation with other existing water users within the Fitzroy Basin (such as Rockhampton City Council) to purchase some of their water allocations under water trading arrangements; and/or
- Licensing water allocations through water harvesting either by developing own infrastructure or trading with existing water harvesters.

Demineralised and potable water will be supplied from the existing SPS water facilities or from independent water treatment facilities. Fire system make-up water may be supplied from the project raw water supply or via the existing SPS drains reclaim dam, via a new and independent piping system. A fully independent ring main type firewater system will be incorporated around the Power Plant.

As a result of the large volume of water used, the Project will create a number of waste water streams. Blowdown water from the Power Plant may be re-used for coke quenching, disposed of by evaporation or discharged to Quarry Creek via buffer ponds. Stormwater runoff from the Coke Plant will be re-used for dust suppression at the coal and coke stockpiles and a proportion (approximately 10% of water required) may be used for coke quenching. Sewage from the Project will be treated within the existing SPS sewerage system or via site-specific treatment options. Other potential aqueous waste streams will include oily waste water (from miscellaneous plant and equipment wash water), contaminated runoff from chemical storage areas, potentially contaminated drainage from fuel oil storage areas, oil-filled transformer yard areas and general washdown water.

Chemical, fuel and oil storage areas for the Project will be bunded and have spill cleanup kits in accordance with Australian Standards (AS 1940 and AS 3780) to prevent the contamination of surrounding surface runoff. Closed isolation valves will be installed on the outlet drains from bunded storage areas to allow any spills to be contained and managed within the bunded area. Any significant leakage/spillage will be immediately reported and appropriate emergency clean-up operations implemented to prevent possible mobilisation of contaminants. Any rainfall collected in the bunded areas will be allowed to evaporate or be drained and removed to evaporation dams. Any contaminants or major spillages of stored material in the bunded areas will be collected by licensed waste collection and transport contractors for disposal off site at a licensed facility.

Waste water from washdown areas will be directed through oil and grease separators and the water directed to settlement/evaporation ponds for re-use. Separated hydrocarbon material will be collected and periodically removed off-site by licensed waste collection and transport contractors to a licensed recycling/disposal facility.

A number of management practices will be implemented at the site to ensure risks are minimised during day-to-day operations. Although potential contaminants will only be present in limited volumes on-site, an Emergency Spillage Response Plan will be prepared and implemented. This will address actions to be taken upon discovery of a spillage, the use of spillage response equipment and reporting of incidents. Good housekeeping practices will include keeping all areas tidy, strategically locating bins wherever litter generation is likely to be high and daily site inspections for potential surface water impacts. Personnel will also be trained and kept informed regarding all relevant aspects of good environmental management practice.

Additional measures will be taken to limit environmental impacts during the construction phase. These will include the diversion of runoff water from around the work site and minimising activities within or adjacent to drainage lines. Fuels and other hazardous chemicals will be stored in bunded areas with ‘clean’ runoff diverted around them.

During construction, the contractors will conduct regular inspections of construction areas and assess the condition and operability of site drains and erosion mitigation measures, as well as for the presence of contaminants in sediment limitation facilities. Inspections will be conducted on a regular basis during the wet season and immediately after each significant rainfall event.

Potential seepage from the project ponds and the effectiveness of the site’s stormwater management system will be regularly assessed (Section 5.2 – Groundwater). This will include monitoring of water in the ponds for sediment and associated particulate contaminants. A review of monitoring data will be carried out on a regular basis. All monitoring will be undertaken in accordance with the requirements of the Project’s development approval.

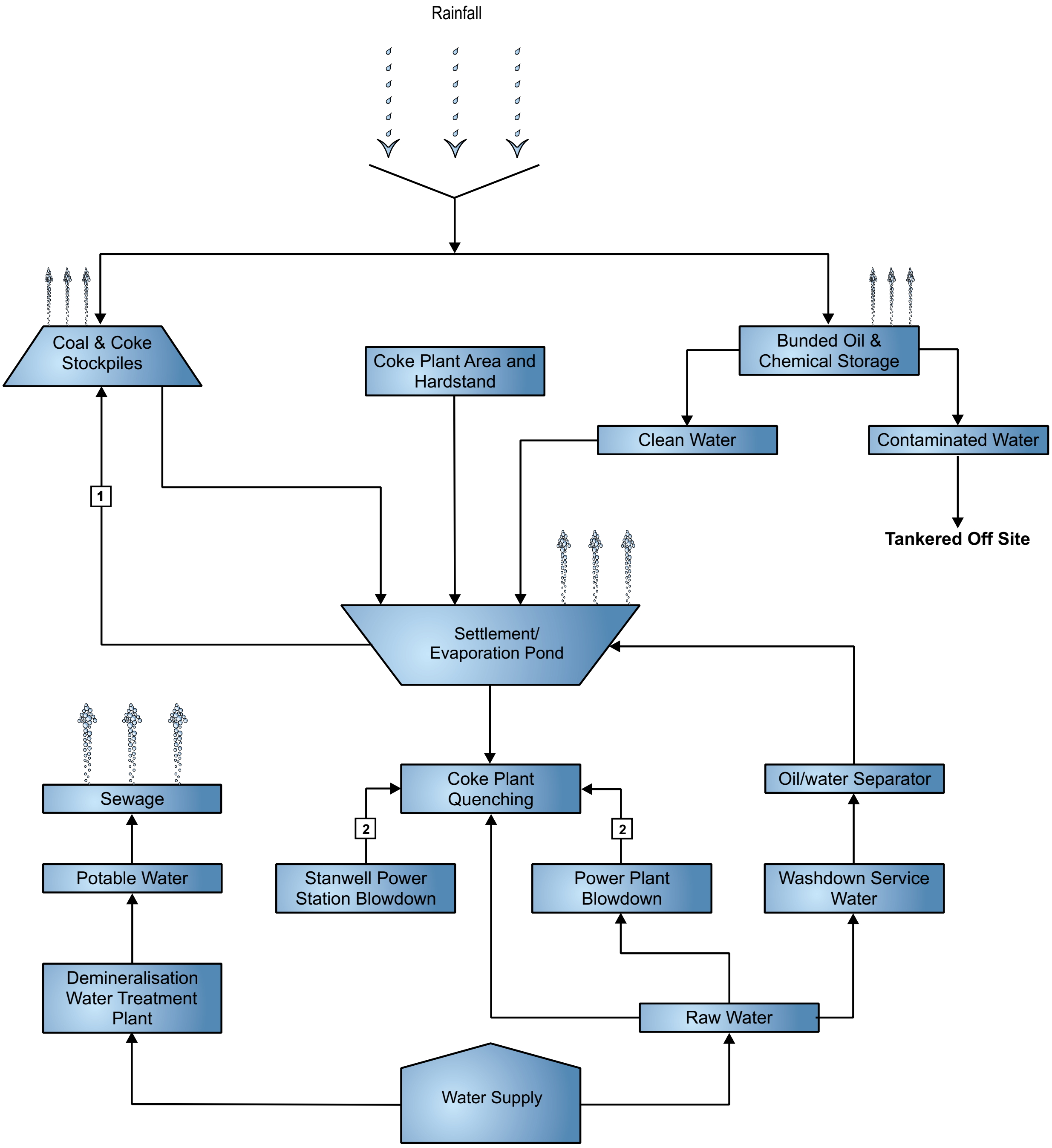
Control measures will be implemented at any authorised point from the Project to the creek system to prevent erosion or bed instability. Suitable erosion control and energy dissipation measures at the outfall may include matting, riprap and gabions. There is also the potential to install stormwater controls and treatment upstream of the outfall through settlement/evaporation ponds, wetlands, infiltration devices and vegetative filters upon detailed design and finalisation of the project layout.

As part of the detailed design for the Project, an assessment of water storage structures consistent with the DNRM requirements for failure risk and referable dam criteria will also be undertaken.

Areas of disturbed or exposed soil will be managed to minimise the loss of sediment, either through revegetation and/or use of other stabilisation techniques in accordance with “Soil Erosion and Sediment Control Guidelines for Queensland” (IEAust, 1996). Work will be concentrated in as small an area as possible and progressively expanded to reduce the area potentially at risk. A minimum number of passes by heavy earth moving equipment will also help to minimise erosion and dispersion of soils by the wind. Usable topsoil will be stripped and stockpiled away from drainage lines to protect it from erosion. To limit sediment mobilisation, the existing sediment limitation devices (e.g. settlement/evaporation ponds, drainage ditches) will be used in accordance with the construction phase Surface Water and Erosion Management Plan (Section 16 – Environmental Management Plan). Berms to restrict flow velocities across the project site will also ensure that risks are minimised. No clearing work will be carried out during heavy rainfall. Upon completion of works, revegetation using local species will take place wherever possible and as soon as practicable considering seasonal influences. The earthworks contractor will be required to prepare a Sediment and Erosion Control Plan prior to the commencement of construction.

When complete, the Coke Plant and Power Plant will cover an area of approximately 60 hectares (ha), the majority of which will be impervious. Coke and coal stockpiles, and settlement/evaporation ponds will comprise a further 34 ha of essentially impermeable area. Conceptual diagrams of operational-phase water use and disposal for the Coke Plant and Power Plant are presented in Figures 5.5 and 5.6 respectively.

It is not anticipated that fine coke material will be significant at the Fisherman’s Landing site as the majority of fine coke particles are removed during the product screening and sizing activities at the project site. Any remaining fine coke material has the potential to discharge into Port Curtis. To prevent coke particulates from being mobilised into the sea, dust suppression measures involving irrigation will be installed at the coke stockpile. Runoff from the stockpile will be routed to a settlement/evaporation pond via a similar system to that which already exists at the Fisherman’s Landing facility and similar to the system proposed for the coal and coke stockpiles at the project site. This will be designed and managed to provide sufficient storage to contain runoff from a 1 in 10-year ARI rainfall event. The pond will either be excavated out of the existing wharf and therefore allow discharge of water into the bay via seepage, or will be impermeable to prevent seawater ingress and capture rainwater for use in stockpile irrigation. The system will be managed to prevent any discharges from the site into the bay except during extreme events and it is assumed that all water will be obtained from within the existing CQPA system operating at the Fisherman's Landing facility.



LEGEND

Evaporative losses

Notes:

[1] Water for dust suppression

[2] Use of blowdown from the Stanwell Power Station or the Power Plant is yet to be confirmed

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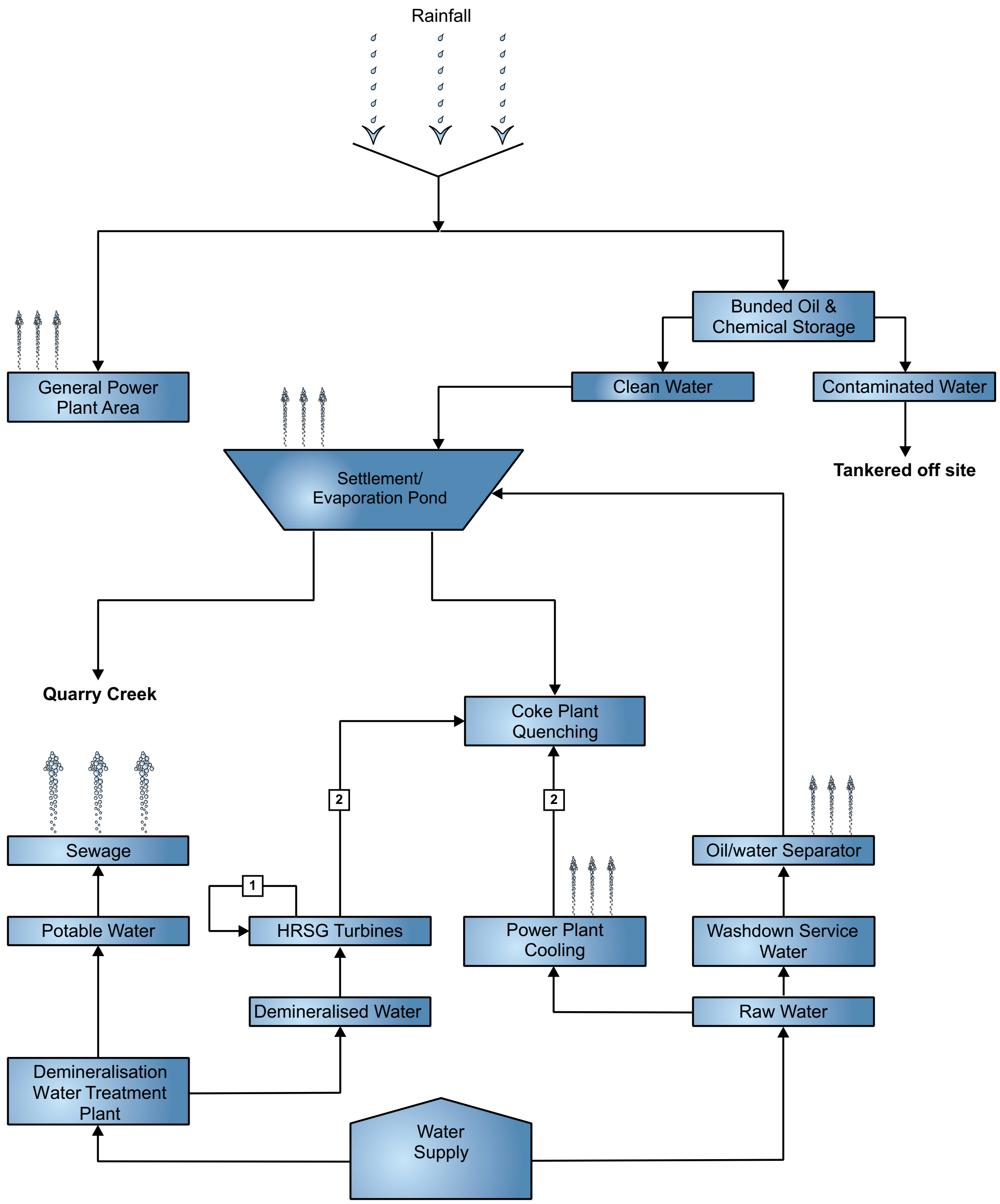
QUEENSLAND COKE
AND POWER PLANT PROJECT
ENVIRONMENTAL IMPACT STATEMENT

CONCEPTUAL COKE PLANT OPERATIONAL PHASE WATER USE AND DISPOSAL

Drawn: VH	Approved: JMcD	Date: 06-01-06	Figure: **5.5**	Rev. A
Job No.: **42625626**	File No. 42625626-g-053.cdr			A4



LEGEND

Evaporative losses.

Notes:

1 Cooling process water is recycled 5 times before being 'blown-down'

2 Blowdown from HRSGs and power plant cooling process may be used for coke quenching or will be discharged to Quarry Creek via a settling pond

STANWELL CORPORATION LIMITED / QUEENSLAND COKE & ENERGY	QUEENSLAND COKE AND POWER PLANT PROJECT ENVIRONMENTAL IMPACT STATEMENT			CONCEPTUAL POWER PLANT OPERATIONAL PHASE WATER USE AND DISPOSAL
URS	Drawn: VH	Approved: JMcD	Date: 06-01-06	Figure: 5.6 — Rev. A
	Job No.: 42625626	File No. 42625626-g-054.cdr		A4

5.2 Groundwater

Summary

The groundwater regime in the area of the Project comprises alluvial aquifers associated with the creeks in the area and coal and sandstone formations. The alluvial aquifer has numerous licensed bore extractions within a nominal 5 km radius. Local groundwater use is primarily for livestock watering and irrigation purposes and is not considered potable owing to the moderately high salinity levels.

There were no alluvial aquifer groundwater users identified in the immediate vicinity, or within the boundaries, of the proposed site, and no groundwater users who rely on groundwater from the coal seam beds that outcrop across most of the site. The low yield (due to very low permeability) and poor water quality of the coal seams preclude interest in utilising these aquifers for water supply purposes.

Groundwater removal to assist in foundation excavation is not anticipated during the construction phase. There will be no abstraction of groundwater during the operational phase of the Project and the effect of covering the area with impermeable concrete surfaces will not impact the recharge of the underlying aquifers. Hence, there will be no interference with the existing groundwater resources and no direct impact on the local groundwater flow regime.

The proposed surface water containment system will be lined with low-permeability material and the system will be designed and managed only to discharge during extreme rainfall events where natural dilution will be substantial. Therefore, no detrimental effects on the groundwater by surface water originating from the Project are expected.

Groundwater monitoring bores will be installed to confirm that there are no detrimental effects on groundwater from the Project. Monitoring of existing bores within the area will be undertaken to verify no detrimental effects occur as a result of the Coke and Power Plant activities.

5.2.1 Description of Environmental Values

Review of Information

The description of hydrogeological conditions at the site is based on a review of the following information:

- Australian Magnesium Project Environmental Impact Statement (Dames & Moore, 1999);
- Stanwell Power Station Surface and Groundwater Quality Review (Waste Solutions Australia Pty Ltd, 2001);
- Investigation of Environmental Impact of Ash Disposal Facilities Stanwell Power Station (Woodward Clyde, 1997);
- Rockhampton 1:250,000 Geological Map (Sheet SF56-13);

- Port Clinton 1:250,000 Geological Map (Sheet SF56-9);
- Groundwater Bore Information from the Queensland Department of Natural Resources and Mines (DNRM) Groundwater Database; and
- Historical groundwater monitoring data for the period 2002 and 2004, recorded by Stanwell Corporation Ltd (SCL).

Groundwater Geology and Aquifer Occurrence

The groundwater geology and aquifer occurrence beneath the project site has been described previously by Dames and Moore (1999). From a regional context, groundwater occurs in the following aquifers:

- Quaternary-age alluvium (sand, silt and gravel) deposited in Sandy Creek, Stony Creek, Quarry Creek and Neerkol Creek;
- Quaternary-age colluvium;
- Coal seams and sandstone beds within the Cretaceous Stanwell Coal Measures;
- Fractures within Cretaceous basalt and gabbro units and the Triassic Native Cat Andesite;
- Sandstone layers in the Permian Dinner Creek Formation; and
- Sandstone, conglomerate and limestone layers within the Permian to Carboniferous Neerkol Formation.

From a local context, groundwater beneath, and in the near vicinity of, the site mainly occurs within Quaternary alluvial deposits of Stony, Neerkol and Quarry Creeks floodplains, and within the Cretaceous Stanwell Coal Measures. The Neerkol Creek alluvium is the major aquifer in this area, with nearly every licensed bore within a 5 km radius of the site extracting from this groundwater resource. This unconsolidated heterogeneous alluvial aquifer is comprised of lenticular sand, silt, gravel and clay deposits. The aquifer is mainly unconfined, although in some areas, laterally continuous clay beds promote shallow groundwater to perch above the clay beds and semi-confined groundwater to reside below the clay (within underlying coarser material). Generally, this aquifer is 15 to 25 m thick, with a typical saturated thickness of 10 m.

The Stanwell Coal Measures outcrop across most of the project site, and further to the south. This aquifer unit contains an 8 to10 m thick clay-rich weathering profile in some parts of the site, which overlies coal seams and sandstone beds. This formation is generally not a high yielding aquifer and only one licensed bore in the area is extracting groundwater from it. The aquifer is unconfined in directly outcropping areas, and confined underneath the alluvial plains. A previous hydrogeological conceptual model of the site (Woodward Clyde, 1997) has described the presence of a north-east/south-west trending fault, namely the Stanwell Fault. This fault is said to cut through the bedrock aquifer beneath the ash disposal area (situated to the west of the power plant, in the land residing between Sandy Creek and Stony Creek). Highly jointed sandstone beds adjacent to this fault are likely to have secondary permeability, leading to higher groundwater yields. This fault is approximately 1 km west of the area designated for the product coke stockpiles, (which is the western most point of the coke plant activities), and as such, will not be of concern to the coke and power plants.

Recharge Processes

Recharge to the shallow alluvial aquifer is likely to come from two main sources:

- Seepage from creek beds and banks during strong surface water flow or flooding; and
- Surface infiltration of rainfall and overland flow, where alluvium is exposed and no substantial clay barriers occur in the shallow subsurface.

During extended periods of low surface water flow in the creeks, it is likely that the alluvial aquifer will discharge into the creek. However, during intense surface water flow periods, the creeks will likely recharge the alluvial aquifer and reverse the direction of groundwater flow. Recharge into the Stanwell Coal Measures bedrock aquifer is likely to come from the following sources:

- Direct infiltration where the aquifer outcrops in the vicinity of the site and further to the south;
- Seepage from creek banks and beds during periods of high surface water flow;
- Vertical seepage from overlying alluvial aquifers; and
- Groundwater flow along the Stanwell Fault and jointed zones adjacent to the fault.

Groundwater Levels and Flow

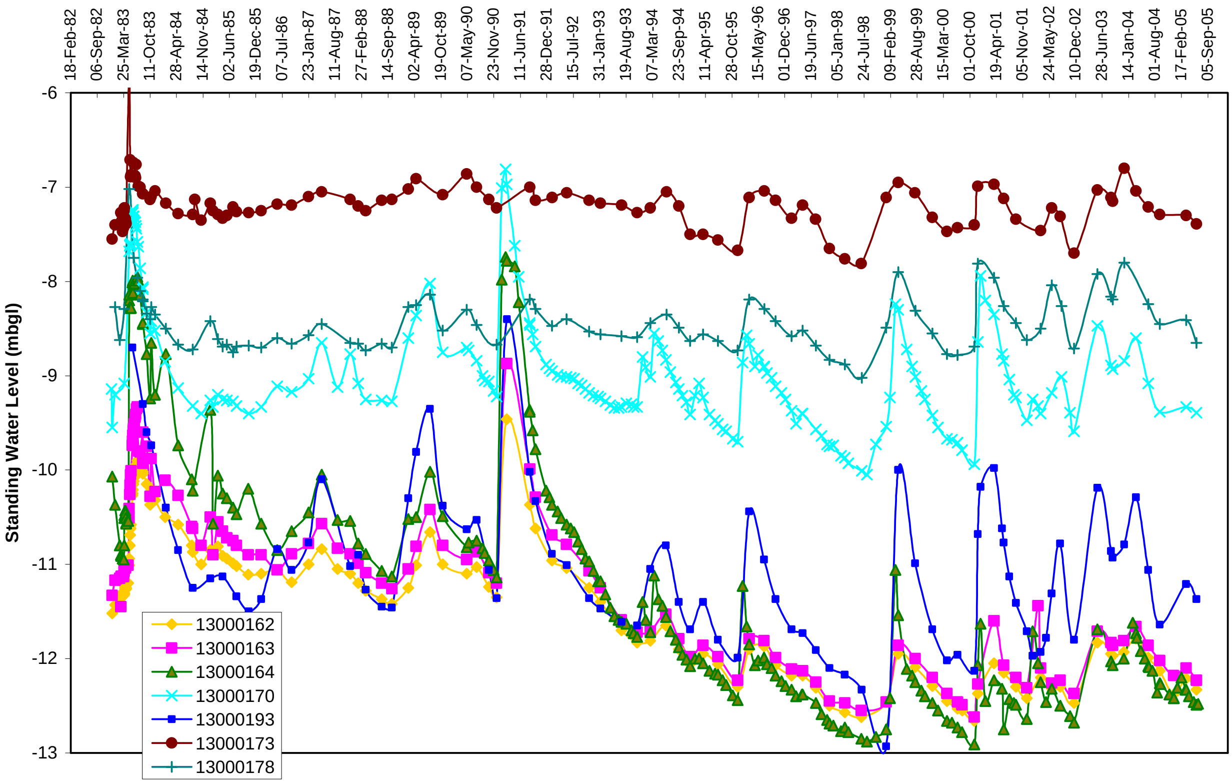
A search of the DNRM registered bore database on 18 July 2005, revealed that within a notional 5 km radius of the proposed project site, 64 bores are screened in either the alluvial (52) or Stanwell Coal Measures (12) aquifers. Water level data from this search is mainly limited to bores screened across the alluvial aquifers, owing to the fact that this is the preferred water supply resource in the region. Historical groundwater level data has been recorded at monthly or quarterly intervals for 17 of the 64 bores from December 1982 to June 2005.

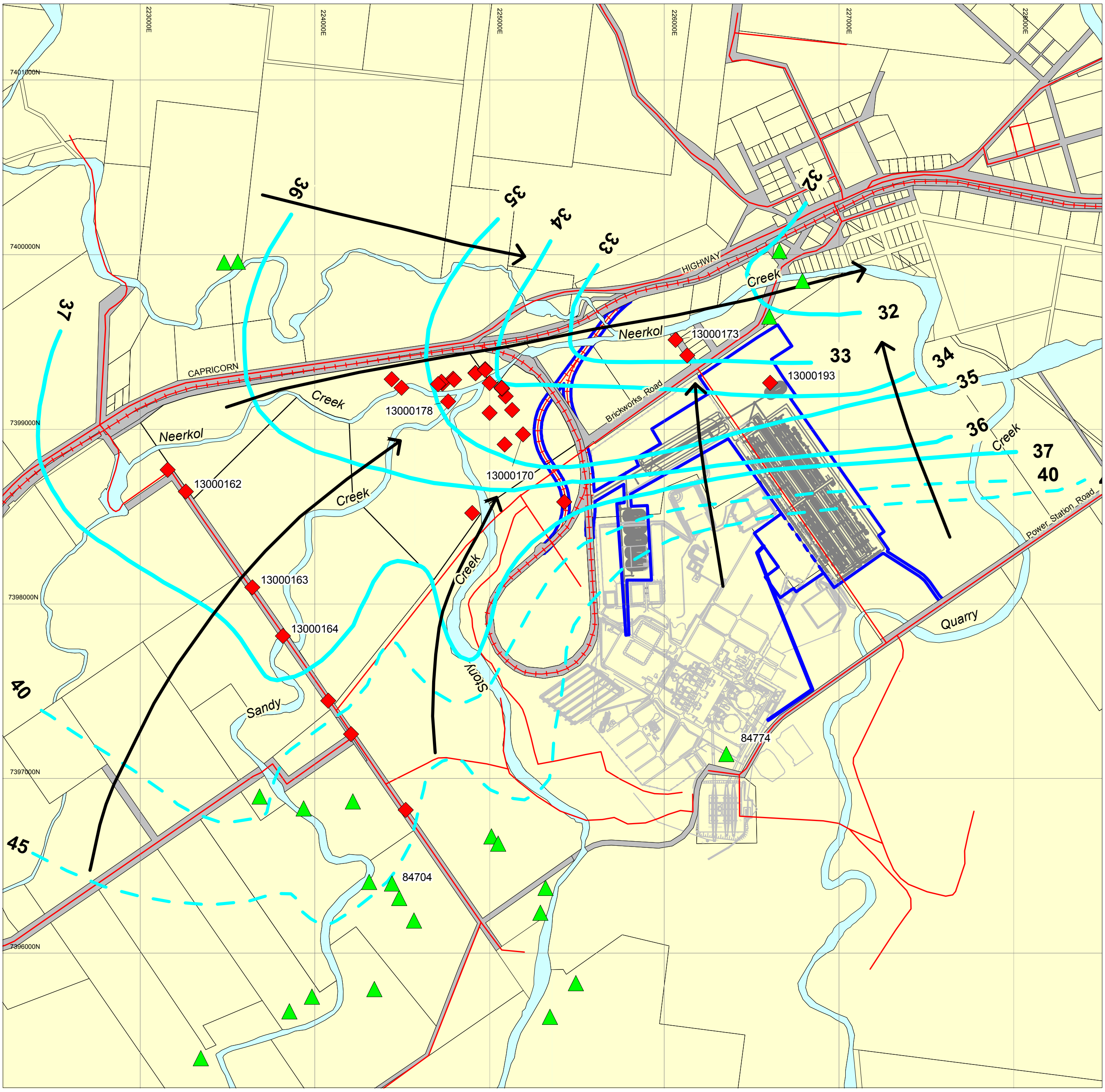
In addition, the SCL has carried out groundwater monitoring both within and around the Stanwell Power Station (SPS) site for over a decade. The most recent analysis of the SPS monitoring data was reported by Waste Solutions Australia in 2001. This report is supported by further monitoring data from 2002 and 2004 (provided by SCL). Analysis of the abovementioned data has enabled an approximate indication of groundwater levels in the vicinity of the site to be established for both aquifers, as well as general directions of groundwater flow to be estimated.

Alluvial Aquifer

The water level measurements indicate that the water table within the alluvium varies between 6 to 13 m below ground level, with seasonal fluctuations of up to 1 m noted for most bores. Figure 5.7 shows representative hydrographs for a selection of alluvial bores in the Stanwell area. Details of these selected bores are listed in Table 5.2.1 and their locations are shown on Figure 5.8.

Figure 5.7 Hydrographs of Selected Alluvial Groundwater Bores from the Stanwell Area (DNRM Groundwater Database)





LEGEND

- Licensed Bore (Dept. of Natural Resources)
- Exploration/Monitoring Bore (Dept. of Natural Resources)
- 32 Groundwater Elevation Contour 1m Interval (mAHD)
- 45 Groundwater Elevation Contour 5m Interval (mAHD)
- Approximate Groundwater Flow Direction
- Proposed Development Footprint
- Proposed Plant
- Existing Stanwell Power Station
- Cadastral Boundaries

N

0 500m 1000m

Scale 1:35 000 (A4)

Horizontal Datum GDA94 Zone 56

STANWELL CORPORATION LIMITED / QUEENSLAND COKE & ENERGY / URS	QUEENSLAND COKE AND POWER PLANT PROJECT ENVIRONMENTAL IMPACT STATEMENT			REGISTERED BORES AND ALLUVIAL AQUIFER GROUNDWATER ELEVATION CONTOURS (MARCH 1991)	
	Drawn: VH	Approved: JMcD	Date: 06-01-06	Figure: **5.8**	Rev:B
	Job No: **42625626**	File No: 42625626-g-025b.wor			A4

Table 5.2.1: Physical Details for Selected Stanwell Bores

Bore Reference Number	Surface Elevation (m AHD)	Easting[1] (m)	Northing[1] (m)	Screened Aquifer	Screen Interval (m BGL)
13000162	48.71	223263	7398644	Neerkol Creek Alluvium	14 – 16.2
13000173	39.96	226067	7399513	Neerkol Creek Alluvium	5.7 – 13.4
13000193	45.89	225622	7398798	Neerkol Creek Alluvium	
13000163	48.62	223645	7398096	Sandy Creek Alluvium	11.6 – 16.5
13000164	48.92	223819	7397816	Sandy Creek Alluvium	7.9 – 12.6
13000170	43.84	225194	7398972	Stony Creek Alluvium	11.6 – 17.8
13000178	43.85	224765	7399160	Stony Creek Alluvium	10 - 16
84704	NK	224444	7396399	Stanwell Coal Measures	27.4 – 40.8
84774	NK	226348	7397162	Stanwell Coal Measures	36 - 42

Notes: [1] Zone 56 – GDA94; NK= Not Known; m AHD = metres Australian Height Datum; m BGL = metres below ground level.

Normalisation of all of the available alluvial groundwater levels to the Australian Height Datum (m AHD), using the surveyed bore heights obtained from the DNRM bore search, reveals a distinct groundwater gradient that generally trends from south to north towards Neerkol Creek, then west/south-west to east/north-east along Neerkol Creek. There is a clear correlation between the alluvial water table surface and the surface expression of the creeks, indicating a high interconnection between them. The height of flow in the creeks (related to seasonal rainfall intensity) will dictate over time whether the creeks recharge the alluvial aquifer or the aquifer discharges into the creek.

Stanwell Coal Measures Aquifer

There is limited water level data available in the DNRM database for the Stanwell bedrock aquifer. Recorded Stanwell monitoring data indicates that water levels are generally between 10 and 20 m below ground level, and that the general direction of flow is south to north from the zone of outcrop towards the Stanwell Fault and Neerkol Creek. Groundwater in the bedrock is likely to be intercepted by the Stanwell Fault, where it could rise to discharge into the Neerkol Creek.

Groundwater Chemistry in the Project Area

Alluvial Aquifers

Water quality in the alluvial aquifers is relatively consistent across the 23 years of available recorded data from both the DNRM database and SCL monitoring records. Groundwater salinity is low to moderately high, with a range of total dissolved solids (TDS) of 400 to 5,900 mg/L, and an average value of 2,400 mg/L. The environmental value of the alluvial groundwater to be protected, as identified in the *EPP (Water)* is one of suitability for agricultural use, with a local relevance to stock watering. The indicators for agricultural environmental values are established in water quality guidelines that are published by a recognised authority. In Australia, the benchmark for water quality guidelines is the

ANZECC/ARMCANZ (2000) guidelines. For the *EPP (Water)* values to be considered protected, all relevant indicators for agricultural use, i.e. stock watering, should not exceed the thresholds stipulated in the ANZECC/ARMCANZ (2000) water quality guidelines. The key indicators for stock watering are salinity, sulphate and calcium.

Average TDS levels within the alluvium exceed the guidelines for fresh water aquatic ecosystems (ANZECC/ARMCANZ, 2000) of 1,000 mg/L. However, TDS values are generally within the upper tolerance limits for livestock drinking water (4,000 mg/L) for most animals without risking adverse effects (although poultry and dairy cattle have upper tolerances of 2,000 and 2,400 mg/L, respectively, which are exceeded by the average salinity for the aquifer). Additionally, the upper limit of 1,000 mg/L of calcium and sulphate in groundwater to be used for stock watering is not exceeded by any of the alluvial groundwater.

Other water quality indicators measured from samples of the alluvial groundwater include:

- pH ranges from 6.8 to 8.3, with an average of 7.6;
- Silica ranges from 19 to 67 mg/L, with an average of 38.4 mg/L;
- Sulphate ranges from 1 to 434 mg/L, with an average of 59 mg/L;
- Nitrate ranges from 0 to 46 mg/L, with an average of 1.1 mg/L; and
- No noticeably elevated levels of metals (iron, manganese, copper, zinc, aluminium) recorded for the regional alluvium during the period of monitoring.

The nitrate and sulphate values in the alluvial groundwater have been determined as total concentrations. The ranges seen within the above alluvial groundwater quality values are likely to be associated with a variety of sources and processes. Sulphate and nitrate could be derived from the natural decomposition of catchment derived organic matter, agricultural fertilizers and gypsum-based products, and local geological terrain is also likely to affect sample chemistry.

Time-series analysis of major ion groundwater chemistry for the selected bores listed in Table 5.2.1 above has indicated a common sodium, bicarbonate, chloride type water (with noticeable contributions of calcium and magnesium) for all of the alluvial aquifers. A snapshot of the chemical character of the alluvial aquifers (a representative bore has been selected from each of the three alluvial bodies: Neerkol Creek, Sandy Creek, and Stony Creek floodplains) is provided in Table 5.2.2 below to highlight the relative similarity in major ion chemistry between the different water bodies at a given point in time (13 August 1999).

Stanwell Coal Measures Aquifer

Water quality in the Stanwell Coal Measures aquifer is less consistent owing to the variability of the sandstone beds, siltstone beds and coal seams. Bores which intersect the siltstone/coal seams, have TDS levels between 5,000 and 13,500 mg/L. According to the ANZECC/ARMCANZ (2000) guidelines, this high salinity water is unsuitable for domestic, livestock or irrigation purposes, and therefore has no direct environmental value that requires protection, in accordance with *EPP (Water)*. The poor water quality is indicative of minimal recharge to the coal measures in the area of outcrop, as well as slow groundwater movement, and hence long residence times within the coal seams (Dames & Moore, 1999).

Water bores which intersect the sandstone beds (particularly those adjacent to the Stanwell Fault), such as Bore 84774 (Table 5.2.2), have moderate salinity levels, with TDS values ranging from approximately 500 to 4,000 mg/L. Major ion water chemistry analyses were available for one sampling period in 1983, for only two bores within the Stanwell bedrock aquifer. The water chemistry was generally consistent for both of these bores, with sodium, magnesium, chloride, bicarbonate type water.

Table 5.2.2 Summary of Water Chemistry for Representative Bores in Stanwell Area

Indicator	ANZECC/ARMCANZ (2000) Guidelines– Stock Watering (Upper Limits)	Registered Bore Number			
		13000162	13000164	13000178	84774
		Neerkol Creek Alluvium	Sandy Creek Alluvium	Stony Creek Alluvium	Stanwell Coal Measures
Date Sampled		13.08.99	13.08.99	13.08.99	9.11.83
Total Dissolved Solids (mg/L)	*Beef cattle, sheep, horses, pigs*: 4000 *Dairy cattle*: 2400 *Poultry*: 2000	3070	1890	995	510
pH	NR	7.9	8	7.9	7.7
Alkalinity (mg/L as $CaCO_3$)	NR	544	859	296	120
Na (mg/L)	NR	665.5	426.9	211.1	125
Ca (mg/L)	1000	296.6	159	83.7	20
Mg (mg/L)	NR	150.9	96.8	51.3	23
Cl (mg/L)	NR	1503	613.3	347.9	205
HCO_3 (mg/L)	NR	652.4	1030.9	356	145
CO_3 (mg/L)	NR	5.4	8.4	2.2	0.6
SO_4 (mg/L)	1000	84.9	15	70.4	20

Notes: NR = No values recommended

Hydraulic Parameters

There is a limited availability of hydraulic parameters for the aquifers of concern in the project area. Previous measurements of the permeability of alluvium and sandstone have indicated that the aquifers are heterogeneous (Woodward Clyde, 1997; Dames & Moore, 1999). Table 5.2.3 provides a summary of the permeability test results.

Table 5.2.3 Aquifer Permeabilities

Material Tested	Number of Test Sites	Permeability (m/day)
Weathered Coal Measures / Soil	7	8.7×10^{-6} to 4.7×10^{-4}
Alluvium	5	0.2 to 10
Stanwell Coal Measures (Sandstone Beds)	1	11

It is apparent from the available test results, that the alluvium and sandstone beds of the Stanwell Coal Measures have a reasonably high permeability, while the actual coal seams and the weathered residual soil profile have a very low permeability. As the project site mainly overlies coal seams and the weathered soils of the coal seams, the potential for off-site groundwater discharge from beneath the site is much lower than it would be if the site was situated above the alluvial or sandstone aquifers 1 km to the west.

Groundwater Use in Neighbouring Areas

As previously mentioned, there are 64 registered bores within 5 km of the proposed site. A high concentration of these bores occurs approximately 2 km to the south-west of the site in the Sandy Creek and Stony Creek floodplains, as well as approximately 1 km to the west of the site on the Neerkol Creek floodplain. Local groundwater use is primarily for livestock watering and irrigation purposes owing to the moderately high salinity levels. The average yield of the licensed bores in the area is 3.6 L/s, with a maximum yield of 33 L/s from a bore (RN13000185) in the Neerkol Creek floodplain. However, it is not known if this represents a sustainable yield for the aquifers.

There were no alluvial aquifer groundwater users identified in the immediate vicinity, or within the boundaries of the proposed site, and no groundwater users who rely on groundwater from the coal seam beds that outcrop across most of the site. The low yield (due to very low permeability) and poor water quality of the coal seams preclude interest in utilising these for water supply purposes.

5.2.2 Potential Impacts and Mitigation Measures

Construction Phase

Groundwater removal to assist in foundation excavation is not anticipated during construction. Groundwater monitoring of the bores on-site in 2002 and 2004 has shown that the water table within the underlying bedrock aquifer is generally greater than 5 m below ground level. In the unlikely event that dewatering is required during foundation excavation, the groundwater will not be discharged to the local drainage system, but instead will be used for dust suppression, or suitably captured in storage facilities.

Compression of the ground surface associated with the construction of roads and building foundations is not expected to greatly alter the permeability of strata immediately beneath the site for two reasons: Firstly, a substantial coverage of competent outcrop and sub-crop exists beneath the proposed site; and secondly, the pre-construction permeability of the weathered residual soils and the underlying Stanwell

Coal Measures bedrock is already very low (consequently reducing the potential for pollution of the groundwater from construction activities). Therefore, any minor reductions in recharge infiltration due to compaction will be negligible.

During construction of the Project, mobile and stationary machinery including excavators, cranes, trucks and other vehicles will be required. There is potential for hydrocarbon contamination of the soil associated with leaks or spills from this machinery (or fuel storage devices for the maintenance of machinery). Dissolved and free-phase hydrocarbon may impact on the bedrock aquifer underlying and down-gradient of areas of fuel spillage.

Operational Phase

Direct Impacts

There will be no extraction of groundwater during the operational phase and, therefore, there will be no direct interference of the existing groundwater environment or direct influence on the local groundwater flow regime.

All surface water flows across the site will be appropriately controlled and managed to restrict the potential for low quality water to recharge into the underlying groundwater. The Project will create a number of low-quality effluent streams and discharges, including:

- Power plant cooling tower discharge effluent (blowdown);
- Dust suppression and rain water runoff at the coke and coal stockpiles;
- Sewage;
- Oil-bearing effluent (plant and equipment spillage or wash down); and
- Potentially dirty waters from chemical and fuel oil storage areas.

The Coke Plant and the power plant will be built on extensive concrete slabs, which will prevent the direct migration of any low quality water (from sources mentioned above) into the shallow soils and aquifers beneath the site. The coal and coke storage areas will be based on compacted fill which will also prevent infiltration and reduce the already low vulnerability of the aquifer to pollution. The coal will have already been washed prior to delivery to the coke plant site. Dust suppression and rainwater runoff from these areas will be collected in sediment collection and evaporation ponds.

Sewage from the Coke Plant will either be treated within the existing SPS treatment plant, or within a new plant constructed on the coke plant site. The SPS sewage treatment plant does not discharge any waste water and potential groundwater impacts from this effluent are covered by the existing SPS environmental management controls. Should a stand alone sewerage facility be constructed and utilised at the project site, best practice technology will be employed to minimise potential groundwater impacts that may result from operation of the plant.

An extensive settlement and evaporation pond system is proposed to prevent discharge of surface storm water contaminants to off-site water bodies. The settlement and evaporation pond system will be managed as a non-release system under normal operating conditions, with discharge only expected during extreme rainfall events when significant dilution is available. This pond system area, positioned to the north of the Coke Plant, has the potential to overlie some alluvial sediments of the Neerkol Creek floodplain (Figure 3.3). Lining of this pond with low permeability material is proposed, and should form an effective barrier to seepage into the groundwater below.

Dissolved and free-phase hydrocarbons, as well as other stored chemicals, may impact on the underlying soils and aquifers down-gradient of areas of fuel storage and usage, and chemical storage and usage, if these areas are not managed appropriately. Workshop areas, vehicle and equipment wash down areas and equipment and machinery repair areas all have the potential to spill fuels, lubricants, solvents or other products. Appropriate design of fuel storage areas, which includes spill containment bunding, sealing the surface area, and location within dirty water capture facilities, will reduce the risk of groundwater contamination resulting from fuel and chemical spills.

Indirect Impacts

The Project will cover a significant area of the ground surface with concrete slabs, and in doing so will reduce the surface coverage of outcrop (or recharge zone) for the Stanwell bedrock aquifer. However, the pre-construction permeability of the weathered residual soils and the underlying Stanwell Coal Measures bedrock is already very low, therefore, any minor reductions in recharge area due to coverage with concrete slabs would be negligible.

Off-site surface water discharge into Quarry Creek has the potential to recharge alluvial aquifers of the Quarry Creek and Neerkol Creek floodplains, down-gradient of the proposed site. During low flow periods in the creek, when the alluvial aquifers are understood to discharge into the creek, the risk of aquifer recharge from site discharge is low. During intense flow periods or floods, when the alluvial aquifers are understood to be recharged by the creeks, the risk of off-site discharge entering the aquifers is greater. However, the potential risk of contamination during high flow periods will be significantly reduced due to the design of on site containment systems and the substantial dilution processes that would occur during high flow events. It should be noted that current discharge from the SPS has created permanent flow conditions in Quarry Creek, and any recharge of down-gradient alluvial aquifers from Quarry Creek is substantially attributed to discharge from the SPS.

Mitigation Strategies and Management Plans

Seepage from Pond System

The coke plant settlement/evaporation pond system will be lined with suitable low permeability material to prevent seepage of solutes or contaminants into underlying aquifers. A small network of monitoring bores will be installed to monitor any seepage from the pond system. This monitoring bore network would consist of:

- Two shallow bores (up to 20 m in depth) spaced evenly down-gradient of the pond and down-dip along a shallow bedding plane of the Stanwell Coal Measures to identify any potential lateral seepage advance (in the event that seepage would flow laterally along bedding planes rather than vertically into the aquifer);

- Three shallow bores (up to 20 m in depth) spaced around the perimeter of the pond system; and

- Two shallow bores (up to 20 m in depth) to be drilled midway between the pond system and Neerkol Creek (spaced 20 m apart) to monitor any potential salt/contaminant/metals dispersion in the water table.

Early detection of discharge will enable management of any potential problems. This network of monitoring bores is a dedicated seepage analysis system and therefore will provide limited additional value to the existing monitoring program in place for the SPS.

Groundwater flow in both the alluvial and bedrock aquifers is perennial from the south to the north towards Neerkol Creek. Strategically installing a small network of bores to the north of the Coke Plant enhances the detection of contamination that may occur from plant leakages (as a result of breaching the integrity of the concrete slab platform at the coke or coal storage facilities or pipe/tank ruptures beneath the plant). This type of monitoring bore network is a valuable mitigation strategy that can provide progressive information regarding changes to the groundwater regime such as artificial rises in aquifer water levels, the presence of any seepage into shallow aquifers, and the dispersion of saline water through an aquifer. The key indicator parameters of seepage that will be monitored will include standing water level, salinity (as total dissolved salts), sulphate, dissolved metals, and major ions.

In the unlikely event of groundwater impact, mitigation strategies will include some or all of the following measures (depending on the specific requirements):

- Investigation of pond system integrity;

- Removal of contamination source and repair/redesign of any pond structures as required;

- Installation of, and pumping from, groundwater interception wells; and/or

- Installation of, and pumping from, groundwater interception trenches.

Hydrocarbon Contamination

Areas of hydrocarbon and chemical storage will have spill control measures and regular inspection regimes in order to prevent and monitor operational activities that potentially could lead to contamination of both surface and groundwater.

Regular fuel tank inspections, testing programs and management of containment systems will be conducted to reduce the potential of hydrocarbon contamination. Installation of monitoring bores down-gradient of all potential contaminant sources will enable early detection of any underground leaks. Any accidental spills will be assessed on a case by case basis and remediated, which may include excavation and disposal of any contaminated soil to a licensed facility, in accordance with the requirements of the Environmental Protection Agency.

General Groundwater Monitoring Program

Regular monitoring of existing bores adjacent to the coke and power plants will continue to enable an understanding of seasonal water table fluctuations and will include groundwater depth and groundwater quality measurements. The objectives of the groundwater monitoring program are to:

- Detect potential groundwater impacts early, so that effective mitigation procedures can be developed and instigated;
- Determine the characteristics and trends of any contaminated groundwater flowing off-site; and
- Identify whether any potential contaminants are varying in concentration or extent.

An additional pair of shallow bores will be situated between the eastern boundary of the Coke Plant and Quarry Creek to provide early detection of any site-sourced contaminants entering the water table and flowing off-site towards Quarry Creek. These bores will be spaced 250 m apart running parallel with the eastern boundary of the plant.

If a stand-alone sewage treatment facility is installed at the project site, a monitoring bore should also be situated down-gradient of the treatment plant to monitor nutrient, general water quality and chloride values. Monitoring of this bore will provide valuable information regarding leaks that may occur in the facility, the evaporation facility or the disposal facility.

Off-site Discharge Component

There is a remote possibility that contaminants discharged off-site via Quarry Creek may enter the alluvial aquifer downstream of the site through surface water recharge during high flow periods. However, due to the design of the site water containment system and substantial natural dilution that would be available in the event of such a discharge, the potential for this occurrence is considered extremely low. Surface water monitoring results associated with Quarry Creek will be regularly assessed to identify any potential groundwater impacts associated with surface discharge.