7 GAS FIELD OPERATIONS

7.1 INTRODUCTION

The Project description for the Queensland Curtis LNG (QCLNG) Project Gas Field Component, as described in the draft environmental impact statement (EIS), was based on best available, conceptual information prior to Front End Engineering and Design (FEED). By the time the supplementary EIS (sEIS) was prepared, the Project description had been further refined through the progression of engineering design and option selection processes.

This chapter describes the changes in Project description for the Gas Field operations between the draft EIS and the sEIS. The impact of these changes, and measures to mitigate impacts, are described in *Volume 3* of this sEIS. Where the Project description provided in the draft EIS has not changed, that aspect of the Project is not discussed in the sEIS.

In addition, any submissions received that relate to the description of Gas Field Operations are addressed in this chapter.

7.2 SUBMISSIONS RECEIVED

Table 2.7.1 provides a summary of the submissions received on the operations of the Gas Field and a response to those submissions.

Table 2.7.1 Responses to Submissions on the Draft EIS

Issue Raised	QCLNG Response	Relevant Submissions(s)
The locations of Gas Field infrastructure are not presented	The first 5 years of development is described in *Volume 3, Chapter 19.* At the current stage of development, the exact location of wells and associated infrastructure (as detailed in *Volume 2, Chapter 7* of the draft EIS and this chapter) is not known. Wells will be spaced, on average, 750 m apart to maximise coal seam gas (CSG) recovery. Each block (refer *Figure 2.7.1*) is subject to environmental and social constraints and it is estimated that between 70 and 90 per cent of each block will have wells nominally spaced at 750 m. The approximate locations of other infrastructure are described in *Table 2.7.2*. QGC has determined that the average well spacing for optimal gas production is 750 m, based on the gas content, pressure and permeability of coal seams. Gas fields in other parts of the world have different gas content, pressures and permeability and hence the requirements for optimal well spacing are different. Despite not providing the exact location of each infrastructure item, the impacts have been assessed based on worst case scenarios, constraints mapping to identify sensitive areas and mitigation measures to reduce impacts. These are detailed in *Volume 3* of the draft and sEIS.	9, 11,12, 32,

Issue Raised	QCLNG Response	Relevant Submissions(s)
Clarify the expected area of disturbance relating to all water disposal, storage and treatment facilities and associated infrastructure	Refer to *Section 7.5.6.6 to Section 7.5.6.11.* All pond footprint areas exclude the footprint of existing ponds constructed under QGC's existing petroleum licences.	32
Project water requirements should be supplied from Associated Water. Municipal water supplies will not be available.	Refer to *Section 7.5.9*.	34, 36, 38
Pond inspection and maintenance not discussed	Refer to *Section 7.5.6.12*.	32
Commitment should be provided on commercial salt disposal and reinjection of brine	Refer to *Section 7.5.6.13*.	32

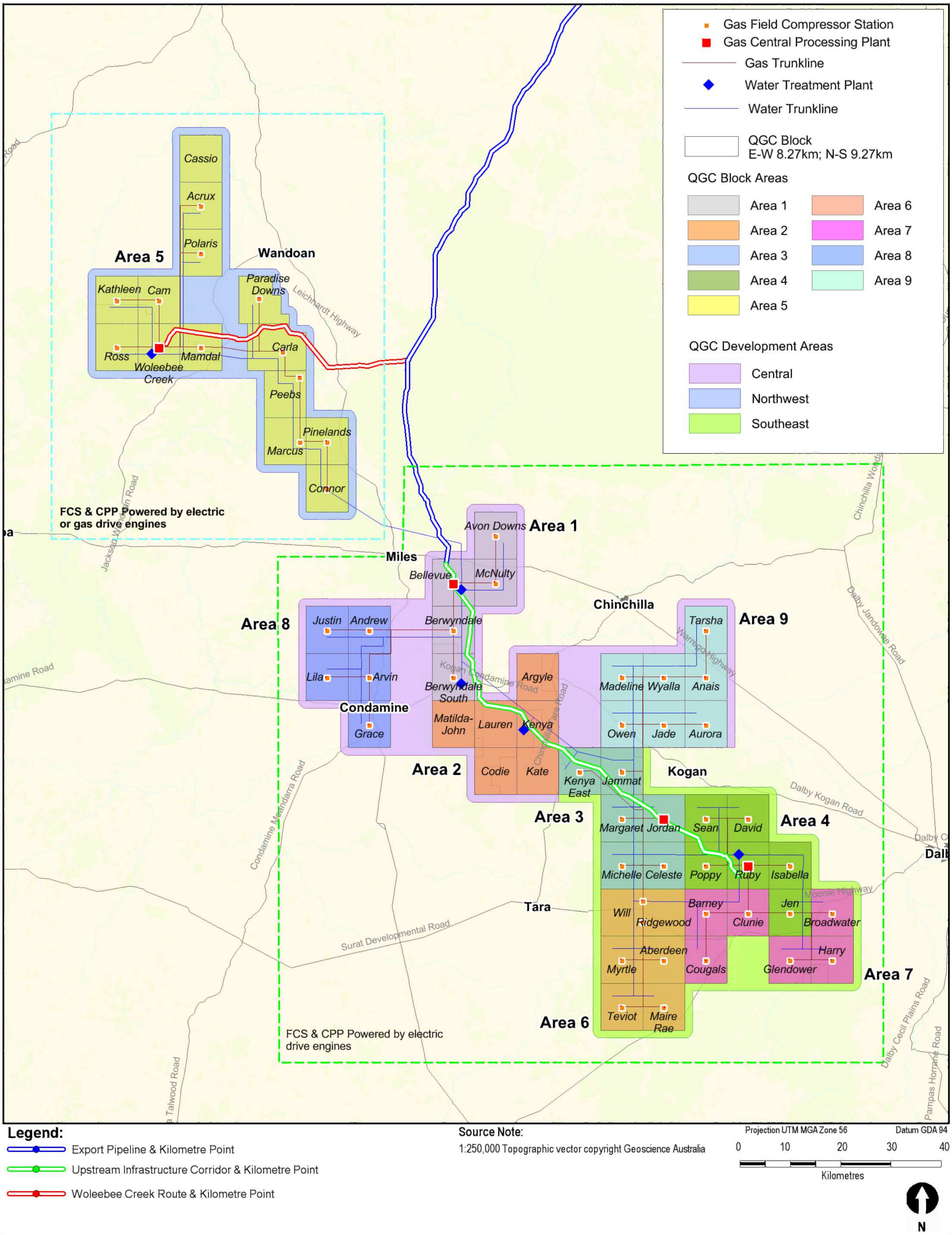
7.3 PROJECT AREA

The Gas Field is divided into 61 blocks, as defined under the *Petroleum and Gas (Production and Safety) Act 2004 (Qld)* (P&G Act). For internal purposes the Gas Field has been divided into a number of categories:

- 61 blocks, each approximately 9.27 km by 8.27 km
- nine block areas, containing groups of blocks
- three development areas, containing groups of block areas

The three development areas are referred to as the Northwest Development Area (NWDA), Southeast Development Area (SEDA) and Central Development Area (CDA).

Figure 2.7.1 shows the division of the Gas Field into these categories and the general location of major facilities.



QUEENSLAND CURTIS LNG A BG Group business	Project: Queensland Curtis LNG Project Client: QGC - A BG Group business	Title: **Gas Field Areas and Major Facilities**
ERM Environmental Resources Management Australia Pty Ltd	Drawn: Unidel Approved: CDP Date: 20.01.2010	sEIS Volume 2 Figure S2.7.1 File No: QC02-T-MA-00129 Revision: Supplementary

Disclaimer:
Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only.
ERM does not warrant the accuracy of any such Maps and Figures.

Wells and gas compression infrastructure in Area 2 will principally supply gas to the domestic market under petroleum licences already held by QGC. There is the potential for the supply of some gas from Area 2 to the QCLNG Project. No gas compression infrastructure is expected to be developed in Area 2 for the purposes of the QCLNG Project.

7.4 OVERVIEW OF CHANGES TO PROJECT DESCRIPTION

Table 2.7.2 provides a summary of the changes to the Project description, identifies the environmental factors affected by the changes and the section of this sEIS in which the impacts of those changes is assessed using the refined reference case.

The sEIS has used the same assessment methodology as the draft EIS. As such, where the project description presents a level of optionality, the assessment takes the most conservative of the options for assessment. This approach ensures that the impacts of the Project are not underestimated.

In completing the impact assessment works for the QCLNG Project, opportunities have been identified that could potentially reduce the overall environmental and social impacts of the Project. Some of these opportunities lie in partnership with other organisations or companies and QGC will progress the development of these opportunities over the coming months.

Table 2.7.2 Summary of Project Description Changes to Gas Field Operations

Project element	draft EIS description	Section of draft EIS	Supplementary EIS description	Environmental factors affected by change	Section Describing Impact Assessment of Change
Wells	• Approximately 6,000 wells. • At each well site there will be a wellhead, separator and wellhead drive unit (for approximately six months at the start of life of a well). • Infrastructure powered by gas engines.	*Vol 2, 7.3* and *7.4*	• Approximately 6,000 wells. • At each well site there will be a wellhead, separator, wellhead drive unit (for approximately 6 to 12 months at the start of life of a well) and flare. • An option to reduce wellhead pressure (after approximately five to 10 years of well life for a period of approximately 10 to 20 years) will involve installation of single wellhead compressors at some wells. • Well site infrastructure powered by gas engines.	• Noise • Air quality • Transport • GHG	• *Vol 3, Ch 13* • *Vol 3, Ch 12* • *Vol 3, Ch 14* • *Vol 7*
Gas gathering lines between wells and FCSs	• Total length of 2,500 km. • Easement width 15 m.	*Vol 2, 7.6*	• Total pipe length of 6,700 km. • Total length of gathering line easement, including water-gathering lines (6,700 km), is 9,200 km. • Easement width 15 to 30 m, with approximately 75 per cent being 15 m.	• Ecology • Land use • Surface water	• *Vol 3, Ch 7,8* • *Vol 3, Ch 5* • *Vol 3, Ch 9*
Gas trunklines from FCSs to CPPs	• Total length of 1,200 km. • Easement width 30 m.	*Vol 2, 7.6*	• Total pipe length of 1,600 km. • Total length of trunkline easement, including water trunklines, is 600 km. • Easement width 20 to 54 m, including electricity transmission lines, water trunklines and communication lines.	• Ecology • Land use • Surface water	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 9*

Project element	draft EIS description	Section of draft EIS	Supplementary EIS description	Environmental factors affected by change	Section Describing Impact Assessment of Change
FCSs	• Approximately 27 FCSs with 8 screw compressors per FCS. • FCS powered by gas engines located at each screw compressor. • At each FCS there will be either a vent or flare and water management system including a pond. • Total area for all FCS components approximately 5 ha. • Locations of FCSs not determined.	*Vol 2, 7.7*	• Approximately 53 FCSs with up to eight screw compressors per FCS. • The number of screw compressors per FCS will fluctuate depending on volume of gas compressed. At any one time there will be between 150 and 200 screw compressors operating simultaneously. • FCSs in SEDA and CDA powered by electric motors. • Electricity supplied through a grid connection. • FCSs in NWDA powered by gas engines at each compressor or electric motors powered from grid connection or decentralised gas turbines. • Grid connection from CPP substations to FCS substations approximately 1,600 km of 33 kV underground powerlines, with limited percentage of aboveground lines. • Powerlines included in trunkline easement, with multiple parallel powerlines in 600 km trunkline easement. • At each FCS there will be a flare, water management system including a pond and substation. • Total area for all FCS components approximately 7 ha. • Locations of FCSs not determined, but approximately one FCS required near the centre of each graticular block. • An option to reduce wellhead pressure (after approximately 5 - 10 years of well life for a period of approximately 10 - 20 years) is the use of screw compressors at some FCSs.	• Noise • Air quality • Transport • Greenhouse gas (GHG) • Ecology • Land use	• *Vol 3, Ch 13* • *Vol 3, Ch 12* • *Vol 3, Ch 14* • *Vol 7* • *Vol 3, Ch 7, 8* • *Vol 3, Ch 5*

Project element	draft EIS description	Section of draft EIS	Supplementary EIS description	Environmental factors affected by change	Section Describing Impact Assessment of Change
CPPs	• Approximately nine CPPs with 10 reciprocating compressors per FCS. • CPP powered by gas engines located at each reciprocating compressor. • At each CPP there will be a flare, five TEG units and a water management system including a pond. • Total area for all CPP components approximately 7 ha. • Locations of CPPs not determined.	*Vol 2, 7.8*	• A total of four CPPs comprising: • One CPP in NWDA with three centrifugal compressors. • Two CPPs in SEDA with two centrifugal compressors each. • One CPP in CDA with one centrifugal compressor. • CPPs in SEDA and CDA powered by electric motors. • Electricity supplied through a grid connection. • CPPs in NWDA powered by gas turbines at each compressor or electric motor powered from grid connection or decentralised gas turbines. • Grid connection from third-party substations to CPP substations has approximately 40 km of 132 kV above-ground power lines. • At each CPP there will be a flare, one TEG unit per compressor, water management system including a pond and a substation. • Total area for all CPP components approximately 19 ha. • Locations of CPPs identified at scale of graticular block.	• Noise • Air quality • Transport • GHG • Ecology • Land use	• *Vol 3, Ch 13* • *Vol 3, Ch 12* • *Vol 3, Ch 14* • *Vol 7* • *Vol 3, Ch 7, 8* • *Vol 3, Ch 5*
• Water gathering lines connect wells to infield buffer storages and regional storage ponds	• Total length of 500 km • Easement width – 15 m	*Vol 2, 7.6, 7.9.3*	• Total pipe length of 6,700 km • Total length of gathering line easement, including gas-gathering lines (6,700 km) is 9,200 km • Easement width 15 to 30 m, with approximately 75 per cent being 15 m.	• Ecology • Land Use	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5*

Project element	draft EIS description	Section of draft EIS	Supplementary EIS description	Environmental factors affected by change	Section Describing Impact Assessment of Change
Water trunklines connect regional storage ponds to collection header ponds or raw water ponds	n/a	n/a	• Fibre-reinforced plastic or concrete lined ductile iron 300 to 1,200 mm. • Total length 600 km. • Total length of easement, including gas trunklines, is 600 km. • Easement width 20 to 54 m.	• Ecology • Land Use	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5*
Untreated water collection Ponds have been reclassified as: • infield buffer storages • regional storage ponds.	• Approximately 39 untreated water collection ponds of 200 ML/pond or 4 ha/pond. • Total pond footprint of approximately 7,800 ML or 156 ha. • Location of ponds not determined, but evenly distributed across tenements.	Vol2, 7.9.3	• Approximately 120 infield buffer storages, comprising either ponds or tanks between 1 and 15 ML per storage and a total capacity of between 300 and 1700 ML. • Depending on whether ponds or tanks are used, footprint is approximately 400 m^2 to 3000 m^2 per storage with a total footprint of between 5 and 30 ha. • Approximately 35 regional storage ponds, approximately 1 ha and 60 ML per pond with a total footprint of 35 ha and total volume of 2,100 ML. • Approximately two to four infield buffer storages per block and one regional storage pond per block.	• Ecology • Land use • Land contamination	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6*
Collection Header ponds	n/a	n/a	• Approximately two Collection Header ponds, approximately 25 ha and 2,000 ML per pond with a total footprint of 50 ha and total volume of 4,000 ML. • Collection Header ponds located adjacent to water Collection Header pipeline.	• Ecology • Land use • Land contamination	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6*
Untreated water storage ponds are reclassified as raw water ponds	• One pond per water treatment plant (WTP), located adjacent to WTP. • Total pond footprint (excluding existing ponds) of approximately 750 ML or 15 ha.	*Vol 2, 7.9.3*	• One raw water pond per WTP, located adjacent to WTP. • Total pond footprint of approximately 1,000 ML or 13 ha.	• Ecology • Land use • Land contamination	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6*

Project element	draft EIS description	Section of draft EIS	Supplementary EIS description	Environmental factors affected by change	Section Describing Impact Assessment of Change
Treated water storage ponds and blending pond	• One pond per WTP, located adjacent to WTP. • Total pond footprint (excluding existing ponds) of approximately 1,900 ML or 43 ha.	*Vol 2, 7.9.3*	• One treated water pond and one blending pond per WTP, located adjacent to WTP. • Total pond footprint of approximately 450 ML or 4 ha.	• Ecology • Land Use • Land Contamination	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6*
Water pump stations	• Approximately 27 pumping stations of 400 to 800 kW.		• 150 - 200 water pumps requiring between 100 and 1,500 kW to power each pump	• GHG • Air quality • Noise	• *Vol 7* • *Vol 3, Ch 12* • *Vol 3, Ch 13*
Water treatment plants	• WTP with 20 to 25 ML/day capacity in NWDA. • WTP with 30 ML/day capacity in CDA. • WTP with 50 to 55 ML/day capacity in SEDA. • Locations of WTPs not known. • WTP comprises desalination plant, brine concentration and water amendment. • Approximate total footprint of 25 ha.	*Vol 2, 7.9.3*	• WTP with 35 ML/day capacity in NWDA. • WTP with 75 ML/day capacity in CDA. • WTP with 65 ML/day capacity in SEDA. • WTPs co-located with CPPs, except in CDA where alternative option is co-location with existing ponds. • Alternative options for WTPs include one WTP in CDA with 175 ML/day capacity. • WTP comprises desalination plant, brine concentration and water amendment. • Footprint of a WTP is 25 ha.	• Noise • Air quality • Transport • GHG • Ecology • Land use • Land contamination	• *Vol 3, Ch 13* • *Vol 3, Ch 12* • *Vol 3, Ch 14* • *Vol 7* • *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6*
Brine evaporation ponds have been subdivided into: • Brine ponds • Brine evaporation basins.	• One pond per WTP, located adjacent to WTP. • Total pond footprint of approximately 700 ML or 21 ha.	*Vol 2, 7.9.3*	• One brine pond and brine evaporation basin per WTP. • Generally located adjacent or within 10 km of a WTP. • Total brine pond footprint of approximately 9,000 ML or 90 ha. • Total brine evaporation footprint of approximately 1,950 ML or 390 ha.	• Ecology • Land use • Land contamination	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6*

Project element	draft EIS description	Section of draft EIS	Supplementary EIS description	Environmental factors affected by change	Section Describing Impact Assessment of Change
Salt disposal landfill	• 4,500,000 tonnes over the life of the Project disposed of in decentralised landfills.	*Vol 2, 7.9.3, Vol 3, 11.10.4*	• 5,400,000 tonnes or 2,700,000 m^3 over the life of the Project disposed of in decentralised landfills. • Total footprint of landfill(s) of approximately 50 ha.	• Ecology • Land use • Land contamination • Waste	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6* • *Vol 3, Ch 16*
Beneficial use of Associated Water	• Preferred options include irrigation of tree crops, reinjection and supply to industry.	*Vol 3, Ch 11*	• Preferred options include irrigation of tree crops with blended water, reinjection of raw or treated water, direct release of treated water to watercourses, supply of treated water to agriculture and supply of raw water to industry.	• Ecology • Land use • Land contamination • Surface water • Aquatic ecology	• *Vol 3, Ch 7, 8* • *Vol 3, Ch 5* • *Vol 3, Ch 6* • *Vol 3, Ch 9* • *Vol 3, Ch 8*
Personnel	• 800 personnel for operations.	*Vol 2, 7.10.4*	• Operations personnel ramping up from 200 to 550 between 2010 and 2014. • 550 personnel for operations from 2014 onwards.	• Social • Ecology • Transport • Waste	• *Vol 8* • *Vol 3, Ch 7, 8* • *Vol 3, Ch 14* • *Vol 3, Ch 16*
Accommodation camps	• During construction and operations small, mobile camps for well drilling, well establishment and gathering lines. • Two permanent camps for operations personnel of approximately 5 ha per camp. • Camp locations not determined.	*Vol 2, 7.10.4*	• Operations camps will be selected from construction camp locations.	• Social • Ecology • Transport • Waste	• *Vol 8* • *Vol 3, Ch 7, 8* • *Vol 3, Ch 14* • *Vol 3, Ch 16*

7.5 DETAILS OF CHANGES TO PROJECT DESCRIPTION

7.5.1 Well Sites

The following have remained unchanged from the draft EIS:

- total number of wells, approximately 6,000
- the well development schedule
- description and operation of wellhead separators
- description and estimated period of operation of wellhead drive units.

The sEIS well site configuration now includes a flare (as required under the *P&G Act*) and potentially a wellhead compressor, where required. QGC intends to lower the pressure at wells as the gas production rate of wells declines. The options for achieving a reduction in well pressure include a compressor situated at wellheads or using installed compression capacity at the appropriate FCS screw compressors.

The wellhead and separator skid design and control system configuration incorporate a number of protection layers to prevent uncontrolled gas releases. The well pad and surrounding area will be cleared of vegetation so that a bush fire will not reach the equipment. Upon high pressure at the well site, due to a downstream LNG or compressor upset flow, the well can be shut-in. Some areas of the coal seam are sensitive to well closure and in these instances (approximately 10 per cent of total wells) the well will flare CSG if required. The separator vessel has a pressure relief valve which will vent to atmosphere to prevent vessel overpressure and any rupture due to fire or blocked outlet.

7.5.1.1 *Well Site Flare*

Flaring will be limited wherever possible and will result from a combination of maintenance and emergency flaring. It is estimated that each well will flare 1 mmscf (28,300 m^3) per annum. There are a range of potential flaring scenarios occurring between once every four years and twice per year. Flaring events range between five minutes and six hours except for flaring during pilot well testing and workover rig activities.

Pilot well testing will occur as part of the exploration and appraisal program for the QCLNG Project and for these wells (approximately 5 per cent or 300 wells) will be for six months. Pilot wells are expected to flare approximately 95 mmscf (2.7 million m^3) per event.

Flaring during workover rig activities occurs once every two years for a duration of approximately three days. Each workover flaring event will flare approximately 0.5 mmscf (14,150 m^3) per day.

The stack for well site flares will be between 2 and 6 m high and between 150 and 250 mm diameter and designed to comply with all relevant standards. The flares will be elevated and will have a sterile radius which will be validated through radiation modelling (with a nominal radius of 20 m). This sterile radius will be cleared of all vegetation so there are no ignition sources in a flaring event. The flare will only ignite in a flaring event, and will not be continuously lit.

7.5.1.2 Wellhead Pressure Reduction

Lowering of wellhead pressure to approximately 35 kPag will result in the recovery of approximately 10 per cent more gas per well over its life, compared to operating it at 345 kPag. The following options to achieve the lower wellhead pressure are under investigation:

- utilisation of the installed compression capacity of screw compressors at the FCSs
- individual compressors with gas engine drivers at wellheads, where required.

It is expected that screw compressors at FCSs will provide the majority of the capacity to lower wellhead pressure and that compression at wellheads will only be required in certain circumstances.

Installed Capacity of Screw Compressors at FCSs

Gas will flow freely from the wells to the FCS, arriving at a pressure of approximately 172 kPag. Screw compressors then compress the gas to approximately 1,450 kPag.

As the production from the wells in a block declines, the pressure at the wellhead will also naturally reduce, since the pressure drop in the gathering system (between wells and FCS) is less at lower flows.

As the required capacity of the FCS reduces (as block production declines) it becomes possible to use the installed compression horsepower to achieve lower FCS inlet pressures and hence lower the pressure at the wells further.

Each screw compressor will be driven by an electric motor of approximately 1,000 kW. Operating the screw compressors at a lower suction pressure reduces the flow that a single compressor can handle. However, even though flow declines the machines will continue to absorb around 1,000 kW of power all the way down to about 45 to 50 per cent capacity: at which time machines will be shutdown and relocated to other parts of the Gas Field. In order to fully utilise the available compression power while achieving the lower pressures it will be necessary to make some minor modifications to the compressor gearboxes to increase the rotational speed.

Wells will be drilled continuously over the life of the Gas Field in order to maintain the required flow of gas to the LNG Plant (approximately 1,500 mmscf (41 million m^3) per day). As wellhead pressures decline the required number of screw compressors will increase, as installed compression capacity is utilised to lower wellhead pressure in declining areas, rather than being relocated to new areas.

So, as new blocks are drilled, additional screw compressors will be required in those areas. Towards the end of life of the Project, it is expected that there may be between 200 and 250 screw compressors in simultaneous operation, with no more than eight screw compressors at any FCS. Without utilising screw compressors to lower wellhead pressure, it is expected that there will be between 150 and 200 screw compressors in operation simultaneously with a maximum of eight screw compressors at each FCS (refer *Section 7.5.4*).

Individual Wellhead Compression

Individual wellhead compression provides an alternative mechanism to lower wellhead pressure, by installing a compressor and gas drive engine at an individual well. Under a worst case scenario, where no screw compressors at FCS contribute to the lowering of wellhead pressure, then wellhead compression would:

- involve a maximum of 3,600 wells requiring compression simultaneously
- be installed after approximately five to 10 years of well operation
- operate for a period of approximately 10 to 20 years
- comprise a single screw compressor and gas drive engine per well.

In a local area, where specific well productivity, the gas resource and configuration characteristics require it, up to 75 per cent of the wells might have wellhead compression. As it is expected that screw compressors at FCSs will provide the majority of the capacity to lower wellhead pressure it is not anticipated that 75 per cent of wells will have wellhead compressors. The scenario of maximum number of wellhead compressors is included for completeness and represents an extremely conservative scenario for impact assessment.

If wellhead compression is required at individual wells then the engine size required to power the compressor will depend on the volume of gas that requires compression, which is estimated at 0.4 mmscf (11,300 m^3) per day. For the purposes of impact assessment, a proprietary engine and compressor, with engine power at 70 per cent load of approximately 40 kW, has been selected as representative of the type of gas drive engines and compressor that will be required.

A number of scenarios for lowering wellhead pressure, involving wellhead compression and utilisation of screw compressor capacity, are considered for impact assessment of air and noise emissions as described in the relevant impact assessment chapters of *Volume 3*.

7.5.2 Gas-Gathering Lines

Gas-gathering lines connect wells to FCSs. Gas-gathering line type (geosynthetic) and dimensions (160 to 315 mm diameter) are unchanged from the draft EIS. The majority of gas-gathering line (greater than 70 per cent) will be located in the same easement as water-gathering line. Easement widths with multiple gas- and water-gathering lines will vary between 20 and 30 m, depending on the number of gas and water lines. Easements with a single gas and water-gathering line will be 15 m wide and this is expected to account for approximately 75 per cent of easements. Where required for safety or operational reasons single gas and water easements may be 20 m. Due to the refinement of engineering requirements, the estimated total length of gas-gathering line has increased from 2,500 km in the draft EIS to 6,700 km for the sEIS. In total approximately 9,200 km of gas- and water-gathering line easement will be required.

The total construction footprint for gas- and water-gathering line easements will be approximately 15,600 ha. During operations, gathering line easements will be progressively rehabilitated by allowing natural regrowth, except for trees whose root zones may interfere with gathering lines. An access track, approximately 4 m wide will be maintained within the easement beside the gathering lines. The estimated footprint of gas- and water-gathering lines after progressive rehabilitation is 6,800 ha.

QGC is investigating ploughing-in technology as an alternative to trenching for installation of gathering lines. If ploughing-in is practicable, this could significantly reduce the easement width required for gathering line.

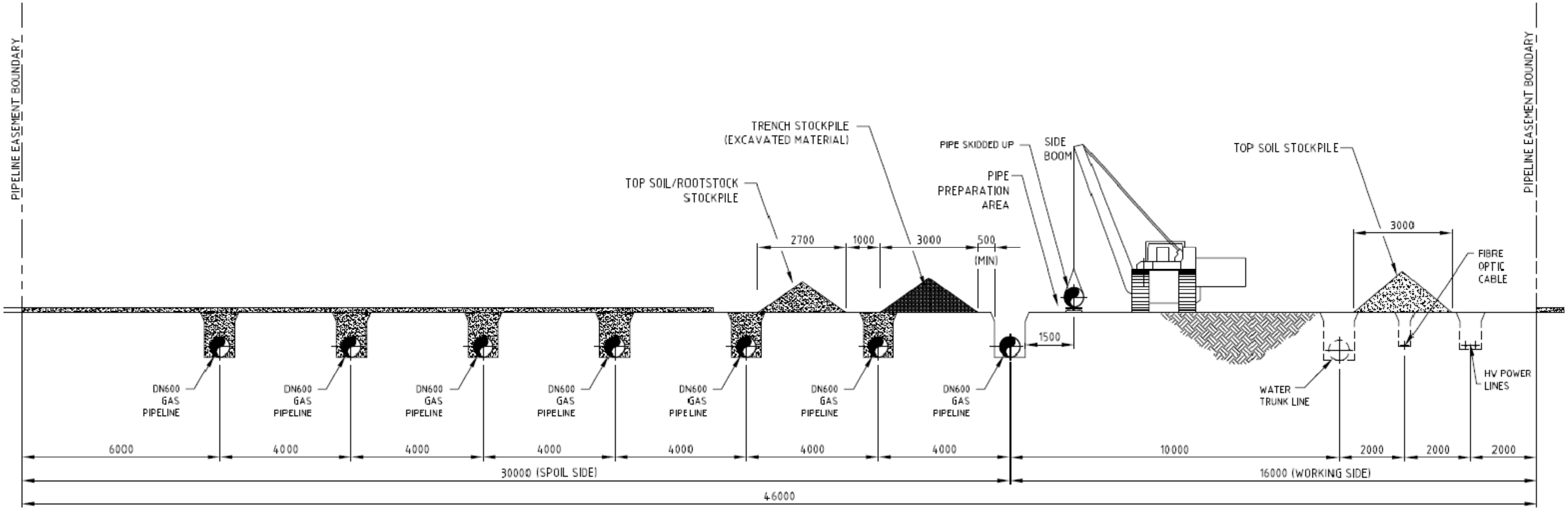
7.5.3 Gas Trunklines

Gas trunklines connect FCSs to CPPs. Gas trunklines will be either steel or fibre reinforced plastic and 400 to 600 mm in diameter. The current preferred option is steel gas trunklines with provision for later injection of corrosion inhibitor, if required, and expected to be added after 10 years of the life of a trunkline. The estimated total length of pipe required for gas trunklines has increased from 1,200 km in the draft EIS to 1,600 km for the sEIS. For the purposes of the sEIS, it has been assumed that there will be an individual gas trunkline from every FCS to a CPP. This represents a worst case scenario for easement width. As gas trunklines from different FCSs approach a CPP they will be co-located in the same easement. Alternatives to merge multiple gas trunklines into a single larger trunkline are currently under investigation. Up to nine gas trunklines may be located in the same easement for distances up to 15 km. There may be a single water trunkline co-located in the same easement as gas trunklines. Easement widths for gas and water trunklines will vary between 20 and 54 m. *Figure 2.7.2* shows that the construction easement with seven gas trunklines, one water trunkline and power lines will be approximately 46 m wide.

The total length of all trunkline easements will be approximately 600 km once multiple trunklines are located in the same easement. The total footprint for gas and water trunklines will be approximately 1,600 ha.

During operations, trunkline easements will be progressively rehabilitated by allowing natural regrowth, except for trees whose root zones may interfere with trunklines. An access track, approximately 4 m wide will be maintained within the easement besides the trunklines. The estimated footprint of gas and water trunklines after progressive rehabilitation is 550 ha.

Figure 2.7.2 Trunkline Easement



TRUNKLINES CONSTRUCTION RIGHT OF WAY (7 PIPELINES PARALLEL) LEFT HAND SET UP - (NORMAL)

(GAS TRUNKLINE CONSTRUCTION BEFORE WATER TRUNKLINE CONSTRUCTION)

SCALE 1:75

7.5.4 Field Compressor Stations

For the draft EIS, the final location and design specifications for FCSs had not been completed. The following equipment specifications and configuration were used as a reasonable representation of expected FCS design. The draft EIS described 27 FCSs with eight single-stage screw compressors (CAT 3512 gas engines with an Ariel screw compressor) at each FCS, with a throughput capacity per compressor of 7 to 11 TJ (190,000 to 300,000 m^3) per day. The total throughput of gas was estimated at between 1,500 and 2,000 TJ (41 million to 55 million m^3) per day. Screw compressors were assumed to be powered by gas engines, fuelled by a portion of the CSG extracted from wells. The draft EIS maintained an option to power compressors through electric motors connected to grid power.

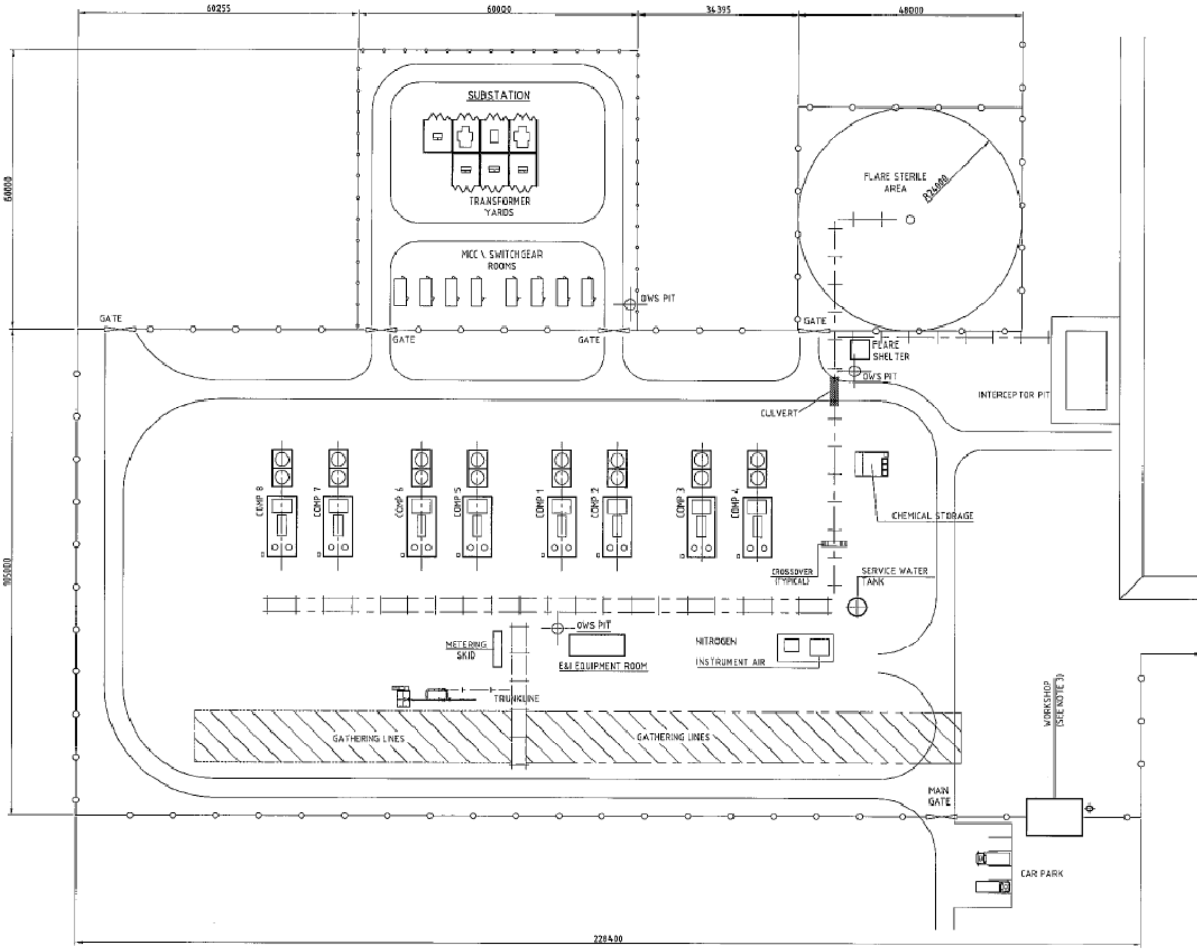
Field design has been further developed since the draft EIS. For the sEIS, the following equipment specifications and configuration have been used as a reasonable representation of expected FCS design:

- Full-field development requiring 53 FCSs, with one FCS located near the centre of the majority of blocks (refer to *Figure 2.7.1*)
- between one and eight Aerial screw compressors per FCS, where the number of screw compressors is dependent on the gas-flow rate from surrounding wells
- between 150 and 200 screw compressors (rotating equipment) operating simultaneously, representing a total gas throughput of between 1,500 and 2,000 TJ (41 million to 55 million m^3) per day (total throughput is unchanged from the draft EIS as the same volumes of gas are considered)
- powered by either a CAT 3516 (or similar) gas engine or electric motor connected to the grid or decentralised gas turbines
- one substation per FCS, where the FCS is connected to the grid
- one flare per FCS
- water separation and management system including pond
- footprint of all infrastructure of approximately 7 ha per FCS based on an eight screw station.

The capacity of the screw compressors is being evaluated and it may be possible to utilise larger screw compressors and thereby reduce the number per FCS.

An eight screw compressor FCS layout is provided in *Figure 2.7.3.*

Figure 2.7.3 Example FCS layout (maximum number of compressors)



The total gas throughput has remained constant between the draft EIS and sEIS. However a greater number of FCSs with, on average, fewer compressors per FCS and variable numbers of screw compressors, has been considered for the sEIS. This allows greater flexibility in matching gas compression with gas production from any particular area. A significant advantage to the use of screw compressors is their ability to handle a large range of flow and gas pressures. This means that later in field life, when well production (and overall production from a block) starts to decline; gas recovery can be enhanced by utilising the installed compression horsepower to achieve lower FCS inlet pressures and hence lower the pressure at the wells.

It is QGC's preference for all FCSs to be powered by electric motors, sourced from the grid, however this may not be practicable in the timeframes required in the NWDA. Screw compressors at FCSs in the SEDA and CDA will be powered by electric motors, with power sourced from a connection to the grid. Screw compressors at FCSs in the NWDA will be powered by either gas engines at each compressor or electric motors, with power sourced from a connection to the grid or decentralised gas-powered turbines. The gas-powered turbines will supply power as an interim measure if a connection to the grid cannot be established in the timeframes required. It is not expected that these turbines would operate for more than three years. Where grid connection is proposed, a substation will be constructed at each FCS connected through a combination of underground and above-ground 33 kV power lines to a substation at the nearest CPP. Underground power lines are the preferred option, but where practicable and constraints are identified, above-ground power lines may be used. The total length of power lines is approximately 1,600 km. Multiple underground power lines will be located in the same easement as gas trunklines where powerlines from multiple FCSs converge at a CPP. The total easement length for trunklines and power lines is approximately 600 km.

Screw compressors at FCSs may be used to lower wellhead pressure. If this occurs, then screw compressors may be retained at a FCS instead of being moved to another FCS for the purpose of CSG compression. This would result in an increase in the number of screw compressors at each FCS as gas flows decline. It is not expected that there will be more than eight screw compressors at any FCS.

Air and noise emissions data for the CAT G3516 and Aerial screw compressor are described in the relevant impact assessment chapters of *Volume 3*.

Detailed design information for flares is not available, but flares are assumed to be approximately 15 m high. Each FCS is expected to have approximately 10 flaring events per annum of approximately 30 minutes' duration, with approximately 0.005 mmscf (142 m^3) flared per event. In total approximately 2.65 mmscf (75,040 m^3) will be flared per annum.

The description in the draft EIS of the FCS water and waste management systems, including interceptor pits and ponds, is unchanged. QGC is pursuing options to minimise the volume of oily water generated, including the recycling of condensed water. Oil will be gravity separated from water and contaminated water may be transferred to the WTP for treatment. Water management tanks may be considered as alternatives to ponds.

7.5.5 Central Processing Plants

For the draft EIS, the location and design specifications for CPPs had not been completed. The following equipment specifications and configuration were used as a reasonable representation of expected CPP design. The draft EIS described nine CPPs with 10 two-stage Aerial reciprocating compressors to pressurise the gas with a throughput capacity per compressor of 18 TJ (500,000 m^3) per day. Reciprocating compressors were assumed to be powered by CAT 3608 gas engines with an option to power compressors through electric motors connected to grid power.

For the sEIS, the final location and design specifications for CPPs have not been completed. The following equipment specifications and configuration have been used as a reasonable representation of expected CPP design:

- four CPPs (refer to *Figure 2.7.1*) in total comprising:

  - one CPP in Woleebee Creek block with three centrifugal compressors with a throughput capacity of 220 mmscfd per compressor
  - one CPP in Ruby block with two centrifugal compressors with a throughput capacity of 220 mmscfd per compressor
  - one CPP in Jordan block with two centrifugal compressors with a throughput capacity of 220 mmscfd per compressor
  - one CPP in Bellevue block with one centrifugal compressors with a throughput capacity of 100 mmscfd per compressor
- centrifugal compressors in the SEDA (Ruby and Jordan blocks) and CDA (Bellevue block) will be powered by electric motors connected to the grid
- centrifugal compressors in the NWDA (Woleebee Creek block) will be individually powered by either gas turbines at each compressor or electric motors, with power sourced from a connection to the grid (preferred) or, if connection to the grid is significantly delayed, by decentralised gas turbines (non-preferred).
- centrifugal compressors will be similar to a Dresser Rand Datum (which has been used as the basis for the impact assessment, but which is not finalised)
- gas turbines such as GE LM2500 (or similar)
- one tri-ethylene glycol (TEG) dehydration unit per compressor
- one substation per CPP, where the CPP is connected to the grid
- one flare per CPP
- water separation and management system including pond
- footprint of all infrastructure of approximately 19 ha per CPP.

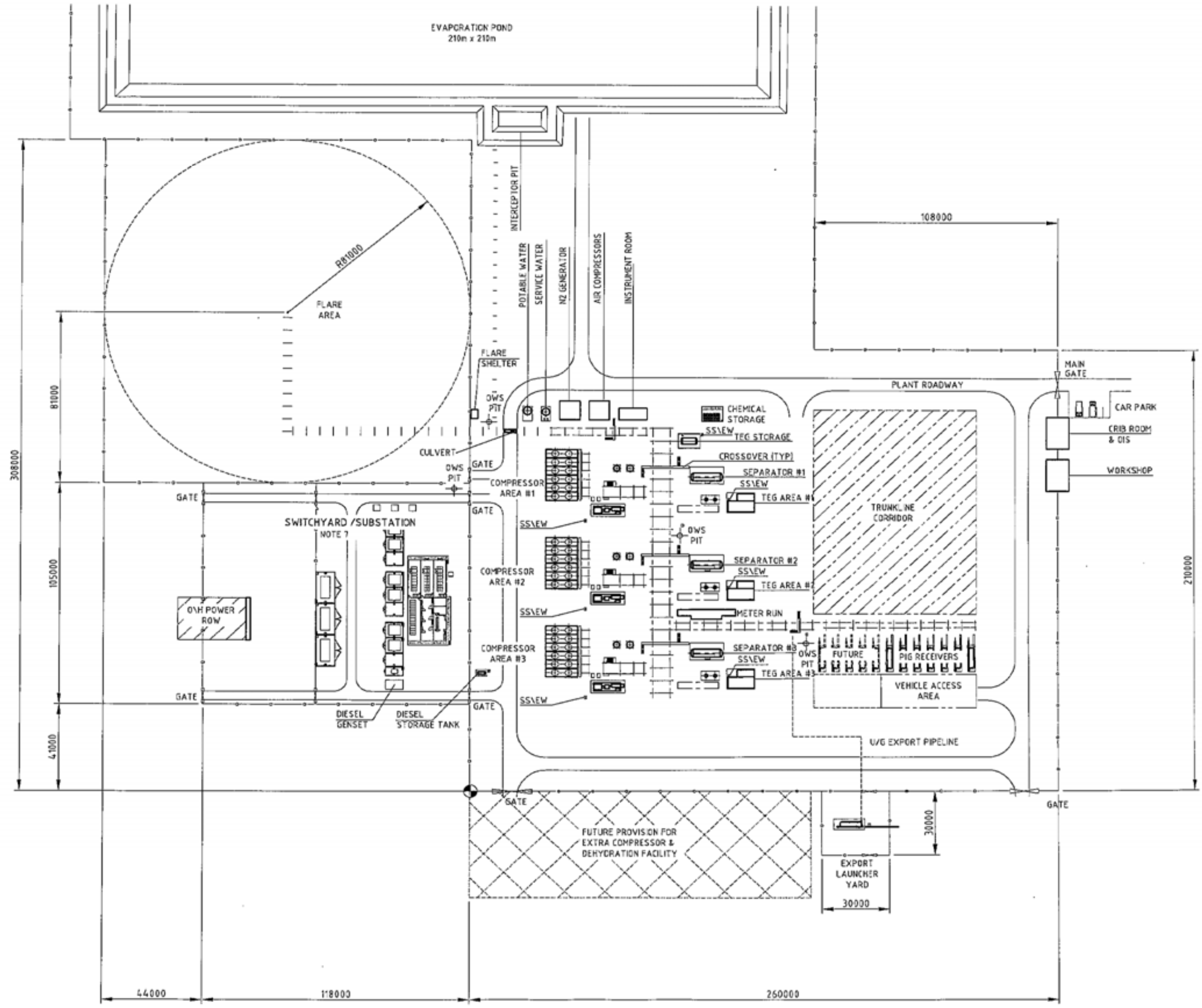
Based on the updated field development plan and demonstration that longer trunklines are feasible; larger, and more centralised CPPs are feasible and preferred. Larger centrifugal compressors are a better selection than small reciprocating compressors for the following reasons:

- a larger capacity compressor means fewer machines. This results in a significantly lower maintenance burden. A smaller CPP means shorter piping runs (albeit of generally larger diameters), less site preparation and civil works and shorter cable runs
- centrifugal compressors are significantly more reliable than reciprocating compressors requiring less downtime, maintenance and flaring events
- large centrifugal compressors will be compliant with American Petroleum Institute standards (and hence QGC standards)
- there are no pulsation issues
- centrifugal compressors are lower cost.

As a result the number of CPPs has reduced from nine to four and the compressor type has changed from 90 reciprocating to eight centrifugal compressors.

A typical CPP layout, showing three centrifugal compressors, is provided in *Figure 2.7.4.*

Figure 2.7.4 Typical CPP layout



The decentralised gas-powered turbines will supply power as an interim measure if a connection to the grid cannot be established in the timeframes required to deliver first gas to the LNG plant. It is not expected that these turbines would operate for more than three years. Where a connection to the grid is proposed, a substation will be constructed at each CPP connected by above-ground 132 kV power lines to a third-party substation. The total length of above-ground 132 kV power lines, for which QGC is seeking approval, is approximately 40 km. This comprises approximately 25 km between the Ruby CPP and Jordan CPP and 15 km to connect the Bellevue CPP to existing QGC power infrastructure. Approval for other 132 kV power lines will be sought by the relevant power provider. This includes a connection from a third-party substation to the Ruby CPP (approximately 5 km) and a connection from a third-party substation to the Woleebee Creek CPP (approximately 15 km).

Air and noise emissions data for the gas turbines and centrifugal compressors are described in the relevant impact assessment chapters of *Volume 3*.

Detailed design information for flares is not available, but flares are assumed to be approximately 30 m high. Each CPP is expected to have approximately six flaring events per annum of approximately 30 minutes' duration, with between 0.3 mmscf (8,495 m^3) and 1.5 mmscf (42,475 m^3) flared per event. In total approximately 22.8 mmscf (645,624 m^3) will be flared per annum. Use of a ground flare will also be considered.

The description in the draft EIS of the TEG units and water and waste management system, including interceptor pits and pond, is unchanged.

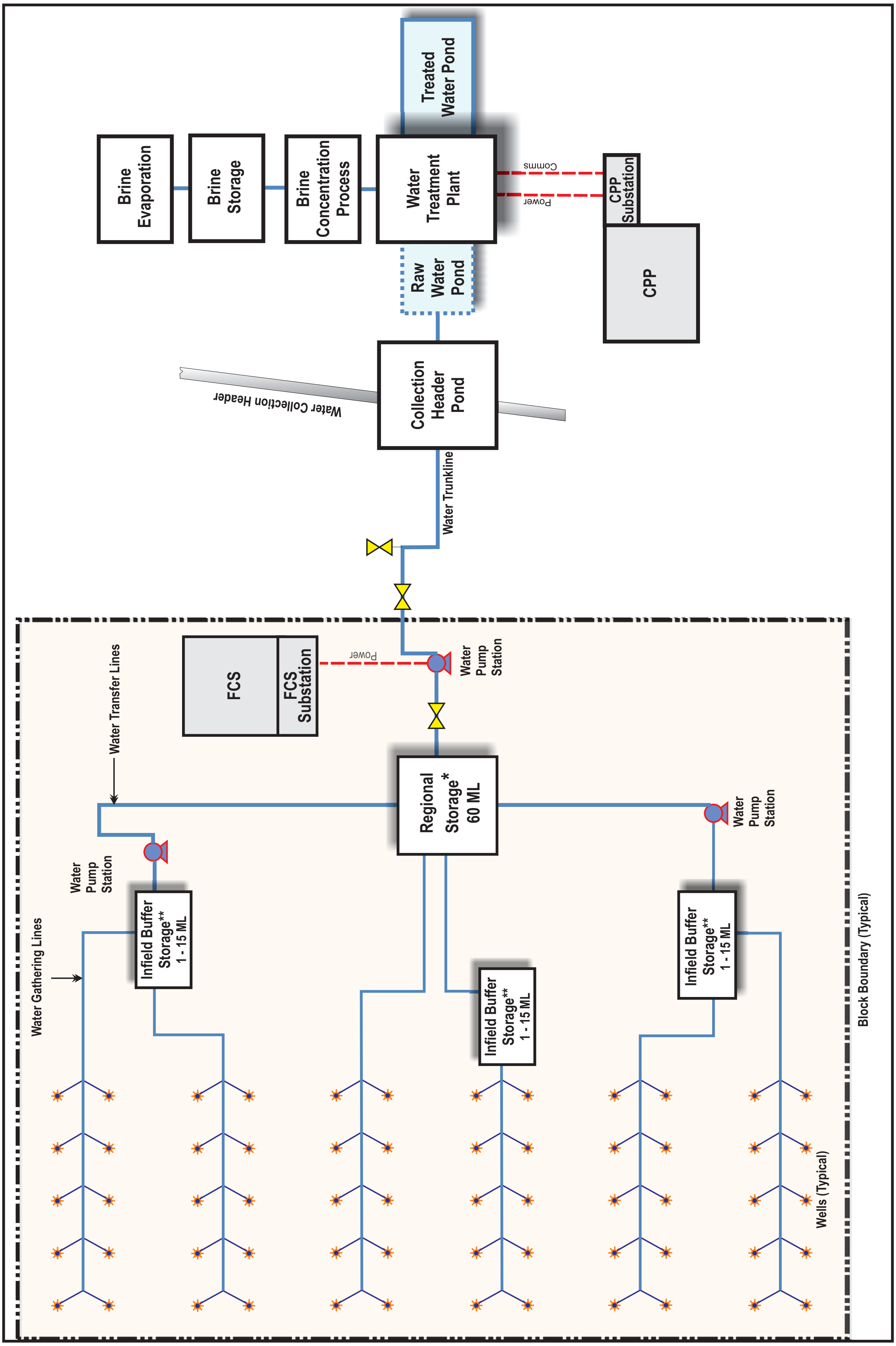
7.5.6 Associated Water Infrastructure

7.5.6.1 Introduction

The approach to the transfer of Associated Water from the wellhead to a water treatment plant (WTP) is unchanged from that proposed in the draft EIS. Further engineering, particularly understanding of the hydraulics has progressed. The following sections describe the interconnecting infrastructure required to manage the volume and location of water within the Project tenements. *Figure 2.7.5* is a schematic of the Associated Water infrastructure described in the sections below.

7.5.6.2 Water Pipelines

Water pipelines comprise water-gathering lines, water trunklines and water Collection Header. Water-gathering lines connect wells to infield buffer storages and regional storage ponds. Water trunklines connect regional storage ponds to collection header ponds, raw water ponds and / or WTPs. The Water Collection Header (refer to *Volume 2, Chapter 12*) connects collection header ponds to WTPs.



Source:
Schematic based on QCLNG-BE00-WAT-DIA-000002, Rev D, 15.09.09

Notes::
* Could be redesignated E & A pond
** Tank or Small Pond

QUEENSLAND CURTIS LNG A BG Group business	Project: Queensland Curtis LNG Project Client: QGC - A BG Group business		Title: **Schematic of Associated Water Infrastructure**
ERM Environmental Resources Management Australia Pty Ltd	Drawn: JB Approved: MH Date: 20/01/10	**sEIS Volume 2** **Figure S2.7.5** File No: 0086165b_SUP_CDR001_S2.7.5 Revision: 1	Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not to be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.

7.5.6.3 *Water-Gathering Lines and Water Transfer Lines*

Water-gathering and transfer lines will be made from geosynthetic material and have diameters between 160 and 315 mm. The majority of water-gathering lines (greater than 70 per cent) will be located in the same easement as gas gathering lines. Approximately 10 per cent of easements will contain multiple water and gas-gathering lines, with the easement widths varying between 20 and 30 m, depending on the number of gas and water lines. Easements with a single gas and/or single water-gathering line (approximately 90 per cent of easements) will be approximately 15 m to 20 m wide. Due to a refinement in engineering requirements, the estimated total length of water-gathering line has increased from 500 km in the draft EIS to 6,700 km for the sEIS. In total approximately 9,200 km of gas- and water-gathering line easement will be required.

7.5.6.4 *Water Trunklines*

Water trunklines will be made from fibre reinforced plastic or concrete-lined ductile iron and have diameters between 300 and 1,200 mm. The total length of water trunklines is estimated at 600 km. Where possible, water trunklines will be co-located with gas trunklines in the same easement. In total approximately 600 km of easement for gas and water trunkline will be required. The combined right of way (ROW) width for water and multiple gas trunklines varies between 20 and 54 m, depending on the number of gas trunklines in the easement.

7.5.6.5 *Water Collection Header*

The water Collection Header connects collection header ponds and WTPs. The water Collection Header is described in *Volume 2, Chapter 8*.

7.5.6.6 *Infield Buffer Storages, Regional Storage Ponds, Collection Header Ponds and Exploration and Appraisal Ponds*

The draft EIS described the requirement for approximately 39 untreated water collection ponds of approximately 200 ML and 4 ha per pond. Pond requirements have been further refined for the sEIS and untreated water collection ponds have been reclassified as infield buffer storages, regional storage ponds and collection header ponds. The pond numbers, areas and volumes below are estimates and are subject to further change based on refinement of water balancing requirements and topographic constraints which influence the capacity and supporting infrastructure (i.e. pumps) for individual locations. QGC's aim is to minimise the number, capacity and footprint of Associated Water storage ponds as far as is practicable.

Infield buffer storages will collect water from groups of wells based on optimising hydraulic flows across the topography. Buffer storages will be either ponds or storage tanks, depending on the volumes of water from a group of wells and the duration of storage required to minimise the risk of ponds or tanks overtopping. Tanks will nominally be polyethylene or metal storages connected to water pumps to transfer water to regional storage ponds.

There will be between two and four infield buffer storages per block (excluding blocks in Area 2), with a total of approximately 120 infield buffer storages Depending on whether infield buffer storages are tanks or ponds, they are estimated to have capacity between 1 and 15 ML per storage and footprint of between 400 m^2 and 3,000 m^2 per storage. In total, infield buffer storages will have a footprint of between 5 and 30 ha and capacity of between 300 and 1,700 ML.

There will, on average, be one regional storage pond per block (excluding Area 2). Regional storage ponds will balance water flows between wells and collection header ponds and provide approximately five days' storage at peak water flows of approximately 12 ML per day, in the case of a localised disruption to water delivery. Regional storage ponds will, on average, be 1 ha and have 60 ML capacity. In total, regional storage ponds will have a footprint of approximately 35 ha and capacity of approximately 2,100 ML.

Under QGC's existing Environmental Authorities (EAs) for tenements covered by ATPs, ponds have been constructed or are planned for storing water from gas exploration and appraisal (E&A) activities. Where it is considered feasible to do so, E&A ponds will be utilised as regional storage ponds rather than construct new ponds. QGC has constructed, or will construct approximately 20 E&A ponds, under existing ATPs. It is estimated that the majority of E&A ponds will be converted to regional storage ponds and that approximately 35 new regional storage ponds will be required across the Gas Field for the QCLNG Project. E&A ponds will be approximately 7 ha have 350 ML capacity.

Approximately three collection header ponds are proposed to be located adjacent to the Collection Header Pipeline route, one each in the NWDA, CDA and SEDA. They will balance water flows between regional storage ponds and water treatment plants and have sufficient capacity to store approximately 30 days of water production should there be a disruption to water delivery at WTPs or water pipelines. Under QGC's existing EAs for granted petroleum leases (PLs), ponds have been constructed to evaporate Associated Water. Where possible, these ponds will be converted to collection header ponds to minimise the requirement for new ponds. It is expected that existing evaporation ponds in the CDA will be used to as the CDA collection header pond.

Table 2.7.3 compares the estimated volume and area of untreated water collection ponds per the draft EIS with the estimated volume and area of infield buffer storages, regional storage ponds and collection header ponds.

Table 2.7.3 Comparison of Gas Field Ponds

Pond Type	Number[1]	Total Area (ha)[1]	Total Volume (ML)[1]
Untreated water collection ponds per draft EIS	39	156	7,800
Infield buffer storages (tanks or ponds)[2]	120	30	1,700
Regional storage ponds	35	35	2,100
Collection header ponds	2	50	4,000
Total for sEIS	**157**	**115**	**7,800**

1 Number, total area and total volume exclude the number, area and volume of existing, approved ponds which will be converted into regional or collection header ponds for the QCLNG Project.
2 Number, capacity and footprint for infield buffer storages are for the estimated maximum

As described above, optimisation of hydraulic flows requires approximately 120 small infield buffer storages. The total estimated area of ponds required to balance water flows between wells and WTPs has remained similar between the draft EIS (156 ha) and sEIS (115 ha). The forecast volume of water that will be stored has remained similar to the draft EIS, but the assumed pond depth is greater than stated. Assumed pond depth per the draft EIS was approximately 5 m. Assumed pond depth for the sEIS varies between 6 and 8 m.

Pond construction methodology is described in *Volume 2, Chapter 11*.

7.5.6.7 Raw Water Ponds

The draft EIS referred to untreated water storage ponds. In the sEIS these are referred to as raw water ponds. At each WTP there will be a raw water pond to balance water flows before entering a WTP. Each raw water pond will have a capacity of approximately five to 10 days' storage in case of a disruption to water delivery at the WTP. Each raw water pond will store approximately 500 ML and have an area of approximately 7 ha. It is probable that at least one raw water pond will be converted from an existing pond constructed under an EA for an ATP or granted PL. The total volume and area of new raw water ponds will be approximately 1,000 ML and 14 ha respectively. *Table 2.7.4* compares the estimated total volume and area of untreated water storage ponds as described in the draft EIS with raw water storage ponds.

Table 2.7.4 Comparison of Raw Water Ponds

Pond Type	Number	Total Area (ha)	Total Volume (ML)
Untreated water storage ponds per draft EIS	2	15	750
Raw water ponds per sEIS	2	14	1,000

The volume and area of raw water ponds has not changed significantly between the draft EIS and sEIS.

7.5.6.8 *Treated Water Ponds and Blending Ponds*

At each WTP there will be a treated water storage pond to balance water flows between the WTPs and beneficial uses and a blending pond to blend treated water with raw water before supply to beneficial uses. There will be one treated water pond and blending pond at each WTP. These will store approximately 75 ML and be approximately 1 ha per pond. In total there will be approximately 450 ML and 6 ha of treated water and blending ponds. This is less than described in the draft EIS for treated water storage ponds of 1,900 ML and 43 ha.

7.5.6.9 *Water Pump Stations*

Water pumps are required to pump water between all types of ponds before entering the WTPs. Pumps within WTPs are included as a component of WTPs. Detailed design of the pumping power requirements has not been completed.

Each infield buffer storage, regional storage pond and collection header pond is likely to require a water pump. Over the life of the Project, approximately 150 to 200 infield pumps will be required across the Gas Field, with approximately 40 per cent of pumps operating simultaneously at peak water flows. For the purposes of the sEIS, infield pumps are assumed to be powered by a gas or diesel generator of between 100 and 1,500 kW per pump, with an average of 500 kW.

An alternative to gas or diesel generators is a connection to the grid via a transmission line connected to the FCS. This would be an underground 11, 22 or 33 kV transmission line located in the same easement as gas- and water-gathering lines. The total length of transmission line would be approximately 600 km.

7.5.6.10 *Water Treatment Plants*

The draft EIS estimated a peak water flow of 160 ML per day with a treatment capacity of 105 ML per day. For the sEIS, at peak water flow, approximately 130 ML per day will require treatment. To provide sufficient excess capacity, WTPs will be sized to treat approximately 175 ML per day. The final locations, configuration and design specifications for WTPs have not been selected and will be based on sites suitable for all associated infrastructure, in particular the ponds. Options under consideration for WTPs include three WTPs with a combined capacity of 175 ML per day located in the NWDA, CDA and SEDA or one WTP with a capacity of 175 ML per day located in the CDA.

Under the option for three WTPs (refer to *Figure 2.7.1*):

- the WTP in NWDA will have 35 ML per day capacity and be co-located with the CPP in the Woleebee Creek block

- the WTP in the CDA will have capacity of approximately 75 ML per day and be either located with existing ponds in Kenya block or Berwyndale South block
- the WTP in the SEDA will have 65 ML per day capacity and be co-located with the CPP in the Ruby block.

Under the option for one WTP, the WTP would be either located with existing ponds in Kenya block or Berwyndale South block.

The components of a WTP, including pre-treatment facilities, reverse osmosis (RO) plant, brine concentrator, amendment and blending plant and chemical storage, are as described in the draft EIS. The footprint of each WTP, excluding ponds, is estimated to be 25 ha.

7.5.6.11 Brine Ponds and Brine Evaporation Basins

Approximately 10 per cent of the total treated water volume will remain as brine following the brine concentration process. Brine evaporation ponds will be used to evaporate the remaining water from the salt crystals. At peak, approximately 13 ML of brine and 530 t of salt will be produced per day.

The brine evaporation process will be managed by transferring brine to relatively deep brine ponds (8 to 10 m) for the purpose of holding peak flows of brine and feeding brine from brine ponds into shallow brine evaporation basins. To maximise evaporation, brine evaporation basins will be relatively shallow (approximately 0.5 m brine height contained within a 2.5 m embankment). There will be one brine pond and one brine evaporation basin per WTP. Each brine pond will store approximately 3,000 ML in an area of approximately 30 ha. Each brine evaporation basin will hold approximately 650 ML in an area of approximately 130 ha. By storing peak flows of brine and releasing brine from the brine ponds to the brine evaporation basins as brine flows decline, the footprint of the brine evaporation basin will be minimised.

Table 2.7.5 compares the area and volume of brine storages described in the draft EIS and sEIS.

Table 2.7.5 Comparison of Brine Storages

Pond Type	Number	Total Area (ha)	Total Volume (ML)
Brine ponds per draft EIS	4	21	700
Brine ponds per sEIS	3	90	9,000
Brine evaporation basins per s EIS	3	390	1,950

The combination of brine concentration and brine ponds to manage peak brine flows results in the smallest practicable footprint for brine evaporation basins. Without these measures it is estimated that the brine evaporation footprint would be greater than 2,000 ha. The draft EIS used an estimated depth of

3.5 m for brine ponds, with an average evaporation period of approximately 60 days. Further modelling of peak brine flows has resulted in the requirement to hold approximately two years of brine flow in brine ponds and an evaporation period of approximately 160 days at 0.5 m depth in brine evaporation basins. This has resulted in a significant increase in the footprint of brine ponds and brine evaporation basins compared to the draft EIS. A technical alternative to brine evaporation is brine crystallisation. However assessment of brine crystallisation technology has concluded that the energy usage is uneconomic.

Brine evaporation basins will be designed as regulated storages to current regulatory guidelines and engineering standards and practice to prevent discharge of salt to the environment. All ponds would be geosynthetic lined. Risk factors such as flood levels and design to prevent overflow up to a certain confidence level will be agreed with the relevant regulator (DERM). Pond design and construction is detailed in *Volume 2, Chapter 11*. Sizing of the basins will be finalised using water balance modelling. The effect of increasing salinity on water evaporation rates has been included in the modelling undertaken. Seasonal and long-term climatic variation will be accounted for using stochastic modelling techniques to give suitable levels of confidence in the outcomes. Pond design and construction is detailed in *Volume 2, Chapter 11*. The basins will be designed as a series of separate sub-basins which will be managed to produce crystallised salt which will be periodically removed for commercial sale or to an engineered landfill. Salt will be extracted using heavy industrial equipment after the evaporation basins have dried out. Geosynthetic liner will be protected from the extraction equipment by a layer of clay or sand.

7.5.6.12 Pond Operations

Monitoring and inspection of ponds will take place in accordance with QGC's Standard Ponds Operating Procedures[1], Ponds Operational Plan Guide[2] and individual ponds operating plans. These detail routine pond inspections and monitoring as per *Table 2.7.6*. Installation and monitoring of piezometers in the pond walls and in bores around the ponds, where considered necessary, will act as early warning systems for potential pollution incidents, for safety purposes and to quantify the concentration and load of any contaminant that may have seeped vertically below the pond. Annual inspections will be conducted by a certified engineer and reported to the Department of Environment and Resource Management (DERM) in accordance with EA conditions.

The Groundwater Monitoring Plan will require monitoring around untreated water ponds to monitor for and detect pond seepage and groundwater effects. Measures to mitigate any detected changes in groundwater quality will be recommended.

1 Standard Ponds Operating Procedures, PRO-W-PCR-001, Rev [1], September 2009

2 Ponds Operational Plan Guide, PRO-T-PLN-004, Rev 1, February 2009

Table 2.7.6 Pond Monitoring and Inspections

Aspect of Monitoring	Monitoring Frequency
Water level	daily, continuous (using a monitoring device) or following a specified event [1]
Groundwater level	quarterly
Embankment seepage	annually
Liner seepage	monthly or quarterly
Spillway inspection (occurs before 1 November each year)	annually
Hydrological structures	annually
Embankment	annually
Pipework and valves	weekly
Pond water quality	quarterly
Groundwater quality	continuous (using a monitoring device) or monthly
Rainfall	daily
Wind speed	daily
Evaporation	daily
Environmental impacts	following a specified event [1]
Exceptions/unusual events	At each event

1 "Following a specified event" includes:

- Heavy rainfall event (define as a total depth greater than 20 mm in a 24-hour period)
- Protracted dry spell (define as no rain for 90 days)
- Water level reaching a critical height (e.g. mandatory operating level and mandatory reporting level)

Geosynthetic-lined ponds will generally contain under drainage seepage collection systems which are constructed to rigorous quality assurance and control standards including whole of pond liner hole detection surveys at the completion of liner placement. Since, in general, lined ponds will be constructed above regional aquifers, groundwater monitoring bores will only be provided where ponds are considered to be located in high-risk environments for potential groundwater contamination. Where monitoring indicates the presence of seepage in collection systems QGC would install site-specific groundwater monitoring systems where appropriate. Monitoring and control automation systems will be constructed for each pond to relay continuous information about water levels and volumes and presence of seepage in collection systems.

7.5.6.13 Salt Disposal

Over the life of the Project, approximately 5,400,000 tonnes or 2,700,000 m^3 of salt will be produced. QGC will seek to dispose of salt to third parties through commercial arrangements and is working in partnership with a leading Australian organisation with specialist technical expertise and economic and commercial interests in sodium bicarbonate; sodium carbonate and sodium chloride production.

In addition QGC is investigating the feasibility of injection of Associated Water into the aquifer formations. Exploratory drilling, testing and sampling of existing and planned QGC exploration wells is being conducted to complete groundwater modelling which will better define the physical and spatial properties of geological formations underlying the Gas Fields, the geochemistry of well water and recipient aquifers. These investigations will enable QGC to determine the feasibility of injection, including injection locations and injection water quality, with consideration of water quality criteria specified by DERM.

If the injection trials are successful (technically, environmentally and economically), this will provide an opportunity to reduce the footprint of infrastructure required for water treatment and disposal or beneficial use of Associated Water.

The disposal of salt to engineered, secure landfills will be considered by QGC if other options are not available. Landfills proposed specifically for this purpose would be designed by an appropriately qualified professional to meet the relevant engineering and environmental specifications. The operational performance of each landfill would be managed through implementation of an environmental management plan, which would set out a detailed monitoring program, reporting protocols and mitigation measures.

In seeking to inject Associated Water or enter commercial arrangements, QGC is attempting to meet the requirements of the waste disposal hierarchy by seeking waste re-use and recycling strategies ahead of waste disposal to a landfill.

If all salt was to be disposed in one landfill, then the landfill would be approximately 53 ha at 5 m depth. QGC has not finalised the number or location of salt landfills, but there is potentially one salt landfill near each of the three WTPs. The landfill will be designed to relevant engineering standards, in close consultation with regulators, to ensure that the risk of salt release to soils, surface water or groundwater is minimised. Construction methodologies for a salt landfill are described in *Volume 2, Chapter 11*. A comprehensive soils, surface water and groundwater monitoring plan will be developed and implemented to detect leakage from the landfill.

QGC is also considering waste management disposal through a licensed waste management contractor, which would enable waste to be transported elsewhere for disposal. In this situation, compliance with waste disposal and management standards would be the responsibility of the waste management contractor.

7.5.7 Beneficial Uses of Associated Water

The suite of beneficial use options presented in the *Volume 3, Chapter 11* of the draft EIS is unchanged. QGC's base case option for beneficial use of Associated Water is tree cropping, using treated Associated Water for irrigation. In addition QGC is investigating a number of other options, which may be preferred to tree cropping. These options include reinjection to aquifers, river discharge, evaporation ponds, supply to agriculture and supply to industry. QGC has secured contracts to supply water to two external users. QGC's assessment of the benefits and constraints posed by each of these options is provided in *Volume 3, Chapter 11* of the draft EIS.

Further information on beneficial uses options is provided in *Volume 3, Chapter 11* of the sEIS. The final design, configuration and location of infrastructure required for beneficial uses cannot be determined until the environmental, technical and economic evaluation of options is complete and compared to the base case option. The potential infrastructure required for tree cropping and reinjection is described in the draft EIS.

QGC will seek approval for selected beneficial use or disposal of Associated Water option(s) through a separate approvals process to the QCLNG Project EIS.

7.5.8 Accommodation Camps

7.5.8.1 Operations Personnel

The number of operations personnel has been re-evaluated since the draft EIS. Between 2010 and 2014 the number of operations personnel will ramp up from approximately 200 to 550, with approximately 550 thereafter.

The draft EIS described 800 operations personnel, which included 600 personnel for drilling crews and well establishment crews that are now considered to be part of the construction workforce. The draft EIS described 200 operations personnel that would be considered the same in the sEIS.

7.5.8.2 Accommodating the Operations Workforce

The location of operations accommodation camps will be determined after an assessment of the workforce logistics. The sites will be selected from the former construction camp locations scaled down to suit the projected workforce distribution.

7.5.8.3 Energy/Electricity Requirements

The draft EIS described all power being sourced from gas engines. Subsequent infrastructure design and improvements has resulted in a combination of options for power, with the majority of infrastructure powered by electric motors connected to the transmission grid and the balance of infrastructure powered by gas engines. The principal reasons for the shift from gas engine to electric motor are:

- higher reliability of electric motors
- reduced noise and air emissions, especially a reduction in low-frequency noise
- potential long-term community benefit through the creation of a power distribution network

- ability in the long term to contract for power supplies with a lower greenhouse gas intensity than QGC's own gas engines.

Table 2.7.7 describes the energy requirements for Gas Field infrastructure. CPPs, FCSs and WTPs will be powered by electricity through a grid connection in the SEDA and CDA. This is reflected as megawatt hours of electricity consumed in *Table 2.7.7*. For the purposes of estimating energy requirements it has been assumed that all infrastructure in the NWDA will be powered by gas engines or gas turbines and this is expressed as terajoules (TJ) of CSG consumed. The option to supply a grid connection to the NWDA is being progressed with a major utility provider. This investigation is occurring in conjunction with power infrastructure providers and the proposed Wandoan Coal Mine.

The greatest increase in energy requirement from that described in the draft EIS is as a result of the requirement to lower wellhead pressure.

7.5.9 Water Supply and Management

Water requirements for construction purposes have been re-forecast for the sEIS and are presented in *Table 2.7.8*. The draft EIS estimated a total annual water requirement of 365,000 kL. The estimate for the sEIS is similar at 335,000 kL.

All water requirements for operations will sourced from raw or treated Associated Water, depending on the water quality required. Municipal water supplies will not be used for QGC's operations.

7.5.10 Waste Disposal

The waste inventory has not varied significantly from the draft EIS.

Table 2.7.7 Energy Requirements

Power requirement	Base load power per draft EIS (MW)	Base load power per sEIS (MW)	Source per draft EIS	Source per sEIS	CSG consumed per annum – draft EIS[1] (TJ)	CSG consumed p.a. sEIS (TJ)	Electricity consumed p.a. sEIS (MWh)
Screw compressors	162	114	CSG from own wells	CSG from own wells or connection to grid	7,753	4,950	570,000
Reciprocating compressors / centrifugal compressors	158	132	CSG from own wells	CSG from own wells or connection to grid	11,059	5,050	670,000
Ancillary power – CPP	2	Included above	CSG from own wells	CSG from own wells or connection to grid	112	Included above	Included above
Ancillary power – FCS	2	Included above	CSG from own wells	CSG from own wells or connection to grid	112	Included above	Included above
Wellhead pumps	2	9	CSG from own wells	CSG from own wells	112	320	0
Wellhead pressure reduction	0	75	n/a	CSG from own wells	n/a	0	500,000
Water treatment infrastructure	9	68[2]	CSG from own wells	CSG from own wells or connection to grid	504	800	350,000
Water pumps	14	35[2]	CSG from own wells	CSG from own wells or diesel	784	23	0
Campsites	2	10	CSG from own wells	CSG from own wells or connection to grid	112	9	0
Field offices	1	1	CSG from own wells	CSG from own wells or connection to grid	66	1	0
Telemetry systems	1	1	CSG/solar	CSG/solar	66	1	0
Total	**353**	**445**			**20,680**	**11,154**	**2,090,000**

1: Engine efficiency factor not included in calculation of CSG consumed.
2: Power requirements at peak water flows

Table 2.7.8 Indicative Water Requirements for the Gas Field (Operations)

Activities, processes and facilities requiring water	Water quantity requirement (kL)	Water quality requirements	Source of water	Additional treatment requirements	Onsite water storage facilities
Operation Phase					
Wash down facilities	Mean daily: 55 kL/day Annual total: 20,000	TDS < 4,000	Associated Water	Treatment by RO or other methods	Ponds
Dust suppression	Mean daily: 750 kL/day Annual total: 273,750	TDS < 2,000	Associated Water	Treatment by RO or other methods	Ponds
Accommodation camps	Mean daily: 0.2 kL/person per day Annual total: 40,000	Australia and New Zealand Environment and Conservation Council (ANZECC) water guidelines for potable water	Associated Water	Treatment by RO or other methods	Ponds
Fire fighting and other emergency services	Annual total: when required	TDS < 2,000	Associated Water	Treatment by RO or other methods	Ponds
Operation Phase Total	*Mean daily: 1,000 kL/day* *Annual total: 333,750*				