In the Taromeo Tonalite between Blackbutt and Nanango, in the area drained by Oaky Creek, are several gold and base metal occurrences. Cobalt mineralisation is reported in one of the gold prospects. On Oaky Creek, about 15 km southeast of Nanango, minor silver lead deposits occur in the Maronghi Creek Beds (Ball, 1901, 1912, 1920b; Brooks, 1959; Cameron, 1916; Denmead, 1934; Sawers, 1967).

Gold, silver, lead, zinc. Deposits of this type occur in the Lower Permian Marumba Beds and Permo-Triassic Kimbla Granodiorite in the Monsildale area 35 km northwest of Kilcoy (Brooks, 1971).

Silver, lead, zinc. On portions 1V and 2V, Parish of St. John, small deposits of silver, lead, zinc and copper occur on Reedy Creek with minor arsenic (Ball, 1920c).

In summary, minor amounts of arsenic, antimony, and mercury are known to occur in the headwaters of streams in the catchment area. The effect of these elements on water quality is not known, but it is recommended that the stream waters be tested.

Of more importance is the likely high manganese content of most of the rocks of the catchment area. The state in which this element occurs is unknown and it is recommended that all stream waters be tested for this element.

Coal

The coal recorded from the sandstone of the Woogaroo Sub-Group near the damsite occurs only in very thin, sporadic seams. The drilling of the damsite did not encounter seams greater than 2.5 cm in thickness (Zahawi, 1970). The sandstone is expected to be underlain at shallow depth by the non-coal bearing Esk Formation. Consequently, coal mining activities in the vicinity of the damsite cannot be expected.

Construction Materials

Considerable volumes of gravel and sand suitable for concrete aggregate are present in the existing river channel and in certain low alluvial terraces within the proposed ponded area. Major deposits of these are outlined on the accompanying map.* Field observations and information from limited drilling indicate that the higher alluvial terraces are composed only of silt and clay.

The gravels are at present too remote from urban areas for economical exploitation, apart from the minor needs for road base and concrete aggregate of local communities such as Esk. However, future expansion of the Ipswich area, together with depletion of existing sources of river aggregate, may make exploitation of the Wivenhoe gravels economically feasible in the long-term future. Unfortunately, at this stage an accurate estimate of the quantities involved cannot be made.

* Map not included in this Appendix.

Despite the intended flooding, exploitation may be possible by a dredging operation in the shallow waters of the reservoir, provided that problems with the resulting suspended sediment can be overcome. For this reason it is suggested that an evaluation of the exposed deposits, and a certain amount of drilling of the likely gravel-bearing terraces, be undertaken before flooding to provide data on location, quantity and quality of deposits. Detailed investigation of the higher, silty terraces is not needed, as the removal of such considerable thicknesses of silty and clayey overburden by dredging would be impractical.

An alternative course of action would be the removal and stockpiling of gravels for future use. However, this would probably be too expensive considering the low cost value of the commodity and the long-term nature of its demand. Limited stockpiling to supply local needs may however be warranted.

Significant deposits of rock suitable for quarrying will not be affected by the reservoir, and sources of clay materials are not known in the area.

Groundwater

In a reconnaissance investigation of groundwater supplies in the Brisbane Valley, Laycock (1967) reports that reasonable supplies of groundwater could be expected from the Cainozoic alluvium along the river, but that little development of such sources had taken place due to the availability of water for irrigation from the river itself. Most of these sources would be gravel bands in low terraces close to the river which would be recharged from the river. Alluvial flats suitable for irrigation will remain above water level in the north of the area, but it is not known if irrigation will be permitted from the reservoir, or from alluvial gravel aquifers.

Groundwater supplies in the rocks of the Toogoolawah Group surrounding the reservoir are reported to be only minor, and in the case of the Neara Volcanics, of poor quality. The effect of the reservoir on supplies in these generally impermeable rocks will be minimal, with only a slight rise in water table immediately adjacent to the shoreline.

Geological Structures

Immediately east of the proposed reservoir area the rocks of the Toogoolawah Group are separated from the older rocks in the D'Aguilar Range by major fault structures forming the eastern edge of the Esk Trough. Although these are now largely inactive, minor earthquakes have been recorded with epicentres on their continuations further to the north (Jones, 1959). The strongest shock of magnitude m = 5 occurred near Kilcoy in 1913, while two weaker shocks of undetermined magnitude occurred near Murgon and Mt. Stanley (9 km east of

Nanango) in 1955. Another shock with a magnitude of m = 5.1 which occurred to the east near Mt. Nebo in 1960 was apparently unrelated to any recognised geological situation (Bauer, 1972). The University of Queensland Department of Geology is about to undertake a long-term microseismic monitoring programme to gather more information on the seismicity of the area, and will continue this work after flooding to determine the effect of the reservoir on such activity. Provided consideration is given in the design of the dam to the likely nearby occurrence of shocks such as above, no particular danger in constructing the reservoir in such an area is envisaged.

Special Features of Interest

No geological features of special scientific, scenic or aesthetic value are known in the area to be inundated.

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APPENDIX 2

REPORT BY QUEENSLAND FISHERIES SERVICE
ON IMPACT OF WIVENHOE DAM ON FISH AND FISHING

The following species of native fishes are likely to occur as adults in the Brisbane River upstream of Wivenhoe Pocket: #

Long-finned eel *	Anguilla reinhardti
Bony bream	Fluvialosa elongata
Australian smelt	Retropinna semoni
Freshwater catfish	Tandanus tandanus
Rainbow fish	Nematocentrus fluviatilis
Blue-eye	Pseudomugil signifer
Hardy-head	Craterocephalus marjoriae
Perchlet	Ambassis nigripinnis
Spangled perch	Therapon unicolor
Mouth Almighty	Glossamia aprion
Sea mullet	Mugil cephalus
Freshwater mullet	Trachystoma petardi
Carp gudgeon	Hypseleotris compressus
Firetail gudgeon	Hypseleotris galii
Purple-spotted gudgeon	Mogurnda mogurnda
Striped gudgeon	Mogurnda australis
Lung fish	Neoceratodus forsteri

Those fish which occur as fry and "stragglers" from the estuary have not been listed in this Appendix. The list is essentially comprised of fresh water fish other than the sea mullet and long-finned eel.

* The long-finned eel is the predominant species of eel in the River although the short-finned is also reported as occurring in the area.

Of the fish listed above, the long-finned eel and the sea mullet both require access to the sea to breed. The sea mullet will disappear from the river and tributaries upstream of the Dam, as the structure would be too high to permit the functioning of a conventional fish ladder. In the case of the sea mullet, this will mean its disappearance from the Esk and Toogoolawah districts. Of more significance, however, are the indirect effects on the commercial fishing industry on the southern Queensland coast. Sea mullet is the principal commercial food fish found in Queensland waters and forms one-third to one-half of the landings of fin-fish in the State.

Although essentially marine, this species spends the greater part of its early life in freshwater streams, and the Brisbane River is one of the three most important mullet rivers in the State. The Dam will deny access to about half the freshwater habitat currently available to mullet in the Brisbane River watershed. Although an accurate estimate is impossible, conceivably this could result in a reduction of the order of 10 per cent in the Region's sea mullet run, which, at the worst estimate, could represent a potential loss to the industry of about $100 000 annually.

On the other hand, impoundment will provide a very considerable lacustrine habitat less than fifty miles distant from Brisbane. If a suitable species can be found to stock the lake and provided that the authority in charge of administration of the Dam permits angling activities therein, a considerable potential exists to develop freshwater angling opportunities close to the main concentration of the State's population.

1976.

APPENDIX 3

IMPACT OF WIVENHOE DAM ON FISH
BY PROF. J.M. THOMSON

The Fish Fauna

The only species of fish of commercial importance likely to migrate into the upper Brisbane River is the Sea Mullet (Mugil cephalus). The young of a number of estuarine species are known to wander into fresh water and presumably individuals or groups of individuals of these species must from time to time reach the upper Brisbane River. This conclusion is based on studies on the freshwater zone of the Albert and Logan Rivers as a detailed survey of the fish of the upper Brisbane River is lacking.

The species involved are mainly:

The Fan-tail Mullet	Mugil georgii
The River Garfish	Hemirhamphus ardelio
The Snub-nosed Garfish	Arramphus sclerolepis
The Estuary Catfish	Cnidoglanis macrocephalus
The Ox-eye Herring	Megalops cyprinoides
The Black Bream	Mylio australis
The Silver Bream	Rhabdosargus sarba
The Old Wife	Enoplosus armatus

These species appear in freshwater only as fry and rarely occur there after their first year of life.

The only migratory fish other than the sea mullet that remains in the freshwater zone till it reaches a large size is the short-finned Eel (Anguilla australis). Although a minor commercial fishery for this species exists near Newcastle, N.S.W., this species is not subject to commercial exploitation in Queensland. It does provide a possible angling catch for anglers in the freshwater zone, though many Australians have an entirely unjustified feeling of repulsion about eels and will not eat them.

The Sea Mullet can be caught by line but their capture requires skill and the use of hooks much finer than those normally used.

The native freshwater fish that can provide a catch for the angler are confined to four species: the Freshwater Jewfish or River Catfish (Tandanus tandanus), the Long-tailed Catfish (Euristhmus lepturus), the Spangled Perch (Therapon unicolor) and the Freshwater Mullet (Trachystoma petardi). As well as these there are several species of small-sized fish which do not grow large enough to attract attention.

A notable absentee from the above list is the Australian Bass (Percalates colonorum), which appears not to inhabit the Brisbane River although it is found in the Noosa River, the Pine River and the Nerang River. Possibly its absence from the upper Brisbane River is associated with the fast run and the rapids as they appear to prefer slow-moving streams.

The probable effects of a dam

(a) without a fish ladder

The migratory fish, and in particular the Sea Mullet, would no longer be able to reach the waters above the dam and within a few years the mullet already above the dam would die out, decreasing the diversity of fish available to the local fishermen. Whether eels would be barred from movement upstream would depend on the nature of the dam, the season of suitable discharge flow rates and the topography of the country at the end of the dam walls. Eels are tenacious in their attempts to get upstream and where there is any dampness will climb a dam wall (if not too high) or climb around it if and when the adjacent banks are wet with rain.

The effect of barring mullet from the upper reaches of the river would in my opinion have little effect on the mullet stocks of Moreton Bay. Sea mullet in freshwater are usually in small scattered groups, not in the schools of considerable size that are typical in the estuarine environment. Also due to pollution in the lower reaches of the Brisbane River the large schools of mullet which once habitually entered the estuary have not been a feature in recent years yet the mullet stocks of Moreton Bay have not declined.

Even if the mullet which previously ran to the upper Brisbane River are counted as a total loss when the dam is built, the value to the commercial fishery would have been small. The U.S. Corps of Engineers in assessing the need for fish ladders on American streams uses as a guide the criterion that the worth of the fish threatened must be 4% of the cost of the structure to warrant expenditure on a fish ladder. Even putting a benefit value on to the mullet which local farmers, etc. may take from the upper Brisbane River, their value could not approach this sum.

(b) with a fish ladder

If a properly designed fish ladder were built the benefits would be to perpetuate the run of sea mullet and the upstream migration of the eels. It is doubtful if the fry of other estuarine species would have the capacity to swim against the rapid currents which necessarily exist in the flume of a fish ladder.

There are constraints on the construction of fish ladders if they are to be effective. It is easy to design a ladder with a determined discharge and flow rate but to be effective the

ladder must take into account the biological properties of the fish. Many a physically well-designed fish ladder has failed to fulfil its function because the entrance point downstream for ascending fish was sited too far downstream of the dam wall and/or not opening from the main flow of the water. Fish will follow the strongest currents upstream and in doing so may by-pass the fish ladder entrance if it is sited too far from the main flow. The fish simply approach the normal discharge point of water from the dam and fail to get upstream. Experience also shows that fish enter a ladder more readily if the flow from the ladder is in the same direction as the main flow of the river. Power dams present special difficulties because during the dry season of the year the whole flow, or most of it, passes through the turbines and issues via the turbine's tail race. During wet weather the main flow may be via the spillway and this discharge rarely reaches the river at the same place as the tail race. Hence such dams really need two ladders, one at the tail race and one at the spillway.

Within the fish ladder there are physical aspects of design which must take account of the fish's swimming powers. Fish can swim at a high speed for short periods only. It would be impossible for a fish to mount a dam wall of any height via its fish ladder if that ladder had a constant flow greater than the fish's average swimming rate along the whole length.

There are 5 or 6 basic design types of fish ladders. The type selected varies with the gradient involved, current flow rates, etc.. In general it may be said that fish pass more easily from one pool to another in a fish way if the orifice leading from one pool to the next is submerged. Fish will pass over a shallow spillway between pools, but not so readily. There are also problems in siting the upstream exit from the ladder, mostly as a function of design as a result of varying water levels during the year.

Doubts have been raised about whether fish would find their way to the exit point when moving downstream. The theory suggests that coming down river the fish drift or swim with the current but on entering the essentially standing water of the dam they would have no guide posts to lead them to the dam and the exit by the fish ladder. However, mullet successfully find their way to the exit from coastal lakes, such as Noosa Lakes or Lake Macquarie, after entering them from their in-flowing rivers and creeks. Studies at Lake Macquarie indicate that mullet move about continually following the shores of the lake around. Presumably they would behave similarly in an impoundment of water and follow the shore line to the dam where proper siting of the exit for the ladder should lead them downstream.

The gravest problem for downswimming fish at the dam face is counterattraction offered by the pull of the turbine race and at times the flow over the spillway. Protection of turbines from entry of fish has been a major problem in American power dams.

Diversification of species

The major argument in favour of a fish ladder would appear to be maintenance of the diversity of fish species above the dam. This object could be achieved, though with different species, by the introduction of new fish into the river or dam. Yellow-belly (Plectroplites ambiguus) would seem an obvious choice. Although this fish is typical of the Murray-Darling system, it also exists already in the Dawson River. The periodic flooding of shallow ground near the lake edge during the rainy season may well provide the type of environment they seem to need for successful spawning.

A stocking programme would cost a fraction of the amount needed for a fish ladder.

APPENDIX 4

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

CITY CHEMIST'S LABORATORY

BRISBANE RIVER - CATCHMENT AREA

WIVENHOE DAM PROJECT

MEMORANDUM: City Chemist

Date _____

Sampled By: _____

Chlorinated Pesticide Survey

The following results were obtained on samples from the Brisbane River - Catchment Area

Date of Sampling: _____

Chlorinated Pesticide Levels Expressed in p.p.t.	Location No.											
	Blank	1	2	4	6	8	12	15	16	17	20	23
1. Total B.H.C. (includes α, β + γ Isomers)												
2. α - Endosulfan												
3. Heptachlor												
4. Aldrin												
5. Heptachlor Epoxide												
6. o,p D.D.E.												
7. p,p D.D.E.												
8. o,p D.D.D.												
9. Dieldrin												
10. Endrin												
11. p,p D.D.D.												
12. o,p D.D.T.												
13. p,p D.D.T.												
14. Methoxychlor												
15. 2,4D												
16. 2,4,5T												
17.												
18.												

p.p.t. = part per trillion = ng/litre = 10^{-9} gram/litre

Location:

1. Bremer R. U/S Ipswich
2. Bremer R. D/S Ipswich
4. Brisbane R. Mt. Crosby
6. Lockyer R. O'Reilly's Weir
8. Brisbane R. Wivenhoe
12. Brisbane R. Mt. Beppo Rd.
15. Sheep Station Creek
16. Kilcoy Creek
17. Sandy Creek
20. Esk Creek
23. Sandy Ck. Bryden Rd.

Chemist

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

BRISBANE RIVER - CATCHMENT AREA

WIVENHOE DAM PROJECT

CITY CHEMIST'S LABORATORY

Date ______________

Inorganic Results

MEMORANDUM:

Sampled By: ______________

Date of Sampling: ______________

The following results were obtained on samples from the Brisbane River - Catchment Area

Sample No.	Sampling Location	Appearance Sampler's Remarks	Flow cu mec	Time	Temp. °C	pH	Turbidity F.T.U.	Colour Co-Pt. Units	Alkalinity mg/l CO_3	Carbon Dioxide mg/l CO_2	Total Hardness mg/l $CaCO_3$	Calcium mg/l $CaCO_3$	Magnesium mg/l $CaCO_3$	Chloride mg/l Cl	Sulphate mg/l SO_4	Sodium mg/l Na	Potassium mg/l K	EC_{25} millimhos/cm	T.D.S. mg/l	Ammonia mg/l N	Nitrate mg/l N	Phosphate mg/l PO_4	Silica mg/l SiO_2

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

BRISBANE RIVER - CATCHMENT AREA

WIVENHOE DAM PROJECT

CITY CHEMIST'S LABORATORY

Date _____

MEMORANDUM: City Chemist

Sampled By: _____

Trace Metals and Pollution Results

The following results were obtained on samples from the Brisbane River - Catchment Area

Date of Sampling: _____

* NOTE: 1 yg/l = 10^{-3} mg/l

Sample No.	Sample Location	Mercury ug/l Hg *	Zinc ug/l Zn *	Copper ug/l Cu *	Nickel ug/l Ni *	Cadmium ug/l Cd *	Barium ug/l Ba *	Chromium ug/l Cr *	Lead ug/l Pb *	Tin ug/l Sn *	Arsenic ug/l As *	Antimony ug/l Sb *	Iron ug/l Fe *	Iron Fe * (unfiltered sample) ug/l	Manganese ug/l Mn *	Manganese Mn* (unfiltered sample) ug/l	Silver ug/l Ag *	Aluminium ug/l Al *	T.I.C. mg/l C	T.O.C. mg/l C	S.S. mg/l

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

BRISBANE RIVER - CATCHMENT AREA

WIVENHOE DAM PROJECT

MICROBIOLOGICAL RESULTS

CITY CHEMIST'S LABORATORY

MEMORANDUM: City Chemist

Date _____

Sampled by: _____

2. Algae

The following results were obtained on samples from the Brisbane River - Catchment Area

Date of Sampling: _____

Sample No.	Location	Pre Incubation							Post Incubation							Initial Count Probable Effect of Algae Present
		Date Examined	Initial Algal Count Orgs/ml	Predominant General	%	Amorphous Material No./ml	Other Organisms Type	Other Organisms Count %	Date Examined	Final Algal Count Orgs/ml	Predominant General	%	Amorphous Material No./ml	Other Organisms Type	Other Organisms Count Orgs/ml	

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BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

BRISBANE RIVER - CATCHMENT AREA

WIVENHOE DAM PROJECT

MICROBIOLOGICAL RESULTS

CITY CHEMIST'S LABORATORY

MEMORANDUM: City Chemist

Date _____

Sampled By: _____

1. Bacteriology

Date of Sampling: _____

The following results were obtained on samples from the Brisbane River - Catchment Area

Date Examined	Sample No.	Location	Total Coliforms /100 mls	Faecal Coliforms /100mmls	Plate Count /ml	Pathogens Isolated (Type)	Remarks

APPENDIX 5

CATTLE DIPPING - WIVENHOE DAM CATCHMENT BY DEPARTMENT OF PRIMARY INDUSTRIES

The hazard, or otherwise, posed by the use of veterinary acaricides in conjunction with grazing in the catchment of the Wivenhoe Dam may be considered in general or specific terms.

General considerations discussed under specific sub-headings are as follows:-

1. Chemicals

The availability of all agricultural chemicals is regulated by the Agricultural Standards Acts. Registration for use follows assessment of both their efficacy and the hazard associated with their proper use. This assessment is by separate national committees set up by the Agricultural Council and the National Health and Medical Research Council. In addition to meeting the requirements of the Agricultural Standards Acts veterinary acaricides must also be acceptable in terms of the Stock Acts, which prescribe and proscribe the use of specific chemicals for the purpose.

The functioning of these Acts, the nature of the dipping operation and the demands of the consumers of animal products here and overseas combine to ensure that these chemicals are of low mammalian toxicity and are not significantly persistent in biological systems. Although, by necessity, not as ephemeral as horticultural chemicals of the same chemical class, they are readily degraded both by photodegradation and in biological systems and present no long term hazard to aquatic fauna. The immediate hazard is confined to newly formulated chemicals as, by chance, they are all virtually insoluble in water. The traditional and virtually passé arsenical acaricide is an exception to most of these considerations but can be rendered virtually insoluble in water and fixed in the soil by special treatment. Because of the nature and spectrum of resistance to chemicals exhibited by ticks in Queensland generally and in this area in particular, it is likely that different chemicals and indeed a new and different class of chemical may provide the active materials in vats in the catchment of the dam when completed.

Other than the chance consideration of water solubility any consideration generally applied to the current acaricides will apply also to these chemicals.

2. Dipping operations

The dipping of cattle, unlike most applications of agricultural chemicals, is a closed system. The aim of the system is to preserve the dip wash for re-use. By commercial necessity stripping of the active material, although it occurs, is kept

to a minimum. A dip wash of average concentration (0.075%) would, even if the stripping factor was 2 to 1, deposit no more than 3 or 4 grams of active material on a mature beast and this would be largely degraded within 4 days. The escape of chemicals is minimal.

3. Emptying the vat

Vats have their contents discharged when their effectiveness is reduced to an unacceptable level. This may arise from a gradual accumulation of solid debris or more suddenly from the degradation of the active material or the selection of a resident tick population resistent to the acaricide in the vat.

In a newly charged vat the active material is dissolved in the solvent of the formulation and this emulsifies in the water of the vat. As the vat matures solvent is lost and the insoluble active material is adsorbed on clay or organic debris. In operation a vat requires manual stirring and the use of stirrer-cattle before use. At the time of discharge the vat fluid consists of a supernatent containing little active material and a sediment of debris containing the active material. In practice the supernatent is discharged by pumping over grass and presents little hazard as the material is readily degraded in these circumstances. The sediment should be spread in an area not adjacent to watercourses and allowed to degrade. No direct discharge to water is recommended. In considering vat discharge it should be noted that a standard sized vat at 0.1% strength would contain less than 15 kilograms of active material that is already adsorbed on solids. It would carry to water only if the solids were carried also and would then precipitate with the solids.

Accidental discharge could occur in time of flood but here the hazard is minimal. If the flood is, as usual, a back-water flood, the vat fluid consisting of an active sediment and a largely inactive supernatent is virtually unaffected by inundation. A badly located vat, subject to scouring by flash flooding could discharge some active material but it would be largely adsorbed on debris that would settle in the watercourse and not be available to aquatic fauna.

The incorrect storage and disposal of formulated acaricides in containers could provide active material to a water system but dilution factors and the nature of the chemicals would make for a local and transient hazard. This, however, is the most likely hazard to water supplies.

There has been some discussion regarding the vats as a potential source of phosphate to the water supply. An organo-phosphate vat contains less than 2 kilos of phosphorus at recommended strength. However a restricted range of acaricides require super phosphate as a buffer in the vat. Use would be restricted to one or two hundred pounds per vat which is insignificant compared with agricultural use. While

dissolved phosphate will readily carry to water in streams it is rapidly fixed by passage through soils and unlike nitrogen is not leached.

It is not likely that acaricides requiring buffering will be commercially viable given competition with new chemicals now available and its use can be regarded as a transient phenomenon.

In summary the use of veterinary acaricides is not considered to present any significant hazard to water quality. Even minor hazard can be reduced by locating vats away from proximity to watercourses and preferably on sites that have indirect drainage to the dam.

A table is attached giving a composite of toxicity data and also the residue tolerances of foodstuffs of animal origin recommended by the appropriate sub-committee of the National Health and Medical Research Council. These tolerances are not safety levels but are the lowest levels consistent with good agricultural practice. They give some indication of what is acceptable and exceed any levels likely to occur in water supplies.

TOXICITY AND RESIDUE DATA FOR VETERINARY ACARICIDES

Chemicals	Milligrams per kilogram	Parts per million
Dursban	MLD sheep 200 LD_{50} rats 160	2.0 meat fat
Nexagan	LD_{50} rats 250	3.0 meat fat
Asuntol	LD_{50} sheep 25	0.5 meat fat
Ethion	LD sheep 50	2.5 meat fat
Delnav	LD_{50} rats 20-100 LD calf 10	1.0 meat fat
Trithion	LD_{50} rats 20 LD sheep 25	1.0 meat fat
Sevin	LD_{50} rats 400-800	1.0 meat
Promicide	LD_{50} mice 1200	0.5 meat
Bimarit	LD_{50} rats 3000 LD calf > 500	2.0 meat fat
Diazinon	LD_{50} mouse 90 LD calf 10	
Chlorphenamidine	LD_{50} rat 250	1.0 meat fat

APPENDIX 6

TERMS USED IN ECONOMIC AND FINANCIAL ANALYSIS

Interest Rate

The interest rate is the price one person pays to use the capital of another person. It is the price of money and it is determined by the capital market. Interest rates are used to examine financial questions such as cost sharing, funding, charges, etc.

Discount Rate

Because $1 received in the future is worth less that $1 received now, it is not possible to compare the time streams of expenditures and receipts arising from alternative projects unless expected receipts and expenditures are 'discounted' to arrive at their present value or present worth. The discount rate or discount factor is a value judgment by the analyst or the decisionmaker, depending on who decides on the rate. Public funds can be used for a particular project, for other public works, or they can be left for investment in the private sector by not raising public loans or levying taxes. If the public funds are used for a particular project there is no opportunity to use these funds for other public or private works. The discount rate acts in some way to measure the social opportunity cost of the capital invested in the project. Three discount rates - 8%, 10% and 12% - have been used in this text to test the sensitivity of the analysis to different rates.

The discount rate is used in all the economic analyses. It is only coincidental that in this report the interest rate is of approximately the same order as the discount rate.

Planning Period

The Planning Period or Planning Horizon is the most distant future time (75 years) considered in this study for the purpose of analysis.

Present Worth

If the year by year expenditures (receipts) for the planning period for a particular project are discounted at the appropriate discount rate, the sum of the discounted expenditures (receipts) is the present worth of the expenditures (receipts). The net present value or net present worth is the difference between the sum of the discounted expenditures and the sum of the discounted receipts. Present worth always refers to a particular time base which may be in the future.

Equivalent Annual Value

The net present value can be converted into an equivalent number of annual instalments evenly spread over the planning period. By investing in the project rather than by investing

elsewhere, at an interest rate equal to the discount rate, the community will be better off by the equivalent of the 'equivalent annual value' each year for the planning period. The equivalent annual value is the equal annual amount that could be provided each year of the planning period if the net present value was invested at an interest rate equal to the discount rate. Similarly an equivalent annual cost and an equivalent annual benefit can be obtained.

Risk

An event is subject to risk when the outcome of that event is uncertain but can be represented by a known probability distribution of outcomes.

Uncertainty

An event is subject to uncertainty when the outcome of that event is uncertain and can only be represented by a subjective probability distribution.

APPENDIX 7

FLOOD MITIGATION - AN ECONOMIC AND SOCIAL EVALUATION

General

'Flood Mitigation' is considered in more detail than in Section 11: 'Flood Mitigation'. The aspects of risk and uncertainty and floodway clearance are considered at some length. The terms interest rate, discount rate, planning period, present worth, equivalent uniform annual cost (or benefit), risk and uncertainty, used in the analysis, are defined in Appendix 6.

Time Profiles of Expenditure and Costs

The Co-ordinator-General's Department prepared in September 1975 a tentative expenditure programme for the construction of the Dam assuming a commissioning date of 30th June, 1982. The costs applied to a dam of F.S.L. EL 67 AHD and crest level of EL 79 AHD. As a variety of dam sizes was examined in this study, the Co-ordinator-General's Department's programme was used as a basis for developing time profiles of expenditure for each of the major categories of the work. The distributions of expenditure used in the analysis are listed in Table A7.1. Also shown are the revised estimates of expenditure as at January 1977. The use of the earlier distribution of expenditure underestimates discounted costs in Table A7.2 by about 5 per cent. The effect of this error on the conclusions of the analysis is minimal.

TABLE A7.1

EXPENDITURE TIME PROFILES

Year	Per cent by Year by Works Category			
	Estimates used in Analysis		Revised estimates of Jan. 1977	
	Land Acquisition	Dam & Services Relocation	Land Acquisitions	Dam & Services Relocation
1972/73	2.4	-	4.1	0.2
1973/74	11.7	-	17.2	0.7
1974/75	19.3	-	16.0	2.4
1975/76	24.4	-	24.7	4.0
1976/77	22.0	-	14.5	13.2
1977/78	11.4	-	10.7	16.9
1978/79	6.3	25.0	4.3	14.3
1979/80	2.5	25.0	2.2	20.5
1980/81	-	25.0	2.1	16.7
1981/82	-	25.0	2.1	7.4
1982/83	-	-	2.1	3.7

The costs which have to be incurred over and above urban water costs (F.S.L. EL 67 AHD) to provide flood storage were obtained from the Irrigation and Water Supply Commission (21). These costs, together with present worth and equivalent uniform annual costs for a base year of 1981/82 expressed in 1974 money values, are presented in Table A7.2. Section 12: 'Cost Allocation and Cost Sharing' discusses the appropriateness of using incremental costs.

TABLE A7.2

COSTS OVER AND ABOVE URBAN WATER COSTS FOR VARYING FLOOD STORAGES (1974 MONEY VALUES)

Costs	Flood Storage - Ml			
	500 000	800 000	1 100 000	1 400 000
	$M	$M	$M	$M
Total: Dam	0.62	0.95	2.41	3.86
Land Acquisition	2.40	4.24	6.09	9.52
Relocations	0.83	1.46	2.09	2.72
Total	3.85	6.65	10.59	16.10
Present Worth of Costs 1981/82				
8% p.a.	5.41	9.40	14.68	22.44
10% p.a.	5.88	10.23	15.90	24.31
12% p.a.	6.42	11.16	17.26	26.45
Equivalent Uniform Annual Cost as from 1981/82 (75 year planning period)				
8% p.a.	0.433	0.752	1.174	1.795
10% p.a.	0.588	1.023	1.590	2.431
12% p.a.	0.770	1.339	2.071	3.174

Stage Damage and Damage Probability Curves

Using the stage damage curve derived by the Snowy Mountains Engineering Corporation (23), (31) and the historic flood height data (27), (28), damage probability curves were derived for the 1974 stage of development in the flood plain at 1974 money values. The 'best fit' curves were obtained by means of a procedure developed by Bobée (36). Curves were fitted to permit analysis of risk and uncertainty. Expected equivalent uniform annual damage for the range of flood storages was determined from the areas under the curves. The expected equivalent uniform annual damage in the Somerset Dam only case has been assessed as $6.18M. The reduction in expected equivalent uniform annual damage between the Somerset Dam only case and the particular Wivenhoe flood storage was defined as the expected equivalent uniform annual benefit for that storage. See Table A7.3. A range of expected equivalent uniform annual benefits over a 75 year planning period was obtained by applying a range of possible growth rates to development in the Valley. The results are shown in Table A7.4. Note that the flood storages tabulated are the flood compartments for various sizes of Wivenhoe Dam, additional to the existing Somerset Dam flood storage capacity.

TABLE A7.3

TOTAL EXPECTED EQUIVALENT UNIFORM ANNUAL BENEFITS - ($M)
Mid 1974 Development and Money Values
Discount Rate 10% - 75 year planning period

Somerset Dam plus a Wivenhoe Dam Flood Storage of (Ml)	Expected Equivalent Uniform Annual Benefit ($M)	Residual Expected Equivalent Uniform Annual Damage ($M)
None (Somerset Dam only)	0	6.18
500 000	2.78	3.40
800 000	3.91	2.27
1 100 000	4.97	1.21
1 400 000	5.28	0.90

TABLE A7.4

TOTAL EXPECTED EQUIVALENT UNIFORM ANNUAL BENEFITS ($M)
Mid 1974 Development + Growth and 1974 Money Values
75 year planning period

Wivenhoe Dam Flood Storage of (Ml)	Discount Rate								
	8% p.a.			10% p.a.			12% p.a.		
	Growth Rate p.a.			Growth Rate p.a.			Growth Rate p.a.		
	1%	2%	5%	1%	2%	5%	1%	2%	5%
500 000	3.20	3.74	6.80	3.12	3.54	5.66	3.06	3.40	4.96
800 000	4.50	5.26	9.65	4.39	4.97	7.96	4.31	4.78	6.98
1 100 000	5.72	6.68	12.26	5.57	6.32	10.12	5.47	6.08	8.88
1 400 000	6.08	7.10	13.03	5.92	6.72	10.75	5.82	6.46	9.43

Optimum Flood Storage -'Total Benefits' Approach

The optimum size storage for a given benefit-cost relationship is defined as that size beyond which marginal benefits will be less than marginal costs. Applying this criterion, a range of optimum size storages corresponding to the choice of discount rate and growth rate was obtained, as set out in Table A7.5. The sizes ranged from 1 050 000 Ml for zero growth and 12 per cent per annum discount rate to 1 290 000 Ml for 5 per cent per annum growth and an 8 per cent per annum discount rate. The results were not sensitive to the assumptions re growth rates or to the discount rate selected.

TABLE A7.5

OPTIMAL FLOOD STORAGE SIZE (Ml)
(No complementary non-structural measures)

Discount Rate % p.a.	Growth Rate % p.a.		
	0%	2%	5%
8%	1 100 000	1 175 000	1 290 000
10%	1 090 000	1 160 000	1 260 000
12%	1 050 000	1 100 000	1 150 000

Risk

The above analysis was confined to considerations of the expected equivalent uniform annual damages and benefits. However, because of the random pattern of arrival of flooding events and the short usable record of flooding in the Brisbane River (89 years), it was considered that the significance of these considerations should be examined in more detail.

Risk in the economic sense arises because the sequence of damaging floods in the future will be random over time. That is, following the construction of the flood storage, there is a small but finite chance, for instance, that no damaging floods might occur within, say, the next 75 years. Conversely, the next 75 years may be a period with highly damaging floods in almost every year. Again, immediately following the provision of the storage, major flooding events may occur followed by a lengthy flood-free period or the reverse may occur where a lengthy flood-free period follows the provision of the storage with the first major flooding many years into the future. The actual equivalent uniform annual benefit realised from the provision of the flood storage as opposed to the expected equivalent uniform annual benefit may conceivably range from a very low to a very high value.

The results of this analysis for a 10 per cent per annum discount rate and a 75 year planning period (no growth) are listed in Table A7.6.

TABLE A7.6

EQUIVALENT UNIFORM ANNUAL BENEFITS AND RISK

Flood Storage Size (Ml)	Per cent Risk that Actual Benefits $\leq$ Amount Shown ($M)				Expected Equivalent Uniform Annual Benefit ($M)	Equivalent Uniform Annual Cost of Storage ($M)
	20%	40%	60%	80%		
500 000	1.0	1.9	3.1	5.0	2.78	0.588
800 000	1.2	2.4	4.1	6.8	3.91	1.023
1 100 000	1.3	2.6	4.8	8.1	4.97	1.590
1 400 000	1.3	2.8	5.1	8.9	5.28	2.431

The corresponding risk that realised benefits will be less than costs are 11%, 16%, 22% and 35% for flood storages of 500 000, 800 000, 1 100 000 and 1 400 000 megalitres respectively.

The analysis of the risk that benefits might be less than costs was pursued further. The optimum size storage was examined to see how it would vary if a certain maximum risk level was specified as a criterion for investment. The results of this analysis are presented below in Table A7.7 in the form of the optimum size flood storage for a specified risk.

The Table shows the per cent risk that the specified storage will be smaller than the justified optimum size.

TABLE A7.7

SPECIFIED RISK PER CENT THAT NOMINATED FLOOD STORAGE IS LESS THAN OPTIMUM
10 per cent per annum discount rate, zero growth, 75 year planning period

Risk Per cent	78%	45%	30%	25%
Nominated Flood Storages (Ml)	500 000	800 000	1 100 000	1 400 000

While the expected values of benefits should be used as the guiding principle in any investment decision, due recognition should be given to the risk associated with the final investment. Risk considerations may affect the decision in a particular case when other equally 'attractive' investments from the point of view of expected returns are available.

Uncertainty

The analysis of risk assumes that the probability of any damaging flood is known with certainty. However, this is not the case. Only a short time period of usable flood records is available (in this case 89 years) from which to draw inferences about the probabilities of occurrence and consequently there is likely to be uncertainty resulting from sampling errors in flood distribution. The error is likely to be small for the more frequent small floods but the errors could be quite large for the rarer flooding events which also happen to be potentially the most damaging.

Consideration of the likely consequences of uncertainty on the analysis is therefore warranted. Applying standard statistical techniques, such as those described by Kite (37), the following distributions of expected benefits were obtained for a range of flood storage sizes - Table A7.8. The mean value of the expected equivalent uniform annual benefit shown in Table A7.8 is the mean value of the distribution of all the expected equivalent uniform annual benefits.

TABLE A7.8

EXPECTED EQUIVALENT UNIFORM ANNUAL BENEFITS AND UNCERTAINTY
10 per cent per annum discount rate, zero growth, 75 year planning period

Flood Storage Size (Ml)	Per Cent Confidence Expected Equivalent Uniform Benefits ≥ Amount Shown ($M)					Mean Value of Expected Equivalent Uniform Annual Benefit ($M)	Equivalent Uniform Annual Cost of Storage ($M)
	90%	80%	60%	40%	20%		
500 000	1.9	2.5	3.2	3.7	4.8	2.78	0.588
800 000	1.9	2.8	4.6	8.5	14.3	3.91	1.023
1 100 000	1.9	2.9	5.2	10.2	25.9	4.97	1.590
1 400 000	1.9	2.9	5.3	11.2	33.4	5.28	2.431

The chance that due to uncertainty the expected benefits will be less than costs is less than 1%, 1.5%, 3.5% and 15%, for flood storages of 500 000, 800 000, 1 100 000 and 1 400 000 megalitres respectively.

A further analysis gave the following values of confidence that the choice of a particular size flood storage will be smaller than the justified optimum size - Table A7.9

TABLE A7.9

SPECIFIED CONFIDENCE LEVEL THAT NOMINATED FLOOD STORAGE IS GREATER THAN OPTIMUM
10 per cent per annum discount rate, zero growth, 75 year planning period

Confidence Level (Per Cent)	13%	25%	48%	68%
Flood Storage (Ml)	500 000	800 000	1 100 000	1 400 000

The Table illustrates, for example, that there is a 68% chance that a 1 400 000 megalitres flood storage will prove to be larger than optimum over the 75 year planning period. The analysis indicates that conclusions drawn from the short period of flood records are highly sensitive to hydrologic uncertainty. Fortunately in this case, the chance of the investment realising benefits less than costs due to uncertainty is relatively low. In the case of a 1 400 000 megalitres flood storage there is about an 85 per cent chance that benefits will exceed costs and further there is an estimated 32 per cent chance that a larger storage could have been justified.

Residual Damage

The emphasis until now in the analysis described has been on benefits and how these are influenced by risk and uncertainty and the consequent implications on investment recommendations. While these benefits are measured as reduced damage, it is to be remembered that there will still be residual flood damage for any chosen flood storage. Since the level of residual damage is of significance to existing and potential development in the flood plain areas, e.g. with respect to location decisions, flood insurance premiums, etc., it deserves separate consideration. With Somerset Dam alone, the expected equivalent uniform annual damage on the flood plain at mid 1974 stage of development and mid 1974 prices is $6.18M.

In the case of Somerset Dam plus a 1 400 000 megalitres flood storage in Wivenhoe Dam, expected residual equivalent uniform annual damage at the 1974 level of development and 1974 money values has been assessed as $0.9 million. See Table A7.3. A risk analysis indicates that there is about a 30 per cent chance that the residual equivalent uniform annual damage could be greater than this. See Table A7.10.

TABLE A7.10

RESIDUAL EQUIVALENT UNIFORM ANNUAL DAMAGE AND RISK
1 400 000 Megalitres Flood Storage
10 per cent per annum discount rate, zero growth,
75 year planning period

Per cent Risk that Residual Equivalent Uniform Annual Damage ≥ Amount Shown ($M)					Mean Value of Expected Residual Equivalent Uniform Annual Damage ($M)
90%	80%	60%	40%	20%	
0.11	0.17	0.32	0.64	1.68	0.9

The results when uncertainty is analysed are given in Table A7.11.

TABLE A7.11

EXPECTED RESIDUAL EQUIVALENT UNIFORM ANNUAL DAMAGE AND UNCERTAINTY
1 400 000 Megalitres Flood Storage
10 per cent per annum discount rate, zero growth,
75 year planning period

Per cent Confidence that Residual Equivalent Uniform Annual Damage ≥ Amount Shown ($M)					Mean Value of Expected Residual Equivalent Uniform Annual Damage ($M)
70%	60%	50%	40%	30%	
0	0.3	1.7	5.6	14.6	0.9

There is approximately a 55 per cent chance that expected residual equivalent uniform annual damage will be greater than or equal to the $0.9M. The above assumes mid 1974 money values and stage of development in the flood plain. Development in the flood plain since 1974 would result in higher residual equivalent uniform annual damage.

Uncertainty considerations make it clear that no occupant of the flood plain can ever really know the true flood hazard. This should be taken into account when formulating regulatory controls on flood plain development or in the development of flood plain zoning schemes. It is also important in flood insurance schemes.

Non-Structural Measures

In Section 11: 'Flood Mitigation' - a combination of structural and non-structural measures was suggested as necessary if all the benefits of the Dam were to be realised. Further, it was suggested that there is a need to establish a 'socially acceptable' flood hazard so that the community, by planning, could ensure that no individuals through ignorance are exposed to hazards greater than this limit. The community at large also has the right to protect itself from the claims of individuals who know of the flood hazard but still locate in flood hazardous areas.

There is a range of opinion on what constitutes a 'socially unacceptable' degree of hazard and the decision is, in the end, subjective. The decision can, however, be guided by the economic costs incurred in adopting a particular hazard level and by consideration of the social hardships experienced by flood plain occupants subjected to periodic flooding. Table A7.12 showing the risk of flooding can be used as a basis for assessment of the likely social hardship to be experienced in the case of Wivenhoe Dam.

TABLE A7.12

RISK OF FLOODING

Probable Frequency of Flooding	Risk that Intervals between Floods of this Magnitude $\leq$ Interval specified			
	50%	25%	10%	5%
1 : 100	69 yrs.	29 yrs.	11 yrs.	5 yrs.
1 : 30	21 yrs.	8 yrs.	4 yrs.	2 yrs.

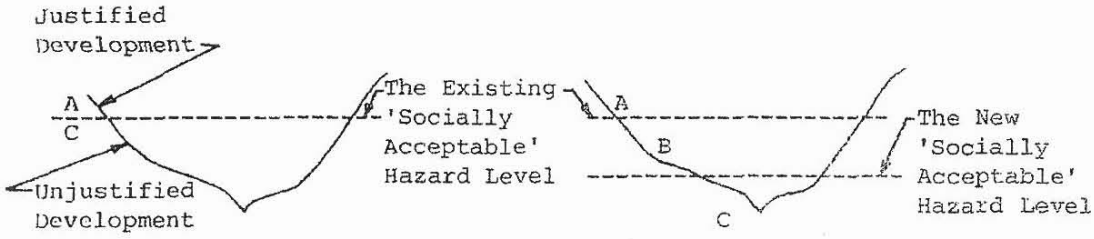
Structural means, such as Wivenhoe Dam, by reducing the flood hazard, can be used to reduce flood damage in developments that have been approved at too low a level in the flood plain. Experience has shown that structural measures encourage further development and continuing encroachment into areas of high flood hazard. If the benefits of the flood storage are not to be lost, complementary non-structural measures (zoning, land use regulation etc.) are needed.

A method of analysis has been adopted that aims to distinguish between development above the 'socially acceptable' flood hazard level and developments below that level. The approach can be used to show the costs that have to be incurred to reduce flood damage in developments still below the 'socially acceptable' flood hazard level by initially selecting the optimum storage size on the basis of benefits accruing to development above the 'acceptable' flood hazard level. Any additional costs incurred can then be identified as those necessary to correct development approvals agreed to in the past either in a mistaken view of the likely flood damage or because of a too optimistic view of the flood mitigating effect of engineering structures. The costs of reducing flood damage in areas still below the particular 'socially acceptable' flood hazard level adopted are costs over and above those 'justified' in economic terms.

An analysis based on a 'socially acceptable' flood hazard level, i.e. the 'regulatory' flood, assumes that non-structural measures such as flood plain zoning, subdivisional and building regulations etc. are in force so that encroachment onto the flood plain at levels above the 'socially acceptable' flood hazard level are regulated to flood tolerant activities and so that there is no continuing encroachment onto areas below the 'regulatory' flood level.

Redefining Benefits

There is therefore a need to revise the earlier findings, based on total benefits to all development. An analysis using a range of possible 'socially acceptable' flood hazard levels was performed. For each hazard level in turn, development above and below this level was identified - See Figure A7.1 - for the case of Somerset Dam only and for the case of Somerset Dam plus an added flood storage in Wivenhoe Dam.



FLOOD PLAIN CROSS SECTION
SOMERSET DAM ONLY

FLOOD PLAIN CROSS SECTION
SOMERSET DAM + WIVENHOE
FLOOD STORAGE

FIGURE A7.1

Developments in areas marked A are above the 'socially acceptable' flood hazard level both before and after the provision of a flood storage at Wivenhoe. The full reduction in flood damage to activities in areas marked A can be claimed as a benefit arising from the structural measure (engineering works). Developments in areas marked B are subject to 'socially unacceptable' flood hazard prior to the provision of the flood storage, but they are above the 'acceptable' flood hazard level after the structural measure is built. In the analysis the full reduction in flood damage is not claimed as a benefit arising from the structural measure. Only that flood damage avoided due to floods equal to or greater than the 'regulatory' flood is counted. Developments in areas marked C are still below the 'socially acceptable' flood hazard level and no flood damage reduction is claimed as a benefit arising from the structural measure.

No flood damage reduction is claimed as a benefit due to the flood storage, therefore, until the storage size is so large that the particular development is at or above the 'socially acceptable' flood hazard level. The total damage reduction arising from the structural measure is claimed as a benefit for developments at or higher than the level of the boundary between areas A and B. No flood damage reduction arising from the structural measure is claimed as a benefit for developments at or lower than the level of the boundary between areas B and C. Between the two boundary lines, i.e. area B only, the flood damage reduction arising from the structural measure, for floods equal to or greater than the 'regulatory' flood, is claimed.

In this analysis, because of insufficient data, one half of the total flood damage reduction in area B is claimed as a benefit.

These benefits and the costs of various flood storages were used to determine revised 'economically justified' optimum sized flood storages for a range of assumed growth rates and discount rates. See Table A7.13.

TABLE A7.13

FLOOD STORAGE CAPACITIES (Ml) BASED ON BENEFITS ONLY TO DEVELOPMENT ABOVE 'ACCEPTABLE' HAZARD LEVEL

'Socially Acceptable' Hazard - Probable Frequency Flood	Growth Rate % p.a.	Discount Rate		
		8% p.a.	10% p.a.	12% p.a.
1 : 100	0%	980 000	500 000	0
	5%	1 240 000	1 140 000	1 090 000
1 : 50	0%	1 050 000	1 040 000	570 000
	5%	1 230 000	1 140 000	1 120 000
1 : 30	0%	1 080 000	1 045 000	920 000
	5%	1 210 000	1 160 000	1 130 000
1 : 20	0%	1 100 000	1 050 000	1 040 000
	5%	1 190 000	1 180 000	1 130 000
Any Hazard level acceptable	0%	1 100 000	1 090 000	1 050 000
	5%	1 290 000	1 260 000	1 150 000

The Table shows, for example, that if a 1:100 'socially acceptable' flood hazard level, a 10 per cent discount rate and no growth are assumed, a 500 000 megalitres storage can be 'justified'. If development is allowed anywhere in the flood plain for the same discount and growth rate, a storage equivalent to 1 090 000 megalitres can be 'justified'.

Larger flood storages can be 'justified' if benefits to development below the 'socially acceptable' hazard level are included, than would be the case if development had only been permitted in 'socially acceptable' flood hazard areas after the completion of Somerset Dam.

Coping with Development which is still in a flood hazard area

Development in lower levels of the flood plain has occurred, perhaps because of mistaken views as to likely flood damage in the future or of the effectiveness of Somerset Dam in mitigating floods, although a good deal of development had taken place before Somerset Dam was built. On social grounds, the flood damage in these areas should be reduced.

There would appear to be three options available if the concept of a 'socially unacceptable' flood hazard is accepted, namely:

(a) acquisition over time of properties below the 'socially acceptable' flood hazard level after Wivenhoe Dam is built;

(b) building a flood storage large enough to reduce the flood hazard below the acceptable level in all flooded areas; this may not be feasible;

(c) a combination of (a) and (b).

The likely minimum cost solution would be a strategy combining increased storage, above the economically 'justified' optimum storage, and the limited acquisition of property at low levels of the flood plain. The acquisition of properties below flood heights of 'acceptable' hazard would serve the dual purpose of providing a floodway for the passage of the frequent small floods and for flood waters released from the flood storages after a major flooding event.

Commercial and industrial activities in these high hazard areas have access to flood insurance or are a use tolerant to flooding i.e. suffer low flood damage. The siting of commercial and industrial activities in the flood plain in the future should be carefully considered with respect to flood hazard and in most cases these activities should not be allowed below the 'acceptable' flood hazard level. Only residential properties have been considered in the analysis below because they do not have, in general, access to flood insurance and in many cases they are located unwittingly in the flood plain. Residential properties were divided into those flooded above floor level by floods of a particular height and those flooded below floor level for the same flood. The analysis considers the acquisition over time of all residences flooded above floor level as well as all residential property below the particular flood level. The decision to adopt one or the other strategy would depend on both economic and social wellbeing considerations.

Details of development in the Brisbane River Valley flood plain in terms of the number of buildings affected by floods of different heights are set out in Table A7.14.

TABLE A7.14*

ESTIMATES OF FLOOD DAMAGE (MID 1974 MONEY VALUES)
1974 Stage of Development

Flood Height Brisbane City Gauge m	Flooded Area km^2	Buildings Affected	Flood Damage ($M)	
			Direct	Direct + Indirect
2	12	470	8	10
4	57	6 700	67	83
6	102	15 300	173	217
8	153	23 500	288	362
10	205	31 000	426	531

Source: Snowy Mountains Engineering Corporation (23).

*In this and subsequent Tables flood heights on the Brisbane City Gauge refer to the 1974 river conditions and flood plain development and floods are adjusted to a standard 2.0m tide on Port Office Gauge.

Table A7.15 below shows the estimated number of residential properties affected for different probable frequency floods.

TABLE A7.15

RESIDENTIAL DEVELOPMENT AND FLOOD HAZARD
SOMERSET DAM ONLY
(All values interpolated except values for 2 m flood)

Flood Hazard - Probable Frequency Flood	Flood Height Brisbane City Gauge m	Residential Properties Affected		
		Above Floor Level	Below Floor Level	Total
1 : 10	2.0	42	166	208
1 : 20	3.2	950	1 480	2 430
1 : 30	4.1			5 300
1 : 50	5.5			10 000
1 : 100	7.7			17 500

Source: Based on Snowy Mountains Engineering Corporation (23),(31).

See Footnote Table A7.14.

If the 'socially acceptable' flood hazard level chosen is the 1:50 probable frequency flood, then currently there are some 10 000 residential properties subject to 'unacceptable' flood hazard and possibly upwards of 5 000 would be flooded above floor level by the 1:50 probable frequency flood.

Table A7.16 shows that the construction of a flood storage in Wivenhoe Dam would reduce the probable frequency that a flood would reach a particular height on the Brisbane City Gauge and hence would reduce the number of residential properties that would be affected by the level of the 'socially acceptable' flood hazard. The problem is the present and possible future development in areas still below the particular 'acceptable' flood level.

TABLE A7.16

PROBABLE FREQUENCY OF FLOODS
(Log. Pearson Type III Distribution)

Brisbane City Gauge Height AHD	Probable Frequency				
	Somerset Dam only	Somerset Dam + Wivenhoe Dam with Flood Compartments of -Ml			
		500 000	800 000	1 100 000	1 400 000
2 m	1 : 11	1 : 25	1 : 30	1 : 35	1 : 40
4 m	1 : 28	1 : 45	1 : 50	1 : 60	1 : 70
6 m	1 : 60	1 : 70	1 : 95	1 : 135	1 : 200
8 m	1 : 110	1 : 250	v/rare	v/rare	v/rare
10 m	1 : 200	v/rare	v/rare	v/rare	v/rare

v/rare $\gg$ 1:250

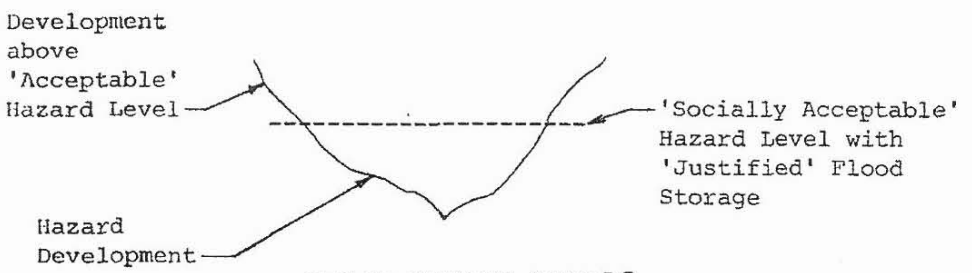
Note: 1:28 represents the probable frequency of such a flood and means that there is one chance in twenty-eight that a flood of that height or higher will occur in any one year.

Source: Snowy Mountains Engineering Corporation (23).
Interpreted from graphs - Irrigation and Water Supply Commission (28).

See Footnote Table A7.14.

Cost Analysis - 'Hazard' Areas

The 'justified' optimum flood storage size was determined for a range of growth and discount rate assumptions and for a range of possible 'socially acceptable' hazard levels. See Figure A7.2.



FLOOD HAZARD LEVELS

FIGURE A7.2

Assuming that the 'socially acceptable' flood hazard level corresponds to the 1:50 probable frequency flood and that there is zero growth and a 10 per cent per annum discount rate, then on economic grounds alone a flood storage in Wivenhoe Dam of 1 040 000 megalitres can be justified and the 'acceptable' flood hazard level will be 2.9 m on the Brisbane City Gauge. See Tables A7.13 and A7.16.

For the areas at hazard below this flood height, an analysis was made on a number of combinations of larger flood storages, and the acquisition over time of the properties still subject to 'unacceptable'degree of hazard. Larger flood storages would reduce the 'socially acceptable' flood hazard height so as to bring the additional properties within areas of 'acceptable' hazard. The results of this analysis are shown in Table A7.17. The acquisition of affected properties was assumed to take place over a period of 10 years if flooded above floor level and over 25 years if flooded below floor level.

The analysis, from which Table A7.17 was compiled, showed that the cost minimising strategy for the case of acquiring properties flooded above floor level by the 1:50 probable frequency flood is to increase the flood storage from 1 040 000 megalitres to 1 150 000 megalitres (new 'acceptable' flood hazard level 2.75 metres) and to acquire about 400 residences located below that level. If all the residences located below the hazard level are acquired, the cost minimising strategy is a flood storage of 1 200 000 megalitres (new 'acceptable' flood hazard level 2.7 metres) and the acquisition of some 1 250 properties. It is assumed that no development is allowed in the future in the areas below the 'regulatory' flood level, i.e. 'socially acceptable' hazard level. It is important to realise that, if all properties below the 'regulatory' flood level are acquired, there is about a 20 per cent chance that properties at the 'regulatory' flood level will be flooded at least once in any ten year period and a 40 per cent chance that they will be flooded at least once in any 25 year period.

TABLE A7.17

COST ANALYSIS - 'HAZARD' AREAS - ILLUSTRATIVE CASE

'1:50 probable frequency flood' as one of 'socially acceptable' hazard, zero growth, 10 per cent discount rate per annum
Optimum Flood storage, 'justified' on economic grounds only = 1 040 000 megalitres

Flood Storage Ml	'Socially Acceptable' Flood Hazard Level m	Extra Storage Cost Present Worth $M	Properties flooded above Floor		All Properties	
			Acquisition Costs Present Worth $M	Total Costs Present Worth $M	Acquisition Costs Present Worth $M	Total Costs Present Worth $M
1 040 000	2.9	0	10.4	10.4	21.7	21.7
1 100 000	2.8	1.4	8.6	10.0	18.4	19.8
1 200 000	2.7	3.8	6.8	10.6	15.3	19.1
1 400 000	2.6	9.8	4.8	14.6	11.5	21.3

See Footnote Table A7.14.

The analysis was repeated for a number of cases. Table A7.18 (p.153) shows the range in acquisition limits, in the estimated number of residences to be acquired and in flood storage volumes for various hazard levels. The Table illustrates that for the discount rates and growth rates considered the flood storage volumes do not vary greatly. Table A7.19 shows benefits and costs and total damage reduction for the case of zero growth and the acquisition of properties flooded above floor levels for various discount rates and 'acceptable' hazard levels.

TABLE A7.19

COSTS AND BENEFITS - ZERO GROWTH
(Residences flooded above floor level acquired only)
Mid 1974 stage of development - zero growth

Discount Rate (% p.a.)	'Socially Acceptable' Hazard	Costs		Equivalent Uniform Annual Justified Benefits ($M)	Sum of Damage Reduction and Damage Avoided in Equivalent Uniform Annual Terms ($M)
		Annual Costs ($M)	Present Worth at 1981/82 ($M)		
8%	None	1.20	15.0	5.00	5.00
	1 : 20	1.20	15.0	4.20	4.95
	1 : 30	1.23	15.4	3.20	4.90
	1 : 50	1.92	24.0	2.25	4.95
	1 : 100	3.04	38.0	1.40	5.35
10%	None	1.55	15.5	4.95	4.95
	1 : 20	1.50	15.0	4.10	5.10
	1 : 30	1.55	15.5	3.15	5.10
	1 : 50	2.31	23.1	2.15	5.10
	1 : 100	3.74	37.4	0.70	5.10
12%	None	1.95	16.3	4.85	4.85
	1 : 20	1.90	15.8	4.05	4.80
	1 : 30	1.84	15.3	2.85	4.35
	1 : 50	3.09	25.8	1.35	4.65
	1 : 100	4.42	36.8	0	4.90

TABLE A7.18

TOTAL COSTS FLOOD STORAGES AND ACQUISITION LEVELS
1974 Development and Money Values
(Above floor level acquisition only)

Discount Rate % p.a.	Growth Rate % p.a.	'Socially Acceptable' Flood Hazard	Flood Storage		Floodway Acquisition			Total Cost Present worth ($M)
			Size Ml	Cost Present worth ($M)	Limit m.	Residential Properties Approx.	Cost Present worth ($M)	
8%	0%	1 : 100	1 200 000	17.1	3.25	1 020	20.9	38.0
		1 : 50	1 100 000	15.0	2.80	490	9.0	24.0
		1 : 30	1 080 000	14.4	2.00	42	1.0	15.4
		1 : 20	1 100 000	15.0	1.20	0	0	15.0
		No restriction	1 100 000	15.0	None	-	-	15.0
	5%	1 : 100	1 240 000	18.1	3.20	950	19.5	37.6
		1 : 50	1 230 000	17.8	2.70	390	8.0	25.8
		1 : 30	1 210 000	17.5	1.95	30	0.8	18.3
		1 : 20	1 190 000	16.9	1.20	0	0	16.9
		No restriction	1 290 000	19.4	None	-	-	19.4
10%	0%	1 : 100	1 120 000	16.5	3.35	1 160	20.9	37.4
		1 : 50	1 080 000	15.5	2.80	490	7.6	23.1
		1 : 30	1 045 000	14.7	2.05	50	0.8	15.5
		1 : 20	1 050 000	15.0	1.25	0	0	15.0
		No restriction	1 090 000	15.5	None	-	-	15.5
	5%	1 : 100	1 140 000	17.0	3.30	1 080	19.5	36.5
		1 : 50	1 140 000	17.0	2.75	440	6.8	23.8
		1 : 30	1 160 000	17.5	1.95	30	0.5	18.0
		1 : 20	1 180 000	18.0	1.20	0	0	18.0
		No restriction	1 260 000	20.5	None	-	-	20.5
12%	0%	1 : 100	1 075 000	16.7	3.40	1 240	20.2	36.8
		1 : 50	1 000 000	15.0	2.95	650	10.8	25.8
		1 : 30	920 000	13.3	2.25	105	2.0	15.3
		1 : 20	1 040 000	15.8	1.25	0	0	15.8
		No restriction	1 050 000	16.3	None	-	-	16.3
	5%	1 : 100	1 090 000	17.1	3.35	1 160	19.8	36.8
		1 : 50	1 120 000	17.9	2.80	490	7.8	25.8
		1 : 30	1 130 000	18.3	2.00	42	0.7	19.0
		1 : 20	1 130 000	18.3	1.20	0	0	18.3
		No restriction	1 150 000	18.8	None	-	-	18.8

See Footnote Table A7.14.

The results indicate that only small differences occur in the flood storage size recommended with changes in the discount rate or the 'socially acceptable' hazard level. There is, however, a major difference in the acquisition limits to provide the cleared floodway and this means large differences in acquisition costs. The Tables show the cost of alternative strategies with respect to 'socially acceptable' flood hazard level.

The analysis indicates that no significant increase in flood storage above that size economically 'justified' can be used as an alternative to the acquisition of properties below the 'socially acceptable' hazard level (compare Tables A7.19 and A7.13), i.e. flood storage in the Dam alone cannot be justified in economic terms as a complete solution to the flood problem in the lower Brisbane Valley. Lower 'acceptable' flood hazard levels can only be attained at increased cost and this increased cost is due to development approved in the past at too low a level in the flood plain.

Table A7.20 (p.155) summarises total costs, flood storage volumes and acquisition limits for a number of possible 'socially acceptable' hazard levels. If growth in the flood plain is allowed, flood storages increase slightly and the level up to which properties should be acquired falls.

TABLE A7.21

ACQUISITION LIMITS, PROPERTIES TO BE ACQUIRED AND FLOOD STORAGE FOR VARIOUS HAZARD LEVELS

'Socially Acceptable' Hazard - Probable Frequency Flood	Case	Range of			
		Acquisition Limit = Height on Brisbane City Gauge m	Residential Properties to be acquired (approx.)	Flood Storage (,000 Ml)	Approx.Expected Residual Equivalent Uniform Annual Residential Damage ($M)
1 : 100	A.F.*	3.20 - 3.40	900 - 1240	1075 - 1240	very small
	All	3.05 - 3.15	2020 - 2290	1300 - 1450	very small
1 : 50	A.F.	2.70 - 2.95	400 - 650	1000 - 1230	0.07
	All	2.60 - 2.75	980 - 1290	1150 - 1325	0.05
1 : 30	A.F.	1.95 - 2.25	35 - 105	920 - 1210	0.14
	All	1.95 - 2.05	175 - 240	1050 - 1210	0.13
1 : 20	A.F.& All	1.20 - 1.25	0	1040 - 1190	0.14
No level set	A.F.& All	None	0	1050 - 1290	0.14

A.F.* = above floor. See Footnote Table A7.14.

Table A7.21 shows for various hazard levels and the two cases of acquisition, the range of acquisition limits, properties to be acquired and flood storages as well as an estimate of mean residual annual residential damage.

TABLE A7.20

SUMMARY - FLOOD STORAGE VOLUMES, COSTS, ACQUISITION LIMITS, ETC.
(Above floor level acquisition only)

'Socially Acceptable' Hazard	Flood Storage Ml	Storage Costs Present Worth at 1981/82 ($M)	Acquisition Limit on Brisbane City Gauge	Acquired Residential Properties	Acquisition Costs Present Worth at 1981/82 ($M)	Total Cost Present Worth at 1981/82 ($M)
1 : 100	1 075 000-1 240 000	16.7 - 18.1	3.20 - 3.40	900 - 1 240	19.5 - 20.2	36.2 - 38.3
1 : 50	1 000 000-1 230 000	15.0 - 17.8	2.70 - 2.95	400 - 650	8.0 - 10.8	23.0 - 28.6
1 : 30	920 000-1 210 000	13.3 - 17.5	1.95 - 2.25	35 - 105	0.8 - 2.0	14.1 - 19.5
1 : 20	1 040 000-1 190 000	15.8 - 16.9	1.20 - 1.25	0	0	15.8 - 16.9
None	1 050 000-1 290 000	16.3 - 19.4	None	0	0	16.3 - 19.4

See Footnote Table A7.14.

The analysis shows the conflict between costs and the 'acceptable' level of hazard. It shows the economic and social advantages of preserving in the flood plain a 'floodway' free of development. The storage size that could be justified on the basis of the analysis is in the range 1 000 000 - 1 300 000 megalitres.

Uncertainty Reconsidered

The analysis for 'hazard' areas has assumed that the chance that a flood of a certain height will occur is known with complete certainty. As discussed previously, this is not the case. If uncertainty is included in the analysis it will have an increasingly significant effect as the 'socially acceptable' hazard decreases, i.e. as the emphasis changes to the rarer flooding events. A precise specification of the necessary level below which properties should be acquired, corresponding to a particular height of flood at the Brisbane City Gauge, will not be possible.

The analysis has shown that a flood storage in the range 1 000 000 - 1 300 000 megalitres can be justified on economic and social wellbeing criteria. The justification for an increase in flood storage on this basis depends on the aversion to uncertainty and the importance of avoiding uncertainty. An increase in flood storage should also be made to allow for human error in the interpretation of information received during the flood and for possible malfunction of equipment during flooding.

The uncertainty analysis indicates that a case could be made for a small increase in flood storage.

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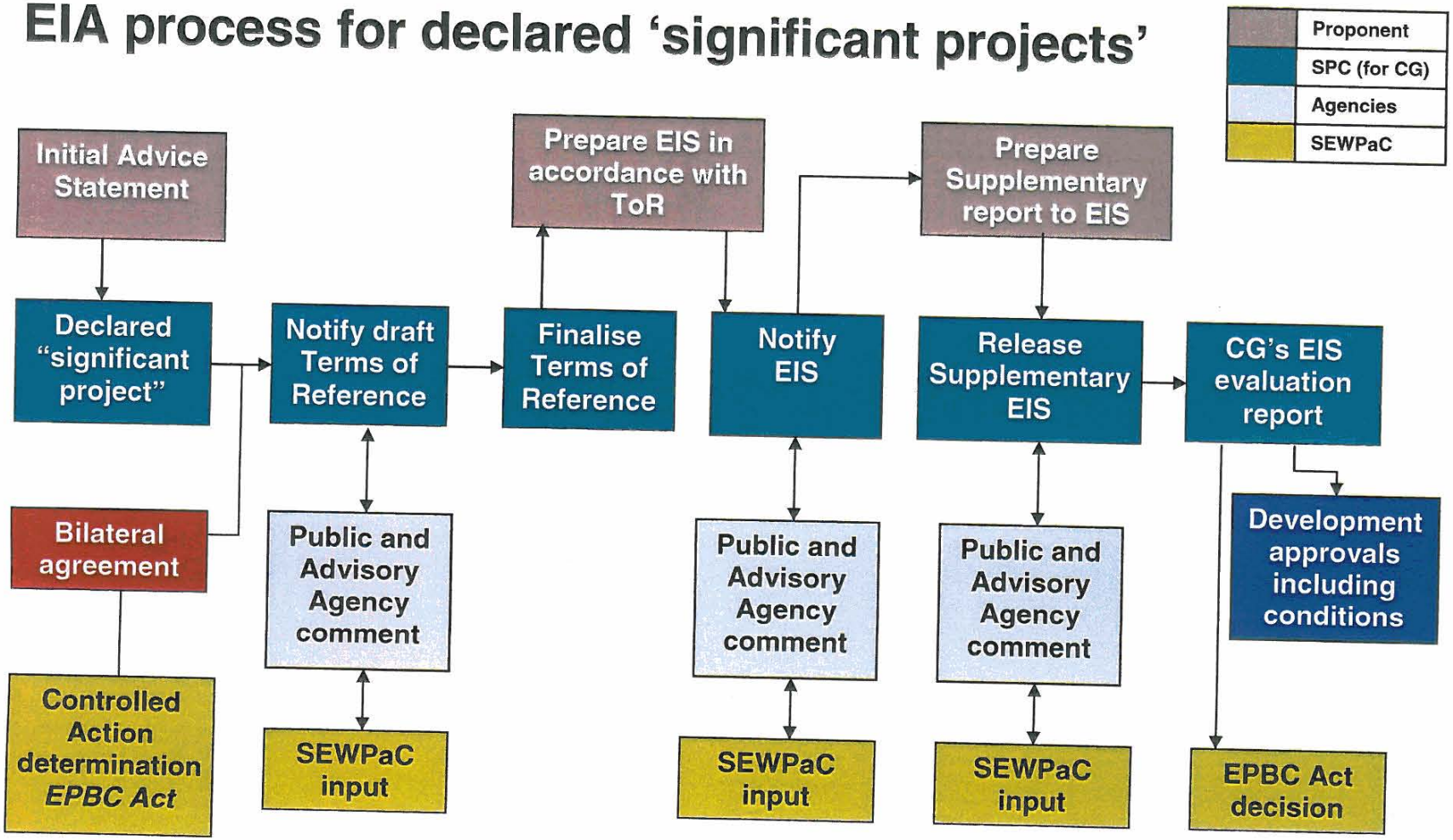
Attachment CG-2 – EIA process for declared 'significant projects'

EIA process for declared 'significant projects'



'CG-02'

'CG-03'

Attachment CG-3 – Wandoan Coal project Terms of Reference

Under Part 4 of the *State Development and Public Works Organisation Act 1971* (Qld)

The Coordinator-General
November 2008

Terms of reference

Preamble

Project summary

The Wandoan Coal Project will comprise the development of thermal coal resources for export and possibly domestic markets with an open-cut coal mine and related local infrastructure by Wandoan Joint Venture. The joint venture partners are Xstrata Coal Queensland Pty Ltd, Itochu Coal Resources Australia (ICRA) RPW Pty Ltd and Sumisho Coal Australia Pty Ltd.

The coal resources, which are the subject of three mining lease applications (MLAs) 50229, 50230 and 50231, are located immediately west of the Wandoan township, approximately 350 km northwest of Brisbane and 60 km south of Taroom. A locality map is provided in Figure 1.

The coal resource within the three MLAs is in excess of one billion tonnes, with a strip ratio of less than 4:1 (bank cubic metres of overburden per tonne of coal).

A description of the proposal and its various sub-components is outlined in the following sections.

The mine

This aspect of the Wandoan Coal Project involves the mining development of thermal coal resources and includes the construction and operation of an open cut coal mine and supporting infrastructure located on MLAs 50229, 50230 and 50231. Several major coal areas have been identified for the initial mining operations within the MLAs. The mining operations will commence in the eastern deposits on MLA 50230 and progressively expand to the west of Woleebee Creek. The details of the actual mine development and progression will be finalised as part of the overall mine planning.

The mine will be developed using a combination of truck and excavator, dozer and dragline mining equipment. It is intended to initially produce around 30 million tonnes per annum (Mtpa) of run of mine (ROM) coal from the major coal areas that have been identified for initial mining. The rate of mining is still being considered as part of the feasibility for the project and may increase further.

The 30 Mtpa ROM will be processed by three modular coal handling preparation plant units. The coal will be crushed, sized and washed to a yield of around 70 per cent before being railed to port for export. The initial coal handling preparation plant layout will allow for the possible subsequent accommodation of an additional fourth modular unit.

Figure 1: Locality map

Latitude: 26°03'S Longitude: 149°51'E (centre of project area approximately 5 km west-northwest of Wandoan)

The final plan and design of mine infrastructure is still to be completed, although it is expected the mine would consist of:

- open cut pits
- out of pit spoil dumps
- ROM stockpiles
- a water management system
- light vehicle access roads
- heavy vehicle haul roads
- coal handling and preparation facilities including crushing facilities, coal stockpile pads, rejects stockpiles
- rail spur and rail loading facilities
- tailings storage facilities
- mine infrastructure area including office buildings, workshops, fuel and oil storage facilities, and vehicle wash down facilities
- explosive raw material storage facilities and magazines
- high voltage transmission lines/poles and reticulation facilities
- communications infrastructure
- site access from the local road system.

Other components

The scope of the environmental impact statement (EIS) also includes the following components, which may occur partially or wholly outside of the three mining lease application areas:

(a) Accommodation facilities

Accommodation facilities are proposed to house the majority of the workforce outside of the mining lease.

Some additional off-site accommodation may consist of purchasing existing dwellings, construction of new houses or units, and rental of existing houses or flats in the Wandoan region.

(b) Groundwater extraction from the Great Artesian Basin (GAB)

Groundwater resources are being considered for water supply for two purposes:

- supply of construction water during construction of the Wandoan Coal Project
- potable water supply during construction and mine operations for the mine, accommodation facilities, and Wandoan township.

The supply of construction water is proposed from either a GAB bore within the mining lease area or from the existing Wandoan town water supply facility. The use of a GAB bore within the mining lease area will entail either upgrade of an existing bore or construction of a new bore. Treatment to a potable water standard may not be required for construction water. The Department of Natural Resources and Water (DNRW) has indicated a short-term water permit for construction activities is able to be granted, subject to the proponent demonstrating acceptable short-term drawdown criteria. The sustainability of groundwater extraction and the impacts on nearby groundwater users and springs at the margins of the GAB will be investigated as part of the groundwater permit application and the EIS process.

For potable water, use of the existing Wandoan town water supply facility will be subject to assessment of the existing town bores. The assessment will assist in determining the need for an additional bore for supply of potable water. The installation of a new water cooling tower will be required within the existing Wandoan town water supply facility to accommodate potable supply to the mine area.

(c) Raw water supply for mine operations

Raw water requirements for the operation of the mine are estimated at approximately 8500 ML per year to wash 30 Mtpa of ROM coal and provide dust suppression at the mine. The alternatives currently being considered for the supply of raw water to the project for mine operations are:

- from the raising of Glebe Weir on the Dawson River. Raw water from Glebe Weir will be piped to the mine using a new pipeline and associated infrastructure
- treated by-product water from coal seam methane (CSM) extraction, supplied via a new pipeline from CSM operations to the south or west of the proposed mine. While the source of CSM water is yet to be identified, the current major sources of CSM water are likely to be:
  (a) the Spring Gully/Fairfield reserves to the west of the MLAs
  (b) south of the MLAs near Condamine, south of Miles.

The in-ground quality of the CSM by-product water means that it may not be suitable for the operational requirements of the mine, such as coal washing, without at least some treatment and/or dilution. The Wandoan Coal Project proponent will undertake investigations to enable determination of its water quality requirements. The viability of this water supply alternative will depend in part upon the comparison of what the CSM producers are capable of supplying against the project water quality requirements.

(d) Wastewater treatment

Sewage from the mine and accommodation facilities will be disposed of at the existing Wandoan wastewater treatment plant. An assessment as to the condition of, and whether or not expansion to, the existing wastewater facilities will be undertaken will be conducted. An assessment of the proposed pipeline connecting the mine to the wastewater treatment plant will also be undertaken.

(e) CSM supply pipeline and power supply

Preliminary assessment of the power requirements for the project demonstrates:

- the mine's average demand will be approximately 65 MW with short term peaks of up to around 150 MW
- voltage regulation will be required on site
- short term energy storage (fly wheels) will be required if a dedicated on-site generation facility is used.

The preliminary considerations into power supply indicate that power for the project could be supplied from:

- power supply from the electricity grid and ancillary infrastructure
- total on-site generation fuelled by CSM from producers in the vicinity of the project, with a new high pressure gas pipeline from the Peat-Scotia gas line to the mine. Short-term energy storage using fly wheels will be required
- partial supply from the electricity grid and partial supply from on-site CSM fuelled power generation. Short-term energy storage using fly wheels will be required for the on-site power generation component.

(f) Airstrip

Provision of an airstrip for transport requirements to the mine will be investigated as part of the overall project. Whether an upgraded airstrip at Taroom or new airstrip at Wandoan is adopted as a transport option for the Wandoan Coal Project will be assessed during feasibility studies and the EIS.

Exclusions

The description and relationship with other actions not part of the Wandoan Coal Project and not included in the scope of these terms of reference or the EIS are:

(a) Surat Basin Rail

Surat Basin Rail Pty Ltd acts as an agent for and on behalf of the Surat Basin Rail Joint Venture, a consortium comprising ATEC (Dawson Valley Railway) Pty Ltd, IFM DVR Project Pty Ltd, QR Surat Basin Pty Ltd, Xstrata Coal Surat Basin Rail Pty Ltd and Anglo Coal Australia Pty Ltd. Surat Basin Rail Pty Ltd are currently investigating the feasibility of developing a railway between Wandoan and the existing Moura – Gladstone line to primarily allow transport of coal by rail to the Port of Gladstone, with potential access for other coal mines, grain, and general freight. Environmental assessment and approval for the proposed rail project will be coordinated as a separate, though related project to the Wandoan Coal Project.

(b) Port Alma expansion

Xstrata Coal Queensland Pty Ltd (XCQ) and Gladstone Ports Corporation are investigating the feasibility of a considerable expansion of Port Alma to export up to approximately 25 Mtpa of coal. The Wandoan Joint Venture is not involved in these investigations and will not be involved in the potential development of the expanded Port Alma.

(c) Wiggins Island Coal Terminal Project

The Gladstone Ports Corporation and Queensland Rail (QR) propose to develop a coal terminal in the Port of Gladstone. In order to supplement the current coal capacity at the Port, the Wiggins Island Coal Terminal will be constructed west of the existing RG Tanna coal terminal. In parallel, QR proposes to develop rail infrastructure to connect the new terminal with the existing rail infrastructure. The Wiggins Island Coal Terminal Project, which has undergone environmental assessment, will be undertaken as a separate, though related, project to the Wandoan Coal Project.

(d) Power station

The proposed mine is intended primarily as an export mine. However, domestic coal sales are also possible. In light of the historical interest in a power station at Wandoan, Xstrata Coal—but not the other members of the Wandoan Joint Venture—is seeking interest from potential proponents for a coal fired power station in the vicinity of the mine to use product coal from the mine. This power station would potentially supply multiple users. Any power station will be a separate project with its own impact assessment and approval process. Discussions to date have indicated that power station operators may seek to dispose of ash from any such power station in the mining voids at the mine. If a coal fired power station proceeds, the impacts of disposal of fly ash on the mine will be considered at the relevant time as part of the EIS process for the power station.

(e) Mineral development licence activities

The proponent will separately undertake certain investigative activities pursuant to its current mineral development licence tenures in parts of the MLAs prior to the grant of the mining leases for the Wandoan Coal Project. Activities include but are not limited to bulk sampling and on-going exploration activities under relevant environmental authorities. These are separate actions and are not included in the scope of these terms of reference (TOR) or the EIS.

(f) Surrounding coal tenements

The proponent holds other coal tenements in the vicinity of the proposed mine area of this project. Mineral development lease 224 is considered as part of a subsequent project and is expected to aid in continuing the supply of coal at a later stage (i.e. beyond the life of the mine within the three MLA areas). This is considered primarily as an additional resource

given the smaller size, a total of 3014 ha. Exploration within the proponent's EPC's surrounding the MLAs will continue on an on-going basis independently of the development and implementation of the Wandoan Coal Project. Any future development or utilisation of any viable resources as a result of exploration activities is considered to be part of a subsequent project. Such a subsequent project may involve a proposal to expand mining operations beyond the life of mine within the three MLAs.

Further details of the project are contained in the proponent's initial advice statement (IAS) dated December 2007, which can be downloaded from the Department of Infrastructure and Planning website www.dip.qld.gov.au/projects.

Project proponent

The proponent for the project is the Wandoan Joint Venture, whose joint venture partners are Xstrata Coal Queensland Pty Ltd (75 per cent), Itochu Coal Resources Australia RPW Pty Ltd (12.5 per cent) and Sumisho Coal Australia Pty Ltd (12.5 per cent).

XCQ will manage the operation of the project for the Wandoan Joint Venture.

XCQ, headquartered in Brisbane, is a wholly owned subsidiary of Xstrata Coal Ltd—an Australian company with a global reputation as the largest exporter of thermal coal and a significant producer of coking coal and semi-soft coal products. With interests in 30 operations throughout Australia, South Africa and Colombia, Xstrata Coal Ltd has access to both the Pacific and Atlantic export coal markets.

Xstrata plc is a major global diversified mining group, listed on the London and Swiss stock exchanges and included in the FTSE (Financial Times Stock Exchange) top 15. The group is headquartered in Zug, Switzerland and has around 43 000 employees worldwide, including contractors. Xstrata plc obtains approximately 25 per cent of its revenue from Australia and has invested more than A$8.5 billion in this country since 2002 in its coal, copper and zinc operations in Queensland, New South Wales and the Northern Territory. Xstrata Coal Ltd makes up to 17 per cent of Xstrata plc's commodity businesses. XCQ produced 24.4 million tonnes in 2006 of thermal and coking coal for the Asia-Pacific export market.

Existing operations being managed by XCQ include the Oaky Creek Mine Complex east of Tieri (three underground mines), the Newlands Mine at Glenden (one underground and one open cut mine), the Collinsville Mine at Collinsville (one open cut mine) and the Rolleston open cut. XCQ also operate the export coal port of Abbot Point at Bowen. XCQ has invested some $770 million in these assets over the past five years, directing spending into local regions where possible.

Itochu Coal Resources Australia RPW Pty Ltd and Sumisho Coal Australia Pty Ltd are both major Japanese trading houses with interests in numerous industries including mining, power generation and commodity trading.

Parsons Brinckerhoff has been commissioned by the proponent to conduct the environmental impact assessment for this project.

The contact details for the proponent are:

Project Manager—Wandoan Coal Project
Xstrata Coal Queensland Pty Ltd
GPO Box 2587
Brisbane Qld 4000
tel +61 7 3115 5363
fax +61 7 3115 5412
aubnewwandoan@pb.com.au
www.xstrata.com

Administrative procedures for these terms of reference

The Wandoan Coal Project was declared a significant project for which an environmental impact statement (EIS) is required pursuant to s.26(1)(a) of the *State Development and Public Works Organisation Act 1971* (SDPWO Act) on 21 December 2007 by the Coordinator-General (CG). Matters considered by the CG in making this declaration included information contained in an IAS prepared by the proponent; relevant planning schemes and policy frameworks; infrastructure impacts; employment opportunities; environmental effects; complexity of local, state and federal requirements; level of investment; and the project's strategic significance. The TOR assists the proponent to develop a comprehensive EIS for the project satisfying the requirements of the SDPWO Act.

The project is essentially an updated and refined version of the Wandoan Project, which was declared a significant project in March 2007. Much of the Wandoan Coal Project remains as was proposed under the Wandoan Project. However, the proponent advised the CG that recent changes/refinements in the project scope and legislative amendments necessitated a new declaration, as the February 2007 IAS may not adequately describe the project.

The earlier Wandoan Project declaration has now been withdrawn at the request of the proponent.

To undertake the mining components of the project, the proponent will require a mining lease under the *Mineral Resources Act 1989* (the MRA) issued by the Queensland Minister for Mines and Energy and an environmental authority under the *Environmental Protection Act 1994* (the EP Act) issued by the Queensland Minister for Sustainability, Climate Change and Innovation. Some elements of the project may invoke the *Integrated Planning Act 1997* (IPA) and where this is the case, the Dalby Regional Council will be the likely assessment manager.

The proponent has referred the project to the federal Minister for the Environment, Heritage and the Arts under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) as four inter-related EPBC referrals addressing the mine and infrastructure, CSM (South) water supply pipeline, CSM (West) water supply pipeline, and the Glebe Weir raising and pipeline.

On 21 July 2008, the federal Minister decided that all four referrals were controlled actions and that the relevant controlling provisions for all four referrals were sections 18 and 18A (listed threatened species and ecological communities) and in relation to the Glebe Weir raising referral only the additional relevant controlling provisions were sections 20 and 20A relating to listed migratory species.

In accordance with the Minister's decision on the assessment approach, the project will be assessed under the Bilateral Agreement with the Queensland Government. Under the Bilateral Agreement, the Australian Government has accredited the Queensland SPDWO Act EIS process to meet the impact assessment requirements under both federal and state legislation.

Consequently, the term EIS used in these TOR should be interpreted as satisfying the impact assessment requirements of all relevant Queensland and Australian Government statutes for this project (i.e. includes, but not limited to, the SDPWO Act, the EP Act, MRA, IPA, *Transport Infrastructure Act 1994* and the EPBC Act).

The Queensland Department of Infrastructure and Planning is coordinating the environmental impact assessment on behalf of the CG. Relevant federal, state and local government authorities have been invited to participate in the EIS process as advisory agencies.

The first step in the impact assessment process is the development of TOR for an EIS for the project. The process involves the formulation of draft TOR that are made available for public and advisory agency comment. The draft TOR were made available for public and advisory agency comment on Saturday 16 August 2008, with submissions closing on 15 September 2008. A total of 27 submissions on the draft TOR were received, including 17 from advisory agencies and 10 from members of the public and organisations.

In finalising the TOR, the CG has considered all properly made submissions and other submissions and information. The TOR has been presented to the proponent, who will prepare an EIS to address the TOR. Once the EIS has been prepared to the satisfaction of the CG, a public notice will be advertised in relevant newspapers circulating in the region and nationally. The notice will state where copies of the EIS can be viewed or purchased, the submission period, and where submissions should be sent. The proponent may also be required to prepare a supplementary report to the EIS to address specific matters raised during the EIS submission period.

At the completion of the EIS phase, the CG will prepare a report evaluating the EIS and other relevant material, pursuant to s35 of SDPWO Act. The CG report will include an assessment and conclusion about the environmental effects of the project and any associated mitigation measures. Material that will be assessed includes: the EIS; properly made submissions and other submissions accepted by the CG; and any other material the CG considers relevant to the project such as a supplementary report, comments and advice from advisory agencies and other entities, technical reports and legal advice.

The CG report will be publicly notified by placing it on the Department of Infrastructure and Planning website at www.dip.qld.gov.au. The CG report will also be presented to the proponent; the IPA assessment manager; the federal Minister for Environment, Heritage and The Arts (under the EPBC Act); the state Minister for Sustainability, Climate Change and Innovation and the state Minister for Mines and Energy.

Under s45 of SDPWO Act, the CG's report may state conditions for the proposed mining lease. If CG's conditions are included in the report:

- the report must state reasons for their inclusion
- the CG must give the MRA Minister a copy of the report
- the conditions of the proposed mining lease are, subject to any inconsistency with native title conditions that have paramountcy under s47 of SDPWO Act, taken to include the CG's conditions.

Similarly, the CG's report may, under s49 of SDPWO Act, state conditions for any draft environmental authority under the EP Act for the proposed environmental authority (mining lease). If conditions are included in the report:

- the report must state reasons for their inclusion
- the CG must give the EPA Minister a copy of the report.

Finally, if the project involves development requiring an application for a development approval under IPA, the CG's report may, under s39 of SDPWO Act, state for the assessment manager one or more of the following:

- the conditions that must attach to the development approval
- that the development approval must be for part only of the development
- that the approval must be preliminary approval only.

Alternatively the report must state for the assessment manager that:

- there are no conditions or requirements for the project
- the application for development approval be refused.

For further inquiries about the EIS process for this project, please contact:

Project Manager—Wandoan Coal Project
Significant Projects Coordination
Department of Infrastructure and Planning
PO Box 15009 City East Qld 4002

tel +61 7 3234 0540
fax +61 7 3225 8282
wandoan@dip.qld.gov.au

www.dip.qld.gov.au

Contents

Abbreviations

The following abbreviations have been used in this document:

CG	Coordinator-General of the State of Queensland
CHMP	Cultural Heritage Management Plan
CSM	Coal seam methane
DEWHA	Federal Department of Environment, Water, Heritage and the Arts
DMR	Queensland Department of Main Roads
DNRW	Queensland Department of Natural Resources and Water
DIP	Queensland Department of Infrastructure and Planning
EIS	*Environmental impact statement*
EMP	Environmental management plan
EP Act	*Environmental Protection Act 1994*
EPA	Queensland Environmental Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPP(Noise)	*Environmental Protection (Noise) Policy 1997*
EPP(Water)	*Environmental Protection (Water) Policy 1997*
GAB	Great Artesian Basin
GQAL	Good quality agricultural land
IAS	Initial advice statement as defined by Part 4 of the *State Development and Public Works Organisation Act 1971*
IPA	*Integrated Planning Act 1997*
MLA	Mining lease application issued pursuant to the *Mineral Resources Act 1989*
MRA	*Mineral Resources Act 1989*
Mpta	million tones per annum
NES	National environmental significance, as defined under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth)
RoM	Run of mine coal
SDPWO Act	*State Development and Public Works Organisation Act 1971*

The proponent	The Wandoan Joint Venture
TOR	Terms of reference as defined by Part 4 of the *State Development and Public Works Organisation Act 1971*
XCQ	Xstrata Coal Queensland Pty Ltd

PART A—Information and advice on the preparation of the EIS

1. Introduction

These TOR for an EIS for the Wandoan Coal Project have been prepared in accordance with s29 and s30 of the SDPWO Act. The objective of the TOR is to identify those matters that should be addressed in the EIS. The TOR is based on the initial outline of the proposed project given in the IAS dated December 2007.

The CG may request additional information on any matter not adequately dealt with in the EIS report. In order to clarify the nature and level of investigations that are envisaged in the TOR, the proponent may contact relevant government agencies (known as advisory agencies), peak community interest organisations and relevant individuals and groups as necessary. However, the CG reserves the final decision on interpretation of the requirements of the TOR.

Reference to any culturally sensitive information should be indicative only and disclosure of any such information must be negotiated with traditional custodians. Confidential information supplied by or to the proponent must be clearly identified and placed in discrete attachments to the main report.

2. EIS objectives

The objective of the EIS is to ensure that all potential environmental, social and economic impacts of the project are identified and assessed and, where possible, how any adverse impacts would be avoided or mitigated. Direct, indirect and cumulative impacts must be fully examined and addressed. The project should be based on sound environmental protection and management criteria.

The EIS should be a self-contained and comprehensive document that provides sufficient information for an informed decision on the potential impacts of the project and the management measures employed to mitigate adverse impacts. The EIS document should provide information for the following persons and groups, as the project stakeholders:

- **for interested bodies and persons**—a basis for understanding the project, prudent and feasible alternatives, affected environmental values, impacts that may occur, and the measures to be taken to mitigate all adverse impacts.
- **for groups or persons with rights or interests in land**—an outline of the effects of the proposed project on that land including access arrangements.
- **for government agencies**—a framework for decision-makers to assess the environmental aspects of the proposed project with respect to legislative and policy provisions, and based on that information, to make an informed decision on whether the project should proceed or not, and if so, subject to what conditions, if any.
- **for the proponent**—a mechanism by which the potential environmental impacts of the project are identified and understood, including information to support the development of management measures, such as an environmental management plan, and to mitigate the effects of adverse environmental impacts of the development.

The proponent is required to address the TOR to the satisfaction of the CG before the EIS is made publicly available. It should be noted that the CG does not evaluate the EIS until public notification is completed and the CG has obtained any other material the CG considers relevant to the project, including additional information or comment about the EIS and the project from the proponent.

3. General EIS guidelines

The EIS is to provide stakeholders with sufficient information to understand the type and nature of the project, the potential environmental, social and economic impacts, and the measures proposed by the proponent to mitigate all adverse impacts on the natural, built and social environments. It should be recognised that federal, state and local governments, special interest groups and the general public will have an interest in the EIS.

All phases of the project should be described in the EIS including pre-construction, construction, operation and decommissioning, including final rehabilitation of the mine site and any redundant infrastructure. Direct, indirect and cumulative impacts should be identified and assessed with respect to the environmental values of the project area and its potential area of impact. Cumulative impacts include impacts accumulating over time and impacts exacerbated by intensity or scale or frequency or duration of impacts both at the site and remote to the site.

Specifically, the EIS should provide:

- an executive summary of the potential environmental impacts of the project
- an overview of the proponent and its existing operations
- a description of the project's objectives and rationale, as well as its relationships to strategic policies and plans
- a description of the entire project, including associated infrastructure requirements
- a description of feasible alternatives capable of substantially meeting the proposal's objectives
- an outline of the various approvals required for the project to proceed
- descriptions of the existing environment, particularly where this is relevant to the assessment of impacts
- measures for avoiding, minimising, managing and monitoring adverse impacts, including a statement of commitment to implement the measures
- rigorous assessment of the residual risks of environmental impacts arising from the project and relevant alternatives on environmental, social and economic values, relative to the 'no project' scenario. The extent of baseline and predictive studies should be commensurate to risks. Assessments should address direct and indirect, combined, short- and long-term, beneficial and adverse impacts, as well as cumulative impacts in combination with other known activities. An estimation of the reliability of predictions should also be provided
- a description of stakeholder consultation undertaken
- responses to issues raised during public and stakeholder consultation.

The main EIS report needs to be supported by appendices containing relevant data, technical reports and other sources of the EIS analysis. In preparing the EIS, the approach to be adopted requires that:

- predictions of environmental impacts are based on scientifically supported studies
- the EIS is to present all technical data, sources or authority and other information used to assess impacts
- the methods used to undertake any specialist studies are outlined, together with any relevant assumptions and professional or scientific judgements
- the scientific reliability of investigations and predictions is indicated, including the estimated degree of certainty or, if possible, statistical confidence wherever appropriate

- proposed measures to mitigate and manage identified issues are described and evaluated
- residual impacts that are not quantifiable are described qualitatively, in as much detail as reasonably practicable.

The assessment of all environmental impacts needs to encompass both potential impacts on and uncertain risks to the environment. The level of investigation of potential impacts or particular risks needs to be proportionate to both the severity of the potential consequences of possible events and the likelihood of those events occurring.

Project specific types of relevant impacts requiring investigation are set out in Part B. However, the EIS will need to address other issues or aspects that may emerge during the investigations and preparation of the EIS. Ultimately, it is the proponent's responsibility to ensure that adequate studies are undertaken and reported.

The EIS should state the criteria adopted in assessing the proposed project and its impacts, such as compliance with relevant legislation, policies, standards, community acceptance and maximisation of environmental benefits and minimisation of risks.

The level of analysis and detail in the EIS should reflect the level of significance of the expected impacts on the environment. Any prudent and feasible alternatives should be discussed and treated in sufficient detail, and reasons for selection of the preferred option should be clearly identified.

Where possible, information provided in the EIS should be clear, logical, objective and concise, so that non-technical persons may easily understand it. Where appropriate, text should be supported by maps and diagrams. Factual information contained in the document should be referenced wherever possible. Where applicable, aerial photography and/or digital information (e.g. of project site) should be presented.

The terms 'detail' and 'discuss' should be taken to include both quantitative and qualitative matters as practicable and meaningful. Similarly, adverse and beneficial effects should be presented in quantitative and/or qualitative terms as appropriate. Should the proponent require any information in the EIS to remain confidential, this should be clearly indicated, and separate information should be prepared on these matters.

4. Stakeholder consultation

The proponent should undertake a comprehensive and inclusive program of consultation with the stakeholders identified in section 2 (above). The consultation program should provide stakeholders with the opportunity to obtain information about the project, to raise issues and express their concerns and to receive feedback on how the proponent intends to address the issues and mitigate all adverse impacts of the project.

Consultation with the advisory agencies should be the principal forum for identifying legislation, regulations, policies and guidelines relevant to the project and EIS process.

Where appropriate, information bulletins can be used to disseminate information to a wider audience. These bulletins can also be used to inform stakeholders of the proponent's progress in the EIS process and on specific investigations.

The proponent is required to provide opportunities for the general public to obtain information about, and comment on, the project through public information sessions.

5. General EIS format

The EIS should be written in a format matching the TOR or include guidelines (preferably as an appendix) describing how the EIS responds to the TOR.

The EIS documentation is to include appendices containing:

- a copy of the final TOR
- a list of persons, interest groups and agencies consulted during the EIS
- a list of advisory agencies consulted with an appropriate contact
- the names of, and work done by, all personnel involved in the preparation of the EIS.

Maps, diagrams and other illustrative material should be included in the EIS to assist in the interpretation of the information.

The EIS should be produced on A4 size paper capable of being photocopied, with maps and diagrams on A4 or A3 size. The EIS document should not contain watermarks across the body of the text. The EIS should also be produced on CD-ROM/DVD.

Two separate CD-ROM/DVD copies should be provided:

1. CD-ROM/DVD copies resolution equivalent to the printed document for distribution to the stakeholders
2. CD-ROM/DVD copies for placement on the internet, in Adobe® PDF format. All compression must be down-sampled to 72 dpi. PDF documents should be no larger than 1 MB in file size. The executive summary should be supplied in HTML 3.2 format with *.jpg graphics files. Text size and graphics files included in the PDF document should be of sufficient resolution to facilitate reading and enable legible printing, but should be such as to keep within the 1 MB file size.

The final nature and number of EIS copies required to be submitted and made available, should be discussed and agreed with the CG in the early stages of the EIS process.

PART B—Specific requirements: content of the EIS

The EIS should include the following sections but need not be limited to these sections or inferred structure.

Executive summary

The function of the executive summary is to convey the most important aspects and options relating to the project to the reader in a concise and readable form. It should use plain English and avoid the use of jargon. The executive summary should be written as a standalone document, able to be reproduced on request and distributed to interested parties who may not wish to read or purchase the EIS as a whole.

The structure of the executive summary should follow that of the EIS, and focus strongly on the key issues to enable the reader to obtain a clear understanding of the project and its potential adverse and beneficial environmental, social and economic impacts and the management measures to be implemented by the proponent to mitigate all residual impacts.

The executive summary should include:

- the title of the project
- name and contact details of the proponent, and a discussion of previous projects undertaken by the proponent and their commitment to effective environmental management
- a concise statement of the aims and objectives of the project
- the legal framework, decision-making authorities and Advisory Agencies
- an outline of the background and need for the project, including the consequences of not proceeding with the project
- a description of the alternative options considered and reasons for the selection of the proposed development option
- a brief description of the project (pre-construction, construction and operational activities) and the existing environment, utilising visual aids where appropriate
- an outline of the principal environmental impacts predicted (including economic and social impacts) and the proposed environmental management strategies (including waste minimisation and management) and commitments to minimise the significance of these impacts
- Community attitudes to the project and community consultation undertaken
- detailed maps of the proposed project location.

Glossary of terms

A glossary of technical terms, acronyms and abbreviations should be provided.

1. Introduction

The introduction should clearly explain the function of the EIS, why it has been prepared and what it sets out to achieve. It should also define the audience to whom it is directed, and contain an overview of the structure of the document.

1.1 Project proponent

This section should describe the experience of the project proponent (and its joint venture partners), including the nature and extent of business activities, experience and qualifications, and environmental record, including the proponent's environmental policy.

1.2 Project description

This section should provide a brief description of the key elements of the project including associated infrastructure requirements. The location of the project and its infrastructure requirements should be described and mapped. Detailed descriptions of the project should follow in section 2.

1.3 Project rationale

This section should provide a statement of the objectives of the project and a brief outline of the events leading up to the project's formulation, including alternatives, envisaged time scale for implementation and project life, anticipated establishment costs and actions already undertaken within the project area.

1.3.1 Project need, costs and benefits

The justification for the project should be described, including its strategic, economic, environmental and social implications and its technical feasibility and commercial viability. The status of the project should be discussed in a regional, state and national context. The project's compatibility with relevant policy and regulatory frameworks should also be described.

This section should also summarise the economic and social costs and benefits for businesses and the wider community arising from the project; regional socio-economic issues including cultural impacts, community disruption, related land use changes, employment, skills development and any workforce accommodation issues; and increased demands on natural resources.

1.3.2 Relationships to other projects

This section should also describe how the project relates to any other actions, of which the proponent should reasonably be aware, that have been, or are being, taken or that have been approved in the area affected by the project.

1.4 Alternatives to the project

This section should describe feasible alternatives, including conceptual, technological and locality alternatives to the project, and discussion of the consequences of not proceeding with the project. Alternatives should be discussed in sufficient detail to enable an understanding of the reasons for preferring certain options and courses of action and rejecting others. Comparative environmental impacts of each alternative should be summarised.

Should water supply, power, transport and/or storage infrastructure be included as an element of the project or as a separate but inter-related component of the project, this section should include a description of and rationale for such infrastructure.

Reasons for selecting the preferred options should include technical, commercial, social and natural environment aspects. In particular, the principles of environmentally sustainable

development and sustainable development should be included. The relationship of options chosen for waste management and any emissions produced should be detailed.

This information is required to assess why the scope of the project is as it is and to ensure that the environmentally sustainable development principles and sustainable development aspects have been considered and incorporated during the scoping and planning of the proposal.

1.5 Co-location opportunities

Where linear infrastructure is proposed (i.e. water pipeline, electricity transmission and distribution lines, gas pipelines etc) opportunities may exist for efficiency gains and the mitigation of environmental and property impacts through the location of other proposed linear infrastructure in, near or parallel to the proposed infrastructure.

The project proponent should identify any proposals to develop infrastructure within the vicinity of the proposed linear infrastructure investigation corridor. Such proposals would be limited to those projects which are in the public arena during the period of preparation of this EIS and for which a proponent entity can be readily identified.

It would be inappropriate for this EIS to evaluate the environmental impacts of other infrastructure not directly required for this project. However, the EIS should describe the implications of locating other forms of linear infrastructure within or near the infrastructure. Where co-location may be likely, the EIS should consider opportunities to coordinate or enhance any of the impact mitigation strategies proposed for the infrastructure through cooperation with other proponents in the locality. [1]

1.6 The environmental impact statement process

1.6.1 Methodology of the EIS

This section should make clear the objectives of the EIS process under the SDPWO Act, the environmental authority approval process under the EP Act and mining lease approval under the MRA. This section should include a description of the impact assessment process steps, timing and decisions to be made for relevant stages of the project, in the context of the EP Act and MRA process. In particular, this section should outline mechanisms in the process for public input and the public release of an EIS which will specify all responses to stakeholder submissions.

The information in this section is required to ensure:

- relevant legislation is addressed
- readers are informed of the process to be followed
- the stakeholders are aware of any opportunities for input and participation.

1.6.2 Objectives of the EIS

This section should provide a statement of the objectives of the environmental impact assessment. The structure of the EIS can then be outlined as an explanation of how the EIS will meet its objectives. The purpose of the EIS is to:

- provide public information on the need for, and likely effects of, the project on the natural, social and economic environment
- set out acceptable standards and levels of impacts (both beneficial and adverse) on environmental values
- demonstrate how environmental impacts can be managed through the protection and enhancement of the environmental values.

[1] 10 – Gulugaba ALG (1)

The role of the EIS in providing information for the formulation of the environmental management plan (EMP) for the project should be discussed. Discussion of options and alternatives is a key aspect of the EIS.

1.6.3 Submissions

The reader should be informed as to how and when public submissions on the EIS will be addressed and taken into account in the decision-making process. The EIS should inform the reader as to how to make submissions and what form the submissions should take.

1.7 Public consultation process

An appropriate public consultation program is an important component of the EIS process.

This section should outline the methodology that will be adopted to:

- identify the stakeholders and how their involvement will be facilitated
- identify the process conducted to date and future consultation strategies and programs, including during the operational phase of the project
- indicate how consultation involvement and outcomes will be integrated into the EIS process and future site activities, including opportunities for engagement and provision for feedback and action if necessary.

A list of the stakeholders consulted during the program should be provided, as well as any meetings held, presentations made and any other consultation undertaken for the EIS process.

The public consultation process should identify broad issues of concern to local and regional community and interest groups and address issues from project planning through commissioning and project operations. A consultation plan should be prepared during the initial phase of the EIS process. This should identify:

- the types of activities to be undertaken
- timing
- target stakeholder/community representatives
- integration with other EIS activities and the project development process
- consultation responsibilities
- communication protocols
- reporting and feedback arrangements.

Information about the consultation process that has taken place and the results should be provided.

The public consultation program should provide opportunities for community involvement and education. It may include interviews with individuals, public communication activities, interest group meetings, production of regular summary information and updates, and other consultation mechanisms to encourage and facilitate active public consultation.

1.8 Project approvals

1.8.1 Relevant legislation and policy requirements

The aim of this section is to provide the reader with an explanation of the legislation and policies controlling the approvals process for the project. Reference should be made to the SDPWO Act, EP Act, MRA, *Integrated Planning Act 1997* (IPA), *Transport Infrastructure Act 1994*, *Land Act 1994*, *Water Act 2000*, *Vegetation Management Act 1999*, *Cultural Heritage*

Act 2003, Land Protection (Pest and Stock Route Management) Act 2002, Fisheries Act 1994, Electricity Act 1994, Nature Conservation Act 1992[2], *Soil Conservation Act 1986*, *Forestry Act 1959*[3] and other relevant Queensland laws. All requirements of the EPBC Act and *Native Title Act 1993* should also be included.

The EIS should describe the approval process resulting from the gazettal of this project as a significant project pursuant to the SDPWO Act and outline the linkage to other relevant state and federal legislation. This outline should describe the public notification processes and appeal rights that will be available in the anticipated approval processes. The EIS should indicate the level of approvals anticipated by the proponent for each project element in order that approval agencies are able to determine the completeness of the information presented and the scope to generate the anticipated approvals.

Local government planning controls, local laws and policies applying to the development should be described, and a list provided of the approvals required for the project and the expected program for approval of applications.

This information is required to assess how the legislation applies to the proposal, which agencies have jurisdiction, and whether the proposed impact assessment process is appropriate.

1.8.2 Planning processes and standards

This section should discuss the project's consistency with existing land uses or long-term policy framework for the area (e.g. as reflected in local and regional plans), and with legislation, standards, codes or guidelines available to monitor and control operations on site. This section should refer to all relevant state and regional planning policies. This information is required to demonstrate how the proposal conforms to state, regional and local plans for the area.

1.9 Accredited process for controlled actions under Commonwealth legislation

Projects that are declared 'significant projects' pursuant to s.26(1)(a) of the SDPWO Act requiring the preparation of an EIS may also be controlled actions under the federal EPBC Act. In which case, the federal government may accredit the state's assessment process under Part 8 of the EPBC Act.

Under an accredited state EIS process, it will be necessary for TOR to address potential impacts on the matters of national environmental significance (NES) that were identified in the '*controlling provisions*' when the proposed project actions were declared controlled actions on 21 July 2008.

It is preferable that a stand-alone report be provided as an appendix to the EIS that exclusively and fully addresses the issues relevant to the controlling provisions, for each component of the Wandoan Coal Project. In which case, it should structured as per the following outline for each component of the Wandoan Coal Project.

1. Introduction
2. Description of proposed action (as it would impact on NES matters)
3. Description of the affected environment relevant to the controlling provisions (i.e. describe the features of the environment that are NES matters protected under the EPBC)
4. Assessment of impacts on NES matters and mitigation measures
5. Conclusions

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[2] 18 – EPA(3)
[3] 20 – NRW (7)

6. References.

Alternatively, as a minimum requirement, the EIS should provide separate discussions under sub-headings in the relevant sections that describe the values and address the potential impacts on NES matters. The locations of those sub-headings should be readily identifiable from the table of contents. For example, if one of the controlling provisions was 'Listed threatened species and communities', then subsections, headed 'Matters of national environmental significance', should be placed in section 3.3 (Nature conservation) under both the 'Description of environmental values' and 'Potential impacts and mitigation measures' headings. Those subsections should address exclusively and fully the issues relevant to the controlling provisions.

2. Description of the project

The objective of this section is to describe the project, and its various components (as outlined in the preamble), through its lifetime of construction, operation and decommissioning (including rehabilitation). This information is required to allow assessment of all aspects of the project, including which approvals may be required and how they may be managed through the life of the project.

2.1 Overview of project

The EIS should provide an overview of the project to put it into context. This section should include:

- a description of the key components of the project through the use of text and design plans where applicable
- the expected cost and overall duration and timing of the project
- the employment benefits from the construction and operational phases of the project
- a summary of any environmental design features of the project should be presented.

2.1.1 Mine

This section should provide details on aspects of the mine components of the project, including:

- the location of the proposed mine, illustrated on maps
- probable pit boundaries and mine path
- mine development sequence or timeframes
- proposed stream diversions and water storages
- any road and other infrastructure diversions (water pipelines, electricity transmission lines etc.)
- any final void to be left at the cessation of mining.

The rationale for the preferred operational program should be explained. The identification of all site access points to, from and within the project should also be identified on maps, to assist in the assessment of emergency planning.

2.1.2 Associated mine infrastructure

This section should provide details on the following aspects of the mine's associated infrastructure (e.g. coal handling facilities and tailings storage facilities), including any infrastructure associated with delivery of coal and secondary coal distribution infrastructure such as:

- a description of plant and equipment to be employed
- the capacity of plant and equipment
- water requirements
- chemicals to be used.

Concept and layout plans should be provided highlighting proposed buildings, structures, plant and equipment associated with the processing operation. The nature, sources, location and quantities of all materials to be handled, including the storage and stockpiling of raw materials, should be described.

2.1.3 Ecologically sustainable development

The EIS should provide a comparative analysis of how the project conforms to the objectives for ecologically sustainable development (see the *National Strategy for Ecologically Sustainable Development 1992*available from the Australian Government Publishing Service).

This analysis should consider the cumulative impacts (both beneficial and adverse) of the project from a life-of-project perspective, taking into consideration the scale, intensity, duration or frequency of the impacts to demonstrate a balance between environmental integrity, social development and economic development.

This information is required to demonstrate that sustainable development aspects have been considered and incorporated during the scoping and planning of the project.

2.2 Location

The regional and local context of the project should be described and illustrated on maps at suitable scales and reference points. Real property descriptions of the project site should be provided. Maps should show the precise location of the project area, and in particular:

- the location of the resource to be explored, developed or mined
- the location and boundaries of land tenures, in place or proposed, to which the project area is or will be subject
- the location and boundaries of mining tenures, granted or proposed, to which the project area is or will be subject
- the location and boundaries of the project footprint showing all key aspects, including mine excavation(s), stockpiles, areas of fill, watercourses, plant locations, water storages, buildings, bridges, culverts, hardstands, car parks and any final void to be left at the cessation of mining etc
- any part of the resource not intended to be mined and any part of the resource that may be sterilised by the proposed mining operations
- the location of all proposed project transport and coal loading infrastructure for both new works and upgrades of existing infrastructure, including the various coal transport options considered with an explanation for the rationale for the preferred transport option(s) for the project
- the location of any proposed buffers surrounding the working areas
- the identification of all site access points to, from and within the project on maps, to assist in the assessment of emergency planning.

Consideration should be given to providing a rectified air photo enlargement to illustrate components of the project in relation to the land and mining tenures and natural and built features of the area.

2.3 Construction

The extent and nature of the project's construction phase should be described (as well as any works required off-site enabling construction to commence, e.g. road upgrades), including a map at reasonable scale that shows the footprint of the mine and construction works. The description should include the type and methods of construction, the construction equipment to be used and the items to be transported onto the construction site including the quarry sites from which any gravel/rock is extracted.

Any staging of the project should be described and illustrated showing site boundaries, development sequencing and timeframes.

2.3.1 Mine

This section should provide a description of construction activities relating to the project including:

- site access:
  - upgrading of roads, railways and other infrastructure
  - clearing
  - establishment requirements for construction facilities.
- construction requirements, including source and extraction of construction inputs and materials, including construction water:
  - details of the method of construction of the mine and volumes of material required
  - any staging of construction activities.
- type, source, quantity and method of transport of construction materials
- general construction standards and site management, including environmental and safety management
- an assessment of expected physical and chemical properties and quantities of soil/rock to be excavated
- details of any potential disruption to flows of waterways during construction and any diversion works required
- relocation of existing infrastructure
- timetable for construction, particularly noting seasonal rainfall or flows
- the hours of operation
- emergency aid/medical facilities to be provided on site
- the construction methods and containment/disposal of construction spoil
- solid and liquid waste handling.

2.3.2 Associated infrastructure

This section should provide a description of construction activities relating to the project's associated infrastructure, including for transport of coal and water:

- a map showing location of any works
- on-site plans, layouts, boundaries and elevations
- detailed concept and staging (if any proposed) for additional transport facilities and locations
- plant and machinery likely to be involved
- supply and storage of materials—volume, composition, handling and storage during construction
- extent that service corridors will be used during construction and maintenance
- width of vegetation clearing required. This information must indicate where vegetation to be cleared has significant conservation value (such as sensitive environmental areas and creek crossings), and must also reference where in the EIS the impacts on such vegetation have been addressed
- the location(s) of any road/rail crossings along proposed conveyor/water pipeline routes for the project

- typical crossing techniques including restoration works that would be used at creek crossings, and road, rail, and other service corridor crossings
- disposal of plant-matter left after clearing vegetation
- details of any hydrostatic testing procedures (discussion of water usage for this activity must be addressed in section 3)
- cleanup and restoration (rehabilitation) of areas used during construction including any accommodation facilities and storage areas
- disposal/reuse of surplus excavated material and if this material can be coordinated with concurrent construction activities in the vicinity.

2.4 Operations

2.4.1 Mine and associated infrastructure

The EIS should include a description of the following:

- mine life and coal resource base:
  - the proposed mine life and an outline of the coal resource base
  - the quantity of coal to be mined annually including any proposed ramping-up of production or staging of development.
- mining methods and equipment:
  - the mining type and methods to be used, including the major equipment to be used in the various components of the operation
  - the use of different techniques in areas of different topographic or geo-technical character.
- mine sequencing:
  - the proposed sequence and timing of mining of each seam within the mining lease
  - the physical extent of excavations, including proximity of mining to any state-controlled or local roads to ensure management of any potential for subsidence of road infrastructure from mining
  - the location of stockpiles of overburden or coal reject/tailings to be handled during the project's operation or left after mining ceases, including the rate of throughput of stockpiles of product, reject and overburden
  - the proposed progressive backfilling of excavations
  - the area disturbed at each major stage of the project.
- processing and products:
  - concept and layout plans highlighting proposed buildings, structures, plant and equipment
  - the nature, sources, location and quantities of all materials to be handled, including the storage and stockpiling of raw materials
  - the quantities and characteristics of the products produced on an annual basis
  - the source, quantities and uses of water
  - indicative process flow-sheets showing material balances for the processing plant, and the anticipated rates of inputs, along with similar data on products (e.g. product or washed coal), wastes (e.g. tailings and coarse rejects) and recycle streams (e.g. water).

- ongoing evaluation and exploration activities:
  - the extent and nature of any proposed ongoing exploration or geological and geotechnical evaluation within the project area that may be required over the life of the project.
- coal handling:
  - the proposed methods and facilities to be used for coal storage and for transferring coal from the mining lease to the proposed delivery options, including on plans at an appropriate scale
  - any environmental design features of coal stockpiling and blending at any off-site facilities
  - the capacity of the rail option to handle the proposed coal volumes generated by the project over all phases of development.
- associated infrastructure
  - the proposed sources and facilities to supply water for potable and non-potable uses
  - the proposed methods and facilities for wastewater treatment and disposal
  - size, location and configuration of accommodation facilities outside of the mining lease area
  - location, size and facilities required for the supply of coal seam methane gas for on-site power supply.[4]

2.5 Rehabilitation and decommissioning

This section should describe the options, strategies and methods for progressive and final rehabilitation of the environment disturbed by the project. The strategic approach to progressive and final rehabilitation should be described. A preferred rehabilitation strategy should be developed with a view to minimising the amount of land disturbed at any one time. The final topography of any excavations, waste areas and dam sites should be shown on maps at a suitable scale.

The strategies and methods presented for progressive and final rehabilitation of disturbed areas should demonstrate compliance with the objectives of the *Environmental management policy for mining in Queensland* (1991) or with updated versions of that policy available at the time of drafting the EIS. Land suitability assessment should follow the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (1995). In particular, the strategies and methods should have the following objectives:

- mining and rehabilitation should aim to create a landform with land use capability and/or suitability similar to that prior to disturbance unless other beneficial land uses are pre-determined and agreed
- mine wastes and disturbed land should be rehabilitated to a condition that is self-sustaining, or to a condition where the maintenance requirements are consistent with an agreed post-mining land use
- surface and ground waters that leave the lease should not be degraded to a significant extent. Current and future water quality should be maintained at levels that are acceptable for users downstream of the site.

The means of decommissioning the project, in terms of the removal of plant, equipment, structures and buildings should be described, and the methods proposed for the stabilisation of the affected areas should be given. Information should be provided regarding decommissioning and rehabilitation of the plant site, removal of processing plant, rehabilitation

[4] 18 – EPA (4)

of concrete footings and foundations, hardstand areas, storage tanks and wharfage (including any potential for reuse of these facilities). Options and methods for the disposal of wastes from the demolition of plant and buildings should be discussed in sufficient detail for their feasibility and suitability to be established.

Proposals to divert creeks during operations, and, if applicable, for the reinstatement of the creeks after operations have ceased, should be provided. Where dams are to be constructed, proposals for the management of these structures after the completion of the project should be given. Also, the final drainage and seepage control systems and long-term monitoring plans should be described.

A description of topsoil management should consider transport, storage and replacement of topsoil to disturbed areas. The minimisation of topsoil storage times (to reduce fertility degradation) should also be addressed.

Detail of the impacts of the preferred rehabilitation strategy should be discussed in the appropriate subsections of section 3 'Environmental values and management of impacts' particularly with regard to such issues as final landform stability, rehabilitation of flora and the long-term quality of water in any final voids. Implications for the long-term use and fate of the site should also be addressed, particularly with regard to the on-site disposal of waste and the site's inclusion on the environmental management register or contaminated land register.

2.6 Associated infrastructure requirements

This section should provide descriptions, with concept and layout plans, of requirements for constructing, upgrading or relocating all infrastructure in the vicinity of the project area. The matters to be considered include such infrastructure as roads, bridges, dams, power lines and other cables, wireless technology (e.g. microwave telecommunications), and pipelines for any services (whether underground or above).

2.6.1 Workforce and accommodation

This section should provide details on the employment requirements and skills base the required workforce for both the construction and operations phases of the project and any other facilities.

The section should also discuss an accommodation strategy for the construction workforce that addresses the estimated housing needs of both single and accompanied construction workers. This section should include details of the size, location and management of any temporary worker accommodation that will be required either on-site or off-site. Maps should be included as necessary to illustrate the site and should include the location of any proposed workers' accommodation on-site or in the vicinity of the project.

This section should outline the need for, and location of, a site office during the construction phase that will act as a logistics base, materials/vehicle storage depot and workshop area, and highlight the need for power, water and sewerage at the site office. Information in relation to the site office and any construction facility should include:

- food preparation and storage
- ablution facilities
- vector and vermin control
- fire safety
- indoor air quality
- waste management (storage, handling, transport, disposal/treatment)[5]

[5] 26 – Health (1)

- dust and noise control in relation to proximity of accommodation facilities to the construction area.

Outline local government approvals required for establishment and operation of such accommodation facilities.

2.6.2 Transport—road/rail/ship/air

Describe arrangements for the transport of plant, equipment, products, wastes and personnel during both the construction phase and operational phases of the project. The description should address the use of existing local and regional[6] facilities and all requirements for the construction, upgrading or relocation of any transport related infrastructure (e.g. main and local roads, local airstrips, etc.).

Full details of transport volumes, modes and routes along with the assessment of transport impacts on existing infrastructure and impact mitigation strategies[7] should be provided in accordance with section 3.8.

2.6.3 Water supply and storage

The EIS should provide information on water usage by the project, including the quality and quantity of all water supplied to the site. In particular, the proposed and optional sources of water supply should be described (e.g. bores, any surface storages such as the Glebe Weir, municipal water supply pipelines, coal seam gas water). If infrastructure is required for the purpose of supplying water to the project, for example, pipelines from water supplies to the project or the raising of Glebe Weir, then the impacts of such infrastructure are to be assessed as part of the project and discussed for each of the relevant 'Environmental values and management of impacts' subsections outlined in section 3 of these TOR.

If saline water is to be stored on site (e.g. coal seam gas water), details should be provided as to how these storages will be constructed, monitored and managed. This information should be referenced to section 3.4 of these TOR.[8]

Estimated rates of supply from each source (average and maximum rates) should be given. Any proposed water conservation and management measures should be described.

Determination of potable water demand should be made for the project, including the temporary demands during the construction period. Details should be provided of any existing town water supply to meet such requirements. If water storage and treatment is proposed on site, for use by the site workforce, then this should be described.

2.6.4 Waste management[9]

The EIS should outline the waste management requirements during the construction, operational and decommissioning stages of the project. This outline should include waste stream descriptions (including physical and chemical characteristics), expected generation rates, proposed handling, storage, treatment and disposal methods. This outline should also identify the waste avoidance, reuse, recycling, treatment and disposal efforts proposed.

2.6.5 Stormwater drainage

A description should be provided of the proposed stormwater drainage system and the proposed disposal and/or re-use arrangements, including any off-site services and downstream impacts, both for construction and operational purposes.

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[6] 9 – DRC (9)
[7] 16 – DMR (1)
[8] 20 – NRW (15)
[9] 18 – EPA (18)

2.6.6 Sewerage

This section should describe, in general terms, the sewerage infrastructure required by the project. If it is intended that industrial effluent or relatively large amounts of domestic effluent are to be discharged into an existing sewerage system, an assessment of the capacity of the existing system to accept the effluent should be provided. For industrial effluent, this should include detail of the physical and chemical characteristics of the effluent(s).

2.6.7 Energy

The EIS should describe all energy requirements, including electricity, natural gas, and/or solid and liquid fuel requirements for the construction and operation of the proposal. The locations of any easements should be shown on the infrastructure plan. Energy conservation should be briefly described in the context of any federal, state and local government policies.

2.6.8 Telecommunications

The EIS should describe the telecommunications proposed for the project and any impacts on existing telecommunications infrastructure (such as optical cables, microwave towers, etc.) and identify the owners of that infrastructure.

3 Environmental values and management of impacts

The purpose of this section is to:

- describe the existing environmental values of the area which may be affected by the proposal. Environmental values are defined in section 9 of the EP Act, environmental protection policies and other documents such as the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines. Environmental values may also be derived following recognised procedures, such as described in the ANZECC 2000 guidelines. Environmental values should be described by reference to background information and studies, which should be included as appendices to the EIS
- describe the potential adverse and beneficial impacts of the proposal on the identified environmental values. Any likely environmental harm on the environmental values should be described
- describe any cumulative impacts on environmental values caused by the proposal, either in isolation or by combination with other known existing or planned sources of contamination
- present environmental protection objectives and the standards and measurable indicators to be achieved
- examine viable alternative strategies for managing impacts. These alternatives should be presented and compared in view of the stated objectives and standards to be achieved. Available techniques, including best practice, to control and manage impacts to the nominated objectives should be discussed

This section should detail the environmental protection measures incorporated in the planning, construction, operations, decommissioning, rehabilitation and associated works for the project. Measures should prevent, or where prevention is not possible, minimise environmental harm and maximise socio-economic and environmental benefits of the proposal. Preferred measures should be identified and described in more detail than other alternatives.

Environmental protection objectives may be derived from legislative and planning requirements which apply to the proposal including Commonwealth strategies, state planning policies, local authority strategic plans, environmental protection policies under the EP Act, and any catchment management plans prepared by local water boards or land care groups. Special attention should be given to those mitigation strategies designed to protect the values of any sensitive areas and any identified ecosystems of high conservation value within the area of possible proposal impact.

This section should address all elements of the environment, such as land, water, air, noise, nature conservation, cultural heritage, social and community, economy, waste, health and safety, hazards and risk, in a way that is comprehensive and clear. To achieve this, the following issues should be considered for each environmental value relevant to the project.

- **Environmental values affected**—describe the existing environmental values of the area to be affected including values and areas that may be affected by any cumulative impacts (refer to any background studies in appendices—note such studies may be required over several seasons). It should be explained how the environmental values were derived (e.g. by citing published documents or by following a recognised procedure to derive the values).
- **Impact on environmental values**—describe quantitatively and/or qualitatively the likely impact of the proposal on the identified environmental values of the area. The cumulative impacts of the proposal must be considered over time or in combination with other (all) impacts in the dimensions of scale, intensity, duration or frequency of the impacts. In

particular, any requirements and recommendations of the relevant state planning policies, environmental protection policies, national environmental protection measures and integrated catchment management plans should be addressed.

Cumulative impacts on the environmental values of land, air and water and cumulative impacts on public health and the health of terrestrial, aquatic and marine ecosystems must be discussed in the relevant sections. This assessment may include air and water sheds affected by the proposal and other proposals competing for use of the local air and water sheds.

Where impacts from the proposal will not be felt in isolation to other sources of impact, it is recommended that the proponent develop consultative arrangements with other industries in the proposal's area to undertake cooperative monitoring and/or management of environmental parameters. Such arrangements should be described in the EIS.

- **Environmental protection objectives**—describe qualitatively and quantitatively the proposed objectives for enhancing or protecting each environmental value. Include proposed indicators to be monitored to demonstrate the extent of achievement of the objective as well as the numerical standard that defines the achievement of the objective (this standard must be auditable). The measurable indicators and standards can be determined from legislation, support policies and government policies as well as the expected performance of control strategies. Objectives for progressive and final rehabilitation and management of contaminated land should be included.
- **Control strategies to achieve the objectives**—describe the control principals, proposed actions and technologies to be implemented that are likely to achieve the environmental protection objectives; include designs and relevant performance specifications of plant. Details are required to show that the expected performance is achievable and realistic.
- **Monitoring programs**—describe the monitoring parameters, monitoring points, frequency, data interpretation and reporting proposals.
- **Auditing programs**—describe how progress towards achievement of the objectives will be measured, reported and whether external auditors will be employed. Include scope, methods and frequency of auditing proposed.
- **Management strategies**—describe the strategies to be used to ensure the environmental protection objectives are achieved and control strategies implemented e.g. continuous improvement framework including details of corrective action options, reporting (including any public reporting), monitoring, staff training, management responsibility pathway, and any environmental management systems and how they are relevant to each element of the environment.
- **Information quality**—information given under each element should also state the sources of the information, how recent the information is, how any background studies were undertaken (e.g. intensity of field work sampling), how the reliability of the information was tested, and what uncertainties (if any) are in the information.

It is recommended that the final TOR and the EIS reasonably reflect the heading structure shown below. The mitigation measures, monitoring programs, etc., identified in this section of the EIS should be used to develop the EMP for the project (see section 4).

3.1 Climate and natural disasters

This section should describe the rainfall patterns (including magnitude and seasonal variability of rainfall), air temperatures, humidity, wind (direction and speed) and any other special factors (e.g. temperature inversions) that may affect management of the project. Historic weather patterns in the project area and seasonal conditions (e.g. cyclones, thunderstorms, floods and storms) that may influence timing and/or construction methods should be discussed, including how this would be managed. Extremes of climate (e.g.

droughts, floods, etc) should be discussed with particular reference to water management at the project site.

The potential impacts due to climatic factors should be addressed in the relevant sections of the EIS. The impacts of rainfall on soil erosion should be addressed in section 3.2. The impacts of storm events on the capacity of waste containment systems (e.g. site bunding / stormwater management and tailings dams) should be addressed in section 3.7 with regard to contamination of waterways and in section 3.4 with regard to the design of the waste containment systems. The impacts of winds, rain, humidity and temperature inversions on air quality should be addressed in section 3.5.

The implications of climate change on the project's environmental and commercial feasibility should be assessed in detail.

Impacts of climate change risks and adaptation measures should include the following:

- analyse risks to the project from climate change impacts (i.e. increased risk and severity of flood; increased vulnerability to more intense bushfires
- identify adaptation measures to minimise risk to the project from climate change impacts, particularly where there may be a significant impact to human safety or property.

The vulnerability of the area to natural or induced hazards, such as bushfires and earthquakes should be addressed. The relative frequency and magnitude of these events should be considered together with the risk they pose to the construction and operation of the project. Hazard and risk assessment and management should be provided in section 3.14.

3.2 Land

This section describes the existing environment values of the land area that may be affected by the project. It should also define and describe the objectives and practical measures for protecting or enhancing land-based environmental values, describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed.

3.2.1 Topography and geomorphology

3.2.1.1 Description of environmental values

Maps should be provided locating the project in both regional and local contexts. The topography of the project site should be detailed with contours at suitable increments, shown with respect to Australian Height Datum. Commentary on the maps should be provided highlighting the significant topographical features.

The environmental values of the cultural landscapes of the affected area, in terms of the physical and cultural integrity of the area, should be described.

3.2.1.2 Potential impacts and mitigation measures

The potential impacts of the landscape character of the project site and the surrounding area should be described. Particular mention should be made of any changes to the broad-scale topography and vegetation character of the area, such as due to spoil dumps, excavated voids and broad-scale clearing.

Details should be provided of measures to be undertaken to mitigate or avoid the identified impacts.

3.2.2 Geology

3.2.2.1 Description of environmental values

The EIS should provide a description, map and a series of cross-sections of the geology of the mine site, with particular reference to the physical and chemical properties of surface and sub-surface materials and geological structures within the proposed areas of disturbance. The general suitability of the mine site overburden material for road building (or other productive use) should be discussed briefly.

Geological properties of all project sites which may influence stability, occupational health and safety, rehabilitation programs, or the quality of waste water leaving any area disturbed by the project should be described.

Investigations into the physical, geo-mechanical and chemical properties of waste rock in both fresh and weathered forms needs to be determined for slope stability, rehabilitation and possible acid generation for waste rock dump design.

This section should also consider the geology underlying the proposed infrastructure corridors for coal transport, electricity easements, pipeline easements and other off-mine infrastructure. Of particular interest are any other possible coal, petroleum, gas or other mineral resources that may be impacted or sterilised by the infrastructure.

The EIS should provide a summary of the results of studies and surveys undertaken to identify and delineate the coal and mineral resources within the project area (including any areas underlying related infrastructure).

The location, tonnage and quality of the coal resources within the project area should be described in detail and, where possible, should be presented on a 'seam by seam' basis and include the modifying factors and assumptions made in arriving at the estimates. The resources should be estimated and reported in accordance with the Australasian code for reporting of mineral resources and ore reserves (the JORC Code available at www.jorc.org/main.php) and the principles outlined in the *Australian guidelines for the estimating and reporting of inventory coal, coal resources and coal reserves* (available at www.jorc.org/pdf/coalguidelines.pdf) as appropriate.

3.2.2.2 Potential impacts and mitigation measures

The EIS should analyse the effectiveness of the mining proposal in achieving the optimum utilisation of the coal resources within the project area and consider its impacts on other resources. It should demonstrate that the mining proposal will 'best develop' the coal resources, minimise resource wastage and avoid any unnecessary sterilisation or loss [10] of these or any other of the state's coal, mineral, and petroleum (including gas and coal seam methane) resources that may be impacted upon or sterilised by the mining activities or related infrastructure.

If geological conditions are conducive, the proponent should consider the possibility that significant fossil specimens (such as of dinosaurs or their tracks) may be uncovered during construction/operations and propose strategies for protecting the specimens and alerting the Queensland Museum to the find.

3.2.3 Soils

3.2.3.1 Description of environmental values

A soil survey of the sites affected by the project should be conducted at a suitable scale, with particular reference to the physical and chemical properties of the materials that will influence erosion potential, storm water run-off quality, rehabilitation and agricultural productivity of the land. Information should also be provided on soil stability, suitability for construction of proposed facilities and any approved soil conservation plans.

[10] 18 – EPA (1)

Soil profiles should be mapped at a suitable scale and described according to the *Australian soil and land survey field handbook* (McDonald et al, 1990) and *Australian soil classification* (Isbell, 1996). An appraisal of the depth and quality of useable soil should be undertaken. Information should be presented according to the standards required in the *Planning guidelines: the identification of Good Quality Agricultural Land* (DPI & DHLGP, 1993), and the State Planning Policy 1/92: Development and the Conservation of Agricultural Land (DME, 1995).

The requirement for soils mapping in terms of area and mapping scale should follow the *Queensland Department of Mines and Energy: Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (1995). These guidelines recommend that disturbed areas be mapped more intensively than non-disturbed areas and provide guidance on acceptable mapping scale and site intensity.

3.2.3.2 Potential impacts and mitigation measures

Possible erosion rates and management techniques should be described for all permanent and temporary landforms. The erosion potential (wind and water) and erosion management techniques should be outlined for each soil type identified. An erosion-monitoring program, including rehabilitation measures for erosion problems identified during monitoring, should also be outlined. Mitigation strategies should be developed to achieve acceptable soil loss rates, levels of sediment in rainfall runoff and wind-generated dust concentrations.

The EIS should include an assessment of likely erosion effects for all disturbed areas such as:

- areas cleared of vegetation
- waste dumps
- stockpiles
- dams, banks and creek crossings
- the plant site, including buildings
- access roads or other transport corridors
- areas under rehabilitation.[11]

Methods proposed to prevent or control erosion should be specified and should be developed with regard to preventing soil loss in order to maintain land capability / suitability, and preventing significant degradation of local waterways by suspended solids.

Consideration should be given to the amendment or revocation of any approved soil conservation plans as a result of project activities.

3.2.4 Land use

3.2.4.1 Description of environmental values

The EIS should provide a description of current land tenures, current land uses and identify the areas covered by Native Title claims in all project areas, with particular mention of land with special purposes.

The location and owner/custodians of all tenures, reserves, roads and road reserves, railways and rail reserves, stock routes and the like, covering the affected land should be shown on maps of a suitable scale. Indicate locations of gas and water pipelines, power lines and any other easements. The environmental values affected by this infrastructure should be described.

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[11] 18 – EPA (5)

A map at a suitable scale showing existing land uses and tenures, and the proposed mine and coal handling locations, should be provided for the entire project area and surrounding land that could be affected by the development. This map should identify areas of conservation value in this zone. The location of existing dwellings and the zoning of all affected lands according to any existing town or strategic plan should be included.

The land use suitability of the affected area in terms of the physical and economic attributes should be described. The assessment should set out soil and landform subclasses assigned to soil mapping units in order to derive land suitability classes. The limitations and land suitability classification system to use is that in Attachment 2 of *Land Suitability Assessment Techniques in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (1995).

A land suitability map of the proposed and adjacent area should be provided, setting out land suitability and current land uses, e.g. for grazing of native and improved pastures and horticulture. Land classified as good quality agricultural land in the Department of Natural Resources' land classification system should be shown in accordance with the planning guideline, The Identification of Good Quality Agricultural Land, which supports State Planning Policy 1/92.

3.2.4.2 Potential impacts and mitigation measures

The potential for the construction and operation of the project to change existing and potential land uses of the project site and adjacent areas should be detailed. Consideration should be given to impacts arising from property disruption and severance, construction and maintenance[12]. Post operations land use options should be detailed including suitability of the area to be used for agriculture, industry, or nature conservation. The factors favouring or limiting the establishment of those options should be given in the context of land use suitability prior to the project and minimising potential liabilities for long-term management.

The potential environmental harm caused by the project on the adjacent areas currently used for agriculture, urban development, recreation, tourism or other business and the implications of the project for future developments in the impact area including constraints on surrounding land uses should be described. If the development adjoins or potentially impacts on good quality agricultural land, then an assessment of the potential for land use conflict is required. Investigations should follow the procedures set out in the planning guideline, The Identification of Good Quality Agricultural Land, which supports State Planning Policy 1/92.

Incompatible land uses, whether existing or potential, adjacent to all aspects of the project, including essential and proposed ancillary developments or activities and areas directly or indirectly affected by the construction and operation of these activities should be identified and measures to avoid unacceptable impacts defined.

3.2.5 Landscape character and visual amenity

3.2.5.1 Description of environmental values

This section should describe in general terms the existing character of the landscape that will be affected by the project. It should comment on any changes that have already been made to the natural landscape since European settlement. It should describe the general impression of the landscape that would be obtained while travelling through and around it.

This section should also describe existing landscape features, panoramas and views that have, or could be expected to have, value to the community whether of local, regional, state-wide, national or international significance. Information in the form of maps, sections, elevations and photographs should be used, particularly where addressing the following issues:

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[12] 10 – Gulugaba ALG (2)

- identification of elements within the proposal and surrounding area that contribute to their image of the town/city as discussed in the any local government strategic plan—city image and townscape objectives and associated maps
- major views, view sheds, existing viewing outlooks, ridgelines and other features contributing to the amenity of the area
- focal points, landmarks (built form or topography), gateways associated with project site and immediate surrounding areas, waterways, and other features contributing to the visual quality of the area and the project site
- character of the local and surrounding areas including character of built form (scale, form, materials and colours) and vegetation (natural and cultural vegetation) directional signage and land use
- identification of the areas of the proposal that have the capacity to absorb land use changes without detriment to the existing visual quality and landscape character
- the value of existing vegetation as a visual screen.

3.2.5.2 Potential impacts and mitigation measures

The potential impacts of the project landscape character of the site and the surrounding area should be described. Particular mention should be made of any changes to the broad-scale topography and vegetation character of the area, such as due to spoil dumps, excavated voids and broad-scale clearing. Details should be provided of measures to be undertaken to mitigate or avoid the identified impacts.

This section should analyse and discuss the visual impact of the project on particular panoramas and outlooks. It should be written in terms of the extent and significance of the changed skyline as viewed from places of residence, work, and recreation, from road, cycle and walkways and other known vantage points day and night, during all stages of the project as it relates to the surrounding landscape. The assessment is to address the visual impacts of the project structures and associated infrastructure, using appropriate simulation. Sketches, diagrams, computer imaging and photos are to be used where possible to portray the near views and far views of the completed structures and their surroundings from visually sensitive locations.

Special consideration is to be given to public roads, public thoroughfares, and places of residence or work, which are within the line-of-sight of the project.

Details of the design and colour of any major structures, buildings or fixed plant and all proposed screenings either vegetative or material should be described and discussed where relevant to the minimisation of the visual impacts of the project. Consideration should be given to a landscaped screen / buffer between the mine site and the town of Wandoan to mitigate any negative visual impacts.[13] Where plantings for screening or landscaping are proposed, details should be provided of the species that will be used, and their likely provenance. Preference should be given to species native to the area.[14]

The obstruction of sunlight due to the construction of buildings or alteration of landforms should be considered, as well as major illumination or reflection impacts on adjacent properties or roads.

Detail should be provided of all management options to be implemented and how these will mitigate or avoid the identified impacts.

Management of the lighting of the project, during all stages, is to be provided, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid:

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[13] 9 – DRC (13)
[14] 18 – EPA (6)

- the visual impact at night
- night operations/maintenance and effects of lighting on fauna and residents
- the potential impact of increased vehicular traffic
- changed habitat conditions for nocturnal fauna and associated impacts.

3.2.6 Land contamination

3.2.6.1 Description of environmental values

This section should discuss the potential for land contamination within the project area from existing and past uses, based on known land use history and the nature and concentrations of any contaminants. The review should identify land within the proposed mine, associated infrastructure corridors and any other areas affected by the proposed works, which has been used, or is being used, for a Notifiable Activity as listed in Schedule 2 of the EP Act, or is potentially contaminated, or is on the environmental management register or contaminated land register.

The EIS should include a preliminary site investigation for all properties that have been impacted by existing and past land uses that could have resulted in land contamination.

3.2.6.2 Potential impacts and mitigation measures

The EIS should discuss the management of any contaminated land and potential for contamination from construction, commissioning and operation, in accordance with EPA's Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (1998) and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*.

The EIS should also describe the possible contamination of land from aspects of the project, including waste, saline water from coal seam gas extraction used for dust suppression,[15] reject coal, overburden, coal washing plant and spills at chemical and fuel storage and handling areas.

This section should describe strategies and methods to be used to prevent and manage any land contamination resulting from the project, including the management of any acid generation or saline impacts from the mining activities and the management of chemicals and fuels to prevent spills or leaks.

3.2.7 Land disturbance

3.2.7.1 Potential impacts and mitigation measures

The EIS should contain strategies aimed at minimising the amount of land disturbed at any one time. The strategic approach to progressive rehabilitation and final decommissioning should be described. The consistency of the approach with relevant guidelines and the results of recent research should be described.

Management of all dams, roads, rail, electricity and other infrastructure during construction operation and decommissioning phases should be described in detail.

The methods to be used for the project, including backfilling, covering, re-contouring, topsoil handling and revegetation, should be described. Consideration should be given to the use of threatened plant species during any landscaping and revegetation.

Proposals should be provided to divert creeks during construction or operations, and, if applicable, for the reinstatement of the creeks. Where dams and roads and other infrastructure

[15] 9 – DRC (14)

are to be constructed, proposals for the management of these structures after the completion of the project should be given. A contour map of the area should be provided (if relevant). Also, the final drainage and seepage control systems and any long-term monitoring plans should be described.

Proposed decommissioning of project operations should be described in detail, including consolidation, revegetation, fencing, and monitoring. Discussion of any decommissioning works should address rehabilitation of concrete footings and foundations, hard stand areas and storage tanks (including any potential for reuse of these facilities).

A description of topsoil management should consider transport, storage and replacement of topsoil to disturbed areas. The topsoil management should also outline how soil from good quality agricultural land will be best utilised. The minimisation of topsoil storage times (to reduce fertility degradation) should also be addressed. Erosion and sediment control measures should be described, particularly in relation to the management of sodic and saline overburden material.

3.3 Nature conservation

This section describes the existing environment values for nature conservation that may be affected by the project. Describe the environmental values of nature conservation for the affected area in terms of:

- integrity of ecological processes, including habitats of rare and threatened species and ecological communities
- conservation of resources
- biological diversity, including habitats of rare and threatened species
- integrity of landscapes and places including wilderness and similar natural places
- aquatic and terrestrial ecosystems.

A discussion should be presented on the nature conservation values occurring in the areas likely to be affected by the project, both directly and indirectly. The flora and fauna communities which are rare or threatened, environmentally sensitive localities including waterways (permanent, semi-permanent and ephemeral)[16], riparian zone, wilderness and habitat corridors should be described. The description should include a plant species list, a vegetation map at appropriate scale and an assessment of the significance of native vegetation, from local, regional, state and national perspectives. The description should indicate any areas of state or regional significance identified in an approved biodiversity planning assessment produced by the EPA including matters of NES identified within the EPBC Act.

3.3.1 Sensitive environmental areas

3.3.1.1 Description of environmental values

The EIS should identify areas that are environmentally sensitive in proximity to the project. Environmentally sensitive areas should also include areas classified as having national, state, regional or local biodiversity significance, or flagged as important for their integrated biodiversity values. Consideration should be given to nature refuges, national parks, conservation parks, declared fish habitat areas, wilderness areas, aquatic reserves, heritage/historic areas or items relating to biodiversity, national estates, world heritage listings and sites covered by international treaties or agreements (e.g. Ramsar, Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korean-Australia Migratory Bird Agreement), areas of cultural significance relating to biodiversity and scientific reserves.

[16] 18 – EPA (7)

The proximity of the project to any environmentally sensitive areas should be shown on a map of suitable scale. Areas that would be regarded as sensitive with regard to flora and fauna have one or more of the following features:

- important habitats of species listed under the *Nature Conservation Act 1992* and/or the EPBC Act as presumed extinct, critically endangered[17], endangered, vulnerable or rare
- regional ecosystems recognised by the EPA as 'endangered' or 'of concern' or 'not of concern' but where permits are no longer granted due to being at threshold levels, and/or ecosystems listed as 'presumed extinct', 'critically endangered' 'endangered' or 'vulnerable' under the EPBC Act
- ecosystems that provide important ecological functions, such as riparian vegetation, important buffer to a protected area, refugia or important habitat corridor between areas
- protected areas which have been proclaimed under the *Nature Conservation Act 1992* or are under consideration for proclamation.

3.3.1.2 Potential impacts and mitigation measures

This section should discuss the following:

- the impact of the project on species, communities and habitats of local, regional or national significance
- proposals to mitigate impacts (e.g. timing of works, minimise width of disturbance, proposed rehabilitation of in-stream and floodplain disturbances)
- planned rehabilitation of vegetation communities and any relevant previous experience/experiments rehabilitating these communities
- appropriate mitigation measures for remnant ecosystems that may be affected by the project should refer to the *Regional Vegetation Management Code: Brigalow Belt and New England Tablelands (20 November 2006)*[18], and address the *Policy for Vegetation Management Offsets* (DNRW 2007)
- offsets relating to residual impacts with regard to the Queensland Government Environmental Offsets Policy[19], the *Policy for Vegetation Management Offsets* as well as the draft policy statement on the use of environmental offsets under the EPBC Act.

Potential impacts and associated mitigation measures should be discussed further under section 3.3.4 Aquatic biology, and section 3.4 Water resources.

3.3.2 Terrestrial flora

3.3.2.1 Description of environmental values

The terrestrial vegetation communities within the affected areas should be described at an appropriate scale with mapping produced from aerial photographs and ground truthing, showing the following:

- location and extent of vegetation types including recognised regional ecosystem type descriptions and any areas of national, state or regional significance
- location of vegetation types of conservation significance

[17] 4 – DEWHA (1)
[18] 20 – NRW (22)
[19] 18 – EPA (10)

- vegetation map unit descriptions, including their relationship to regional ecosystems. Sensitive or important vegetation types should be highlighted and their value as habitat for fauna and conservation of specific rare floral and faunal assemblages or community types discussed
- the current extent (bioregional and catchment) of protected vegetation types of conservation significance within the protected areas (e.g. national parks, conservation parks, resource reserves, nature refuges)
- any plant communities of cultural, commercial or recreational significance
- the distribution and abundance of significant exotic and weed species.

The description should contain a review of published information regarding the assessment of the significance of the vegetation to conservation, recreation, scientific, educational and historical interests. The assessment should also include a description of vegetation (including re-growth and restored areas in addition to remnant vegetation) to indicate any areas of state, regional or local significance identified in the Brigalow Belt Biodiversity Planning Assessment version 1.3 produced by the EPA.[20]

For each significant natural vegetation community likely to be impacted by the project, vegetation surveys should be undertaken at an appropriate number of sites, allowing for seasonal factors, as follows:

- all data requirements of the Queensland Herbarium CORVEG database should be collected
- appropriate minimum site sizes should be selected, observing recognised sampling approaches and to provide an adequate sample of surveyed communities
- a list of species present at each site should be recorded
- the relative abundance and community structure of plant species present should be recorded
- any plant species of conservation, cultural, commercial or recreational significance should be identified
- vegetation mapping and data should be submitted to the Queensland Herbarium to assist the updating of the CORVEG database
- specimens of species listed as protected plants under the *Nature Conservation (Wildlife) Regulation 1994,* other than common species, are to be submitted to the Queensland Herbarium for identification and entry into the HERBRECS database.

The existence of rare or threatened species should be specifically addressed under sensitive areas. Any special landscape values of natural vegetation communities should be described.

Existing information on plant species may be used instead of new survey work provided that the data are derived from surveys consistent with the above methodology and describe existing conditions. Methodology used for flora surveys should be specified in the appendices to the report. Any existing information should be revised and comments provided on whether the areas are degraded, cleared or affected in ways that would affect their environmental value.

The occurrence of pest plants (weeds), particularly declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002* should be shown on a map at an appropriate scale. A weed management strategy will be required.

The location of any horticultural crops in the vicinity of the project area should be shown.

3.3.2.2 Potential impacts and mitigation measures

[20] 18 – EPA (8)

This section should discuss all foreseen direct and indirect effects on terrestrial flora and the potential level of environmental impact identified. Action plans for protecting rare or threatened species and vegetation types identified as having high conservation value should be described, and any obligations imposed by state or federal government biodiversity protection legislation or policy should be discussed.

Construction and operation of the project involving clearing, salvaging or removal of vegetation should be described, and indirect impacts on vegetation not cleared should be discussed.

Impacts during construction and operation of the project should be assessed. The number of hectares of remnant vegetation proposed to be cleared (by conservation status and regional ecosystem type) for the mine and each proposed infrastructure component should be identified. These figures should be discussed in terms of the long-term sustainability of these ecosystems to remain in the landscape at a regional level.[21] Short- and long-term durations should be considered.

Measures to mitigate the impacts of the project on vegetation types identified as having high conservation values, listed species and sensitive habitat or the inhibition of propagation should be described. This should also include the identification of potential offset areas, in an 'offset strategy' to compensate for any loss of vegetation.

With regard to the project area, this section should include:

- the significance of impacts at a local, catchment, bioregional, state or national levels
- impact on any plants of potential or recognised environmental or economic significance
- a discussion of the ability of identified stands of vegetation to withstand any increased pressure resulting from the project and identify measures proposed to mitigate impacts
- a description of the methods to ensure rapid rehabilitation of disturbed areas following construction, including the species chosen for revegetation which should be consistent with the surrounding associations. Details of any post construction monitoring programs and what benchmarks would be used for review of monitoring should be included. Consideration should be given to the establishment of reference sites (at least two for each ecosystem type being rehabilitated) that could be established and monitored to provide benchmarking for rehabilitation activities[22]
- a draft weed management plan should be included in an EMP, to be developed and finalised in consultation with land protection officers (DPI&F) and local government environmental officers, to cover construction, rehabilitation and operation periods
- a description of the potential for the introduction and/or spread of weeds (such as Parthenium, African Box Thorn and Mother of Millions)[23] or plant disease, including:
  - identification of the origin of construction materials, machinery and equipment
  - vehicle inspection regime, which addresses the need for vehicle and machinery wash-down and any other hygiene protocols, including the requirement that all vehicles and equipment must be cleaned before starting the job and that these wash down areas contain water/ soil away from creeks and gullies[24]
  - staff/operator education programs
  - determination of the potential for the introduction of or facilitation of exotic, non-indigenous and noxious plants.

3.3.3 Terrestrial fauna

[21] 18 – EPA (11)
[22] 18 – EPA (12)
[23] 19 – Darryl Waugh (3)
[24] 8 – DPIF (1)

3.3.3.1 Description of environmental values

The terrestrial, and riparian fauna occurring in the areas affected by the project should be described, noting the broad distribution patterns in relation to vegetation, topography and substrate. Wildlife corridors and refugia should be identified and mapped.

The description of the fauna present or likely to be present in the area should include:

- species diversity (i.e. a species list) and indicative abundance of animals, including amphibians, birds, reptiles, mammals (including bats)
- any species that are poorly known but suspected of being rare or potentially threatened
- habitat requirements and sensitivity to changes; including movement corridors and barriers to movement
- the existence of feral or exotic animals, including maps of major pest infestations
- existence of any rare, threatened or otherwise noteworthy species/communities in the study area, including discussion of range, habitat, breeding, recruitment, feeding and movement requirements, and current level of protection (e.g. any requirements of protected area management plans)
- use of the area by migratory and nomadic birds in particular areas for breeding or significant congregations.

The EIS should contain results from surveys for species listed as threatened or migratory under the EPBC Act. Surveys are to be conducted at the appropriate time of the year when the species is known to be present on the site, so that identification and location of these species is optimal.

Methodology used for fauna surveys should be specified in the appendices to the report. The EIS should indicate how well any affected significant communities and species are represented and protected elsewhere in the region where the site of the project occurs. Relevant site data should be provided to the EPA in a format compatible with EPA WildNet database for listed threatened species.

3.3.3.2 Potential impacts and mitigation measures

This section should discuss all foreseen direct and indirect effects on terrestrial fauna. Strategies for protecting rare or threatened species should be described, and any obligations imposed by state or federal government threatened species legislation or policy should be discussed.

Any recovery plans for potentially affected threatened species should be outlined, and strategies for complying with the objectives and management practices of relevant recovery plans should be described. In particular, specific reference should be made to the recovery plan for the EPBC Act listed critically endangered Boggomoss Snail (*Adclarkia dawsonensis)*. Impacts during construction and operation of the project should be assessed. Given the critically endangered status of the Boggomoss Snail, the risk of elimination of any local population must be carefully evaluated. If the evaluation indicates that translocation of such a population would be the only means of avoiding the loss, a translocation trial, under the supervision of the recovery team for the species, should be undertaken to determine the feasibility of translocation. In order to demonstrate that translocation had been successful, at least 70 per cent survival rate would need to be achieved[25]. Short- and long-term durations should be considered. Measures to mitigate the impact on habitat or the inhibition of normal movement, breeding or feeding patterns, and change to food chains should be described. Any provision for buffer zones and movement corridors, or special provisions for migratory or nomadic animals should be discussed.

With regard to terrestrial and riparian fauna, the assessment of potential impact should consider:

[25] 4 – DEWHA (2)

- impacts the project may have on terrestrial fauna, relevant wildlife habitat and other fauna conservation values, including:
  - direct (short-term) and indirect (long-term) impacts due to loss of range/habitat, food supply, nest sites, breeding/recruiting potential or movement corridors
  - cumulative effects of direct and indirect impacts
  - impacts on rare and threatened or otherwise noteworthy animal species
  - threatening processes leading to progressive loss
  - identification of the conservation importance of identified populations at the regional, state and national levels.
- measures to minimise wildlife capture and mortality during construction and operation
- details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries
- methods for minimising the introduction of feral animals, and other exotic fauna such as declared pest ant species (fire ants and yellow crazy ants)
- review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes.

These would also include, where relevant, matters of NES identified within the EPBC Act.

3.3.4 Aquatic biology

3.3.4.1 Description of environmental values

The aquatic flora and fauna occurring in the areas affected by the project should be described, noting the patterns and distribution in the waterways. A description of the habitat requirements and the sensitivity of aquatic flora and fauna species to changes in flow regime, water levels and water quality in the project areas should be provided. The discussion of the aquatic fauna and flora present or likely to be present in the project area at any time during the year should include:

The discussion of the fauna and flora present or likely to be present in the area should include:

- fish species, mammals, reptiles, amphibians and aquatic invertebrates occurring in the waterways within the project area, including any feral and exotic fauna species
- an assessment of the biological values of the waterways affected the project in general and in the context of the Dawson River Catchment, and how these waterways contribute to the fisheries productivity of the catchment as a whole[26]
- aquatic (waterway) macrophytes including native and exotic/weed species
- wetlands listed by the EPA as areas of national, state or regional significance, and their values and importance
- a description of terrestrial species that are ecologically associated with wetlands or waterways and are likely to be affected by the project[27]
- aquatic substrate and stream type.

These would also include, where relevant, matters of NES identified within the EPBC Act.

[26] 8 – DPIF (5)
[27] 18 – EPA (13)

3.3.4.2 Potential impacts and mitigation measures

This section should discuss all foreseen direct and indirect effects on aquatic flora and fauna, including strategies for protecting rare or threatened species and any obligations, legislation or policies imposed by the state and federal governments. The discussion should include:

- measures to minimise wildlife injury and mortality during construction and operation
- details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries
- details of measures to be used to maintain fish passage in creeks that will be affected
- methods for minimising the introduction of feral animals, and other exotic fauna
- review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction activities and disposal of construction wastes
- identification of necessary permits/authorities required by the project
- description of mitigation measures to prevent the creation of new mosquito and biting midge breeding sites during construction (e.g. in quarries and borrow pits)
- description of the potential for and mitigation measures to prevent the introduction, transfer or facilitation of exotic, non-indigenous and noxious plants and water borne insect pests.

3.4 Water resources

3.4.1 Description of environmental values

This section describes the existing environment for water resources that may be affected by the project in the context of environmental values as defined in the Queensland water quality guidelines for region-specific parameter values, and such documents as the EP Act, Environmental Protection (Water) Policy 1997 (EPP (Water)) and ANZECC 2000. [28]The definition of waters in the EPP(Water) includes the bed and banks of waters, so this section should address impacts on benthic sediments as well as the water column.

Where a licence or permit will be required under the *Water Act 2000* to take or interfere with the flow of water, this section of the EIS should provide, where specific design information is available, sufficient information for a decision to be made on the application. Similarly, waterway barrier works may need approval under the *Fisheries Act 1994*, and if so should be addressed in the EIS.

3.4.1.1 Surface water and watercourses

A description should be given of the permanent, semi-permanent and significant ephemeral surface watercourses in the area affected by the project, including their quality and quantity and[29] an outline of the significance of these waters to the river catchment system in which they occur. Details provided should include a description of existing surface drainage patterns, and flows in major streams and wetlands. Also provide details of the likelihood of flooding, history of flooding including extent, levels and frequency, and a description of present and potential water uses downstream of the areas affected by the proposal. Flood studies should include a range of annual exceedance probabilities for affected waterways, where data permits.

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[28] 18 – EPA (14)
[29] 18 – EPA (15)

The EIS should provide a description, with photographic evidence where appropriate, of the geomorphic condition of any watercourses likely to be affected by disturbance or stream diversion. The results of this description should form the basis for the planning and subsequent monitoring of rehabilitation of the watercourses during or after the operation of the proposal.

An assessment is required of existing water quality in surface waters and wetlands likely to be affected by the proposal. The basis for this assessment should be a monitoring program, with sampling stations located upstream and downstream of the proposal. Complementary stream-flow data should also be obtained from historical records (if available) to aid in interpretation.

The water quality should be described, including seasonal variations or variations with flow where applicable. A relevant range of physical, chemical and biological parameters should be measured to gauge the environmental harm on any affected creek or wetland system.

The EIS should describe the environmental values of the surface waterways of the affected area in terms of:

- values identified in the EPP(Water)
- sustainability, including both quality and quantity
- physical integrity, fluvial processes and morphology of watercourses, including riparian zone vegetation and form
- any water resource plans, land and water management plans relevant to the affected catchment.

3.4.1.2 Groundwater

The EIS should review the quality, quantity and significance of groundwater in the project area, together with groundwater use in neighbouring areas. Specific reference should be made to the Great Artesian Basin Water Resource Plan (2006) and Great Artesian Basin Resource Operation Plans (2006). The review should also provide an assessment of the potential take of water from the GAB and how current users and the aquifer itself and any connected aquifers will be affected by the take of water from the GAB.[30]

The review should include a survey of existing groundwater supply facilities (bores, wells, or excavations) to the extent of any environmental harm. The information to be gathered for analysis is to include:

- location
- pumping parameters
- draw down and recharge at normal pumping rates
- seasonal variations (if records exist) of groundwater levels.

A network of observation points which would satisfactorily monitor groundwater resources both before and after commencement of operations should be developed.

This section should include reference to:

- Nature of the aquifer(s):
  - geology/stratigraphy—such as alluvium, volcanic, metamorphic
  - aquifer type—such as confined, unconfined
  - depth to and thickness of the aquifers.
- Hydrology of the aquifer(s):
  - depth to water level and seasonal changes in levels
  - groundwater flow directions (defined from water level contours)

[30] 20 – NRW (24)

- interaction with surface water
- interaction with sea/salt water
- possible sources of recharge
- vulnerability to pollution.

The data obtained from the groundwater survey should be sufficient to enable specification of the major ionic species present in the groundwater, pH, electrical conductivity and total dissolved solids.

Describe the environmental values of the underground waters of the affected area in terms of:

- values identified in the EPP(Water)
- sustainability, including both quality and quantity
- physical integrity, fluvial processes and morphology of groundwater resources.

3.4.2 Potential impacts and mitigation measures

This section is to assess potential impacts on water resource environmental values identified in the previous section. It will also define and describe the objectives and practical measures for protecting or enhancing water resource environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed.

The EIS should describe the possible environmental harm caused by the proposal to environmental values for water as expressed in the EPP(Water).

Water management controls should be described, addressing surface and groundwater quality, quantity, drainage patterns and sediment movements. The beneficial (environmental, production and recreational) use of nearby surface and groundwater should be discussed, along with the proposal for the diversion of affected creeks during mining, and the stabilisation of those works. Monitoring programs should be described which will assess the effectiveness of management strategies for protecting water quality during the construction, operation and decommissioning of the project.

Key water management strategy objectives include:

- protection of important local aquifers and protection of their waters
- maintenance of sufficient quantity and quality of surface waters to protect existing beneficial downstream uses of those waters (including maintenance of in-stream biota and the littoral zone)
- management of impacts on flooding levels and frequencies both upstream and downstream of the project.

Conduct a risk assessment for uncontrolled emissions to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and list strategies to prevent, minimise and contain impacts.

3.4.2.1 Surface water and water courses

The potential environmental harm to the flow and the quality of surface waters from all phases of the project should be discussed, with particular reference to their suitability for the current and potential downstream uses, including the requirements of any affected riparian area, wetland, estuary, littoral zone, and any marine and in-stream biological uses. The impacts of surface water flow on existing infrastructure should be considered. Refer to the EPP(Water) and *Water Act 2000*.

The hydrological impacts of the proposal should be assessed, particularly with regard to stream diversions, scouring and erosion, and changes to flooding levels and frequencies both upstream and downstream of the project. When flooding levels will be affected, modelling of afflux should be provided and illustrated with maps.

Quality characteristics discussed should be those appropriate to the downstream and upstream water uses that may be affected. Chemical and physical properties of any waste water (including concentrations of constituents) at the point of entering natural surface waters should be discussed along with toxicity of effluent constituents to flora and fauna.

Reference should be made to the properties of the land disturbed and processing liquid wastes, the technology for settling suspended clays from contaminated water, and the techniques to be employed to ensure that contaminated water is contained and successfully treated on the site.

In relation to water supply and usage, and wastewater disposal, the EIS should discuss anticipated flows of water to and from the proposal area. Where dams, weirs or ponds are proposed, the EIS should investigate the effects of predictable climatic extremes (storm events, floods and droughts) on: the capacity of the water storages (dams, weirs, ponds), the ability of these storages to retain contaminants; the structural integrity of the containing walls; relevant operating regime[31] and the quality of water contained, and flows and quality of water discharged. The design of all water storage facilities should follow the technical guidelines on site water management.

The need or otherwise for licensing of any dams (including referable dams) or creek diversions, under the *Water Act 2000* should be discussed. Water allocation and water sources, including impacts on existing water entitlements, including water harvesting[32], should be established in consultation with DNRW.

Having regard for the requirements of the EPP(Water), the EIS should present the methods to avoid stormwater contamination by raw materials, wastes or products and present the means of containing, recycling, reusing, treating and disposing of stormwater. Where no-release water systems are to be used, the fate of salts and particulates derived from intake water should be discussed.

The Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) *National Water Quality Management Strategy, Australian Water Quality Guidelines for Fresh and Marine Waters* and the EPP(Water) should be used as a reference for evaluating the effects of various levels of contamination.

Options for mitigation and the effectiveness of mitigation measures should be discussed with particular reference to sediment, acidity, salinity and other emissions of a hazardous or toxic nature to human health, flora or fauna.

Where it is proposed that creeks will be diverted, the EIS should detail how rehabilitation will affect both the physical and ecological condition of the creek's bed and banks and the quality of water in it. Furthermore, the EIS should describe the monitoring that will be undertaken after decommissioning, and who will have responsibility for management measures and corrective action, to ensure that rehabilitated creeks do not degrade.

3.4.2.2 Groundwater

The EIS should include an assessment of the potential environmental impact caused by the project (and its associated project components) to local groundwater resources, including the potential for groundwater induced salinity[33].

The impact assessment should define the extent of the area within which groundwater resources are likely to be affected by the proposed operations and the significance of the project to groundwater depletion or recharge, and propose management options available to

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[31] 8 – DPIF (3)
[32] 20 – NRW (24)
[33] 16 – EPA (16)

monitor and mitigate these effects. The response of the groundwater resource to the progression and finally cessation of the proposal should be described.

An assessment should be undertaken of the impact of the project on the local ground water regime caused by the altered porosity and permeability of any land disturbance.

Any potential for the project to impact on groundwater dependent vegetation should be assessed and described. Avoidance and mitigation measures should be described[34].

An assessment of the potential to contaminate groundwater resources and measures to prevent, mitigate and remediate such contamination should be discussed.

3.5 Air

3.5.1 Description of environmental values

This section describes the existing air environment that may be affected by the project.

A description of the existing air shed environment should be provided having regard for particulates, gaseous and odorous compounds. The background levels and sources of suspended particulates, SO_x, NO_x, and any other major constituent of the air environment that may be affected by the project should be discussed.

Sufficient data on local meteorology and ambient levels of pollutants should be gathered to provide a baseline for later studies or for the modelling of air quality environmental harms within the air shed. Parameters should include air temperature, wind speed and direction, atmospheric stability, mixing depth and other parameters necessary for input to the models.

3.5.1.1 Greenhouse gas emissions

This section of the EIS should:

- provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in CO^2 equivalent terms
- estimate emissions from upstream activities associated with the proposed project, including fossil fuel based electricity consumed
- briefly describe method(s) by which estimates were made.

Coal mining projects should include estimates of coal seam methane to be released as well as emissions resulting from such activities as transport of products to rail, and energy use by the project.

3.5.2 Potential impacts and mitigation measures

This section defines and describes the objectives and practical measures for protecting or enhancing environmental values for air, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed. Information should be submitted on the use of new technologies to reduce air emissions from the point source(s) or other emission sources.

The objectives for air emissions should be stated in respect of relevant standards (ambient and ground level concentrations), relevant emission guidelines, and any relevant legislation, and the emissions modelled using a recognised atmospheric dispersion model. The potential for interaction between the emissions from the plant and equipment, and emissions in the air shed, and the likely environmental harm from any such interaction, should also be detailed.

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[34] 18 – EPA (17)

The proposed levels of emissions should be compared with the national environmental protection measures for ambient air quality (1998), the National Health Medical Research Council national guidelines (1985) for control of emissions from stationary sources, and the *Environmental Protection (Air) Policy (1997)*.

Where appropriate, the predicted average ground level concentrations in nearby areas should be provided. These predictions should be made for both normal and expected maximum emission conditions and the worst case meteorological conditions should be identified and modelled where necessary. Ground level predictions should be made at any residential, industrial and agricultural developments believed to be sensitive to the effects of predicted emissions. The techniques used to obtain the predictions should be referenced, and key assumptions and data sets explained. The assessment of the project's impact on air quality should include at least the following matters:

- evaluate the contribution of nitrogen oxides, sulfur oxides and volatile hydrocarbon emissions from the proposal to impacts within the local air shed. Address both acute and cumulative impacts by considering the project in conjunction with existing emission sources within the region
- detail the features of the proposal designed to suppress or minimise emissions, including dusts and odours
- the assessment of proposed levels of emissions of dust and odours should include emissions during both normal and upset conditions. Consideration should be given to the range of potential upset condition scenarios and the air emissions that may be generated as a result
- where there is no single atmospheric dispersion model that is able to handle the different atmospheric dispersion characteristics exhibited in the proposal area (e.g. strong convection, terrain features, temperature inversions and pollutant re-circulation), a combination of acceptable models will need to be applied
- the limitations and accuracy of the applied atmospheric dispersion models should be discussed. The air quality modelling results should be discussed in light of the limitations and accuracy of the applied models
- air quality predictions should be compared to the relevant goals in the National Environmental Protection Council (Ambient Air Quality) Measure and the *Environmental Protection (Air) Policy 1998* goals
- air shed management and the contribution of the project to air shed capacity in view of existing and future users of the air shed for assimilation and dispersion of emissions.

3.5.2.1 Greenhouse gas reduction

This section of the EIS should propose and assess greenhouse gas reduction measures against the background of the carbon pollution reduction scheme proposed by the federal government. It should include:

- a description of how the proposed carbon pollution reduction scheme will or is anticipated to relate to the project
- a description of the proposed measures (alternatives and preferred) to avoid and/or minimise greenhouse gas emissions directly resulting from activities of the project, including such activities as transportation of products and consumables, and energy use by the project
- an assessment of how the preferred measures minimise emissions and achieve energy efficiency
- an indication of how the preferred measures for emission controls and energy consumption compare with practice in the relevant sector of industry with a view to achieving best practice environmental management.

Direct means of reducing greenhouse gas emissions could include such measures as:

- minimising clearing at the site (which also has imperatives besides reducing greenhouse gas emissions)
- integrating transport for the project with other local industries such that greenhouse gas emissions from the construction and running of transport infrastructure are minimised
- maximising the use of renewable energy sources
- co-locating coal seam methane use for energy production with coal extraction.

Consideration should also be given to indirect means of reducing greenhouse gas emissions that may be relevant in respect of the direct emissions of the project taking into account the proposed carbon pollution reduction scheme.

The environmental management plan in the EIS should include a specific module to address greenhouse reduction. That module should include:

- commitments to the reduction of greenhouse gas emissions from the project with details of the intended objectives, measures and performance standards to avoid, minimise and control emissions
- commitments to energy management, including undertaking periodic energy audits with a view to progressively improving energy efficiency
- a process for regular review of new technologies to identify opportunities to reduce emissions and use energy efficiently, consistent with best practice environmental management
- any voluntary initiatives such as projects undertaken as a component of the national Greenhouse Challenge Plus program, or research into reducing the energy carbon intensity of the project's processes or products
- commitments to monitor, audit and report on greenhouse emissions from all relevant activities and the success of reduction measures.

3.5.2.2 Climate change adaptation

Climate change, through alterations to weather patterns and rising sea level, has the potential to impact in the future on developments designed now. Most developments involve the transfer to, or use by, a proponent of a community resource in one form or another, such as the granting of a non-renewable resource or the approval to discharge pollutants to air, water or land. Therefore, it is important that the project design be adaptive to climate change so that community resources are not depreciated by projects that would be abandoned or require costly modification before their potential to provide a full return to the community is realised. Consequently, the EIS should provide an assessment of the project's vulnerabilities to climate change and describe possible adaptation strategies for the activity including:

- a risk assessment of how changing patterns of rainfall and hydrology, temperature, extreme weather and sea level (where appropriate) may affect the viability and environmental management of the project
- the preferred and alternative adaptation strategies to be implemented
- commitments to undertaking, where practicable, a cooperative approach with government, other industry and other sectors to address adaptation to climate change.

The EPA recognises that predictions of climate change and its effects have inherent uncertainties, and that a balance must be found between the costs of preparing for climate change and the uncertainty of outcomes. However, proponents should use their best efforts to incorporate adaptation to climate change in their EIS and project design.

3.6 Noise and vibration

3.6.1 Description of environmental values

This section describes the existing environmental values that may be affected by noise and vibration from project activities.

If the proposed activity could adversely impact on the noise environment, baseline monitoring should be undertaken at a selection of sensitive sites affected by the proposal. Noise sensitive places are defined in the *Environmental Protection (Noise) Policy 1997* (EPP(Noise)). Long-term measured background noise levels that take into account seasonal variations are required. The locations of sensitive sites should be identified on a map at a suitable scale. The results of any baseline monitoring of noise and vibration in the proposed vicinity of the proposal should be described.

Sufficient data should be gathered to provide a baseline for later studies. The daily variation of background noise levels at nearby sensitive sites should be monitored and reported in the EIS, with particular regard given to detailing variations at different periods of the night. Monitoring methods should adhere to accepted best practice methodologies, relevant EPA guidelines and Australian Standards, and any relevant requirements of the EPP(Noise).

Comment should be provided on any current activities near the proposal area that may cause a background level of ground vibration (for example: major roads, quarrying activities, etc.).

3.6.2 Potential impacts and mitigation measures

This section defines and describes the objectives and practical measures for protecting or enhancing environmental values from impacts by noise and vibration, describes how nominated quantitative standards and indicators may be achieved for noise and vibration management, and how the achievement of the objectives will be monitored, audited and managed. The assessment of noise impacts should include matters raised in the document *The health effects of environmental noise – other than hearing loss* published by the enHealth Council, 2004 (or later editions).

Information, including mapped noise contours from a suitable acoustic model, should be submitted based on the proposed generation of noise. The potential environmental harm of noise and vibration at all potentially sensitive places, in particular, any place of work or residence should be quantified in terms of objectives, standards and indicators to be achieved. Particular consideration should be given to emissions of low-frequency noise; that is, noise with components below 200Hz. The assessment should also include environmental impacts on terrestrial and aquatic animals and avifauna, particularly migratory species. Proposed measures for the minimisation or elimination of impacts should be provided, including details and illustrations of any screening, lining, enclosing or bunding. A discussion should be provided of timing schedules for construction and operations with respect to minimising environmental nuisance and harm from noise.

Information should be supplied on blasting which might cause ground vibration or fly rock on, or adjacent to, the site with particular attention given to places of work, residence, recreation, worship and general amenity. The magnitude, duration and frequency of any vibration should be discussed. A discussion should be provided of measures to prevent or minimise environmental nuisance and harm. Blasting noise and vibration limits are provided in section 6 of the *Environmental Protection Regulation 1998*. Reference should also be made to the *EPA Guideline: Noise and vibration from blasting.*

The assessment should also address off-site noise and vibration impacts that could arise due to increased road transportation directly resulting from the project.

3.7 Waste

3.7.1 Waste generation

This section should provide technical details of waste generation, treatment, minimisation and management. All sources of waste to be generated during the construction, operational and decommissioning stages of the project should be identified and described in this section. Refer to each of the waste streams previously described and provide references to more detailed descriptions of the relevant environmental values in other sections of the EIS.

3.7.2 Waste management

The EIS should provide details of waste management strategies (including reduction, reuse, recycling, storage, transport and disposal of waste) which demonstrate that waste minimisation and cleaner production techniques and designs have been implemented through the selection of processes, equipment and facilities to prevent or minimise environmental impacts.

This section should assess the potential impact of all wastes to be generated during the construction, operational and decommissioning stages of the project, and provide details of each waste in terms of:

- operational handling and fate of all wastes including storage
- on-site treatment methods proposed for the wastes
- methods of disposal (including the need to transport wastes off-site for disposal) proposed to be used for any trade wastes, liquid wastes and solid wastes
- the potential level of impact on environmental values
- proposed discharge/disposal criteria for liquid and solid wastes
- measures to ensure stability of the dumps and impoundments should be described
- methods to prevent, seepage and contamination of groundwater from stockpiles and/or dumps should be given
- market demand for recyclable waste (where appropriate) should be addressed
- waste minimisation techniques processes proposed
- decommissioning of the site.

Having regard for best practice waste management strategies and the *Environmental Protection (Waste) Policy,* the proposals for waste avoidance, reuse, recycling, treatment and disposal should be described in the appropriate sub-section below. Information should also be provided on the variability, composition and generation rates of all waste produced at the site and processing plant.

Cleaner production waste management planning should be detailed especially as to how these concepts have been applied to preventing or minimising environmental impacts at each stage of the proposal. Measures to improve natural resource use efficiency (e.g. energy and water), integrated processing design, any co-generation of power and by-product reuse as shown in a material/energy flow analysis should be presented.

This information is required to enable the resource management agencies and other stakeholders to assess the efficiency of resource use, and allocation issues.

- **Air emissions**—this section should provide information on air emissions, including particulates, fumes and odours, during the construction and operation stages of the project. Particulate emissions include those that would be produced by any industrial process, or disturbed by wind action on stockpiles and conveyors, or by transportation equipment (e.g. trucks, either by entrainment from the load or by passage on unsealed roads). The methods to be employed in the mitigation of impacts from air emissions should be described in the Section 3.5 Air.
- **Excavated waste**—this section should describe and show the location, design and methods for constructing dumps for waste rock and subsoil. The location of the dumps should be shown on a map relative to topography and other natural features of the area.

- **Tailings**—this section should describe the tailings waste produced by preparation and/or processing plants and the proposed methods for its disposal. Describe alternative options for tailings disposal including the proposed location, site suitability and volume of any tailings storage and/or disposal site(s), including the method of construction.

  Describe the approximate quantity of tailings to be produced by the project and its processing plant annually for the life of the mine. Tailings characterisation information should also be presented in this section.

  The construction of the tailings storage facility should be described with regards to construction material and design. The EIS should address how the tailings storage facility complies with relevant codes for the construction of such containment systems.

  Describe the strategies to monitor and manage seepage into ground and surface waters. The location of the storage and/or disposal site with regard to adjacent creeks and rivers should be described.

- **Solid waste disposal**—describe the quantity and quality of solid wastes (other than waste rock, subsoil and tailings addressed in other sections) and the proposed methods of their disposal. The proposed location, site suitability, dimensions and volume of any landfill, including its method of construction, should be shown.

- **Liquid waste**—a description should be presented of the origin, quality and quantity of wastewater and any immiscible liquid waste originating from the project other than that addressed in other sections. Particular attention should be given to the capacity of wastes to generate acid, and saline or sodic wastewater. A water balance for the proposal and processing plant is required to account for the estimated usage of water.

  The EIS may need to consider the following effects:

  - groundwater from excavations
  - rainfall directly onto disturbed surface areas
  - run-off from roads, plant and industrial areas, chemical storage areas
  - drainage (i.e. run-off plus any seepage or leakage)
  - seepage from other waste storages
  - water usage for (1) process use (2) dust suppression, and (3) domestic purposes
  - evaporation
  - domestic sewage treatment—disposal of liquid effluent and sludge
  - water supply treatment plant—disposal of wastes.

3.8 Transport

3.8.1 Transport methods and routes

The EIS should describe transport modes and routes for all aspects of the transport task, including arrangements for the transport of plant, equipment, products, wastes and personnel during both the construction and operation of the project. The description must address the use of existing facilities and all requirements for the construction, upgrading or relocation of any transport related infrastructure. Information should include:

- existing traffic volumes on the proposed transport routes
- volumes, tonnage, and composition of construction inputs and production outputs

- hazardous or dangerous material that may be transported
- method of transport (e.g. sea, rail, road) and the type of vehicles most likely to be used for transport
- number and type of workforce traffic and service vehicles
- number of trips generated (both light and heavy vehicles)
- origin and destination of inputs and outputs and transport routes proposed (with the use of maps)
- details of over-dimension or excess mass loads
- timing and duration of transport activities.

The EIS should clearly and fully describe transport information for all stages of the project including:

- all requirements for the construction, upgrading or re-location of any transport-related infrastructure, including any need for increased road maintenance
- any new access requirements to state-controlled or local government roads
- sufficient details to allow the Department of Main Roads (DMR), Queensland Transport and local government and other relevant authorities to ascertain compliance with legislative and design requirements.

3.8.2 Potential impacts and mitigation measures

The EIS must provide sufficient information to allow an independent assessment of how the state-controlled and local government road networks will be affected at the local and regional level, and indicate clearly the corrective measures and mitigation strategies necessary to address adverse road impacts including a wet weather management strategy.

An assessment of impacts to existing transport infrastructure associated with project activities should be provided and include the following:

- the likely impacts and mitigation strategies of any new roads or road realignments that are required as a result of the project
- the likely impacts and mitigation strategies of increased traffic on local and regional road networks (with appropriate directional distributions), with reference to:
  - volumes of project inputs and outputs (types and quantities), vehicles, their origin, destination and routes used for transport, including plant, raw materials, wastes, hazardous materials, finished products
  - volume of traffic generated by workforce personnel, visitors and service vehicles, method of transport (vehicle type and number), anticipated times at which movements may occur and likely routes
  - details of heavy and oversize/indivisible loads (including types and composition), and the proposed transport routes including waterway crossings
  - road safety issues, including safe access to and from construction sites and school bus routes within the project area (e.g. consideration of the need for turning lanes, improved sight lines, waiting areas, off-road parking locations)
  - reduced efficiency of traffic flows or intersections along key routes, especially during construction
  - additional wear or reduced life of pavements requiring additional or accelerated rehabilitation and maintenance, if any
  - changes in waterway areas/catchment and drainage lines which may impact on road operations and assets (particularly rail crossing), not addressed in section 3.4

  - operation of existing bus routes and services
  - risks of driver fatigue of workers driving between the project to regional destinations
  - proposed traffic control and traffic management
  - public transport requirements of the development
  - steps to prevent public access to construction access ways that are not public roads.
- specific issues related to construction phase activities, including:
  - site depot location and access
  - construction traffic on local road networks, daily movement patterns, possible road closures and emergency access, especially in rural and urban residential areas
  - methods to be adopted to avoid obstruction to other road users during construction.

Details of the relative impacts generated by each of the project's components to existing transport infrastructure during construction, operation and decommissioning phases should be provided.

This section, in addition to detailing the impacts of all road and rail construction and maintenance, is to include an evaluation of the impact of the project on existing roads, railways, powerlines, pipelines, telecommunication lines, waterways and stormwater flow-paths located within or close proximity to transport infrastructure. This evaluation should include any potential requirements to reschedule existing infrastructure maintenance programs.

Special reference should be made to any relationship between project road works and works proposed in the current Road Implementation Program of the DMR. Road infrastructure should be described and assessed according to DMR's 'Guidelines for Assessment of Road Impacts of Development Projects (April 2006)'.

Strategies for managing the impacts of the project on road safety, including access for emergency response vehicles especially with regard to proposed road diversions, should be presented.

A comparison of the traffic situation and road conditions with and without the project should be shown.

This section should also discuss how transport elements of the project relate to Queensland Transport's existing transport strategies for the Central Highlands area and the future infrastructure needs of this area as presented in local and state government documentation.

As air transport is an option for the project, this section should describe the likely airstrip options (upgrade existing or develop new), proposed locations, operating regime, including make-up of passengers (i.e. workforce and/or members of the public)[35], the likely impacts and mitigation strategies, as well as the regulatory requirements of relevant Commonwealth and state bodies.

The EIS should also outline arrangements made with the Gladstone Ports Corporation for the storage, handling and export of coal from the mine.

Mitigation strategies are to be detailed in a draft road-use management plan, to be finalised in consultation with DMR, which will:

- consider DMR's future upgrades of the road network, as detailed in the roads implementation program, which may affect the study area
- detail impact mitigation strategies including the construction of new transport infrastructure referencing relevant road authority standards and practices (any required road works should be designed and constructed in accordance to Main Roads' Road Planning and Design Manual 2004 or as amended)

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- provide timing and responsibilities for any required road works and additional transport infrastructure. (Traffic management issues for any required road works and any approvals under the *Transport Infrastructure Act (Qld) 1994* may be finalised in a traffic management plan at the project pre-construction stage)
- provide information on product spill contingency plans and the adequacy of equipment and facilities to deal with possible spills for the transport modes of the project if applicable. Indicate whether there is a need to update existing plans based on increase in frequency of traffic and volumes to be transported.

It is understood that some detailed design elements of the road-use management plan may not be known prior to completion of the EIS, and that this information will be supplied subsequently to DMR and other road authorities.

3.9 Indigenous cultural heritage

3.9.1 Description of indigenous cultural heritage values

The EIS should describe the known indigenous cultural heritage values that may be affected by the project. An indigenous cultural heritage survey (as part of the Cultural Heritage Management Plan (CHMP) process or otherwise) should be undertaken for significant Aboriginal objects and significant Aboriginal areas. The indigenous cultural heritage survey should:

- refer to the DNRW Indigenous Site Database and any existing literature relating to the affected areas
- refer to:
  - the consultation and negotiation with traditional owners and the outcomes about:
    - significant Aboriginal objects and significant Aboriginal areas
    - confidentiality of culturally sensitive information
  - the involvement of traditional owners in field surveys.
- include locations of significant Aboriginal objects and significant Aboriginal areas identified during the survey and which are likely to be impacted by the project
- provide a report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and conclusions and management recommendations (having due for any confidentiality requirements specified by community representatives).

3.9.2 Potential impacts and mitigation measures

The management of indigenous cultural heritage impacts should be detailed in either a native title agreement with traditional owners or in a CHMP, with the native title agreement or plan to be developed in a form that complies with the provisions of Part 7 of the *Aboriginal Cultural Heritage Act 2003,* thereby meeting the cultural heritage duty of care. The agreement or plan must provide a process for the conduct of comprehensive cultural heritage investigations and the identification of significant Aboriginal objects and significant Aboriginal areas in the proposed project area. It is also to provide a process for the management of those objects, areas and values identified in the proposed project area.

The agreement or plan should include the following:

- a process for including Aboriginal communities or Aboriginal parties in the identification, management and protection of Aboriginal cultural heritage in the project area
- a process for undertaking a comprehensive and systematic cultural heritage assessment

- processes for the mitigation, management and protection of identified cultural heritage objects and areas in the project area, and in any areas to be affected by development of any associated infrastructure, both during construction and operational phases of the project
- provision for the management of the accidental discovery of cultural material, including burials, in the project area
- processes for determining any requirements for monitoring of the project during construction, and measures by which any monitoring program is to be implemented
- Indigenous cultural heritage induction and awareness programs for project staff, subcontractors and staff, consultants and agents of the project
- a conflict resolution process.

The development of the agreement or plan should be negotiated with all relevant stakeholder representatives, subject to any confidentiality specified by the Aboriginal community, registered native title applicants, and/or Aboriginal parties as appropriate.

As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care under the *Aboriginal Cultural Heritage Act 2003* and the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth).*

If a CHMP has not been approved by the submission of the EIS to the CG then the following should be provided:

- a outline of the draft CHMP, subject to any confidentiality provisions, with the position of the endorsed cultural heritage parties
- details of the proposed steps and timeframes for seeking the ratification of the CHMP.

3.10 Non-indigenous cultural heritage

3.10.1 Description of non-indigenous cultural heritage values

The EIS should describe the existing environmental values for non-indigenous cultural heritage that may be affected by the project activities. The non-indigenous cultural heritage survey should:

- refer to:
  - the Australian Heritage Places Inventory
  - the EPA Queensland Heritage Register and other information regarding places of potential non-indigenous cultural heritage significance
  - local government heritage register
  - any existing literature relating to the affected areas
- refer to consultations and negotiations with the local community and historical societies about:
  - places of non-indigenous cultural heritage significance
  - the significance of any non-indigenous cultural heritage places located or identified.
- include locations of culturally significant sites likely to be impacted by the project
- provide a constraints' analysis of the proposed development area to identify and record non-indigenous cultural heritage places
- provide the location of mining areas with historical significance should be shown on maps

- provide a report of work done which includes background research, relevant environmental data and methodology, as well as results of field surveys, significance assessment and conclusions and management recommendations (having due regard for any confidentiality requirements specified by community representatives).

As a minimum, investigations and consultation should be undertaken in such manner and detail to satisfy statutory responsibilities and duties of care, under the EPBC Act and *Queensland Heritage Act 1992*.

3.10.2 Potential impacts and mitigation measures

The proponent should provide an assessment of any likely effects on sites of non-indigenous cultural heritage values, including but not limited to the following:

- description of the significance of artefacts, items or places of conservation or non-indigenous cultural heritage value likely to be affected by the project and their values at a local, regional and national level
- recommended means of mitigating any negative impacts on non-indigenous cultural heritage values and enhancing any positive impacts
- negotiations with Queensland Heritage Council and the EPA regarding management of places of historic heritage significance, taking account also of community interests and concerns
- documented management strategies in accordance with the outcomes of negotiations with Queensland Heritage Council, EPA and the community.

As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care, including those under the EPBC Act and *Queensland Heritage Act 1992*.

3.11 Health and safety

3.11.1 Description of existing public health and safety community values

This section describes the existing community values for public health and safety that may be affected by the project. For projects proposing air emissions, and/or those with the potential to emit odours, nearby and other potentially affected populations should be identified and described. Particular attention should be paid to those sections of the population, such as children and the elderly that are especially sensitive to environmental health factors.

3.11.2 Potential impacts and mitigation measures

This section defines and describes the objectives and practical measures for protecting or enhancing health and safety community values, describes how nominated quantitative standards and indicators may be achieved for social impacts management, and how the achievement of the objectives will be monitored, audited and managed.

The EIS should assess the effects on the project workforce of occupational health and safety risks and the impacts on the community in terms of health, safety, and quality of life from project operations and emissions. Any impacts on the health and safety of the community, workforce, suppliers and other stakeholders should be detailed in terms of health, safety, quality of life from factors such as air emissions, odour, dust and noise.

Map(s) should be provided showing the locations of sensitive receptors, such as, but not necessarily limited to, kindergartens, schools, hospitals, aged care facilities, residential areas, and centres of work (e.g. office buildings, factories and workshops). The EIS, illustrated by the

maps, should discuss how planned discharges from the project could impact on public health in the short and long term, and should include an assessment of the cumulative impacts on public health values caused by the proposal, either in isolation or by combination with other known existing or planned sources of contamination.

The EIS should address the project's potential for providing disease vectors. Measures to control mosquito and biting midge breeding should be described. Any use of recycled water should be assessed for its potential to cause infection by the transmission of bacteria and/or viruses by contact, dispersion of aerosols, and ingestion (e.g. via use on food crops). Similarly, the use of recycled water should be assessed for its potential to cause harm to health via the food chain due to contaminants such as heavy metals and persistent organic chemicals. Practical monitoring regimes should also be recommended in this section.

3.12 Cumulative impacts

The purpose of this section is to provide clear and concise information on the overall impacts of the project, and to discuss the interrelationship of these impacts. This is in addition to the discussion of cumulative impacts which feature in the relevant sections. The cumulative impacts as they relate to particular issues (e.g. water management, cultural heritage, social and economic costs and benefits, community disruption and accommodation[36] etc.) may also be discussed in this section. These impacts should be considered over time or in combination with other impacts because of the scale, intensity, duration or frequency of the impacts.

Cumulative impacts should also take into consideration other infrastructure projects. In particular, the requirements of any relevant state planning policies, environmental protection policies, national environmental protection measures, water resource planning and any other relevant plans should be addressed

The methodology to be used to determine the cumulative impacts of the project should be discussed. The methodology should detail the range of variables to be considered including, where applicable, relevant baseline or other criteria upon which the incremental aspects of the project should be assessed.

4 SOCIAL VALUES AND MANAGEMENT OF IMPACTS

4.1 Description of existing social values

This section describes the existing social values that may be affected by the proposal.

The social amenity and use of the proposal area and adjacent areas for rural, agricultural, forestry, fishing, recreational, industrial, educational or residential purposes should be described. Consideration should be given to:

- community infrastructure and services, access and mobility
- population and demographics of the affected community
- local community values, vitality and lifestyles
- recreational, cultural, leisure and sporting facilities and activities in relation to the affected area
- health and educational facilities
- on farm activities near the proposed activities

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- current property values
- number of properties directly affected by the project
- number of families directly affected by the project, this should include not only property owners but also families of workers either living on the property or workers where the property is their primary employment
- Aboriginal people's traditional and contemporary uses of the land affected by the project.

Describe the social values for the affected area in terms of the integrity of social conditions, including amenity and liveability, harmony and well being, sense of community, access to recreation, and access to social and community services and infrastructure.

Social, economic and cultural values are not as easily separated as physical and ecological values. Therefore it may be necessary for some material in this section to be cross-referenced with in section 3.9 Indigenous cultural heritage, section 3.10 Non-indigenous cultural heritage and Section 5 Impacts on state and local economies and management of those impacts.

Information should also be provided on the existing housing market in the area, with an emphasis on:

- the size of the private rental market
- the vacancy rate of rental accommodation, including assessment of seasonal fluctuations
- typical rents
- the availability and typical cost of housing for purchase
- the level of social housing
- constraints and opportunities for new housing construction, including the capacity of the local land development and housing construction industries to provide new housing.

4.2 Potential impacts and mitigation measures

This section defines and describes the objectives and practical measures for protecting or enhancing social values, describes how nominated quantitative standards and indicators may be achieved for social impacts management, and how the achievement of the objectives will be monitored, audited and managed.

The social impact assessment of the project should consider the information gathered in the community consultation program and the analysis of the existing socio-economic environment, and describe the project's impact, both beneficial and adverse, on the local community. The impacts of the project on local and regional residents, community services and recreational activities are to be analysed and discussed for all stages of the development. The nature and extent of the community consultation program are to be described and a summary of the results incorporated in the EIS.

The social impact assessment should include sufficient data to enable State authorities, such as Queensland Health and Education Queensland, to plan for the continuing provision of public services in the region of the project. Proponents of projects that are likely to result in a significant increase in population of an area should consult the relevant management units of the State authorities, and summarise the results of the consultations in the EIS. The summary should discuss how the impacts of population increase on public services, particularly health and education, would be mitigated.

The social impact assessment of the project is to be carried out in consultation with the Department of Communities. The assessment of impacts should describe the likely response of affected communities and identify possible beneficial and adverse impacts (both

immediate and cumulative). These impacts should be considered both at the regional and local level.

The EIS should address the following matters:

- include an assessment of impacts on local residents, current land uses and existing lifestyles and enterprises
- include an assessment of impacts on local and state labour markets, with regard to the source of the workforce. This information is to be presented according to occupational groupings of the workforce. In relation to the source of the workforce, information is required as to whether the proponent, and/or contractors, are likely to employ locally or through other means and whether there are initiatives for local employment opportunities
- the EIS should address impacts of both construction and operational workforces and associated contractors on housing demand, community services and community cohesion. The capability of the existing housing stock, including rental accommodation, to meet any additional demands created by the project is to be discussed, and where appropriate mitigation strategies proposed to limit displacement of existing rental households[37]
- the assessment of impacts should take account of relevant demographic, social, cultural and economic profiles
- identify any new skills and training to be introduced in relation to the project. Adequate provision should be made for apprenticeship and worker training schemes. If possible, the occupational skill groups required and potential skill shortages anticipated should be indicated
- provide comment on how much service revenue and work from the project (e.g. provisioning, catering and site maintenance) would be likely to flow to existing communities in the area of the project, particularly if a fly-in, fly-out workforce is proposed
- include an assessment of impacts on existing local residents' values and aspirations
- in regard to affected Indigenous and non-indigenous communities respectively, particular attention should be paid to the effects on:
    - the ability of both Indigenous and non-indigenous people, to live in accordance with their own values and priorities
    - the use of and access to culturally important areas and landscapes
    - the access to existing human and commercial services and housing
    - the ability to participate in regional and local employment and training opportunities
    - the new project workforce and their families.

For the construction and operational phases of the development, describe the effects of the proposal on local and regional residents, including land acquisition and relocation issues and property valuation and marketability, community services and recreational activities. Discussion should also include situations where residents are offered lease arrangements for a period of time post ownership transfer.

Discuss the potential environmental harm on the amenity of adjacent areas used for cropping, grazing, forestry, recreation, industry, education, aesthetics, or scientific or residential purposes. Describe the implications of the proposal for future developments in the local area including constraints on surrounding land uses.

For identified impacts to social values, suggest mitigation and enhancement strategies and facilitate initial negotiations towards acceptance of these strategies. Practical monitoring regimes should also be recommended.

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An assessment of the predicted impacts of the proponent's activities (including activities by any sub-contractors) on the local and regional housing markets should also be undertaken. The assessment should refer to the projected accommodation needs for the project in both the construction and operational phases, and estimate:

- the capacity of local and regional housing markets to meet the accommodation needs of the project, including the potential displacement of low-income residents from affordable rental accommodation and diminished availability of accommodation
- any possible cumulative impacts on the local and regional housing market due to the presence of other existing or proposed major projects in the area, and seasonal employment factors
- the impact of the construction phase of the project on the local and regional residential development and housing construction industry, with particular reference to the demand for local contractors.

5 IMPACTS ON STATE AND LOCAL ECONOMIES AND MANAGEMENT OF THOSE IMPACTS

5.1 Description of existing economic character

This section describes the existing economic environment that may be affected by the project.

The character and basis of the local and regional economies should be described including:

- economic viability (including economic base and economic activity, future economic opportunities, current local and regional economic trends, in particular drought and rural downturn etc)
- identification of existing labour force and unemployment statistics
- existing housing market, particularly rental accommodation which may be available for the project workforce
- types and numbers of businesses
- existing property and land values
- availability and prices of goods and services
- availability of suitable land for support industrial uses
- historical descriptions of large-scale resource developments and their effects in the region.

The economic impact statement should include estimates of the opportunity cost of the project and the loss of value to ecosystem services as a result of the disturbance or removal of natural or modified ecosystems during development.

5.2 Potential impacts and mitigation measures

The function of this section is to define and describe the objectives and practical measures for protecting or enhancing economic values, to describe how nominated quantitative standards and indicators may be achieved for economic management, and how the achievement of the objectives will be monitored, audited and managed.

An economic impact assessment should be presented from national, state, regional and local perspectives as appropriate to the scale of the project. The general economic benefits from the project should be described.

At a level of detail appropriate to the scale of the project, the analysis is to consider:

- the significance of this proposal on the local and regional economic context
- the long and short-term beneficial (e.g. job creation) and adverse (e.g. competition with local small business, reduced local farming productivity[38]) impacts that are likely to result from the development
- the potential, if any, for direct equity investment in the project by local businesses or communities
- the cost to all levels of government of any additional infrastructure provision
- implications for future development in the locality (including constraints on surrounding land uses and existing industry)
- the potential economic impact of any major hazard identified in Section 6 Hazard and risk
- the distributional effects of the proposal including proposals to mitigate any negative impact on disadvantaged groups
- the value of lost opportunities (i.e. loss of GQAL)[39] or gained opportunities for other economic activities anticipated in the future
- impacts on local property values.

The effect on local labour markets should be discussed with regard to the number and source of the workforce. This information should be presented according to occupational groupings of the workforce and show anticipated peaks in numbers during the construction period. This information should include an estimate of the anticipated numbers of workers who will be accompanied by dependents, as well as those who will be unaccompanied (i.e. single workers).

The impacts of both construction and operational workforces and associated contractors on housing demand should be addressed and include:

- an accommodation strategy for the construction workforce, which addresses the estimated housing needs of both single and accompanied construction workers
- details of the size, location and management of any temporary worker accommodation that will be required either on-site or off-site
- maps, as necessary, to illustrate the location of any proposed construction workers' accommodation on-site or in the vicinity of the project
- the capability of the existing housing stock, particularly rental accommodation, to meet any additional demands created by the project
- the capacity of water supply and sewerage systems to service any new residential development and any project proposals to supplement this infrastructure.

Any new skills and training to be introduced in relation to the project should be identified, particularly opportunities for private investment in training. Adequate provision should be made for apprenticeship and worker training schemes, including consideration of a skills development and training strategy to assist disadvantaged groups as well as local residents.

Consideration of the impacts of the project in relation to energy self-sufficiency, security of supply and balance of payments benefits may be discussed. Attention should be directed to the long and short-term effects of the project on the land-use of the surrounding area and existing industries, regional income and employment and the state economy. The scope of any studies should be referred to the government for input before undertaking the studies.

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[38] 20 - NRW (28)
[39] 20 - NRW (5)

For identified impacts to economic values, suggest mitigatory and enhancement strategies and facilitate initial negotiations towards acceptance of these strategies. Practical monitoring regimes should also be recommended.

6 HAZARD AND RISK

6.1 Hazard and risk assessment

This section of the EIS should describe the potential hazards and risks that may be associated with the project and should incorporate all known hazards, which may include:

- identification of potential hazards, accidents, spillages and abnormal events occurring during all stages of the project, including possible frequency of occurrence
- indication of cumulative risk levels to surrounding land uses
- identification of all hazardous substance to be used, stored, processed or produced and the rate of usage
- potential wildlife hazards such as snakes and disease vectors.

The EIS should deal with on-site risks. External risks to the project should also be considered. External risks from natural hazards could be determined on the basis of Australia/New Zealand Standard on Risk Management AS/NZS 4360:2004. The study should assess risks during the construction, operational and decommissioning phases associated with the project. These risks should be assessed in quantitative terms where possible. Possible hazards, accidents, and abnormal events that may arise for the project, both during construction and in operation should be described, including:

- accidental release of hazardous goods or other materials
- fires associated with incidents arising from the project activities
- vulnerability of the project area to bushfire, flooding[40] and landslip and other natural disasters.

Analysis of the consequences of each of these events on safety and environmental damage in the project area should be conducted, including direct harm to the environment as a result of project hazards. The analysis should examine the likelihood of these consequences being experienced, both individually and collectively. In regard to the on-site handling and storage of explosive raw material, consultation is encouraged with the Department of Emergency Services Chemical Hazards and Emergency Management (CHEM) Services Unit.[41]

Details should be provided on the safeguards that would be employed or installed to reduce the likelihood and severity of hazards, consequences and risks to persons, fauna and environmentally sensitive sites within and adjacent to the project area.

6.2 Emergency management plan

An outline of the proposed emergency management procedures should be provided for the range of situations identified in the above risk assessment where there are measurable risks. This should include an overview of the objectives and management principles to be adopted for the preparation of a detailed emergency plan (including emergency response and recovery/cleanup procedures) in consultation with the relevant emergency services. Planning should include reference to State Planning Policy 1/03, Mitigating the Adverse Impacts of Flood, Bushfire and Landslide.

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[40] 18 - EPA (19)
[41] 2 - DES (3)

In particular, the following should be presented:

- contingency plans to deal with hydrocarbon (e.g. diesel, lubricating oils) oil spills during construction, operation and maintenance of the project
- contingency plans to account for natural disasters such as storms, flooding[42] and fires during the construction, operation and maintenance phases
- emergency planning and response procedures that have been determined in consultation with state and regional emergency service providers
- plans for involvement of the relevant state agencies (such as the Department of Emergency Services, which includes the Queensland Ambulance Service, Queensland Fire and Rescue Service and Emergency Management Queensland) in relation to emergency medical response and transport and first aid matters.

7 Environmental management plan

This section of the EIS should detail the EMP developed for the project. Separate EMPs should individually address the discrete project elements. The EMPs should be developed from, and be consistent with, the preceding information in the EIS.

An EMP should provide control actions in accordance with agreed performance criteria for specified acceptable levels of environmental harm.

In addition, the EMPs should identify:

- potential impacts on environmental values
- mitigation strategies
- relevant monitoring
- appropriate indicators and performance criteria
- reporting requirements
- appropriate corrective actions, should an undesirable impact or unforeseen level of impact occur
- the recording of and response to complaints.

The aims of the EMPs are to provide:

- commitments by the proponent to practical and achievable strategies and design standards (performance specifications) for the management of the project to ensure that environmental requirements are specified and complied with
- an integrated plan for comprehensive monitoring and control of impacts
- local, state and federal government authorities, stakeholders and the proponent with a common focus for approvals conditions and compliance with policies and conditions
- the community with evidence that the environmental management of the project is acceptable.

The recommended structure of each element of the EMP is:

Element/issue	Aspect of construction or operation to be managed (as it affects environmental values).

[42] 18 - EPA (19)

Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Measurable performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies, tasks or action program (to nominated operational design standards) that would be implemented to achieve the performance criteria.
Monitoring	The monitoring requirements to measure actual performance (i.e. specified limits to pre- selected indicators of change).
Auditing	The auditing requirements to demonstrate implementation of agreed construction and operation environmental management strategies and compliance with agree performance criteria
Reporting	Format, timing and responsibility for reporting and auditing of monitoring results
Corrective action	The action (options) to be implemented in case a performance requirement is not reached and the person(s) responsible for action (including staff authority and responsibility management structure).

An EMP should commit to manage, enhance or protect identified environmental values. The commitments should contain the following components for performance criteria and implementation strategies:

- Environmental protection objectives for enhancing or protecting each relevant value.
- Indicators to be measured to demonstrate the extent to which the environmental protection objective is achieved.
- Environmental protection standards (a numerical target or value for the indicator), which defines the achievement of the objective.
- An action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to:
  - communication
  - continuous improvement
  - environmental auditing
  - monitoring
  - reporting
  - staff training
  - a decommissioning program for land proposed to be disturbed under each relevant aspect of the project.

8 Conclusions and recommendations

The EIS should make conclusions and recommendations with respect to the project based on the studies presented, the EMP and conformity of the project with legislative and policy requirements.

9 References

All references consulted should be presented in the EIS in a recognised format.

10 Recommended appendices

10.1 Final TOR for this EIS

A copy of the final TOR should be included in the EIS. A summary cross-referencing specific items of the Terms of Reference to the relevant section of the EIS should also be provided.

10.2 Development approvals

A list of the development approvals required by the project should be presented.

10.3 EPBC report

A report addressing matters of NES and potential impacts of the project is recommended.

10.4 Consultation report

A list of advisory agencies should be provided in a summary consultation report, which should also list the federal, state and local government agencies consulted, and the individuals and groups of stakeholders consulted. A summary of the issues raised by these groups, and the means by which the issues have been addressed, should be provided in the text of the EIS.

The EIS should summarise the results of the community consultation program, providing a summary of the groups and individuals consulted, the issues raised, and the means by which the issues were addressed. The discussion should include the methodology used in the community consultation program including criteria for identifying stakeholders and the communication methods used.

Information about identifying affected parties (as defined by the EPBC Act) and interested and/or affected persons (as defined by the EP Act) should be included.

10.5 Study team

The qualifications and experience of the study team and specialist sub-consultants should be provided.

10.6 Glossary of terms

A glossary of technical terms and acronyms should be provided.

10.7 Specialist studies

All reports generated on specialist studies undertaken as part of the EIS are to be included as appendices. These may include:

- flora and fauna studies including the subregional analysis of representativeness and adequacy of protection for the terrestrial/riparian vegetation communities and their component flora and fauna taxa within the affected areas
- an integrated assessment of relative biodiversity/conservation values, based on the methodology outlined in EP Act
- air pollution, noise and vibration
- waterway hydrology
- groundwater
- geology
- economic studies and/or cost-benefit analyses
- hazard and risk studies
- land use and land capability studies.

10.8 Corporate environmental policy

The proponent should attach a copy of its corporate environmental policy and planning framework document.

10.9 List of proponent commitments

A list of all commitments made by the proponent in the EIS should be provided together with a reference to the relevant section in the report.

'CG-04'

Attachment CG-4 – Wandoan Coal project environmental impact statement extracts

7.7.1 FLOOD

The study area is situated within two major catchments. The northern and central extents of the study area are largely situated in the Dawson River Catchment, which is a 43,965 km2 sub-catchment within the Fitzroy River Basin. The southern extents are located within the northern sub-catchments (catchment size of 43,112 km2) of the Condamine River basin.

Due to its immense size and fan-like shape, the Fitzroy River catchment is capable of producing severe flooding following heavy rainfall events. Major floods can result from either the Dawson or the Connors-Mackenzie Rivers. Flood gauge heights at Taroom recorded the following peaks during recent significant floods: 8.15 m in January 1918, 4.08 m in January/February 1978, 7.46 m in May 1983 and 3.95 m in January 1991 (BOM 2005a).

Within the Condamine River catchment, major floods do not necessarily develop in the headwater areas of the catchment but can result from heavy rainfall in any of the large tributaries that enter the main Condamine River. While large scale flooding within the main towns of the catchment is not a regular occurrence, major floods occur regularly and on average every two years. The worst recorded flooding occurred in 1942, 1950, 1956, 1975, 1976, 1983 (twice), 1988 and 1996. However, major floods generally only occur in the first half of the year and occasionally in late spring (BOM 2005b).

Major flooding in both catchments requires a large scale rainfall event over the catchment. Average catchment rainfalls in excess of 200 mm in 48 hours within the Dawson River catchment may cause significant moderate to major flooding and traffic stoppages, particularly in the middle to lower reaches downstream of Taroom (BOM 2005a). While average catchment rainfalls in excess of 300 mm in 48 hours may cause significant major flooding. If average catchment rainfalls exceed 25 mm within the Condamine River catchment, with isolated 50 mm falls in 24 hours, stream rises and the possibility of minor flooding may occur (BOM 2005b). If it is in excess of 50 mm, with isolated 75 to 100 mm falls in 24 hours, significant stream rises with the possibility of moderate to major flooding may occur (BOM 2005b).

7.7.4 CYCLONES

Relatively few cyclones have been experienced in the past 100 years near the study area, with the last tropical cyclone occurring in the mid-1990's (tropical cyclone Gertie, 17–24 December 1995). This is mainly due to the study area's location which is approximately 300 km inland of the Wide Bay-Burnett Coast of Queensland.

Tropical Cyclone Althea has been one of the most severe cyclones to affect the area. It crossed the coast north of Townsville in December 1971 with wind gusts over 200 km/h. The intensity of the cyclone reduced as it continued its path through Queensland, crossing directly through the study area before going back out to sea.

Tropical Cyclone Wanda passed over the coast in January 1974 near Maryborough and continued through Queensland and dissipating into a low pressure system to the south of the study area. Cyclone Wanda caused heavy rains across southeast Queensland which resulted in one of Australia's greatest flood events in the last 50 years.

With only two out of a total of 207 recorded impacts associated with tropical cyclones along the east coast (since 1858) having severely affected the study area (BOM 2008c), the risk that the Project would be impacted by cyclonic conditions is considered to be low.

7.8 POTENTIAL ISSUES AND IMPACTS

The climatic conditions across the northern, central and southern extents of the study area are generally similar for all seasons. The small variations that do occur are considered natural and normal under seasonal variations. Potential climate change scenarios forecast for the future operational phase of the Project are discussed in Chapter 14 Greenhouse gases and climate change.

Based on the historical data, the total annual rainfall for the study area is quite low. Potential impacts of rainfall on soil erosion are discussed in Chapter 9 Geology, Mineral Resources, Overburden and Soils. Storm events also have the potential to impact on waste containment systems (e.g. site bunding and tailings dams) and nearby waterways which are discussed in Chapters 18 Waste Management and 11 Water Supply and Management, respectively.

The wind condition data obtained for the study area indicated that wind speeds are generally low with variable daily and seasonal prevailing directions. Potential impacts caused by wind conditions at the study area are discussed in Chapter 13 Air quality and Chapter 15 Noise.

Natural hazards are not considered a major risk for the study area. However, both flood and drought events may become an issue at some point during the expected life of the Project. These issues are considered further in Chapter 11 Water resources. Additionally, an Emergency Management Plan which will address all foreseeable site specific risks, such as cyclones, fire and flood including appropriate contact details of emergency services agencies will be prepared prior to commencement of construction activities. The risk of natural hazards is considered as part of the business risk management process, with appropriate controls and monitoring under an Emergency Management Plan being a fundamental part of the risk management (refer Chapter 23 Hazard and Risk).

17B.3 EXISTING ENVIRONMENT

17B.3.1 AQUATIC HABITAT

The sites surveyed within the MLA areas typically had moderate River Bioassessment Program habitat assessment scores whereas those in the gas supply pipeline alignment typically had poor to moderate scores. These relatively low scores were generally related to low habitat variability (no riffles observed), moderate to extensive bank erosion and substrates dominated by finer sediments (e.g. sand and silt).

The notable exception to this was a tributary to Mud Creek (initial field trip site 13, shown in Figure 3.1 of TR 17B-1-V1.5), which had the highest score of all of the sites surveyed.

This site included a variety of substrate types and it would contain riffle habitats when flowing. It was not adversely affected by channel alteration or scouring and had relatively stable banks. Although canopy cover was relatively low, there were fallen logs in the channel that would provide in-stream habitat for fauna.

Higher order streams generally scored higher due to more riparian vegetation and a higher proportion of large trees in the riparian zone.

Reach environs

Overall, the reach environs of the creeks surveyed have been moderately impacted by human activities. Land use is dominated by cattle grazing on native and improved pastures and some cropping. There has been some riparian vegetation clearing, although large trees still grow on the banks at many sites (and in particular at sites on higher order streams). Cattle accessing creeks has also caused some disturbance.

Road crossings were a mix of gravel crossings (fords) without culverts, bitumen/concrete crossings with culverts and bridges. Road crossings are likely to alter flow patterns and may restrict aquatic fauna passage.

Bridge crossings and crossings with large culverts (e.g. Frank Creek at Jackson-Wandoan Road) are generally less of a barrier to aquatic fauna movement. During flood events however, pylons and large culverts can alter flow patterns and trap debris that can potentially restrict fish and other fauna movements. Fences also cross several sites and may restrict water flows, fish passage and movement by other aquatic fauna if blocked by debris.

17B.3.2 WATER QUALITY

Summary

Across the study areas, DO concentrations and turbidity levels did not generally comply with the QWQG. Low DO concentrations were probably due to high biochemical oxygen demand and low mixing of the waters. High turbidity was probably related to sedimentladen runoff associated with clearing of riparian vegetation, sloped / steep banks and the preceding flood. By their nature, ephemeral streams such as those in the study area are commonly subject to a range of severe (natural) stresses, and as such the water quality of the creeks within the study area may be characterised by elevated turbidity, salinity and nutrient enrichment (Chessman, B. [Centre for Natural Resources NSW] pers. comm. 2003, 21 October).

Regionally, water quality is also characterised by high turbidity and fluctuating DO concentrations. Due to surrounding land uses, waterways within the region are impacted by relatively high inputs of nutrients, pesticides and other contaminants. The Taroom subcatchment, in which the MLA and gas supply pipeline study areas are located, only contributes 1.6% of the TN and 1.4% of the TP exported out of the Dawson River catchment each year.

17B.5.2 VEGETATION CLEARING AND EARTHMOVING

Without mitigation, there is a high potential for soil erosion and sedimentation following vegetation clearing and earth moving, as outlined in the following sections:

Construction Activities and Timing

Construction Years -2 and -1, and Operational Years 1 to 5

During this period, construction of access roads, haul roads, rail spur, conveyor, and gas supply pipeline will pose the greatest threat to aquatic ecology. These features cross the major waterways of the MLA areas (Frank Creek and Woleebee Creek) and the gas supply pipeline (Juandah and Roche Creeks) and construction will require vegetation clearing and earthmoving in the riparian zones. Construction of levee banks along Frank Creek could impact on aquatic ecology via increased turbidity and nutrient levels in these waterways, as well as alteration of aquatic habitats.

Where an appropriate erosion and sediment control plan is followed, vegetation clearing and earthmoving associated with construction of accommodation facilities, the gas fired power station, MIA, pits and dumps are unlikely to pose a significant threat to aquatic ecology. These features are situated away from the main creeks and protection measures such as levee banks (where a pit is at the Q_{100} flood level) and sediment or environmental dams will be constructed.

Alteration of Aquatic Habitat

The deposition of fine sediments has the potential to decrease stream bed roughness and fill in existing pools. Within the minor (first order) tributaries throughout the MLA areas, this would be unlikely to have a significant impact as these streams generally only carry flood flows. However, in larger watercourses (second order and higher) such as Spring Creek, Mud Creek, Wandoan Creek, Woleebee Creek and Frank Creek, sediment deposition would lead to a decline in habitat diversity and a reduction in the number of pools available as refuge habitat in the dry season. These impacts would lead to a decline in the abundance and diversity of both invertebrate and fish communities.

17B.5.6 CREEK DIVERSIONS

The diversion of creeks around the pits will ensure that the waters of the creeks avoid disturbed areas, and maintain downstream flows as much as possible. The diversions will, however, result in the replacement of the existing natural ephemeral watercourses with artificial channels.

Proposed creek diversions will result in the loss of portions of natural watercourses. Levee banks will be constructed between creek diversions and the mining areas where required, in order to maintain separation of clean (natural) waters and 'dirty' (mine) waters during flood events. Creek diversions will be constructed in accordance with the NRW Central West Regional Office guideline document Watercourse Diversions – Central Queensland Mining Industry. Creek diversions will be constructed two years prior to opening them to flows, in order to allow sufficient time for vegetation to establish.

As there are approximately 2,258 km of similar natural waterways within the Southern Tributaries Catchment of the Dawson River (Telfer 1995), the proposed creek diversions are unlikely to have a regionally significant impact on aquatic ecosystems.

Local aquatic flora and fauna are generally tolerant of a range of habitat and water quality. If the diversion channels are well engineered to maintain fish passage and replicate the aquatic habitat

found in the natural creeks, the loss of natural ephemeral watercourse is highly unlikely to result in the loss (even locally) of any species.

The construction of the diversion channels will require clearing and ground disturbance, which provides the potential for increased soil erosion and sedimentation and water turbidity. Diversion of flows from the existing channels to the completed diversion channels may leave fish and other fauna such as turtles stranded unless appropriate mitigation measures are implemented, as discussed in Section 17B-6.6.

17B.6 MITIGATION MEASURES

17B.6.1 OPERATION AND MAINTENANCE OF VEHICLES AND EQUIPMENT

Risks associated with the spillage of fuels and other contaminants will be substantially reduced where:

- vehicle maintenance areas and storage of fuels, oils and batteries within the MIA is undertaken within bunded areas designed and constructed in accordance with Australian Standard AS 1940 – The storage and handling of flammable and combustible liquids
- portable refuelling stations, for refuelling of machinery in the field, are bunded to meet AS 1940 and placed above the Q_{100} flood level of nearby waterways and dams
- all spills of contaminants (such as diesel, oil, hydraulic fluid etc.) are immediately reported to the Project's Environmental Officer
- appropriate spill containment kits are available, and used for the cleanup of spills in the field. Equipment that is susceptible to spills and/or leakages should have a spill kit onboard or within 5 m of the equipment at all times. The kits should contain equipment for clean-up of both spill on land or in dry creek beds, and spills to water (such as floating booms).

17B.6.2 VEGETATION CLEARING AND EARTHMOVING

Risks associated with the clearing of vegetation will be substantially reduced where an Erosion and Sediment Control Plan (ESCP) is developed (as a part of the EM Plan and Plan of Operations) to minimise the quantity of sediment run off into waterways during construction and operation of the Project. This ESCP will incorporate the following elements where possible and practicable:

- construction of the pipeline in the dry season
- staging of earth moving and vegetation clearing
- use of erosion controls technologies as appropriate
- rehabilitation of vegetation after clearing, including the establishment of ground cover
- rehabilitation of instream aquatic habitat after clearing, including bed and bank rehabilitation.

Timing

Vegetation clearing and earthworks will be done in stages over the life of the mine. During each stage of construction, sediment and environmental dams and levee banks will be constructed to protect natural waterways from sediment-laden runoff.

The risk of sediment runoff impacting nearby waterways will be further reduced where the timing of clearing and earthworks within 100 m of a major waterway (e.g. Frank, Woleebee, Wandoan, Blackant, Mud, Mount Organ and Spring Creeks) is done in the dry season. However, this will be subject to the overall mine schedule and duration of activities adjacent to watercourses.

Erosion control and sediment control

During and after construction and other land disturbance during operations, water quality and ecosystem health of nearby waterways will be protected where practicable by:

- erosion control matting (or mulch), placed along ditches and drainage lines running from all cleared areas, especially on slopes and levee banks
- contour banks, ditches or similar formed across cleared slopes to direct runoff towards surrounding vegetation and away from creeks
- monitoring water quality of creeks.

Further discussion on erosion and sediment control measures is provided in Chapter 9 Geology, Mineral Resources, Overburden and Soils and the associated technical report.

Rehabilitation of vegetation

After construction and other land disturbance during operational activities, water quality and ecosystem health of nearby waterways will be protected by rehabilitation of the landscape by:

- salvaging and appropriately storing and maintaining selected native grass, shrubs and trees prior to clearing

• use of native vegetation of local provenance for replanting where possible
• replanting along creek margins (e.g. following construction of creek crossings). The width of the replanted riparian vegetation should match the existing riparian vegetation. However, 5 m should be the minimum width. Planted trees in the riparian zone should provide canopy cover and have root systems that can stabilise the banks and disturbed area.

17B.6.3 WASTEWATER AND STORMWATER

The quality of waters released from the MLAs area, unless designated as clean stormwater, should be similar to that of the receiving waters. As a guide, Table 17B-6 presents preliminary discharge water quality objectives, based on the water quality recorded during the current studies and published environmental tolerances.
When possible, the discharge of water from the sediment dams to the natural environment should be managed to coincide with natural flow events, minimising disruption of cues for reproduction and/or migration of aquatic fauna.
Table 17B-6: Preliminary water quality objectives for the discharge water quality required to maintain the natural fish communities of the region

17B.6.4 WATER SUPPLY

Transfer of exotic fish species

The use of water from Glebe Weir during the Project could increase the opportunity for mosquitofish and goldfish to become more widely distributed through the region. The significance of this impact is being considered as a part of the Glebe Weir Raising and Pipeline impact assessment (Volume 4 of the EIS). The requirement for screens on the pipeline intake to prevent the transfer of exotic fish will be subject to negotiations with DPI&F.
The WJV will ensure that the dams on the MLAs area are free from noxious species on a regular basis.

17B.6.5 LOSS OF CATCHMENT AREA

The loss of catchment area could reduce the magnitude of freshwater flows to the receiving environment. This may be mitigated through:
• Not discharging treated stormwater to the natural receiving environment during dry periods, to minimise potential local impacts to the timing, duration and magnitude of flows in the creeks, which can each be important cues for reproduction and/or migration of aquatic fauna.
Regional impacts from a loss of catchment are not expected.

17B.6.6 CREEK DIVERSIONS

To effectively mitigate the loss of on site aquatic and riparian habitat, diversions will be designed and constructed to provide bed and bank habitat of a similar character to that of natural watercourses within the region. Key considerations include:
• diversion low flow channels will provide a stable, sinuous channel, of dimensions similar to the existing natural channel, and that will maintain a similar flow to the existing natural channel. Bends and varying depth contours in particular are important in maintaining habitat diversity and refuge areas for fish and other fauna during periods of high flow. Other important physical features of a creek to replicate include sediment type, in-stream habitat availability (e.g. tree roots, logs, boulders etc.) and riparian vegetation. This may include the placement of boulders or logs and branches from vegetation clearing into the channel.
• Diversions will only be opened to flows once geotechnical stability and vegetation requirements have been satisfactorily established. Until this time, the existing channels will continue to function normally.
• Designing diversions channel to have water velocities of ≤0.3 m/s facilitate passage of all native fish species (Cotterell 1998). During flood flows, the time that the channel has water velocities of >1 m/s should be minimised as this will likely impede all fish passage (Cotterell 1998).
• Where practicable, diversion channels will only be initially opened to flows in the dry season (May – September). This will minimise any impacts to fish movement and reproduction that may be occurring in the sections of creeks to be diverted.
Prior to construction of the creek diversions, approvals will be required from the EPA under the *Environmental Protection Act 1994*, the NRW under the *Water Act 2000* and the DPI&F under the *Fisheries Act 1994*. Preliminary recommendations for the design and construction of each creek crossing are presented below. However, these are based on preliminary information only from the survey of one or two sites on each creek.
For further details associated with creek diversion mitigation measures, refer to Sections 7.6.1 and 7.6.2 of the technical report TR 17B-1-V1.5.

Stranding of fish and other aquatic fauna

Opening any diversion channels in the dry season (May – September) will minimise the number of fish that are likely to become stranded in the section of creek to be diverted. If pools remain in the section of creek to be diverted, fish and other aquatic fauna will become stranded once the section is isolated. Once flow is diverted from the existing channel, stranded fish will be captured and translocated to either the diverted creek or upstream of the diverted creek, following the DPI&F Fish Salvage Guidelines (DPI&F 2004), which recommend that:

- fish should be captured from the creek to be diverted using gear appropriate to the waterways and species present
- translocation should be done in the cooler months if possible, to minimise stress to the fish
- fish should be removed from the existing channel before water flow is isolated from the channel
- fish should be handled, transported and released so as to minimise damage to the fish.

The capture of fish using electrofishing, traps, bait nets or cast nets requires a General Fisheries Permit, issued by the DPI&F. The capture, handling and translocation of fish and other fauna will also require an Animal Ethics approval.

In large pools, traps will be set to capture turtles. If caught, turtles should also be transported and released to a relatively permanent waterhole in the study area, in accordance with ethical handling procedures.

17B.6.7 CREEK CROSSINGS

Construction of permanent creek crossings

Impacts associated with the construction of permanent creek crossings by roads, the rail spur, conveyors, or other linear infrastructure will be minimised if:

Dry season

- crossings are located to result in minimal disturbance to vegetated areas
- construction is undertaken during the dry season, thereby minimising the likelihood of rainfall and runoff carrying sediment and other pollutants into the creeks
- stormwater, and erosion and sediment control measures are implemented
- crossing construction methods minimise disturbance to aquatic habitat and fish passage.

Wet season

Where practicable, the workspace is isolated, irrespective of if there is an isolated pool or flowing water. The isolation will be designed such that:

- it is completed within one work-day, to minimise the impact on aquatic fauna
- upstream and downstream dams are installed on the edge of the temporary workspace, to maximise the workspace. These dams should:

□ be constructed of an appropriate material for each creek (e.g. steel plates, flumes, sand bags or aquadam)
□ be made impermeable by using polyethylene liner and sand bags
□ if flowing water is present, 100% downstream flow is maintained by using appropriately sized pumps
□ pump intakes must have a screen, with openings no larger that 2.54 mm, to ensure that no fish are entrapped
□ fish must be salvaged from the isolated workspace and translocated
□ the upstream dam is slowly removed, to allow water to flush the sediment from the workspace area
□ sediment-laden water should be pumped into sumps or onto vegetation
□ operation of the clean-water pump to sustain partial flow below the downstream dams must be continued until the downstream dam is removed.

Construction of temporary vehicle creek crossings

Impacts associated with the construction of temporary road crossings will be minimised if crossings:

- are constructed during the dry season
- follow the guidelines presented above for permanent creek crossings
- have bed and bank habitat rehabilitated after removal of the temporary crossing.

Rehabilitation of instream aquatic habitat

Prior to and following land disturbance of creek crossings, impacts will be mitigated by:

- Salvaging existing bed material prior to construction and placing it back into the creek at completion of construction. If the existing bed material is unable to be salvaged, a comparable sediment size material is recommended to cover the bed and should be approximately 10 cm thick. If the sediment is fine (mud and/or silt), it is recommended that the bed material be replaced with sand, to prevent future erosion.

If the sediment is coarser (gravel, cobble, pebbles and/or boulder), new material must be washed prior to placing in the creek, as usually new coarse substrate is covered in a fine dust, which will become suspended in the water.
• Rehabilitation of the bed and bank structure such that original dimensions and shape of the creek are achieved. Bank recontouring will include stabilisation methods, such as crib walls or soil wraps, where appropriate.
• Revegetation of creek banks.
• Aquatic habitat structures are replaced within the channel. Prior to construction, any instream structures (woody debris, large cobbles) should be salvaged where practicable. Felled trees should also be placed into creeks to create woody debris habitat.

Obstruction of fish passage

Ford crossings can be used for crossings of small gullies and first order streams without having major impacts on fish movement throughout the study areas.
Where practical, bridges are preferred to culverts for crossings of the larger streams in the MLA areas (e.g. Frank, Woleebee, Wandoan, Blackant, Mount Organ, Mud and Spring Creeks).
Where culverts are used, their design and installation will potentially significantly influence fish passage. DPI&F will be consulted during stream crossing design, siting and maintenance. DPI&F guidelines for the design of culverts state that culverts should be designed such that they are:
• located at least 100 m from any other waterway barrier on the creek (e.g. road crossing and, dam) in order to minimise the cumulative effects of fish barriers as short and wide as possible, whilst allowing the passage of anticipated flood volumes, associated debris and enough water depth to facilitate fish movement (estimated at greater than 0.5 m depth for the fish species likely to be present)
• open-bottomed if possible, to retain the natural morphological features of the stream. If this is not possible, culverts should be countersunk below the stream bed and natural materials such as rocks secured to the base of the culvert to increase roughness and reduce water velocity (water velocities of less than or equal to 0.3 m/s are likely to facilitate passage of all native fish species; velocities of greater than 1 m/s will likely impede all fish passage)
• constructed without a 'drop off' at the culvert outlet, as this impedes fish migration upstream
• constructed with minimum disturbance to the outer banks on stream bends, as these are usually the most unstable and prone to erosion
• surrounded by riparian vegetation (that is planted after construction if necessary) to stabilise banks, provide food and habitat for fauna and prevent predation of aquatic fauna by birds.
Where practicable, culverts will be installed at the driest time of year (preferably in the dry creek bed, avoiding pools), in order to minimise erosion and to reduce the impacts of construction on fish migrations (which, within the study area, are likely to be triggered by rain and the onset of corresponding flows). During the wet season, isolation methods should be in accordance with those outlined in Section 17B.6.7.
Culverts will be maintained so that there is regular removal of debris or plant growth.

Gas supply pipeline

The guidelines presented in Section 17B.6.7 apply to the temporary disturbance of the creeks associated with the installation of the gas supply pipeline. Appendix 17B-2-V1.4 contains specific mitigation measures for the pipeline crossing of each waterway. Fish salvage methods are described in Section 17B.6.6 and water quality monitoring is described in Section 17B.6.10.

17B.6.8 BITING INSECTS

Minimisation of Breeding Habitat

Mosquito breeding habitat should be minimised through:
• minimising the area of standing water and ensuring drainage within 4 days
• grading to ensure sufficient drainage
• during construction, routinely filling incidental depressions and holes that may hold standing water
• regularly clearing drainage lines to ensure that water continues to flow and no ponded areas are created
• constructing dams and water storages intended to contain stormwater and wastewater with steep edges in order to minimise the extent of shallow water, which can provide breeding habitat.

Design and engineering

Mosquitoes are less likely to pose a health risk where:

• there is more open window area on the windward side of buildings (rather than the leeward) which passively 'pressurises' a building and reduces opportunities for biting insects to enter from the preferred leeward side
• buildings are fully screened to prevent insect entry
• ceiling fans or air conditioning are installed to increase airflow.

Control of biting insect populations

Natural control using native fish

Where water quality is acceptable and practicable to do so, native larvivorous fish can be stocked into sediment dams and the raw water storage dam on-site to assist mosquito control (water quality in the tailings dam and the environmental dams is unlikely to support fish). Suitable local fish species include Agassiz's glassfish (*Ambassis agassizii*), eastern rainbowfish (*Melanotaenia splendida*) and carp gudgeons (Hypseleotris sp.). These fish can be obtained from some aquariums and from registered fish hatcheries (DPI 2004). Previous studies have suggested that fish stocking densities of around 1 fish per m_2 of potential breeding habitat (i.e. shallow habitat around the margin of a waterbody that may support aquatic macrophytes) should be sufficient to control mosquito populations (frc environmental 2002).
In order for stocked fishes to effectively control mosquito breeding, they must be allowed to develop sufficiently abundant populations and must be able to get to locations used by mosquitoes for breeding. In effect, this requires permanent and relatively stable water quality and sufficient depth of water to allow the fish access to potential breeding habitats.

Chemical control of mosquitoes

Chemical mosquito control is based principally on the application of larvicides. These larvicides are relatively target-specific, and are appropriate for use in the Project area. Complaints by Mine employees or surrounding residents should primarily determine the requirement for application of larvicides in breeding habitats. If complaints are received, breeding habitats should be determined by conducting a survey of breeding habitat, by dipping for larvae along the margins of waterbodies on the site. When a high abundance of mosquito larvae are found in a dip sample (greater than 10 larvae per dip), treatment of the waterbody with a commercial larvicide, such as Altosid 30 day briquettes, may be warranted.

Chemical control of midges

Biting midges cannot be treated by chemical means within breeding areas due to the toxicity of midge adulticides (such as Bifenthrin) to other organisms. Control of biting midges needs to include site specific studies of where midge populations are coming from before control measures such as barriers/fences (which may be treated with 'Bistar', a midge adulticide containing Bifenthrin) can be effectively implemented.

17B.6.9 THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

The Project associated with the MLA areas and gas supply pipeline is highly unlikely to have an impact on any threatened aquatic species or ecological communities as none are likely to occur in the waterways of the MLA areas or along the gas supply pipeline.

17B.6.10MONITORING REQUIREMENTS

Turbidity monitoring

Monitoring of turbidity levels in the creeks will occur at least:
• on a monthly basis in waterways throughout the MLA areas and in the creeks crossed by the gas supply pipeline immediately prior to pipeline installation, in order to determine background turbidity levels
• during periods of rainfall in creeks that are within 500 m of vegetation clearing earth moving activities
• daily when constructing permanent or temporary creek crossings.
Turbidity levels should not exceed 10% above background during construction. If turbidity levels exceed 10% of background concentrations, construction will cease, and stormwater and erosion and sediment control measures be revised prior to re-commencement of construction.
Other water quality monitoring mitigation measures are further discussed in Chapter 11 Water Supply and Management, and the associated water quality technical report.

Aquatic ecology monitoring

A long-term aquatic ecological monitoring program will be required to monitor the impacts of the Project of the waterways within and downstream of the Project area and to contribute to the ongoing improvement and effectiveness of the Project's environmental management plan. The monitoring program should be designed to detect changes to the physical environmental and ecological communities within the waterways, thereby providing the opportunity to prevent further damage if impacts are detected.
Monitoring will occur at approximately five sites within the MLA areas five sites

downstream of the MLA areas, and five comparison (reference) sites that will not be impacted by the Project. Each site should be approximately 100 m in length. Sites should also be established on the diversion channels once they are commissioned. Two monitoring events should be completed each year, one in the early wet season and one in the late wet season. At least two baseline survey events should be completed prior to the commencement of construction.

The monitoring program will include quantitative, replicated monitoring of water quality, aquatic habitat, macrophytes and aquatic fauna (focussing on macro-invertebrates and fish).

Water quality and aquatic habitat

Water quality and aquatic habitat will be assessed in accordance with AusRivAS protocols. The percent cover of each macrophyte species present will also be assessed at each site. This information will be compared among creek sections (within the MLA areas, downstream of the MLA areas and comparison sites) for each survey event using one-way Analysis of Variance (ANOVA). This information may also be used in multi-variate analyses of fish communities.

Macro-invertebrates

A statistically valid monitoring program, as described in TR 17B-1-V1.5 Section 7.10.2, should be developed in order to assess impacts on macro-invertebrate communities.

Fish communities

Fish communities will be surveyed using gear types appropriate to the conditions at each site. This may involve the use of one, or a combination of, the following gear types:

- backpack or boat electrofishing units
- seine nets (approximately 10 mm mesh size); gill nets (75 mm and 150 mm mesh)
- baited traps (of 2 mm and 20 mm mesh)
- dip nets (of 2 mm mesh).

Any electrofishing will be conducted strictly in accordance with the Australian Code of Electrofishing Practice. General Fisheries and Animal Ethics permits will be required to complete the monitoring.

At each site, the species captured and the abundance of each species by life history stage (juvenile, intermediate, adult) will be recorded, along with the apparent health of individuals. Specimens which cannot be identified in the field should be euthanised and preserved for later identification.

The richness, total abundance, abundance of 'key' species and abundance of each life history stage should be compared among creek sections for each survey event.

The relationships between fish communities among different creeks and within the habitats present at each site should be determined.

Monitoring of dams for exotic species

The dams on-site (in particular the raw water storage dam) will be monitored for the establishment of exotic species. This can be done in conjunction with the aquatic ecology monitoring program. Fish will be surveyed using a combination of boat-based electrofishing, set traps and seine nets. If exotic species are discovered, management will be addressed and implemented as part of the Pest Management Plan, as further described in Chapter 17A Terrestrial Ecology.

17B.7 RESIDUAL IMPACTS

17B.7.1 OPERATION AND MAINTENANCE OF VEHICLES AND OTHER EQUIPMENT

Where fuel storage and handling activities are undertaken in accordance with AS1940 Storage and Handling of Flammable and Combustible Liquids – encompassing spill containment and response protocols and appropriate spill kits are carried in the field, the risk from a fuel spill to aquatic ecology is considered to be very low. The risk to aquatic ecology from spilt litter and waste from the MIA and accommodation is also likely to be very low.

17B.7.2 VEGETATION CLEARING AND EARTHMOVING

Where the mitigation measures are adopted, an appropriate Construction Management Plan is followed and turbidity is routinely monitored in the creeks, it is considered unlikely that construction-related increases in turbidity or nutrients in the waterways of the study area will have a significant ecological impact.

17B.7.3 WASTEWATER AND STORMWATER

Stormwater

Release of water of an acceptable quality from the sediment dams is not expected to have a negative impact on aquatic ecology. The impact of small outflows in the wet season would not have a discernable impact when compared to the naturally occurring flows.

Release in the dry season may result in the creation of permanent pools that act as refuge habitat in the creeks and may also trigger fish movement and possibly spawning in the creeks.

Industrial wastewater

Contaminants will be unlikely to impact on aquatic ecology where the Water Management System (WMS) is successful in ensuring that there is no mine water discharge from the site.

Accidental spills from environmental dams AU-E1, MC-E2, SH-E3, and WS-E1 would not be expected to have a large impact on aquatic ecology as these dams are situated away from major creeks and any overflow would be subject to infiltration before the water reached any major creek. However, the tailings dams and environmental dams AU-E2, W-E2, and AU-E4 are in close proximity to Woleebee Creek. A spill from these dams would be expected to have localised impact on the aquatic flora and fauna of this creek and (potentially) some nearby downstream reaches of Juandah Creek. However, no impacts would be expected to waterways further downstream, such as the Dawson River, due to dilution and dispersion of the contaminants.

Domestic wastewater

Sewage has the potential to be accidentally discharged to Woleebee, Frank or Juandah Creeks from the two pump stations. The impacts of nutrient enrichment and any algal blooms due to a sewage spill would also be expected to be short-lived and affected aquatic communities would be expected to recover from such an impact. Therefore, eutrophication of the waterways due to a sewage spill is considered to be a low risk to aquatic ecology.

17B.7.4 WATER SUPPLY

Potable water supply

There will be a short-term, reversible impact to aquatic ecology where pipelines are installed across creeks. Where construction of the potable water pipeline from Wandoan follows the mitigation measures for pipeline construction and creek crossings, no long term impacts to surface waterbodies are expected from the use of Great Artesian Basin water for potable purposes.

Glebe Weir – Dawson River

Where screens are fitted to the intake pipe and are regularly maintained and tested, the opportunity for exotic species to become established within the study area will not be significantly increased above the current situation, as mosquitofish and goldfish are already established within the catchment.

Coal seam methane by-product water

Water supply from CSM by-product water is unlikely to have a significant impact on the aquatic ecology of the natural waterways within the study area. Chapter 17B Aquatic Ecology of Volume 2 describes the risk and mitigation measures necessary to prevent transfer of the declared noxious carp (*Cyprinus carpio*) from the Condamine catchment.

Discharge from raw water storage dam

The raw water storage dam would only be expected to overflow during periods of significant rainfall. Discharge from the raw water storage dam would not be expected to have a discernable impact on aquatic ecology.

17B.7.5 LOSS OF CATCHMENT AREA

The diversion of runoff from approximately 8,500 ha of upper catchment area to the site water management system due to the creation of pits is unlikely to have a regionally significant impact. Locally, a reduction in flows to the creeks could negatively impact on the abundance and diversity of macrophyte, macro-invertebrate and fish populations within the creeks of the MLAs. However, this would not be expected to have an impact on aquatic communities of Juandah Creek or waterways further downstream, such as the Dawson River.

17B.7.6 CREEK DIVERSIONS

At least 20 km of natural watercourse will be lost, including reaches of Spring, Mt Organ, Mud, Woleebee and Frank Creeks and an un-named tributary of Juandah Creek. However, if the diversion channels are well engineered to maintain fish passage and replicate the aquatic habitat found in the natural creeks, this loss of natural ephemeral watercourse is highly unlikely to result in the local loss of any species of aquatic flora or fauna.

The proposed diversions are unlikely to have a regionally significant impact on the abundance of aquatic flora and fauna, on the diversity of aquatic communities, or on aquatic ecosystems functioning.

17B.7.7 CONSTRUCTION OF CREEK CROSSINGS

Construction of creek crossings will result in a temporary disturbance to aquatic and riparian habitat. If these habitats are appropriately rehabilitated, there will be no

permanent local or regional impact.
When there is water present in the channel, there will be a temporary impact to fish passage during construction activities. There may also be impacts to water quality; however, these will not be significant in a local or regional context if appropriate erosion and sediment control measures and monitoring are put in place.

17B.7.8 BITING INSECTS

Construction and operational activities that result in pooled water will potentially provide an increase in mosquito and biting midge breeding habitat in the study area. During the operational phase, dams have the potential to provide additional breeding habitat for these organisms. An increase in the population of mosquitoes and biting midge has the potential to impact on human health. However, the impact of mosquitoes and biting midges on human health can be minimised through appropriate education, breeding control, engineering and building design.

17B.7.9 SIGNIFICANT CONSERVATION HABITATS

The Project MLA areas and gas supply pipeline will not impact on any significant aquatic conservation habitats, including those that are listed under State or Commonwealth legislation.

17B.7.10THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

The Project MLA areas and gas supply pipeline are highly unlikely to have a significant impact on any listed threatened species or communities that are listed under State or Commonwealth legislation.

17B.8 CONCLUSIONS

The biological values of aquatic ecosystems within the study areas are relatively low and consistent with those of the wider catchment. Environmental values are dictated primarily by the ephemeral and intermittent nature of the region's waterways; although surrounding land uses, including vegetation clearing, cattle grazing and cropping, have negatively impacted the aquatic habitat of the study area and the wider catchment. Water quality is relatively poor, and reflects the predominantly agricultural nature of the region and the ephemeral nature of the creeks. However, the aquatic habitat of the study areas are considered to be in a moderate condition overall, with many of the sites surveyed supporting large trees in the riparian zone and characterised by a variety of aquatic microhabitats.
Biodiversity in the study area is slightly lower than that found in the more permanent waters of the region (such as the Dawson River). Only fish and macro-invertebrate species that are tolerant of varying and often harsh conditions inhabit the study area; that is, communities typically have a low sensitivity to changes in water levels and water quality. However, macro-invertebrate and fish communities found within the MLA areas are likely to contribute to the success of downstream populations through movement/migration.
Flow is an important cue for migration and reproduction in many of the species recorded in the study areas. One species of freshwater turtle (the Krefft's river turtle) was found downstream of the MLA areas in Juandah Creek. However, turtles are unlikely to be abundant in the ephemeral creeks of the study areas at any given time. No rare or threatened aquatic floral or faunal species were found in the study areas, or are considered likely to occur, based on the habitats present.
The coal resources of the Project will be developed as an open-cut mine and related local infrastructure. Construction and mining activities, including the operation of vehicles and other equipment, vegetation clearing and earth moving, creation of wastewater in association with the required infrastructure, management of stormwater runoff, creation of dams; construction of creek crossings, creation of stream diversions, and the loss of catchment area, each have the potential to impact on aquatic ecology.
The potential impacts of fuel handling, vegetation clearing, dam operation and stormwater discharge on the creeks within the study areas (and downstream waterways) can be minimised if current best practicable practice environmental management programs are followed.
The Project MLA areas and gas supply pipeline are highly unlikely to have an impact on boggomoss springs, the Great Barrier Reef World Heritage Area or the Shoalwater and Corio Bays Ramsar site. The Project MLA areas and gas supply pipeline are unlikely to impact on any threatened aquatic species or ecological communities (as listed under State or Commonwealth legislation), as these species and communities are unlikely to occur in the waterways of the MLA areas or along the gas supply pipeline.
In summary, the Project MLA areas and gas supply pipeline are not likely to impact on MNES with respect to aquatic ecology.
Of the potential impacts of the Project MLA areas and gas supply pipeline on the creeks of the study areas, the diversion of creek channels, and the construction of creek crossings

(which can affect fish movement) could result in the greatest impact to the aquatic environment. However, the significance of any potential impacts can be reduced if appropriate mitigation measures are followed. In particular, the channel morphology and aquatic habitats of the creeks to be diverted should be surveyed in detail, so that the diversion channels can be constructed so that they replicate the natural channels in terms of channel morphology, sediment type, instream physical habitat and riparian vegetation. Creek crossings should be constructed in accordance with the recommendations in the DPI&F Fish Habitat Guideline FHG 001, Fish Passage in Streams, Fisheries guidelines for design of stream crossings (Cotterell 1998).

Taking into account the low existing biological values of the aquatic environments of the study area, in general, the impact assessment demonstrates that there will be only a low magnitude of impact to the local aquatic environments of the MLA areas and gas supply pipeline alignment, and negligible regional impacts. However, future water quality and aquatic ecology monitoring will be required to determine the impact of the Project on aquatic ecology, in order to inform adaptive management of the Project.

17B.9 SUMMARY OF COMMITMENTS AND MITIGATION MEASURES

Mitigation measures to avoid, minimise and mitigate potential impacts of the Project MLA areas and the gas supply pipeline to aquatic flora and fauna, as previously detailed in this chapter, are summarised below:

- Fuel storage areas will meet AS 1940, to contain any fuel spills or the runoff of other contaminants. Appropriate spill containment kits will be available and used for the cleanup of spills.
- Mobile fuel stations, for refuelling of machinery in the field, will bunded to meet AS 1940, and placed above the Q_{100} flood level of nearby waterways and dams.
- An erosion and sediment control management plan will be developed (as a part of the EM Plan) to prevent excess sediment from running off into the creeks during earth moving and vegetation clearing related to construction and operation of the mine.
- Where practical, clearing and earthworks within 100 m of a major waterway (Frank, Woleebee, Wandoan, Blackant, Mud, Mount Organ and Spring Creeks) will be done within the dry season.
- Erosion control matting (or mulch), placed along ditches and drainage lines running from all cleared areas, especially on slopes and levee banks.
- Contour banks, ditches or similar will be formed across cleared slopes to direct runoff towards surrounding vegetation and away from creeks
- Monitoring water quality of creeks will be undertaken
- After construction, native vegetation will be replanted where possible, and along creek margins where riparian vegetation has been cleared, to a width that matches the existing riparian vegetation (but at least 5 m). Species planted should be the same as the plants naturally found in the riparian zone, and should provide canopy cover and have root systems that can stabilise the banks and disturbed area.
- Where practicable, water should only be released from sediment dams during periods of rainfall and flow in the natural waterways. Water quality of the released water should be maintained at levels similar to those recorded naturally in the study area during periods of rainfall.
- When possible, the discharge of water from the sediment dams to the natural receiving environment should be managed to coincide with natural flow events.
- The creek diversions should be designed and constructed to provide bed, bank and instream habitat of a similar character to that of natural watercourses within the region.
- Prior to diversion, the sections of creeks to be diverted will be surveyed in detail, and used as a basis for designing bends, pools, bars in detailed design of each diversion. Where possible, the natural channel features of each creek will be incorporated into the diversion design.
- The success of rehabilitation and erosion and sediment control methods will be monitored, and the diversions will only be opened to flows once geotechnical stability and vegetation requirements have been satisfactorily established.
- Construction of the Woleebee Creek diversion is proposed in three stages, starting in Year 10 and finishing in Year 12. Sufficient time must be allowed for the habitats within the entire diversion channel to establish prior to commissioning (estimated to be at least two years). That is, if construction finishes in Year 12, the channel should not be opened to flows until at least Year 14.
- The channels of Blackant and Wandoan Creeks will remain open during the construction of the Woleebee Creek diversion, with the diversion channel being built either side of the banks. These banks will only be redesigned to direct flows into the new diversion channel immediately prior to opening it to flows. Reinforcing the banks

of Blackant and Wandoan Creeks with hard structures such as crib walls or riprap if required in these locations would be acceptable.
• Once flow is diverted from the existing channel, stranded fish and turtles will be captured and translocated to either the diverted creek or upstream of the diverted creek, following the DPI&F Fish Salvage Guidelines (DPI&F 2004) and ethical handling procedures.
• Where practicable, construction of road and rail crossings will be undertaken during the dry season. However, stormwater and erosion and sediment control measures will still be put in place during construction.
• In the detailed design phase, where practicable, the exact location of the crossings will be sited so that the minimum number of riparian trees needs to be cleared. Trees that are cleared will be anchored into the stream bed (for example by partial burial of the use of boulders), to enhance in-stream habitat in the creek.
• After removal of a temporary crossing, the rehabilitated bed and bank structure should mimic the existing dimensions and shape of the watercourse.
• At the completion of construction, banks will be recontoured to the original shape and revegetated. Bank recontouring should include stabilisation methods (crib walls or soil wraps) where appropriate.
• Where practicable, existing bed material will be salvaged prior to construction of a temporary creek crossing or pipeline crossing, and placed back into the creek at completion of construction. If the existing bed material was unable to be salvaged, a comparable sediment size material will cover the bed and be approximately 10 cm thick. If the sediment is fine (mud and/or silt), it is preferred that the bed material be replaced with sand, to prevent future erosion. If the sediment is coarser (gravel, cobble, pebbles and/or boulder), the new material will be washed prior to placing in the creek.
• Prior to construction, any instream structures (woody debris, large cobbles) will be salvaged bed and placed back in the creek bed after construction. After construction of a temporary creek crossing or pipeline crossing, the aquatic habitat structures will be replaced in the creeks. Felled trees could also be placed into creeks to create woody debris habitat.
• Where practicable, creek crossings will be constructed in accordance with the recommendations in the DPI&F Fish Habitat Guideline FHG 001, Fish Passage in Streams, Fisheries guidelines for design of stream crossings (Cotterell 1998).
• Culverts will be maintained so that there is regular removal of debris or plant growth, which can impede fish passage.
• Pipeline crossings of creeks will be constructed in the dry season when possible. At the completion of construction, banks will be recontoured to the original shape and revegetated. Bank recontouring should include stabilisation methods (crib walls or soil wraps) where appropriate.
• Where pipeline crossings are done in the wet season, turbidity will be monitored and fish salvaged from isolated areas.
• Mosquito and biting midge breeding habitat will be minimised. All drainage lines will be regularly cleared to ensure that water continues to flow and no ponded areas are created. Where practicable, all dams and water storages created to contain stormwater and wastewater will have steep edges, to minimise the amount of shallow water, which can provide breeding habitat.
• Where practicable , building design and full screening of windows will be used to prevent insect entry and ceiling fans or air conditioning installed to increase airflow.
• Where practicable and the water quality is acceptable, native larvivorous fish should be stocked into sediment dams and the raw water storage dam on-site to contribute to mosquito control at densities of around 1 fish per m_2 of potential breeding habitat. Fish species that occur in the study areas that prey on mosquito and midge larvae are recommended for stocking, these species include Agassiz's glassfish (*Ambassis agassizii*), eastern rainbowfish (*Melanotaenia splendida*) and carp gudgeons (*Hypseleotris* sp.).
• Complaints by Mine employees or surrounding residents should primarily determine the requirement for application of mosquito larvicides in breeding habitats. If complaints are received, breeding habitats should be determined by conducting a survey of breeding habitat, by dipping for larvae along the margins waterways on the site. When a high abundance of mosquito larvae are found in a dip sample (geater than 10 larvae per (cup-sized) dip), the waterway should be treated with a commercial larvicide.
• Monitoring of turbidity levels in the creeks should be completed:
□ on a monthly basis in waterways throughout the MLA areas, and in the creeks crossed by the gas supply pipeline immediately prior to pipeline installation, in

order to determine background turbidity levels
□ during periods of rainfall in creeks that are within 500 m of vegetation clearing earth moving activities
□ daily when constructing permanent or temporary creek crossings.
• Turbidity levels should not exceed 10% above background during construction. If turbidity levels exceed 10% of background concentrations, construction will cease and the erosion control measures in place revised prior to re-commencement of construction.
• A long-term aquatic ecology monitoring program will be implemented, with at least two baseline survey events prior to construction.
• The dams on-site (in particular the raw water storage dam) will be monitored for the establishment of exotic species in these waterbodies. If exotic species are discovered, an exotic species management plan should be developed and implemented.

11 WATER SUPPLY AND MANAGEMENT

11.1 INTRODUCTION

This chapter outlines the existing environment, impacts and mitigation measures associated with the supply and management of water for the Wandoan Coal Project (the Project).
Details are provided of the Project's proposed:
• potable water supply and treatment system
• wastewater collection and treatment systems
• construction raw water supply system
• on-site operational raw water storage and distribution system
• mine site water management infrastructure.

Three potential raw water supply options exist, being southern coal seam methane (CSM) water supply pipeline, western CSM water supply pipeline, and the Glebe Weir Raising and Pipeline (the Glebe Option), with discussion on each of these provided in Volumes 2, 3 and 4 respectively of the EIS. Final selection of the preferred raw water supply option will be subject to detailed design and commercial supply arrangements.

The purpose of the water management system is to mitigate the potential impacts of the mine on local environmental values and manage water-related operational disruptions. The residual impacts of the mine and water management system on flooding, water supplies and water quality are detailed.

Full details of the impact assessment are included in the Water Supply and Surface Water Management Technical Report TR 11-1-V1.5, which includes the Flood Study Technical Report TR 11-2-V1.5, Surface Water Quality Technical Report TR 11-3-V1.5 and Water Management System Technical Report TR 11-4-V1.5. Note that figures/documents with numbering ending in V1.5 refer to figures/documents contained in Volume 1, Book 5 of the EIS.

Figure 11-1-V1.3 shows the relevant Study Area and Project area discussed in this chapter.

11.2 METHODOLOGY OF ASSESSMENT

A number of impact assessment studies have been undertaken for this Chapter: Water Management:
• fluvial geomorphology assessment
• water quality assessment
• conceptual water management system design
• historical simulation water balance assessment
• flood impact assessment.
Water supply:
• water demand assessment
• conceptual water supply system design
• groundwater impact assessment for Great Artesian Basin (GAB).

In undertaking these assessments, the key relevant Acts are the *Water Act 2000* (Water Act) and the *Environmental Protection Act 1994* (EP Act). Other applicable legislation and guidelines are

described in the sections below, which describe the methodology adopted for each impact assessment.

Water Act 2000

In Queensland, the Water Act is the primary statutory document that establishes a system for the planning, allocating and using of non-tidal water. The Act is administered by the Department of Natural Resources and Water (NRW).

The Water Act prescribes the process for preparing Water Resource Plans (WRPs) and Resource Operation Plans (ROPs) for specific catchments within Queensland. Under this process, WRPs are prepared to identify a balance between waterway health and community needs, and to set allocation and management objectives. The ROPs provide the operational details on how this balance can be achieved.

The WRPs and ROPs determine conditions for granting water allocation licences, permits and other authorities, as well rules for water trading and sharing.

The Water Act makes the provision for the preparation of land and water management plans in specific areas. NRW has advised there are no such plans in place in the vicinity of the Project.

The Water Act also specifies requirements for licensing of structures requiring disturbance to the bed and banks of watercourses. Declared watercourses potentially impacted by the Project are listed in Section 11.3.2.

Environmental Protection Act 1994

The EP Act provides the key legislative framework for environmental management and protection in Queensland.

Chapter 5 of the EP Act establishes a process for obtaining an environmental authority (EA) for mining activities. A Level 1 EA (mining activities) is applicable to the Project. In addition, an Environmental Management Plan (EMP) is also required under section 201 of the EP Act.

Under the EP Act, the Environmental Protection Agency (EPA) is the regulatory authority which has responsibility for granting the EA, as well as compliance, auditing and monitoring of the environmental management of the Project mining activities. Conceptual details and design criteria of the water management systems for the Project are described in the following sections.

The Environmental Protection (Water) Policy 1997 (EPP Water) is subordinate legislation under the EP Act that functions as an important tool for ensuring that the broad environmental protection measures are better defined when it comes to the specific issues of protecting water.

11.2.1 FLUVIAL GEOMORPHOLOGY ASSESSMENT

A geomorphology assessment was undertaken to:
- describe the existing topographic, geomorphologic and geological characteristics of the streams within the Project MLA areas, including characteristics that may impact on or be impacted by the Project
- understand the processes that govern the channel and floodplain morphology
- assess channel parameters that can be used for design of civil and mining infrastructure that may affect the streams during the operational phases of the Project.

The assessment comprised a review of available published geologic, soil and geomorphology data and a field survey on 25 and 26 August 2008.

Ten major streams potentially impacted by the Project MLA areas were assessed: Spring, Mount Organ, Mud, Unnamed Tributary of Woleebee, Blackant, Wandoan, Woleebee, One Arm Man, Halfway, and Frank Creeks. These streams are shown in Figure 11-2-V1.3

11.2.5 FLOOD IMPACT ASSESSMENT

It is important to ensure that there is a very low probability that the mine operations could be flooded by creek flooding throughout the mine life. Flood levees creek diversions and other

hydraulic structures such as bridges and culverts for conveyor, road and rail crossings are usually required to ensure operations can be restored shortly after flooding ceases. However, the presence of these structures can impact on flood levels upstream and downstream of the MLAs.

• typically, mathematical computer models are used to develop an understanding of flood behaviour using historical flood records, rainfall records and topographic information of the Project area, and the creek catchments upstream. The guideline document Australian Rainfall and Runoff (Pilgrim, 1999), describes the methodologies which are generally applied, and have been used for this assessment. Full details can be found in the Flood Study Technical Report, TR 11-2-V1.5.

The purpose of this flood impact assessment was to provide the following information:
• the existing extent, level and frequency of flooding in affected waterways, over a range of annual exceedance probabilities (AEPs)
• identification of infrastructure required for flood mitigation, including the management strategies and infrastructure that is needed to minimise impacts on flood levels and frequencies upstream and downstream of the Project Mining Lease Application (MLA) areas
• assessment of the hydrological impacts of the Project, particularly with regard to scouring, erosion, and changes to flooding levels and frequencies both upstream and downstream of the Project.

Only those creeks likely to flood significant areas in the vicinity of the proposed infrastructure and mine operations have been assessed in detail (ie. Two Mile Creek and Duck Creek were not modelled on the basis that proposed works are not proposed on their floodplains).

The assessment was carried out in two parts, with slightly different methodologies in the two areas described in the following sections:
• creeks passing through MLAs 50230 and 50231 (i.e. Juandah Creek tributaries upstream of the Woleebee Creek confluence)
• creeks passing through MLA 50229 (i.e. downstream tributaries of Juandah Creek and Horse Creek).

Creeks passing through MLAs 50230 and 50231

• Estimation of the magnitude and frequency of flood flows using a XP-RAFTS hydrological model. The XP-RAFTS model was calibrated to observed flood hydrographs sourced from NRW stream flow gauge 130344A at Windamere on Juandah Creek, which is located downstream of the MLA areas. The resultant peak design flows were compared with those estimated using a Log Pearson Type III flood frequency curve fitted to the peak annual flow series.

• Identification of the extent of existing flooding for a range of design AEPs using the hydraulic model MIKE11. MIKE11 was used in this area as it allows an assessment of the importance of loss flood storage on downstream flows. This was shown to be important for Woleebee Creek – but less so elsewhere on the site. MIKE21 was also used to help identify flow patterns in the flood plain.

• Preparation of inundation plans using the results of the hydraulic model, in the vicinityof the MLA areas.

Creeks passing through MLA 50229

• estimation of the magnitude and frequency of flood flows using the rational method

• comparison of the magnitude and frequency of flood flows in using the same XP-RAFTS hydrological model that was used for the creeks passing through MLAs 50230 and 50231

• identification of the extent of existing flooding and flow velocities for a range of design AEPs using the hydraulic model, HEC-RAS.

• preparation of inundation plans using the results of the hydraulic model, to highlight existing infrastructure currently affected by flooding in the vicinity of the MLA area.

Impacts and mitigation measures were assessed by modifying the model geometry to reflect the inclusion of proposed stream diversions and flood levees, the outputs included:
• changes to the extents of flooding
• changes to flood levels
• changes to flows

• further details of the methodology can be found in TR 11-2-V1.5.

11.3.4 FLOODING

The maximum recorded flow in Juandah Creek at Windamere streamflow gauge is 891 m_3/s, which occurred in May 1983. The annual series flood frequency curve shown in Figure 11-10 indicates that the design peak 1% Annual Exceedance Probability (AEP) flow (i.e. the flow that has a 1% chance of being exceeded in any year) for Juandah Creek at the Windamere gauge is 1,852 m_3/s.

Figure 11-10: Annual series flood frequency curve–Juandah Creek at Windamere

Peak flood discharges have also been estimated over all significant tributaries for a range of design AEPs.

The extent of flooding in major stream crossing the MLAs is shown in Figure 11-11-V1-3. Full details of the flood impact assessment can be found in the Technical Report TR 11-1-V1.5.

11.4.5 WATER MANAGEMENT SYSTEM

A surface water management system has been devised to mitigate the potential impacts of the Project on receiving water quality, and to protect the operation of the Project from interruptions due to flooding.

The overall guiding principle in the arrangement of the water management system is to wherever possible, separate water of varying quality to minimise the stored volumes of water with high concentrations of contaminants. For the purposes of the Project, three separate water management systems (in ascending order of cleanliness) are considered:
• pit/process dirty water management system – managing water captured in pits and running off dump stations and other areas with the potential to contribute high concentrations of dissolved salts, such as the CHPP and coal product stockpiles
• overburden runoff water management system – treating water running off overburden dumps and other disturbed areas of the site with the potential to have large concentrations of suspended solids
• clean water system – water from undisturbed areas of the MLAs and the catchments discharging through the site from upstream.

Under this arrangement, ten potential discharge points from the MLAs are nominated. All but one (Duck Creek) is located on the northern boundary. Downstream of the discharge points, the receiving waterways make their way to one of four major stream systems crossing the Project area, as summarised in Table 11-2, and shown in Figure 11-2-V1.3.

Pit water/process water management system

While water flows will be carefully managed to minimise the volume of water discharging to mine pits, some will make its way there either via direct rainfall, runoff from and seepage through overburden dumps, or small catchments upslope of pits which cannot be diverted around or *captured in highwall dams.*

The pit water/process water management system comprises:
• small sumps in the pit floor to collect and contain inflows from groundwater seepage and local surface water runoff from the pit floor, highwall, lowall and endwalls
• pit dewatering pumps and associated dewatering pipelines to transfer pit water to the nearest environmental dam, if necessary via a small staging dam
• dirty water drainage system to contain runoff and process water from the disturbed areas and direct it to the nearest environmental dam
• environmental dams to store and contain water from the above sources. Care has been taken in the location of storages and the layout of the drainage system to minimise the areas reporting to *dams, so as to minimise the storage requirements*
• a return water pump station from the environmental dam to deliver stored water to either (in order of priority):
□ a nearby water truck fill station
□ conveyor dump station/crusher dust suppression system
□ the CHPP.

To maximise the opportunity for reusing pit/process water across the site, a water pipeline is proposed to be constructed along the conveyor between the CHPP and the dump stations in the western half of the site. During wet periods, the rate of return from the pits may exceed the capacity of the CHPP to use it, and additional storage will be required.

Water captured in the pit/process water management system will be used as the highest priority water source to minimise the stored quantities of water and hence the risk of offsite discharge.

Overburden runoff water management system

Runoff from active overburden dumps will have high turbidity and will require settlement in sedimentation dams. It is envisaged that in the first instance these dams would be 'ry basins' with low level outlet pipes which would restrict the outflow from the dam, but not permanently contain water. This would allow time for coarse sediments to settle, and if necessary, allow a flocculant to be added to remove very fine sediment to meet allowable turbidity discharge limits. While geochemical testing results indicate that the salinity of runoff from overburden dumps is not likely to be high if the placement of overburden is managed carefully, there is nevertheless some potential for elevated concentrations of dissolved salts and/or metals in the stored water, and provision will be made for a stop valve on all outlets, to prevent discharge if water quality is not suitable.

Most pits are located on ridge tops across the undulating terrain, and drainage generally flows away from the pit areas to the adjacent creeks. Sediment dams are required to intercept sediment laden runoff from these catchments before it reaches the receiving water.

The overburden water management system comprises:
- dirty water drainage system to contain runoff from overburden dumps and nearby disturbed areas and direct it to the nearest sediment dam
- sediment dams to store and contain water from the above sources. Care has been taken in the location of storages and the layout of the drainage system to minimise the areas reporting to dams, so as to minimise the storage requirements. Normal operation is as "dry basins"
- If the dams are operated as wet basins due to elevated salinity levels, to minimise the stored quantities of water and hence the risk of off-site discharge, any water captured and not released will be reused when pit water has been depleted (in order of priority):
  - a nearby water truck fill station
  - conveyor dump station/crusher dust suppression system
  - the CHPP.

Clean water management system

The clean water management system ensures that neither local runoff nor flood waters from the significant creek systems flowing through the Project area enter the mine pits.

The system comprises:
- diversions of streams around active mining areas where the cross creek channels
- flood levees adjacent to pits and dumps to prevent flood waters entering the pits.

Flood levees are sized to provide flood immunity during a 0.1% AEP (1,000 year average recurrence interval (ARI)) design flood event
- highwall bunds and clean water catch drains — to divert minor catchments upslope of highwalls around the endwall. Relatively few are required at Wandoan due to the nature of the site topography and the pit layout. The proposed drains will largely follow existing contours to minimise the risk of erosive velocities.

The design and performance of these components are described in the flood study Technical Report TR 11-2-V1.5.

Staging of mine water management system

The components of the water management system will evolve as the Project expands, to be compatible with the proposed pit layout and mine schedule. Figures 11-16-V1.3 to 11- 18-V1.3 show the mine progression, the areas of disturbance and rehabilitation, and the required water management structures at each stage. Further details are provided in the Technical Report in TR 11-4-V1.5.

Excluding in-pit pump sumps, a total of 39 water management dams are required to manage runoff from disturbed areas during the life of the project. The number of dams increases over time as summarised in the table below.

Table 11-7: Total number of water management dams over project life

The number and characteristics of dams proposed for the site is described in detail in the Technical Report TR 11-1-V1.5. The final configuration of the site dams will be established during later design stages, and will depend on the availability of construction materials and the relative costs of excavation and embankment construction.

Dams containing hazardous waste are not considered referable dams under the Water Act and are instead regulated under the EP Act. Under the definition of hazardous waste in the EP Act, it is possible that the site environmental dams may be deemed hazardous waste dams.

Under the currently proposed mine site water management system, several of the proposed environmental dams meet the storage and catchment criteria that define when a failure impact assessment is required.

There are also several proposed flood levees greater than 8 m high, which will have the potential to store large volumes of water, and thus meet the referable dam criteria. The levees are described in more detail in the Technical Report TR 11-1-V1.5.

The floodplain areas downstream of these structures are sparsely populated, and it is unlikely any would be deemed category two 2 dams. However, a detailed assessment will be carried out following detailed design of any the dam and levee structures, which meet the relevant assessment criteria.

A number of declared watercourses (provisionally declared pending field confirmation by NRW) cross the site. Construction of a number of structures on the MLAs will necessitate disturbance to the bed and banks of these watercourses, and consequently licensing under the Water Act. Details of these structures will be finalised close to the construction date and submitted to NRW with a Water Licence application. The currently expected licensed works and their approximate construction dates are listed below and shown on Figure 11-5-V1.3.

Table 11-8: Works potentially requiring approval

11.5.4 FLOOD IMPACTS

The construction of creek diversions, flood levees, and road, rail or conveyor crossings will potentially result in increased flood levels (afflux) due to reduced flood conveyance capacity on the floodplains.

Works are proposed to manage flood flows around the active mine areas. These in turn could potentially cause:

- increased upstream flood levels due to construction of flood levees and creek diversions.
- increased downstream flood flows and flood levels due to loss of flood storage by construction of flood levees and diversions.

The impact of road bridge and culvert crossings will be relatively small, as all crossings will be low-level structures. For high level conveyor and rail bridge crossings, the impacts will be localised and will not extend upstream of the MLA boundaries.

An assessment of conceptual designs prepared for the proposed stream diversion works at Wandoan, indicates that designs complying with the NRW Watercourse Diversion Guidelines will result in only small upstream flood level increases.

Where the floodplain storage capacity is reduced, it is also possible that downstream flow rate can be reduced. This is potentially the case at Woleebee Creek, where the existing floodplain is very wide, and peak flood flows are significantly reduced as the flood wave moves downstream.

A preliminary assessment of the Woleebee Creek diversion conceptual design, indicates that flood levels downstream of the site could be increased by up to 300 mm downstream of the site. This will have a small impact on the frequency of flooding of the Booral road bridge, and will slightly reduce the flood immunity of the Windamere homestead.

The conceptual diversion designs will be refined during future design phases, and it is possible that the some additional upstream, afflux will be introduced during this process. A detailed assessment of affected properties will be made as part of the licensing process.

A map of flood afflux for the current conceptual diversion designs is shown in Figure 11-19-V1.5. Further details of the flood impact assessment can be found in TR11-2-V1.5.

11.6.4 FLOODING

A system of stream diversions and flood levees is proposed to prevent the ingress of flood waters to the mine pits in events up to the 0.1% AEP (1,000 year average recurrence interval (ARI) design flood event, and to ensure that during Project operations, flow in major streams will pass through the site and maintain downstream processes.

• the diversions and levee structures themselves have the potential to increase upstream flood levels and to impact on the sustainability of the local drainage system through increased flow velocities. The impact of the proposed diversion designs on flood levels was investigated using flood models. The results of the modelling show that at the Woleebee Creek diversion, peak flood flows may increase slightly due to a loss of flood storage, and consequently, downstream peak flood levels in Juandah Creek increase by up to 300 mm during a 1% AEP flood. At other locations, the modelling of the diversion design concept showed limited upstream increases in flood levels.

Refinements of the conceptual diversion arrangements to ensure they meet all current acceptable design criteria, may introduce afflux not currently predicted by the flood modelling. If this is the case, any potentially affected properties and infrastructure will be identified, and the owners notified during the licensing process.

The impact of the proposed diversions and levees on upstream and downstream flood conditions is described in detail in the Flood Study Technical Report TR 11-2-V1.5.

23.5.3 DECOMMISSIONING AND REHABILITATION

Decommissioning and post-decommissioning phase activities and incidents that could involve hazards are:

• unauthorised access to the mine site and dangerous structures and landforms such as high walls, voids, dams and spoil piles, during and after decommissioning — potentially causing falls, drowning, engulfment resulting in injury or death. Events are considered unlikely, and the risk of fatality is expected to be unlikely or rare

• loss of containment of contaminated water from final voids or tailings dams — potentially causing the following environmental impacts: pollution of surface water, impact on water quality and beneficial use, impacts on aquatic ecosystems. The likelihood of impacts from flooding will be minimised by appropriate design of the final landform and storages, and allowance for flood events. These are expected to make any loss of containment an unlikely or rare event.

The main risk remaining post-decommissioning is expected to result from access by individuals to any dangerous structures and landforms that will remain. No section of the local community is expected to be exposed to any significant risk — that is, the combination of the consequence of any adverse event and its expected frequency will not exceed generally acceptable community standards.

23.8 EMERGENCY MANAGEMENT PLAN

For the Project, an Emergency Response and Action Plan (ERAP) that is consistent with the WJV's Crisis Management Plan will be developed in consultation with relevant stakeholders, in particular with each of the agencies of the Department of Emergency Services likely to be involved in any emergency: the Queensland Police Service, the Queensland Ambulance Service, the Queensland Fire and Rescue Service and the Rural Fire Service. The Dalby Regional Council (Council) will also be consulted. The local Counter Disaster Plan and State Planning Policy (SPP) 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide, will be considered in developing the ERAP, and Council will be advised of any implications for the plan that arise from the construction and operation of the Project. In addition, the local health service providers will be consulted to ensure that provision of emergency health care is included in the procedures. WJV will work with local health service providers to ensure that appropriate resources are available in the local area to

address the added demand that the Project is likely to generate. This aspect is discussed further in Chapter 21 Social.
The ERAP will address all relevant risks as identified in Section 23.5 and in the Risk Register that will be maintained and updated through the life of the Project.
The ERAP will be developed to include:
- Emergency Response Procedures
- Emergency Exercises and Drills Guidelines
- Site Incident Management Team Guidelines
- Emergency Assistance to the Community.

The ERAP will identify the primary roles and responsibilities and include provision for regular audit and review, in particular following any incident to confirm that the plan operated as intended or to identify deficiencies.
The Site Incident Management Team Guidelines (SIMT) will control Emergencies that have the potential to escalate to Crisis level and will be aligned to the Xstrata Coal Queensland Crisis Management Manual.
The Emergency Response Procedures will include:
- communication procedures (internal and external)
- duties in the event of an emergency for:

☐ SSE/delegate of SSE
☐ incident controller
☐ persons discovering incident
☐ first response controller
☐ security gate attendant
☐ occupational first aider
☐ emergency response team
☐ area supervisor/manager
☐ mine worker
☐ fire warden.

The risk posed by flooding will vary during the life of the Project as changes occur as part of the Project such as changes in landforms, catchment areas, storage areas, structures and creek diversions as required. However the likelihood of impacts from flooding will be minimised by appropriate design of the final landform and storages, and allowance for flood events. These are expected to make any loss of containment an unlikely or rare event (refer to Chapter 11 Water Supply and Management). Emergency response procedures will be developed and regularly reviewed throughout the Project in response to changes in the site hydrology, mining operations, assessed risk and available controls.
The risks of other natural disasters covered by SPP 1/03 are considered low for the Project, and the management of natural disasters will be adequately covered by the relevant ERAP procedures in collaboration with the emergency services.

Emergency plans to deal with spills of dangerous goods, including the provision of appropriate equipment and training for Project personnel, will be prepared prior to the commencement of each stage of the Project.
These plans and procedures will be reviewed regularly and practised in accordance with the ERAP previously discussed. These exercises would be expected to involve relevant agencies of the emergency services.
The ERAP will include communication arrangements with fire fighting and ambulance backup support from Wandoan, Taroom and Miles as required. Emergency response facilities will be constructed to address the risk of fire, as described below.

Emergency response facilities

A dedicated fire water ring main and hydrant system will be installed at the MIA. Fire water will be held in a raw water storage tank for delivery to the ring main, hydrants and hose reels by a dedicated electrically driven firewater pump set with diesel back up arranged in duty and standby mode. The fire fighting facilities will be approved by the local Queensland Rural Fire Brigade service. All fire fighting facilities and equipment will be installed, serviced, maintained and inspected by certified personnel. All site personnel will be trained in basic fire fighting procedures with hand held extinguishers and selected fire response crews will be trained in more advanced fire control techniques.
The site will have a fire truck or suitably equipped water truck or trailer that can support fire response requirements. Site fire fighting capabilities also will be addressed in the Emergency Response Plan. Induction training will include fire response techniques.
Where appropriate, buildings will be fitted with approved and certified fire detection

(smoke detectors) and sprinkler systems. First aid and fire fighting equipment (hand held extinguishers and fire hoses) will be installed at strategic points within each building. Fire fighting equipment and exit locations will be suitably signed. All work areas will be within the required distance to reach emergency exits.

First aid and emergency response points will be provided at strategic locations during both the construction and operational phases of the Project. An ambulance station will be located together with first aid and health facilities in the MIA with direct access to all parts of the mine and all MIA buildings and facilities.

Appropriately trained personnel will be present on-site throughout the life of the Project to provide first aid and response to on site emergencies. First aid response and provision will be included in the site induction training program that will be provided to all staff members. Outside assistance will be called upon where necessary, including local ambulance and fire services. Refer to the beginning of this section for details of the emergency plan and involvement of emergency services.

'CG-05'

Attachment CG - 5 – Wandoan Coal project Coordinator-General's evaluation report on the environmental impact statement extracts

5.5.2.3 Raw water supply option—southern CSM water supply pipeline

The management of impacts to surface water resources during the construction phase of the proposed pipeline will be closely linked to soil management. Prior to the commencement of any construction activities, an erosion and sediment control plan will be prepared in accordance with *Soil Erosion and Sediment Control; Engineering Guidelines for Queensland* (Institution of Engineers Australia, 1996). The EIS (Volume 2, Section 11.6.1) proposed mitigation measures to minimise impacts at waterway crossings during construction of the proposed pipeline.

The impacts from the proposed pipeline are expected to be minimal due to its design and construction. It is also proposed to be located it at an adequate depth from the bottom of all watercourses crossed to ensure that there is minimal potential for scour and resulting changes to channel morphology. This ensures that operation of the proposed pipeline would not affect the existing stream profile at any of the crossings.

Due to the unlikelihood of any changes to the cross section profile at crossing locations, there will also be no change to the conveyance of any of the waterways and no impact to the flow or flooding regime.

Further details of flooding along the extent of the pipeline route have not been assessed as the proposed pipeline will be constructed below ground and will not impact on flooding either the Dawson River or the Condamine River catchments.

5.5.2.4 Raw water supply option—Glebe Weir raising

The EIS noted the potential hydrological impacts of raising Glebe Weir and supplying the additional high priority demand to the project as follows:

- potential increase in erosion downstream of the dam due to rapid inflation and deflation of fabridam
- increase the extent of flooding upstream of the weir
- impact on Water Allocation Security Objectives (WASOs) for downstream water entitlements
- impact on downstream EFOs.

Flooding and erosion impacts

The project high priority water demand will change the storage level behaviour of the Glebe Weir. Under the current operation strategy, water is released from the weir on a regular basis to top up the downstream storages and, therefore, the water level can fluctuate significantly throughout the year. The high priority demand for the project will require sufficient water to be stored at the weir to supply the mine through extended dry periods. This will mean that the weir will be full to near full more frequently and the water level fluctuations will reduce. The change in operating strategy would improve the opportunity to pump for the three allocation holders located on the Glebe Weir pool.

The proposed inflatable fabridam to raise Glebe Weir could potentially increase flood levels upstream of the dam and erosion downstream of the dam if it is not operated correctly. The proponent has committed to implementing operating rules for the proposed weir to mitigate the impacts for the fabridam based water levels. Also, a fail-safe mechanism will be included so that the fabridam will always deflate when the storage level reaches a set headwater level to ensure that no additional overbank flooding occurs.

Thus under the operating rules discussed in the EIS (Volume 4, Section 8.3.3.1), the weir upgrade will not significantly impact on upstream flood levels or downstream erosion. Further hydraulic analysis is to be undertaken during detailed design to develop operating rules to mitigate any flood and erosion impacts of the raised weir.

5.5.3 Water management

5.5.3.1 Mine water management system

The EIS (Volume 1, Section 11.4.5) presented a surface water management system (WMS), to mitigate the potential impacts of the project on receiving water quality and to protect the operation of the project from interruptions due to flooding. The EIS presented three separate WMSs (in ascending order of cleanliness) as follows:

- pit water and process dirty water management system—managing water captured in pits and running off dump stations and other areas with the potential to contribute high concentrations of dissolved salts, such as the CHPP and coal product stockpiles
- overburden runoff water management system—treating water running off overburden dumps and other disturbed areas of the site with the potential to have elevated concentrations of suspended solids
- clean water management system—water from undisturbed areas of the MLA areas and the catchments discharging through the site from upstream.

The SEIS stated, under the revised mine layout and schedule, there are 12 potential discharge points from the MLA areas. The overflows from the WMS would drain to the four creeks crossing the MLA areas, being Juandah Creek, Woleebee Creek, Mud Creek and Spring Creek, as shown in the EIS Volume 1, Table 11-2.

A water management plan (WMP), prepared in accordance with the DERM *Guideline – Preparation of Water Management Plans for Mining Activities* (2009), is required to ensure the proper and effective management of the actual and potential environmental impacts on surface water values.

Clean water management system

The clean water management system would ensure that neither local runoff nor flood waters from the significant creek systems flowing through the project area enter the mine pits.

The system comprises:

- diversions of streams around active mining areas where they cross creek channels
- flood levees adjacent to pits and dumps to prevent flood waters entering the pits. Flood levees are sized to provide flood immunity during 0.1 per cent AEP (average exceedence probability, that is, a 1000 year average recurrence interval (ARI) design flood event)
- high-wall bunds and clean water catch drains to divert catchments upslope of high-walls around the end-wall. Relatively few are required for the project due to the nature of the site topography and the pit layout. The proposed drains will largely follow existing contours to minimise the risk of erosive velocities.

The draft EA conditions provided in Conditions W23–W37, **Error! Reference source not found.** provided by DERM are sufficient to ensure the suitable preparation, implementation and ongoing review of the project's mine water management system (WMS).

In consultation with DERM, the following conditions are stated to be included in the EA:

- Conditions W25–W28, Schedule 3—that require the proponent to develop a Water Management Plan, in accordance with the DERM Guideline—*Preparation of Water Management Plans for Mining Activities* (2009)
- Conditions W34–W36, Schedule 3—that require the proponent to develop a WMS, to conduct a yearly review of the mine catchments, storage capacity, current storage volumes, transfer capacity, and Standard Operating Procedures of all key infrastructure elements of the mine WMS and update the mine water balance model.

In consultation with DERM, the receiving environmental release criteria, stated in the Conditions W1–W37, **Error! Reference source not found.** must be used, where applicable, for the water balance modelling and design of the components of the WMS.

5.5.4 Watercourse diversions

The proponent has committed to preparing a detailed creek diversion strategy for all proposed creek diversions, with timeframes allowing establishment of stable, vegetated creek channels prior to carrying entire flows of diverted creeks. The creek diversion strategy will be developed to mitigate against flood events, and will form part of the project's Plan of Operations.

Construction of structures on the MLA area would cause disturbance to the bed and banks of watercourses, and consequently require licensing under the Water Act. The SEIS provided an updated list of the works potentially requiring approval.

5.5.7 Flooding

The proponent proposes to implement a system of stream diversions and flood levees to prevent the ingress of flood waters to the mine pits in events up to the 0.1 per cent AEP (1,000 year ARI design flood event), and to ensure that during project operations flow in major streams will pass through the site and maintain downstream processes. As described above in section 5.5.4 (Watercourse diversions), a creek diversion strategy will be developed to mitigate against flood events, and will form part of the project's Plan of Operations.

The proposed diversion designs aim to mimic conditions in the existing channels of the creeks to be diverted, including in-channel storage. This would result in the diversions largely having no impact on the frequency and volume of flows passing to downstream users.

The results from flood modelling for the Woleebee Creek diversion show that it is possible to mitigate the impacts on downstream flooding by re-introducing flood storage in the diverted reaches of the various creeks that contribute to flow in the proposed creek diversion. The final design of the diversion will include this flood storage, which depends on the final mine pit layout and rehabilitation schedule.

The results of the modelling show that at the Woleebee Creek diversion peak flood flows may increase slightly due to a loss of flood storage, and consequently downstream peak flood levels in Juandah Creek could increase by up to 300 mm during a one in a hundred year flood (1 per cent AEP flood).

During detailed design, the proponent proposes to incorporate mitigation measures to confine flood afflux to the MLA areas, though this may not always be possible without sterilising coal reserves.

The EIS noted that the risk posed by flooding would vary during the life of the project (Volume 1, Chapter 23), as changes occur as part of the project (that is, changes in landforms, catchment areas, storage areas, structures and creek diversions as required). The proponent will develop emergency response procedures, which will be regularly reviewed throughout the project in response to changes in the site hydrology, mining operations, assessed risk and available controls.
The proponent has committed to monitor and assess the impacts of flooding during the project, as floodplain works are designed and constructed, to ensure risks to the community and the environment are appropriately identified and mitigated.

8.4.2 Fauna

Mitigation against levee failure
In its submission on the EIS, DEWHA suggested that further mitigation should be proposed in the event that the purpose built levee (on the eastern side of Boggomoss Creek) breaks. The SEIS (Volume 4, Chapter 12) stated that the engineering design of the levee is very secure. During flood events, flood waters would pass down the river such that when the river overtops its banks, the difference between the water level immediately upstream of the weir and that downstream of the weir would be less than 30 cm. By the time the levees are overtopped that difference would only by 20 cm. Hence, there would be no rush of water over the levees that

could lead to failure. In non-flood circumstances, failure would not be expected because the depth of water abutting the levee would be no more than 1.8 m and would be abutting a compacted earth battered structure 12 m wide.

Mitigation against overtopping flood failure

During a flood event, the area downstream of the levee bank (including the boggomoss) will be drowned out by the time the levee overtops, as it normally would prior to the introduction of the levee. By the time the levee overtops, the tailwater level will be approximately 173.3 m AHD giving a drop of only 0.2 m over the levee. The high tailwater will impede flow and will decelerate the velocities relatively rapidly.

The levee will be designed against overtopping failure by providing surface protection such as rock mattresses. In the unlikely event of overtopping failure, the surface protection will be engineered so that failure initiates within purpose-built low levee sections. This will minimise the impact of the downstream flow velocities on the boggomosses.

The low sections of the levee will overtop sequentially. The minimum elevation of the top of bank will be 173.5 m AHD. As this elevation is required to provide the necessary storage, the remainder of the levee will need to be slightly higher than originally designed. The lower sections will be located to direct flow velocities away from Boggomoss 16 so, pending detailed design, will be best located south of Boggomoss 16.

The lateral extent of levee failure will be contained in accordance with the principles of fuse plug design. For example, a vertical concrete retaining wall could be built at each end of each low section to prevent lateral erosion of the levee beyond the low sections. This will limit the higher flow velocities to the desired locations. It will also have the added benefit of limiting the amount of levee embankment material deposited downstream.

Subject to the availability of materials, the internal levee material will be constructed of material with low erodability. This will:

- increase erosion time
- provide gradual rather than rapid failure
- limit the depth of erosion and therefore limit downstream flow velocities and downstream material deposition.

A non-erodable sill will be provided at the base of each low section to prevent potential erosion below FSL. This will prevent the river from re-routing through the boggomoss area in the unlikely event of a levee failure. It will allow the boggomoss to return to natural conditions quickly if a levee failure occurs.