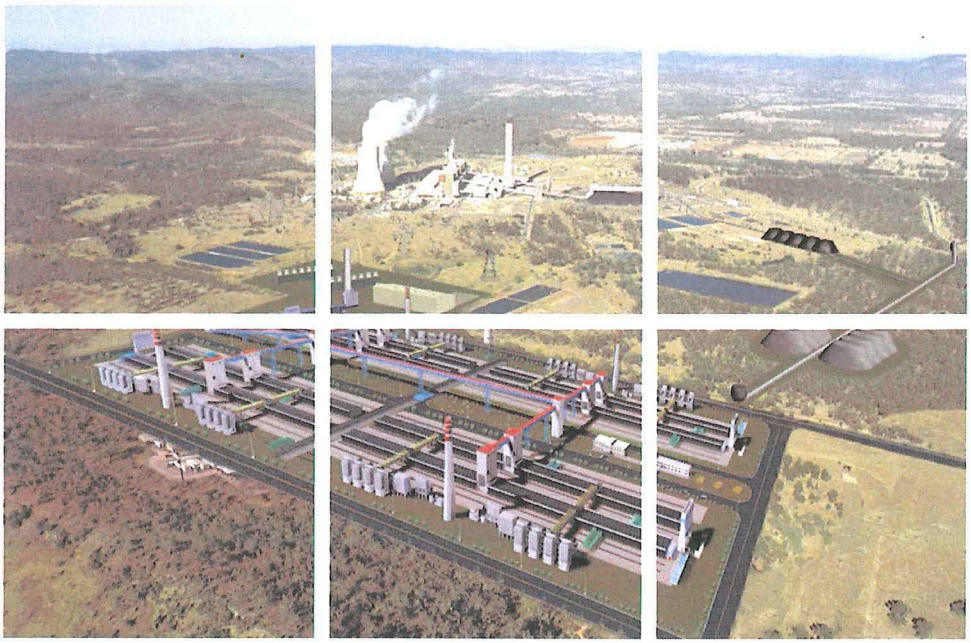
B

Appendix B

Geology, Topography and Soils



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QUEENSLAND COKE & ENERGY

STANWELL CORPORATION LIMITED

Appendix B Geology, Topography and Soils

Appendix B.1 Site/Soil Characterisation

Site ID/ Depth (m)	Terrain Unit	Soil Horizon	Soil Description	Soil pH (1:5 H_2O)	EC (1:5 H_2O) (mS/cm)	Dispersion Class No.	Comments/Soil Classification
CP1:-0-0.15	Ks36	A1	Clay Loam to Light Clay (CL) medium plasticity, dark greyish brown (10YR4/2), weak fine nutty to blocky, crumbly to firm dry consistence (f.d.c.) 30% sub-rounded (s/r) stone to 25mm.	6.8	0.08	3(1)	Hardset surface with small cobles and stone: Db1 13:- Vertic Subnatric-Mesonratric Brown Sodosol.
0.15-0.3		B1	Clay (CH) high plasticity, brown (10YR4/3), strong medium to coarse blocky to prismatic very strong dry consistence (v.st.d.c), smooth ped fabric	7.6	0.52	2(2)	Moderate strongly dispersive
0.5-0.7		B2	Clay (CH) high plasticity, yellowish brown (10YR5/8), massive (v.st.d.c), calcareous flecks	8.3	1.46	6	Highly saline
0.7+		C	HW rock, with dense rock cobbles up to 20cm, underlain by weathered rock	-	-	-	Not sampled
CP2:-0-0.2	Ks36	A1/A2 (sporadic)	Fine sandy silt loam (SM-ML) low plasticity yellowish brown (10YR5/4) massive apedal crumbly to powdery	4.8	0.02	3(3)	Hardset loamy surface duplex soil with yellow-brown clay subsoils (Dy3.33-Db2.33); Hypocalcic Mottled-Subnatric or Mesonatric Brown Sodosol
0.2-0.4		B1	Clay (CH) high plasticity yellowish brown (10YR5/8), mod strong medium to coarse blocky to prismatic (v.st.d.c) diffusely mottled grey brown along structure faces	7.5	0.82	2(2)	Mod. saline and dispersive
0.5-0.7		B2	Clay (CH) high plasticity as above, weak fine to coarse blocky to prismatic tending to massive (v.st.d.c) with soft calcareous inclusions	8.6	1.18	6	Strongly alkaline and saline
1.2-1.3		B-C	Silty clay (CH) high plasticity, light yellow brown and brown (10YR 6/4-5/3) massive, (v.st.d.c) effervescent	8.8	1.19	6	Strongly alkaline and saline
CP3:-0-0.05	Qa2(7-8)	A1	Silty clay (CH) high plasticity dark grey brown (10YR4/2) thin weak self-mulching to fine blocky to prismatic, crumbly (f-st.d.c.)	7.4	0.35	5	Weak surface crust with fine close hexagonal surface cracks; uniform (cracking) clay (Ug5.15-Uf6.32):- Episodic – Endocalcareous Self-mulching Black Vertosol – Sodic Vertic Black Dermosol
0-0.5-0.35		B1	Clay (CH) high plasticity, very dark grey brown (10YR3/2) moderate fine to medium blocky to prismatic (v.st.d.c.)	6.6	0.13	3(3)	
0.5-0.6		B21	Clay (CH) high plasticity dark grey brown	7.6	0.74	2(1)	Some fibrous roots on structure faces

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Site ID/ Depth (m)	Terrain Unit	Soil Horizon	Soil Description	Soil pH (1:5 H_2O)	EC (1:5 H_2O) (mS/cm)	Dispersion Class No.	Comments/Soil Classification
			(10YR4/2), weak, coarse blocky tending to massive (v.st.d.c.)				
1.0-1.1		B22	Clay (CH) high plasticity, brown (10YR4/3) with weak effervescence and some CO_3 concretions, massive (v.st.d.c.)	8.1	0.94	6	
CP4:- 0-0.2	Qa25	A1	Silt Loam (CL-ML) low plasticity, dark brown (7.5YR3/3) weak fine to medium polyhedral tending to massive (f.d.c.) crumbles easily.	5.3	0.02	3(4)	Loamy surface brown duplex soil, (Db1.23); Subnatric or Mesonatric Brown Sodosol
0.2-0.4		A2 (Pale)	Clay Loam to Light Clay (CL) low to medium plasticity, brown (10YR4/3), weak fine to medium blocky to prismatic tending to massive (st.d.c.)	5.3	0.04	3(4)	Strongly acidic and slightly to mod.dispersive
0.6-0.8		B2	Clay (CH) high plasticity, brown (10YR4/3-4/4) weak medium blocky to prismatic tending to massive with depth (v.st.d.c.)	6.6	0.03	3(2)	Representative of 0.4-1.2m layer
1.2-1.4		B2-C	Sandy clay (CL-CH) medium to high plasticity dark yellowish brown (10YR4/6) massive, (st.d.c.) with some s/r-s/a platey gravel	8.3	0.19	3(3)	
CP5:-0-0.2	Qa25	A11	Fine Sandy Loam (SC) just plastic, dark grey-brown (10YR4/3), massive apedal, crumbly friable to partly cohesive, (f.st.d.c.)	5.3	0.0	3(3)	Intensive small hummocky surface mounds due to biological activity, loose, not hard set sandy to loamy surface, brown duplex soils: (Db1.12):- Subnatric Brown Sodosol
0.2-0.4		A12	Fine Sandy Light Clay Loam (SC-CL) low plasticity, brown (10YR4/3), massive tending to weak medium prismatic, crumbly to friable and partly cohesive (f.d.c.)	5.6	0.01	3(4)	Slightly to mod. dispersive
0.6-0.7		B21	Clay (CH) high plasticity, dark yellowish brown (10YR4/4), weak to moderate medium blocky to prismatic tending to massive with depth (v.st.d.c.)	6.5	0.13	5	
1.3-1.4		B22	Clay (CL-CH) medium-high plasticity brown (7.5YR4/4) massive tending to weak fine prismatic, (v.st.d.c)	7.7	0.13	3(1)	
CP6:-0-	Qa16	A1	Silty Clay Loam (CL-ML) low to medium plasticity, brown (10YR4/2), massive cohesive	5.5	0.06	3(2)	Loamy surface brown duplex soil, Db1.43:

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Site ID/ Depth (m)	Terrain Unit	Soil Horizon	Soil Description	Soil pH (1:5 H_2O)	EC (1:5 H_2O) (mS/cm)	Dispersion Class No.	Comments/Soil Classification
0.15			crumbly (st.d.c.)				Subnatric or Mesonatric Brown Sodosol
0.15-0.25		A2 (Bleached horizon)	Clay Loam (CL) medium plasticity, light brownish grey to light grey (10YR6/2-7/2d), massive cohesive crumbly (v.st.d.c.)	5.2	0.16	2(2)	Strongly acidic and strongly dispersive
0.4-0.5		B1	Clay (CH) high plasticity, brown (10YR4/3), moderate fine nutty to medium blocky to prismatic (v.st.d.c.) becoming more massive below 0.5m	7.7	1.11	2(2)	Moderate saline and strongly dispersive
0.9-1.0		B21	Clay (CH) high plasticity, brown (10YR4/3), friable	8.4	1.60	2(1)	Highly saline and dispersive, mod. strongly alkaline
			(f-st.m.c.) a few soft CO_3 segregations.				
1.4-1.5		B22	Clay (CL-CH) medium to high plasticity, massive (v.st.d.c.) a few flecks of soft carbonate and some s/r CO_3 concretions	8.3	1.16	2(2)	Highly saline and dispersive, mod. strongly alkaline
CP7:-0-0.1	Qa2(7-8)	A1	Clay (CL-CH) medium to high plasticity, very dark grey (10YR3/1) granular to weak fine blocky to prismatic, crumbly (st.d.c.)	6.5	0.26	3(1)	Thin weak self-mulching surface soil, no obvious surface cracking – (incipient cracking clay) Uf6.32 – Ug5.15: Sodic-Vertic Black Dermosol.
0.3-0.4		B1	Clay (CH) high plasticity very dark grey (10YR3/1), moderate strong, fine to medium blocky to prismatic (v.st.d.c.)	8.0	0.16	3(4)	Mod. dispersive
0.6-0.7		B2	Clay (CH) high plasticity, black (10YR 3/1), weak medium prismatic tending to massive (v.st.d.c.)	8.4	0.25	2(1)	Mod. dispersive, most likely sodic but not calcareous – represents 0.5-0.9m horizon
1.1-1.2 (0.9-1.24)		B-C	Clay (CH) high plasticity, brown (10YR4/3), massive, crumbly to brittle (st.d.c.)	7.8	0.53	3(4)	Mod. dispersive
CP8-0-0.1	Qa26	A	Silty Clay Loam (CL) low to medium plasticity, dark grey-brown (10YR4/2), massive apedal cohesive, crumbly (st.d.c.)	4.5	2.20	5	Very strongly saline and acidic, thin loamy surface brown duplex soil, Db1.13:- Db3.13, Vertic Mesonatric–Hypermatric Brown Sodosol
0.2-0.4		B1	Clay (CH) high plasticity brown (10YR 4/3), coarse blocky to prismatic (v.st.d.c) weak effervescence in soft CO_3 segregations	8.5	1.07	2(2)	Strongly alkaline, saline and dispersive
0.6-0.8		B21	Clay (CH) high plasticity, brown (10YR4/3), strong fine nutty to fine to medium prismatic, (st.d.c.) tending to friable moist	9.2	1.23	2(2)	Very strongly alkaline, saline and dispersive

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Site ID/ Depth (m)	Terrain Unit	Soil Horizon	Soil Description	Soil pH (1:5 H_2O)	EC (1:5 H_2O) (mS/cm)	Dispersion Class No.	Comments/Soil Classification
1.2-1.3		B22	Clay (CH) high plasticity, strong brown (7.5YR4/4) as above with some CO_3 concretions (10-20mm), (st.d.c.)	9.2	1.07	2(2)	Very strongly alkaline, mod. saline and dispersive.
CP9:-0-0.25	Jp5(2-5)	A1	Loamy Sand (SM-SP) non-plastic, brown (7.5YR4/3), massive apedal, some weakly cohesive lumps (f.d.c.)	5.8	0.0	5	Sandy yellow-brown mottled duplex soil Dy5.81; Bleached Mottled Sodic Yellow-Brown Kurosol
0.25-0.5		A2 (Bleached)	Fine to Medium-grained Sand (SM-SP) non plastic, white (7-5YR8/ld), light brown (7.5YR 6/4m), massive apedal, crumbly single-grain loose to partly cohesive (f.d.c)	6.1	0.0	5	
0.5-0.7		B-C	Sandy Light to Medium Clay (CL) medium plasticity, yellowish brown and grey mottled (10YR5/4-6/2), EW ferruginous clayey sandstone	5.1	0.33	2(1)	Strongly acidic and mod. dispersive
0.9-1.0		C	EW Rock-ferrugmous clayey sandstone, orange, red and grey mottled (v.st.d.c.)	5.0	0.42	2(1)	Strongly acidic and mod. dispersive
CP10:-0-0.2	Jp45	A1	Loamy Sand (SP-SC) just plastic, dark brown (10YR3/3), apedal massive, crumbly cohesive (f.d.c.)	5.3	0.0	3(1)	Thick sandy surface mottled duplex soil (Dy4.61); Mottled Yellow-Brown Kurosol
0.3-0.5		A2 (Pale)	Silty Sand (SM-SP), non-plastic, dark-yellowish-brown (10YR4/6) diffusely mottled red and light-yellow brown (10YR6/4d)	4.7	0.01	3(2)	Strongly acidic, slightly to mod. dispersive fines
0.7-0.8		B-C	Clayey Gravel (GC) with (30%) somewhat silty fines of medium plasticity, with rounded Fe (laterite) gravel (5-15mm)	5.4	0.0	5	Strongly acidic clayey fines
1.0-1.1		C	EW Rock – Ferrugmous clayey sandstone	5.6	0.0	5	
CP11:-0-0.25	Jp45	A1	Loamy Sand (SM-SP) non-plastic, brown (10YR4/3), massive apedal partly cohesive (st.d.c.) tending to crumbly and powdery, some s/r stone (3.8mm)	6.3	0.07	5	Mod. hard-set sandy surface, weak sandy surface brown duplex soil (Dy5.61-Db3.61):- Ferric Brown Kurosol.

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Site ID/ Depth (m)	Terrain Unit	Soil Horizon	Soil Description	Soil pH (1:5 H_2O)	EC (1:5 H_2O) (mS/cm)	Dispersion Class No.	Comments/Soil Classification
0.4-0.6		A2-B	Loamy Sand, (SM-SP) dark yellowish brown (10YR3/4), non-plastic, massive apedal, crumbly friable to single grain and partly cohesive (st.d.c.)	4.4	0.12	5	Very strongly acidic silty fines
0.6-0.9		B-C	Loamy Gravel (GC) with 40% clayey fines of medium plasticity	5.0	0.01	5	Strongly acidic clayey fines
1.1-1.2		C	EW Rock – reddish brown ferruginous clayey sandstone,	5.5	0.01	5	Strongly acidic clayey fines
CP12:- 0.3-0.5	"D"	Fill	Fill-Gravely Clay (GC-CH) with 50-60%) clayey fines of high plasticity and (40-50%) weathered rock (sandstone) gravel	8.6	1.55	3(1)	Area disturbed by cutting and filling. Strongly alkaline and saline fill material.
0.8-0.9		C	HW Rock – platey shaley sandstone	8.9	1.15	2(1)	In situ weathered rock beneath the fill layer strongly alkaline and saline.
CP13-0-02	Qa16	A1/A2 (Sporadic)	Fine Sandy Silt Loam (CL-ML) low plasticity, brown (10YR4/3), apedal massive, with cohesive lumps (st.d.c.)	5.8	0.01	3(1)	Thin loamy surface brown duplex soil, (Db1.33); Subnatric OR Mesonatric Brown Sodosol.
0.4-0.5		B1	Clay (CH) high plasticity, dark brown (10YR4/3), weak to moderate fine to medium blocky to prismatic (v.st.d.c.)	7.0	0.50	2(3)	Representative of 0.2-0.5m layer; strongly dispersive
0.7-0.9		B21	Clay (CH) high plasticity, dark yellowish-brown (10YR4/4), weak to moderate, strong fine prismatic (v.st.d.c.) tending to massive.	8.8	1.28	2(2)	Strongly alkaline, saline and dispersive.
1.3-1.4		B22	Clay (CH) high plasticity, dark yellowish brown (10YR4/4), weak fine prismatic to medium blocky to prismatic (st.d.c.) tending to massive with depth.	8.5	1.00	2(2)	Strongly alkaline, saline and dispersive.

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Appendix B.2 Terrain Unit Descriptions and Assessment of Engineering and Environmental Attributes

Geological Regime: (Qa) Quaternary alluvium in water courses, on terraces, floodplains and older alluvial deposits; sand, silt, clay and gravel.

Terrain Unit	Landform	Soils	Problem Soils	Salinity	ESP	Drainage Condition	Soil Dispersion	Excavation Condition	Permeability	Remarks
Qa04	Channel floors, banks and active levees of major streams and water-ways, with high steep irregular planar and locally benched bank slopes and low floodprone terraces	Stratified alluvial sand deposits in channel floors, uniform coarse to medium-textured alluvial soils in flood terraces and locally forming the channel banks	L	1	N	F4	N-1	1	H	Prone to frequent flooding; banks subject to scour and undercutting and associated instability
Qa16	Near level to broadly depressional alluvial plains and backplains with slopes mostly <1%	Thin loamy surface duplex soils with a bleached or sporadically bleached sub-surface (A2) horizon and brown or dark brown saline, strongly alkaline and sodic heavy clay subsoils (Db1.33-Db1.43)	R1	3	2-3	I-F1	3	1	L	The area may be prone to surface water ponding in lower-lying parts following heavy rainfall; slightly dispersive surface horizons, strongly dispersive subsoils
Qa25	Near level to gently undulating alluvial plains and stream terraces with slopes mostly <2%	Acidic thick (up to 0.4 m) fine sandy to silt loamy, surface duplex soils, locally with a pale (A2) horizon over brown or yellow-brown slightly acidic to slightly alkaline and slightly mod. dispersive and locally sodic heavy clay subsoils; (Db1.12, Db1.23)	R1	1	1	I-F3	N-1	1	ML	Includes slightly to mod dispersive soil layers, locally sodic in the deeper subsoil layers; profile drainage locally impeded by the heavy clay subsoil horizon.
Qa26	Near level to gently undulating higher alluvial plains and older stream terraces with slopes mostly <2%	Strongly acidic silt loamy surface duplex soils with brown or yellowish-brown slightly to strongly alkaline medium to heavy clay subsoils (Db1.13, Db1.23, Db3.13)	R1	2-3	2-3	I-F3	2-3	1	M-L	Mostly strongly dispersive, strongly alkaline and highly saline in the clayey subsoil layers.

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Terrain Unit	Landform	Soils	Problem Soils	Salinity	ESP	Drainage Condition	Soil Dispersion	Excavation Condition	Permeability	Remarks
Qa2(7-8)	Gently inclined, undulating and locally moderately dissected alluvial plains, floodplains, prior stream levees and intermediate and higher terraces; slopes mostly <2%, locally steeper on slopes to drainage.	Mixed association of uniform (non-cracking) dark-coloured structured medium to heavy clay soils (Uf6.32), and crusty thin weak self-mulching dark-coloured (cracking) clay soils with alkaline mod. saline heavy clay subsoils (Ug51.5)	R1-R3	2-3	2	F3	1-2	1	L	These soils comprise cracking and incipient cracking clays; they are slightly to mod. dispersive and mostly mod. saline in the B1 and B2 horizons.

Geological Regime: (Ks) Lower Cretaceous Stanwell Coal Measures; mudstone, arenite, claystone and coal.

Terrain Unit	Landform	Soils	Problem Soils	Salinity	ESP	Drainage Condition	Soil Dispersion	Excavation Condition	Permeability	Remarks
Ks36	Gently undulating plains and rises with gently inclined planar to concave marginal slopes in the range 2-5%	Medium to deep thin loamy surface duplex soils with brown to yellowish-brown alkaline to strongly alkaline, saline and sodic heavy clay subsoils, (Db1.13-Db2.33 and Dy3.33)	R1	3	1-2	W-I	1-2	2	L	Slightly to mod. dispersive in the A - B1 horizons, strongly alkaline and highly saline in the deeper subsoil horizons
"Da"	Land disturbed or modified by cutting and filling operations	Compacted cut and fill material	R2	1-3	N-3	W-I	N-1	2	L	Surficial soil conditions may vary within the area.
"Di"	Land occupied by Stanwell Power Station facilities and associated infra-structure	Reworked and compacted cut and fill material mostly underlain by Stanwell Coal Measures rock types.	R1	3	1-3	W-I	N-1	2	L	Land modified by reworked material and imported fill

Geological Regime: (Jp) Jurassic Precipice Sandstone; cross-bedded poorly sorted fine to very coarse-grained pebbly quartzose sandstone and laminated siltstone.

Terrain Unit	Landform	Soils	Problem Soils	Salinity	ESP	Drainage Condition	Soil Dispersion	Excavation Condition	Permeability	Remarks
Jp45	Undulating plains and low rises, and broadly rounded lower dissection slope interfluves with slopes in the range 5-10 %	Medium deep thick sandy surface acidic yellow-red-grey mottled duplex soils underlain by HW rock	L	1		W	1-2	2-3	M-H	Strongly acidic, the clayey B-C horizon is slightly to mod. dispersive

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Terrain Unit	Landform	Soils	Problem Soils	Salinity	ESP	Drainage Condition	Soil Dispersion	Excavation Condition	Permeability	Remarks
Jp5(2-5)	Irregular planar to shallow concave lower colluvial and erosional slopes (5-15%)	Shallow med. to coarse sand soils over HW rock (Uc2.12, 4.13), some occurrences of soil Type 5, as for unit Jp45	L	1	1-2	W-X	1-2	2-3	M-H	Bleached A2, strongly acidic throughout
Jp6(1-4)	Low irregular rounded low rises and hills with marginal slope within the range 10-25%	Shallow rocky soils in rocky outcrop areas; elsewhere, shallow to medium deep gravelly sandy loam or gradational gravelly loams over HW rock, (K-Um1.41)	L	1	N	W-X	N	3	H	Rapid surface water runoff with locally mod. severe surface sheet erosion where vegetation cleared; local sub-vertical rocky scarps
Jp7(1-4)	Steep irregular planar middle to upper hill and ridge slopes within the range 25-50%	Shallow rocky soils Type 1 and mainly shallow to medium deep gravelly loams, soil Type4 as for unit Jp6(1-4)	L	1	N	X	N	3	H	Rapid surface water runoff and sheet erosion; local subvertical low rocky scarps.

Basis for the Assessment of Engineering/Environmental Attributes

Problem Soils:

Soil Reactivity

L – Non- or low soil reactivity

R1 – Moderately reactive soils, *i.e.* those which have medium to high plasticity, but are not subject to soil swelling or shrinkage cracking;

R2 – Shallow or medium deep, highly reactive soils, underlain hose by non-reactive substrate soils or weathered rock;

R3 – Deep, highly reactive soils subject to swelling and shrinkage cracking on wetting and drying.

Soil Salinity (E.C. – 1:5 H_20)

Rating 1 – E.C (mS/cm) <0.25 (sand), <0.4 (loam), <0.55 (clay) – Low

Rating 2 – E.C (mS/cm) 0.25-0.47 (sand), 0.4-0.8 (loam), 0.55-1.15 (clay) - Medium

Rating 3 – E.C (mS/cm) >0.47 (sand), >0.8 (loam),>1.15 (clay) – High to Very High

Sodicity (ESP)

N – very low or non-sodic, ESP <6%

Rating 1 – Sodic, ESP 6-14%

Rating 2 – Strongly sodic, ESP >14%

Rating 3 - Very strongly sodic, ESP >25%

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Drainage Condition

W - Moderately well to well drained, not floodprone.

I – Impeded drainage, subject to seasonally perched groundwater table.

X – Excessively well-drained (steep slopes, rapid runoff)

F1 – Subject to surface sheet flow/short term flash flooding.

F2 – Rarely floodprone but may be prone to local surface ponding of short-term duration (>10 year flooding frequency)

F3 – Occasionally floodprone and/or prone to surface water ponding (2-10 year flooding frequency)

F4 – subject to regular flooding (<2 year flooding frequency).

Soil Dispersion

Rating N – Non-dispersive [Dispersion Classes 4 and 6 to 8]

Rating 1 – Slightly Dispersive [Dispersion Classes 5 and 3(1)]

Rating 2 – Moderately Dispersive [Dispersion Classes 3(2) to 2(1)]

Rating 3 – Strongly dispersive [Dispersion Classes 2(2) to 1]

Excavation Characteristics (Upper 2.5-3.0m)

Class 1 –Essentially soil-like materials;

Class 2 – Medium to deep soils underlain by weak or low strength weathered rock substrate, some minor indurated or thin hard pan layers may occur;

Class 3 – Alternating bands of weak and moderately strong rock; intermediate strength rock; rock breaking equipment may be required in parts;

Class 4 – Moderately strong to strong rock or continuous high strength rock; rock breaking and/or blasting may be required for removal.

Soil Permeability (Est.)

L – Low ($<10^{-8}$ m/s

M – Medium (10^{-4} to 10^{-8} m/s)

H – High ($>10^{-4}$ m/s)

Topsoil Resources – Suitability

S (suitable) – soils that have adequate textural, structural and chemical properties for use as topsoil without significant amelioration.

M (marginal) – soils that are generally texturally and physically suitable for topsoil, that may require pH correction, the application of fertilizers and/or the addition of other soil ameliorants to improve soil productivity. These marginal materials are generally considered suitable for use as subsoil material to supplement the topsoil resource if there is a shortfall of topsoil.

U (unsuitable) – soils are not suitable for use as topsoil or subsoil.

Land Capability

Class A Crop land – land suitable for current and potential crops with limitations to production which range from nil to moderate levels.

Class B Limited crop land – land that is marginal for current and potential crops due to severe limitations, but is suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for sustainable cropping/cultivation.

Class C Pasture land – land suitable for improved or native pastures due to limitations which preclude continuous cultivation for crop production. Some areas may tolerate a short period of ground disturbance for pasture establishment.

Class D Non-agricultural land - land not suitable for agricultural uses due to extreme limitations. This may comprise undisturbed land with significant habitat, conservation and/or catchment values, or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

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Appendix B.3 Topsoil Suitability Assessment

Soil Type	Soil Description	Horizon *	Soil Physical Factors	Salinity [1]	Sodicity [2]	Soil pH [3]	Dispersion Rating [4]	Overall Rating [5]	Strip Depth (m)
1.	Skeletal, rocky or gravelly soils (>60% rock cobbles and weathered rock gravel) with sand, silt or clayey matrix.	A-C	Coarse rocky soils, sandy or loamy matrix, low plant available water capacity (PAWC)	-	-	-	-	U	0
2	Uniform sand or gravelly sand soils underlain by weathered rock	A1	Non plastic silty sand, very low PAWC	1	1	2a	1	S-M	0.2
		A2	Bleached silty sand very low PAWC	1	1	2a	1	M	0
		B-C	Sandy clay-ferruginous clayey sandstone	1-2	-	3a	2	U	0
3	Earthy sands – sandy earth soils, mod. shallow coarse to medium-textured soils	-	Not mapped in the QCE project area	-	-	-	-	-	-
4	Uniform or gradational, medium-textured sandy loam or loamy alluvial soils, or gravelly loam residual soils	A11	Fine sandy loam, low-medium PAWC	1	1-2	2a	0-1	S	0.2
		A12	Fine sandy loam, low OM and nutrients	1	1	1	1	S	0.3
		B	Fine sandy clay loam low OM and nutrients	1	1	1	1	S-M	0.5
5	Thick sandy or fine sandy to silt loamy surface duplex soils, with strongly acidic mottles (FE) gravelly to sandy clay subsoils over HW rock, or acidic, neutral or slightly alkaline medium to heavy clay subsoils..	A1	Hardset, sandy to loamy, strongly acidic, low, locally moderate PAWC.	1	1	3a	0-1	S-M	0.2
		A2		1	1	2a-3a	1	M	0.2
		B2 or B-C	Heavy clay, locally (Fe) gravelly sandy clay	1	1-2	1-3a	1	U	0
		C	Alluvium or EW rock – clayey sandstone	1-2	1-2	2a-2b	0-2	U	0
6	Silty to loamy surface texture contrast (duplex) soils with alkaline sodic medium to heavy clay subsoils	A1-A2	Hard-set, mod. to strongly acidic	1-3	1	2a-3a	1-2	M	0.3
		B1	Fine to medium hard pedal sodic clays	1-2	2	1-2a	2-3	U	0
		B2	Strongly alkaline, saline hard, sodic clays	1-3	3	2b-3b	1-3	U	0
		B-C	HW rock, strongly alkaline, saline and sodic	2-3	2	2b-3b	1-3	U	0
7	Uniform or weakly gradational (Non-cracking) clay soils	A1	Gravelly weakly pedal clay loam to clay	1	1	1	1	S	0.2
		B1	Friable to hard fine to medium pedal clays	1	1-2	2b	2	S	0.2
		B2	Tough massive, sodic clay	1	2	2b	3	U	0
		B-C	Massive, hard, brittle clay	2	2	2b	2	U	0
8	Uniform dark grey-brown (cracking) clay soils	A1	Weak SM and fine-med. pedal friable clays	1	1	1	1	S	0.1
		B1	Fine (crumbly), hard med.-coarse pedal	1	1-2	1	2	S	0.25
		B2	Hard pedal to massive, mod. saline, sodic	2	2-3	2b	2	M	0.25
		B2-C	Massive apedal, mod. saline and sodic clays	2	2-3	2b	1	U	0

Notes:- Topsoil Suitability Assessment Criteria based on field observations and soil chemical/physical test data given in Appendices A.1, A.2 and A.3.

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*** Horizons:**

A – Surficial soil horizon (generally between 0.1-0.3m thick)

B – B horizon (undifferentiated)

B1 – Upper B horizon (usually about 0.3m thick))

B2 – Lower B horizons (typically about 0.5-1.0m thick)

B2-C transition (includes weathered parent material, locally with remnants of weathered rock)

C or D – Weathered rock/parent material or, other unrelated material below the solum

[1] **Salinity Rating** (E.C. – 1:5 soil/water solution)

Rating 1 – E.C (mS/cm) <0.25 (sand), <0.4 (loam), <0.55 (clay) – Low

Rating 2 – E.C (mS/cm) 0.25-0.47 (sand), 0.4-0.8 (loam), 0.55-1.15 (clay) - Med. To High

Rating 3 – E.C (mS/cm) >0.47 (sand), >0.8 (loam),>1.15 (clay) – High to Very High

[2] **Sodicity Rating**

Rating 1 – Non Sodic, ESP <6%

Rating 2 – Sodic, ESP 6-14%

Rating 3 – Strongly sodic, ESP 14-25%

Rating4 – Very strongly sodic, ESP >25%

[3] **Soil pH (Acidity/Alkalinity) Rating** (pH 1:5 H_20)

Rating 1 – Neutral (pH 6.5-7.5)

Rating 2a – - Slightly to mod. strongly acidic (pH5 5-6.5); 2b – Slightly to mod. strongly alkaline (pH>7.5-8.5)

Rating 3a – Strongly acidic (pH<5.5); 3b - Strongly alkaline (pH>8.5)

[4] **Dispersion Rating** (Refer to Appendix A.2)

Rating 0 – Non-dispersive [Classes 4 and 6-8]

Rating 1 – Slightly Dispersive [Classes 5 and 3(1)]

Rating 2 – Moderately Dispersive[Classes 3(2) to 2(1)]

Rating 3 – Strongly dispersive [Classes 2(2) to 1]

[5] **Overall Suitability Rating**

U – Unsuitable for use as topsoil for rehabilitation purposes

M – Marginal for use as topsoil, but may be suitable for use as subsoil layer

S – Satisfactory for use as topsoil for rehabilitation purposes.

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Appendix B.4 Agricultural Land Suitability Class and Erosion Potential Evaluation

Geological Regime: (Qa) Quaternary alluvium in water courses, on terraces, floodplains and older alluvial deposits; sand, silt, clay and gravel.

Terrain Unit	Landform	Soils	Area (ha)	Agricultural. Land Suitability			Erosion Potential	Remarks
				Ag. Land Class [1]	Cropping Class	Limiting Factors		
Qa04	Channel floors, banks and active levees of major streams and water-ways, with high steep irregular planar and locally benched bank slopes and low floodprone terraces	Stratified alluvial sand deposits in channel floors, uniform coarse to medium-textured alluvial soils in flood terraces and locally forming the channel banks	38.3	D	5	(f5), (t5), (e5)	H	Prone to frequent flooding; banks subject to scour and undercutting and associated instability
Qa16	Near level to broadly depressional alluvial plains and backplains with slopes mostly <1%	Thin loamy surface duplex soils with a bleached or sporadically bleached sub-surface (A2) horizon and brown or dark brown saline, strongly alkaline and sodic heavy clay subsoils (Db1.33-Db1.43)	10.3	C	4	p3, s4, f3, w3	M	The area may be prone to surface water ponding in lower-lying parts following heavy rainfall; slightly dispersive surface horizons, strongly dispersive subsoils
Qa25	Near level to gently undulating alluvial plains and stream terraces with slopes mostly <2%	Thick (up to 0.4 m) acidic fine sandy to silt loamy surface duplex soils, locally with a pale (A2) horizon over brown or yellow-brown slightly acidic to slightly alkaline, slightly to mod dispersive and locally sodic heavy clay subsoils; (Db1.12, Db1.23)	60.6	B	3-4	w2-3, p3, f3, n3, m4	M	Primarily suited to grazing due to moderate to high levels of limitations; limited cultivation for crop production may be possible.
Qa26	Near level to gently undulating higher alluvial plains and older stream terraces with slopes mostly <2%	Fine sandy to silt loamy surface duplex soils with brown or yellowish-brown slightly to strongly alkaline medium to heavy clay subsoils (Db1.13, Db1.23, Db3.13)	3.4	C	4-5	s4-5, w4-5, n5, f3, e4	M-H	Moderately to strongly dispersive soil layers occur; locally strongly acidic surficial soils and strongly alkaline, highly saline and sodic in the sub-surface and deeper clay subsoil horizons.

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Terrain Unit	Landform	Soils	Area (ha)	Agricultural. Land Suitability			Erosion Potential	Remarks
				Ag. Land Class (1)	Cropping Class	Limiting Factors		
Qa2(7-8)	Gently inclined, undulating and locally moderately dissected alluvial plains, floodplains, prior stream levees and intermediate and higher terraces; slopes mostly <2%, locally steeper on slopes to drainage.	Mixed association of uniform (non-cracking) dark-coloured structured medium to heavy clay soils (Uf6.32), and crusty thin weak self-mulching dark-coloured (cracking) clay soils with alkaline mod. saline heavy clay subsoils (Ug51.5)	141.3	A	2-3	ps2, e2, pd3, s3, t2	M-H	These soils comprise cracking and incipient cracking clays; they are slightly to mod. dispersive and mostly mod. saline and sodic in the B1 and B2 horizons.

Geological Regime: (Ks) Lower Cretaceous Stanwell Coal Measures; mudstone, arenite, claystone and coal.

Terrain Unit	Landform	Soils	Area (ha)	Agricultural. Land Suitability			Erosion Potential	Remarks
				Ag. Land Class (1)	Cropping Class	Limiting Factors		
Ks36	Gently undulating plains and rises with gently inclined planar to concave marginal slopes in the range 2-5%	Medium to deep thin loamy surface duplex soils with brown to yellowish-brown alkaline to strongly alkaline, saline and sodic heavy clay subsoils, (Db1.13-Db2.33 and Dy3.33)	82.7	C	4	e4, m4, p3, s4	H	Slightly to mod. strongly dispersive in the A - B1 horizons, strongly alkaline and highly saline in the medium and deeper subsoil horizons

Geological Regime: (Jp) Jurassic Precipice Sandstone; cross-bedded poorly sorted fine to very coarse-grained pebbly quartzose sandstone, arenite and laminated siltstone

Terrain Unit	Landform	Soils	Area (ha)	Agricultural. Land Suitability			Erosion Potential	Remarks
				Ag. Land Class (1)	Cropping Class	Limiting Factors		
Jp45	Undulating plains and low rises, and broadly rounded lower dissection slope interfluves with slopes in the range 5-10 %	Medium deep thick sandy surface acidic yellow-red-grey mottled duplex soils underlain by HW rock	20.5	C	4	e4, t3, r3, pt3, m4	M	Strongly acidic, the clayey B-C horizon is slightly to mod. dispersive

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Terrain Unit	Landform	Soils	Area (ha)	Agricultural. Land Suitability			Erosion Potential	Remarks
				Ag. Land Class [1]	Cropping Class	Limiting Factors		
Jp5(2-5)	Irregular planar to shallow concave lower colluvial and erosional slopes (5-15%)	Shallow med. to coarse sand soils over HW rock (Uc2.12, 4.13), some occurrences of soil Type 5, as for unit Jp45	12.8	C	4	e4, t3, r3, pt3, m4-5	L-M	Bleached A2, strongly acidic throughout
Jp6(1-4)	Irregular rounded low rises and hills with marginal slope within the range 10-25%	Shallow rocky soils in rocky outcrop areas; elsewhere, shallow to medium deep gravelly sandy loam or gradational gravelly loams over HW rock, (K-Um1.41)	6.2	C	4	m4, e4, t4, r4	M-H	Rapid surface water runoff with locally mod. severe surface sheet erosion where vegetation cleared; local sub-vertical rocky scarps
Jp7(1-4)	Steep irregular planar middle to upper hill and ridge slopes within the range 25-50%	Shallow rocky soils Type 1 and mainly shallow to medium deep gravelly loams, soil Type4 as for unit Jp6(1-4)	32.3	D	5	m5, e5, t4, r4	H	Rapid surface water runoff and sheet erosion; local subvertical low rocky scarps.

Suitability for Rainfed Broadacre Cropping

Limitation	Land Suitability Class				
	1	2	3	4	5
Water Availability (est.) (m)	PAWC >150mm	PAWC 125-150mm	PAWC 100-125mm	PAWC 75-100mm	PAWC < 75mm
Nutrient Deficiency (n)	Bicarb. P>10 ppm	Bicarb. P 5-10 ppm and Exchangeable (Exch.) K >0.3 meq.%	Bicarb. P 5-10 ppm, Exch. K ≤0.3 meq.% or pH <5 (60-90cm - bgl) or pH >9 (60-90 cm- bgl)	Bicarb. P<10 ppm, Exch. K ≤0.3 meq.%, Exch. Ca<3 meq.%; or pH<5(30-60cm bgl) or pH >9 (30-60 cm bgl)	pH<5 within 30cm of surface or pH>9 within 30cm of surface
Surface Condition (p3)	Cracking clays with very fine self-mulch (peds <2mm),or Rigid soils with a loose, soft or firm surface when dry	Cracking clays with fine self-mulch (peds 2-10mm)	Cracking clays with coarse self-mulch (peds 10-20mm) or Rigid soils with a hard set surface when dry	Cracking clays with coarse peds at the surface (≥20mm)	
Soil Texture (pt)	Surficial sandy and/or sandy loam texture to depths of:-				
		<450mm	450-900mm	>900mm	

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Limitation	Land Suitability Class				
	1	2	3	4	5
Soil Type Distribution (pd)	Surface texture/soil type changes occur within a distance of:-				
		>300m	150-300m	<150m	
Soil Workability (k)	Friable cracking clays (indicated by very fine self-mulch), or Rigid soils with a loose, soft or firm surface when dry	Firm cracking clays (indicated by fine self-.mulch) or Rigid soils with a hard setting surface when dry	Stiff cracking clays (indicated by coarse self-mulch with peds >10 mm, crusting or hard setting surface		
Salinity (s)	Rootzone EC <0.15 S/cm or Rootzone Cl <300 ppm	Rootzone EC 0.15-0.3 mS/cm or Rootzone Cl 300-600ppm	Rootzone EC 0.3-0.9 mS/cm or Rootzone Cl 600-900 ppm	Rootzone EC 0.9-1.2 mS/cm, or Rootzone Cl 900-1500 ppm	Rootzone EC>1.2 mS/cm or Rootzone Cl≥1500ppm
Rockiness (R)	<10% coarse surface gravel (>6 cm diam.) and rock outcrop	10-20% coarse surface gravel and rock outcrop	20-50% surface cobble (6-20 cm diam.) and rock outcrop	50-90% surface cobble and rock outcrop, or 20-50% stone and boulders (>20 cm diam.)	>90% surface cobble and rock outcrop, or >50% stone and boulders and rock outcrop
Microrelief (g)	No melonholes (semi-circular depressions) <30cm deep and usually surrounded by mounds)	Melonholes 30-60cm deep cover <20% of surface area or Melonholes >60 cm deep, cover 10% surface area	Melonholes 30-60cm deep cover <20-50% of surface area or Melonholes >60 cm deep, cover 10-20% surface area	Melonholes 60-100cm deep, cover 50% surface area	Melonholes at least 100 cm deep, cover >50% surface area
Wetness (w)	Undulating terrain or elevated plains	Low-lying level plains with gilgai covering <25% of the surface area, or Rigid soils with sodic subsoil (ESP 6-14) within 60cm of the surface, or Non-sodic rigid soils with pale grey and yellow mottles within 75 cm of the surface	Low-lying level plains with gilgai covering 25-50% of the surface area, or Rigid soils with strongly sodic subsoil (ESP≥15) within 60cm of the surface, or Non-sodic, rigid soils with coarse pale grey and yellow mottles within 50cm of the surface	Seasonal swamps and low-lying run-on areas	Permanent swamps and lakes
Topography (t)	No gully dissection	Occasional deep gullies impede cultivation slightly	Many deep gullies reduce arable area by <33%, cultivation severely restricted	Many deep gullies make the arable areas too small to cultivate	Abundant deep gullies prevent any practical cultivation
Water Erosion (e)	Slopes <0.5% on non-gilgai cracking clays, or Slopes <1% on gilgaied clays, or Slopes <1% on non-sodic rigid soils, or Slopes <0.5% on sodic rigid soils	Slopes 0.5-1% on non-gilgaied cracking clays; or Slopes 1-3% on gilgaied clays, or Slopes 1-2% on non-sodic rigid soils, or Slopes 0.5-1% on sodic rigid soils	Slopes 1-3% on cracking clays without melonholes or Slopes 2-4% on non-sodic rigid soils, or Slopes 1-2% on sodic rigid soils	Slopes 3-5% on cracking clays or Slopes 4-6% on non-sodic rigid soils, or Slopes 2-3% on sodic rigid soils	Slopes <5% on cracking clays, or Slopes <6% on non-sodic rigid soils, or Slopes <3% on sodic rigid soils
Flooding (f)	No flooding	Rare flooding (only during abnormal (1 in >10 year events)	Infrequent flooding (1 in 2-10 year events)	Periodic flooding (1 in 2 year events	Frequent and/or erosive flooding

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Basis for the Assessment of Erosion Potential

The susceptibility of different soil types to erosion (soil erodibility) is a function of soil texture, and physical and chemical properties. The extent to which an area may be subject to erosion (erosion potential) is a function of factors such as surface slope and form, topographic position in the landscape (runon/runoff), rainfall intensity, surface condition and surface/plant cover.

- Soil erodibility classes identified by Mills and Murphy, (1977) are summarised as follows:
- *Low Erodibility* – soils with high amounts of organic matter (OM), with surficial soils comprising sand or loamy sand (permitting high infiltration), or aggregated non-dispersive clay surface and/or subsoils;
- *Moderate Erodibility*:- soils with medium levels of OM, with surface soils comprising medium amounts of sand, silt and clay *i.e.* medium-textured (loamy) surface soils, with slightly dispersive (Dispersion Class Nos. 3 or 5) or aggregated slightly dispersive clay surface and/or subsoils;
- *High Erodibility*:- soils with low levels of OM, soils with bleached (A2) subsoil horizons with high amounts of fine sand and/or silt, soils with a fine strongly structured (self-mulching) clayey surface horizon, or moderately to highly dispersive clayey surface and/or subsoils (Dispersion Class Nos. 1 or 2)

The potential for accelerated erosion to occur (erosion potential) due to construction activities in the project area as a result of clearing and/or surface disturbance, has been assessed as follows:

- Low (L) - The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.
- Moderate (M) - Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/run-off. Erosion control can be achieved using structural works, topsoiling and revegetation techniques, and other site specific intensive soil conservation works. Some slightly dispersive soil layers may be present in the profile.
- High (H) - High to very high erosion losses are likely due to steepness of slopes, soil erodibility factors and surface runoff conditions. Intensive soil conservation works will be required to minimise the effects of erosion. Moderately high to highly dispersive soil layers may be present.