7 LAND

7.1 Introduction

This Chapter addresses all aspects of potential impact that relate to land including:

- Topography and geomorphology
- Visual amenity
- Geology
- Soils
- Tenure and use
- Land use planning and controls; and
- Contaminated land

It outlines the existing environmental values of the land area that may be affected by the Glebe Option, and identifies potential mitigation measures for any impacts on land values.

7.2 Methodology

Within each subsection the source of the data and the means of identifying potential impacts and mitigation measures varied, as appropriate to the task. Existing information was used where appropriate, such as geological and topographic maps or previous soils surveys. Databases and registers were searched, such as for land tenure or contaminated land, and the Taroom Shire Plan (Taroom Shire Council, 2006a) was reviewed. Stakeholder interviews were also used to supplement the available information such as with respect to existing and potential land use.

7.3 Topography and Geomorphology

7.3.1 Description of Environmental Values

The Dawson River rises in the south-east part of the Carnarvon National Park, to the west of the southern extremity of the Arcadia Valley, approximately 325 km upstream of Glebe Weir. It flows south-east for approximately 225 km then bends to the north-east past Taroom and Glebe Weir. Approximately 16 km downstream of Glebe Weir, the Dawson River bends to the north in Nathan Gorge and generally continues in this direction until it joins the Mackenzie River to become the eastward-flowing Fitzroy River north-east of Duaringa.

The total catchment area of the Dawson River is approximately 50,800 km^2 and the catchment area upstream of Glebe Weir is approximately 19,423 km^2. This upstream catchment is bounded by the:

- Carnarvon, Expedition and Bigge Ranges to the north;
- Great Divide to the west and south; and
- Auburn Range to the east.

Adjacent catchments include, to the:

- North: Comet River and Zamia Creek, a downstream tributary of the Dawson River (Fitzroy Basin);
- West: Maranoa River and Bungil Creek (Murray-Darling Basin);
- South: minor tributaries of the Condamine and Balonne Rivers (Murray-Darling Basin); and
- East: Auburn River (Burnett Basin).

Major tributaries upstream of the Glebe Weir inundation area include:

- Hutton Creek (right bank);
- Eurombah Creek (right bank);
- Juandah Creek (right bank); and
- Palm Tree Creek (left bank).

Juandah Creek joins the Dawson River just upstream of Taroom and is the right bank tributary with the largest catchment. It drains a large area south and south-east of Taroom. Palm Tree Creek is the left bank tributary with the largest catchment and it joins the Dawson River between Taroom and the upstream limit of storage of Glebe Weir.

Larger tributaries that join the Dawson River within the Glebe Weir inundation area are:

- Bentley Creek (right bank);
- Cockatoo Creek (right bank); and
- Boggomoss Creek (left bank).

Cockatoo Creek is the largest tributary within the inundation area and it joins the Dawson River just upstream of Glebe Weir.

Landforms surrounding the Dawson River and its tributaries upstream of approximately 460 km AMTD and upstream parts of the Palm Tree Creek catchment are characterised by rolling to steep hills with a number of plateau surfaces. These hills are associated with resistant quartz sandstones (Gunn, 1977).

Landforms associated with the river and its tributaries further south and to the east are generally gentler and range from undulating and rolling low hills to occasional steep low hills and steep hills, particularly towards the headwaters.

In the vicinity of Glebe Weir, landforms range from level plains to rolling low hills, some of which have plateaus on their crests (Table 7- 1, Figure 7-1) (McDonald *et al*., 1990). The landscapes along the Dawson River for approximately 7 km upstream of the weir and the landscapes along Cockatoo and Boggomoss Creeks are dominated by level to gently undulating plains.

Table 7- 1. Relief / modal slope classes occurring in the landscapes surrounding Glebe Weir

Unit	Relief / Modal Slope Class	Relief	Modal Terrain Slope
1	Level to gently undulating plains	Extremely low (<9 m)	Level (<1%) to very gently inclined (1% - 3%)
2	Gently undulating rises	Very low (9 — 30 m)	Very gently inclined (1% — 3%)
3	Undulating rises	Very low (9 — 30 m)	Gently inclined (3% — 10%)
4	Undulating low hills	Low (30 — 90 m)	Gently inclined (3% — 10%)
5	Rolling low hills	Low (30 — 90 m)	Moderately inclined (10 — 32%)
6	Gently undulating rises (plateau surfaces)	Very low (9 — 30 m)	Very gently inclined (1% — 3%)

By the Upper Cretaceous, the Dawson River catchment upstream of Nathan Gorge was almost entirely one of broadly undulating plains cutting across gently dipping Jurassic and Cretaceous beds. A deep weathering profile was associated with this land surface but only truncated remnants of the lower zones remain (Wright, 1968a). This land surface was dissected by the end of the early Tertiary, probably as a result of uplift, and the main elements of the present drainage pattern came into being. Dissection was deep and extensive lower plains developed in what are now the southern parts of the Glebe Weir catchment. Later in the Tertiary, the newly-created lowlands were masked by terrestrial deposits and some basalt flows with fans and aprons at the foot of the ranges and deep weathering continued (Wright, 1968a).

Processes were complex during the latter part of the Tertiary and the Quaternary but four main stages have been recognised in the region (Wright, 1968a):

- dissection of the Tertiary weathered surface and ensuing deposition;
- dissection and reworking of deposits;
- drainage rejuvenation and floodplain development; and
- later stage drainage rejuvenation and further floodplain development.

Incision associated with the last stage is continuing but younger, lower level, floodplains are forming along the main streams. These are evident in the Glebe Weir area as the level to gently undulating plains adjacent to the Dawson River for approximately 7 km upstream and approximately 3.5 km downstream of the weir and along Cockatoo and Boggomoss Creeks. It is likely that these floodplains developed as a result of the constriction that Nathan Gorge places on the Dawson River and the terrace development within the prior stream channel in response to declining stream flows in the late Quaternary. The Nathan Gorge constriction slows flood flows upstream and results in over-bank flooding and deposition of finer materials. Similar floodplains have been mapped upstream of the Glebe Weir upstream limit of storage (Shields, 1997) and they may result from constriction of the river by adjacent sandstone hills between approximately 348 km and 361 km AMTD or from the Nathan Gorge constriction.

Observations during this study indicate that former Dawson River channels cut into sandstone rises well above the present river level can be identified occasionally and these appear to be remnants of an earlier landscape.

7.3.1.1 Proposed Pipeline Route

The topography along the proposed pipeline route ranges from level to gently undulating plains associated with the Dawson River, Price, Pigeon, Cockatoo, Mayne, Roche and Juandah Creeks and a number of unnamed drainage lines, to rolling low hills (Appendix 7-A — *Pipeline Observations*). Gently undulating rises and undulating rises are the most common landforms along the route (Figure 5-2).

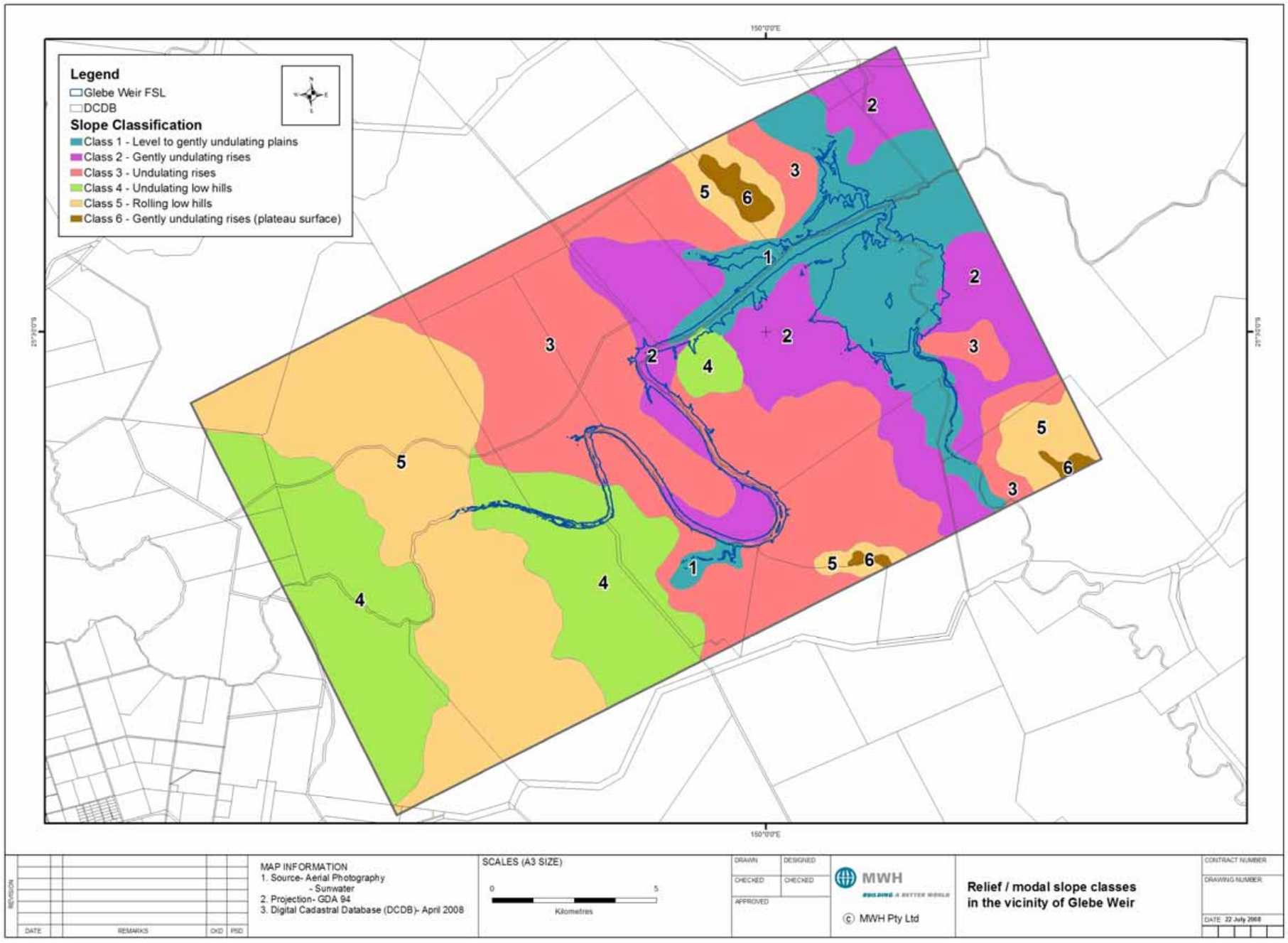

Figure 7-1. Relief / Model Slope classes in the vicinity of Glebe Weir

7.3.1.2 Glebe Weir Geomorphology

The Dawson River is almost straight for approximately 8.5 km upstream and 3.0 km downstream of Glebe Weir, suggesting some structural controls on river location but underlying sedimentary rocks are buried under Quaternary sediments so no structural features were observed. Also, broad scale geological mapping does not show any structural features in the vicinity (DNRMW, 2006a and b; GSQ, 1967; GSQ, 1971). The Boggomoss Creek / Spring Gully system and Cockatoo Creek are both relatively straight for the first four or five kilometres upstream of their junctions with the Dawson River, enter almost opposite each other and at right angles, again suggesting a structural control on location. It is possible that these relate to earlier incision in synclinal folds associated with local uplift.

The Dawson River downstream of Glebe Weir and above its upstream limit of storage is characterised by a broad bed from approximately 200 m to 400 m wide between banks that are approximately 10 m to 18 m high. The clayey bed is dissected by a series of anastomosing channels with some isolated waterholes. Only one, or occasionally two, of these channels carry low flows and the nature and maturity of the vegetation adjacent to these suggests that they are relatively permanent.

Observations of the Dawson River at and around the existing upstream limit of storage of Glebe Weir found no visible evidence of accelerated deposition in this area as a result of the weir. Sediments within approximately 200 m upstream and downstream of the limit of storage were flat-lying clays and silts with similar depositional patterns to those further upstream. Photographs taken by SunWater staff when the weir was empty in September 2006 suggest there is a blanket of fine sediment near the weir wall though the original low-flow channel is readily discernable (Plate 7-1). It appears that a large proportion of the river's present sediment load is carried in suspension and moves through Glebe Weir, with a smaller proportion being deposited in still, deep, water. Observations in May 2008 that both the low flow entering the weir and downstream releases were severely discoloured by suspended clays support this hypothesis.

Limited vegetation cover below the present FSL apparently prevents stabilisation of any sediment that may accumulate near the upstream limit of storage and allows it to be entrained and carried through by subsequent high flows.

Field observations and aerial photograph interpretation indicate that the banks of the Dawson River, Cockatoo Creek, Boggomoss Creek, Bentley Creek and tributary gullies where Glebe Weir backs up are stable with no evidence of bank slumping. There is erosion on the outside of a sharp bend at 55J 797800E 7175500N, but this is above both the present and proposed FSLs. It appears to be the result of rainfall runoff over shallow, dispersible soils, with little vegetation protection, on a steep slope over sandstone. This may be exacerbated by erosion during high floods.

The margins of Glebe Weir have been colonised by tea tree and occasional river oak and many individual tea trees survive up to about 1 m below FSL providing protection from bank erosion and slumping. Evidence for this is in the form of large masses of adventitious roots that exploit the upper oxygenated zone of the storage at the long-term higher storage level (Plate 7-2). The margin from present FSL to the top of the stream banks is generally vegetated with forest red gum, coolibah and occasional river oak. Ground cover in this zone is often sparse, probably because of shading by the trees.

Plate 7-1. Bed of Glebe Weir in September 2006 showing an apparent blanket of fine sediment with the low-flow channel still visible

Plate 7-2. Tea tree surviving in Glebe Weir showing adventitious roots at and below FSL

The Dawson River streambed is stable downstream of the Glebe Weir outlet works which discharge into the low flow channel in the broad bed. The broad bed is vegetated, principally with forest red gum, coolibah, and occasional river oak, and the low flow channel is fringed with tea tree (Plate 7-3). The centre spillway discharges into the low flow channel but larger flood events overtop the entire weir structure. The broader streambed and banks are protected with rock-filled mattresses and rip rap almost to the top of the bank and show no evidence of appreciable erosion (Plate 7-4).

An interesting feature of the left bank of the Dawson River just upstream of Glebe Weir is an embayment opposite the junction of Cockatoo Creek. This has apparently resulted from one or more extreme flood events in Cockatoo Creek discharging into the river when it has been relatively low and eroding the opposite bank (Plate 7-5). The size of the trees around the embayment indicate that its formation pre-dates Glebe Weir. A similar, but much larger, feature occurs on the left bank of the Burdekin River at Millaroo opposite the Bogie River junction, suggesting that such features may be natural geomorphic responses in streams and not a consequence of weir construction.

Plate 7-3. Dawson River streambed immediately downstream of the outlet works of Glebe Weir with forest red gum, coolibah and fringing tea tree

Plate7-4. Rock-filled mattresses and rip rap provide effective erosion protection for the broad streambed and banks downstream of Glebe Weir

Plate 7-5. View across embayment in the left bank of the Dawson River opposite the Cockatoo Creek junction with sheet pile of Glebe Weir just visible in the background

7.3.2 Potential Impacts and Mitigation Measures

7.3.2.1 Glebe Weir Works

The stream banks are stable around the present FSL, and on the basis that tea tree have established rapidly at around this level and are likely to do so around a higher FSL, raising Glebe Weir is not expected to result in bank slumping or erosion.

The Dawson River streambed and banks immediately downstream of Glebe Weir are currently stable and should remain so after the FSL is raised. Changes to outlet discharge characteristics and flood behaviour should be minor and disturbed areas will be given standard erosion protection (Table 20-3).

The condition of the bed and banks downstream will be monitored as part of the Glebe Option EMP (Chapter 21) and may require remedial action after the proposed raising for the following reasons:

- maximum discharge rate through the outlet system will increase marginally because of the 2.36 m increase in maximum head;
- modifications to the downstream discharge apron will cause minor changes to flows immediately downstream;
- construction of a fishway, or modifications to allow for the construction of one, may result in changed flow characteristics in the low flow channel immediately downstream;
- changes to shapes of the spillway crest and the flanking weir walls necessary to allow the inflatable rubber dams to be fitted may change the turbulence characteristics of overtopping flows; and
- if a fishway is fitted, flows designed to attract fish moving upstream will cause minor changes to flows leaving the discharge apron.

Details of implementation strategies, monitoring, reporting and corrective actions (if necessary) are provided in Chapter 21.

Construction of the levee banks and access road is not expected to cause any erosion effects on the basis that the appropriate design standards and the EMP (Chapter 21) will be adhered to. Regular maintenance inspections will be undertaken as detailed in the EMP to monitor erosion.

7.3.2.2 Pipeline Route

The proposed pipeline route traverses landscape that is generally erosional, with floodplains forming along some of the larger drainage lines. The landscape is generally stable (Appendix 7-A — *Pipeline Observations*) but areas of instability noted include:

- erosion of diversion drains, catch drains and minor drainage lines in steeper areas where Mayne Creek flows parallel to the Nathan Road reserve to the east (Plate 7-6);
- erosion in the vicinity of Romeo Creek;
- erosion of some overfalls from cuttings on ridge crests onto the road;
- erosion and landscape instability in and adjacent to Bungaban Creek west of the Nathan Road crossing; and
- erosion of one of the channels of Roche Creek to the west of the Nathan Road crossing where a culvert concentrates flows.

Plate 7-6. Eroded drain in the road reserve east of Nathan Road with Mayne Creek parallel in middle distance

The soils along much of the proposed pipeline route have shrink-swell characteristics. The quantity of bedding sand and the volume of pipe in the trench will mean that the volume of soil and rock material

excavated from the trench will be greater than that required for backfilling. Options identified for disposal of this spoil include:

- using the spoil to fill reclaim existing gully erosion;
- creating shallow broad mounds adjacent to and over the pipeline covering them with topsoil and revegetating them or
- using the spoil as additional fill for railway embankments along the Surat Basin Railway which will be near to the pipeline for much of its route.

Options that result in productive use are preferred. Care should be taken for those soil materials with high sodicity levels. These are highly dispersible and should be incorporated within the structure and not used as surface cover.

Construction of the pipeline will not result in long-term landscape instability provided that work areas that are to be subjected to prolonged disturbance are protected and all disturbed areas are rehabilitated adequately. Strategies to ensure long-term stability will include:

- planning drainage from sites subject to prolonged disturbance and installing sediment barriers and sedimentation ponds where required;
- minimising exposure of dispersible, sodic subsoil materials;
- progressive site clearance, pipeline construction and permanent rehabilitation so that areas are exposed for the minimum possible time and there are no appreciable lengths of open trench that can intercept flows and act as drains;
- placing clay barriers in the bedding sand surrounding the pipe to ensure the sand does not provide a subsurface conduit for downslope water movement;
- planting quick-growing plant species that are naturalised or native to the area to provide ground cover as soon as work is completed;
- ensuring that any drainage required for access tracks discharges where flows will spread naturally;
- ensuring that access tracks do not disrupt flows in natural drainage lines; and
- monitoring rehabilitation work in accordance with an erosion monitoring programme (Chapter 21)and taking corrective actions immediately any problems occur.

7.4 Visual amenity

7.4.1 Description of Environmental Values

Assessment of landscape visual amenity is subjective as it is based on the perceptions of individuals but criteria often considered in the assessment of visual amenity include:

- relative uniqueness of the landscape type or feature — scarcity;
- attractiveness of the landscape — the level of visitation and recognition that the landscape has aesthetic values;
- visibility of the landscape — the number of people viewing the landscape and the vantage points from which they view it; and
- documentation — the availability of visual and written references to landscape character and scenery.

7.4.1.1 Glebe Weir

The landscape in the vicinity of Glebe Weir has many similarities with much of the level to rolling topography in the Central Queensland region. Views of the weir and / or existing inundation area generally include:

- a strip of riparian vegetation;
- cleared floodplains or footslopes of varying width, sometimes cultivated;
- undulating rises and low hills with scattered remnant trees (such as narrow-leaved bottle trees) and small patches of remnant or re-growth brigalow, softwood scrub or eucalypts; and
- rolling hills with more extensive remnants of softwood scrub or brigalow.

Less common features are the weir structure and the expanse of water but the expanse of water is not unique. (Plate 7-7). There are several other natural expanses of permanent water in the area (Plate 7-8) and a number of semi-permanent expanses such as the wetlands associated with Palm Tree Creek, some of which are visible from the Taroom — Bauhinia Downs Road.

Plate 7-7. The expanse of Glebe Weir with the weir structure, a strip of riparian vegetation, the cleared floodplain and a vegetated hill just visible in the background

The Glebe Weir inundation area has only been cleared for approximately 2.4 km upstream of the weir so that the expanse of water is interrupted by the skeletons of the trees that grew in the broad streambed until the early 1970s. These mar the visual impact of the water and restrict boating activities (Plate 7-9).

Plate 7-8. A permanent waterhole in the vicinity of Palm Tree Creek near the Leichhardt Highway north of Taroom

Plate 7-9. Glebe Weir at the upstream limit of clearing showing the dead trees within the inundated area and riparian vegetation on the left bank

The camping area and reserve at Glebe Weir attracts local people for boating and fishing and Queensland and interstate caravaners and other campers for fishing and the relative remoteness of the camping experience. It is recognised and publicised locally as an attraction for these reasons more than for its aesthetic appeal. Average visitor numbers are likely to be of the order of 15 people per day and the landscape is not documented as being of particular visual interest. Public access to view the area is limited to the camping area and reserve for those restricted to the land and the inundation area for boat users.

The only homesteads with views of Glebe Weir inundation at present are those on Lot 15 CP FT2 and Lot 2 CP LE246. Neither of these homesteads is able to view the proposed weir pumping station site. The homestead on Lot 15 CP FT2 is on a low rise approximately 0.6 km southeast of the inundation area adjacent to an area formerly known as Glebe Waterhole, just over 3 km upstream of the weir. Because of the former waterhole, views of the expanse of water are interrupted only by standing dead timber close to each bank.

The homestead on Lot 2 CP LE 246 is on a ridge at the top of a 'U' shaped bend in the Dawson River about 10 km south-west of the weir and 1.1 km from the inundation area. The main view of the weir from this point is to the south-east towards the weir. There is a considerable amount of standing dead timber in the inundation area but its visual impacts are attenuated to a large extent by distance.

7.4.1.2 Pipeline Route

The first 11 km of the route traverses current largely cleared grazing paddocks with no public access (Plate 7-10).

Plate 7-10. Pipeline route east of boundary between Lot 14 CP FT1 and Lot 3 CP FT733

Beyond this area the route is within the Nathan Road reserve, the first section of which is an unsealed road traversing largely cleared grazing land (Plate 7-11).

Plate 7-11. Pipeline route on Nathan Road near Taroom Cracow Rd.

The rolling hills along the route afford occasional expansive views of the agricultural countryside (Plate 7-12). Segments of the route are fringed with a narrow band of trees which is also occasionally a dominant feature of the view (Plate 7-13).

Plate 7-12. View down slope showing brigalow regrowth in road reserve and cleared paddock to east

Plate 7-13. Wide road reserve with forest and forest regrowth in paddock

7.4.2 Potential Impacts and Mitigation Measures

7.4.2.1 Glebe Weir

The visual character of Glebe Weir and the inundation area before and after raising has been considered in relation to a number of factors generally accepted as of relevance to visual appeal (Table 7-2). The principal changes to visual character relate to a narrowing of riparian vegetation around the inundation area, inundation of low-lying land outside the bed and banks of the stream and additional structures. The narrowing of the strip of riparian vegetation is important because landholders have cleared to the top of the high river bank in a number of locations.

Table 7-2. Visual attributes of Glebe Weir and its inundation area before and after the proposed raising

Attribute	Present Condition	Likely Condition after Raising
Land use and land cover	1. Expanse of water within stream bed and banks with riparian vegetation separating water from rural land that is mostly cleared 2. Expanse of rural land mostly cleared and grazed	1. Larger expanse of water within stream bed and banks with reduced riparian vegetation separating water from rural land that is mostly cleared 2. Expanse of water outside stream bed and banks over cleared land at FSL then expanse of land carrying forbs and grasses when weir is below FSL
Slope variation	Slope variation around the inundation area provided by stream banks	Lower slope variation around the inundation area provided by reduced margin between water at FSL and bank tops
Vegetation, particularly trees	Trees in the riparian zone	Reduced width of tree belt in the riparian zone
Water and the attributes of any water bodies	A large, uninterrupted expanse of water for approximately 2.4 km upstream of weir, then interrupted by standing dead timber	A larger, uninterrupted expanse of water for approximately 2.4 km upstream of the weir, then interrupted by standing dead timber for a longer distance upstream, though not visible from most vantage points
Foreshore disturbance or modification	Foreshore at and just below FSL has become naturalised with frequent tea tree establishment	Foreshore at and just below FSL will carry a limited amount of existing vegetation then tea tree will establish as at present over time. There will be a closer visual connection with large eucalypts on the river bank and the raised water level.
Natural or artificial contrasts	1. Natural contrast provided by water within a generally dry landscape 2. Artificial contrast provided by the weir structure	1. Natural contrast provided by water within a generally dry landscape 2. Artificial contrast provided by the weir structure but contrast increased, particularly from any downstream view, or when the weir is below FSL, by the curve of the inflatable rubber dams opposed to the angularity of the concrete and sheet pile structure
Level of natural contrasts	High contrasts provided by water within the landscape	High contrast provided by water within the landscape
Level of intrusive artificial contrasts	Moderate in that existing structures contribute to adding the water to the view	Moderate in that structures contribute to adding water to the view with a slight increase in intrusiveness because of the weir control room and the weir pumping station that will be visible from some areas open to the public

Attribute	Present Condition	Likely Condition after Raising
Natural and human induced movement and activity	Movement provided by water spills and discharges and low levels of human activity	Movement provided by water spills and discharges and low levels of human activity but weir security and personal safety considerations may restrict public access to viewing points
Nature of landscape views	Expanse of water, riparian vegetation, cleared lands and hills that are timbered	Expanse of water, riparian vegetation, cleared lands and hills that are timbered and some constructed levee banks

The increased inundation area outside stream beds and banks is generally away from the areas that can be viewed by members of the public, and the only homestead it may be visible from is that on Lot 2 CP LE284. Tea tree will establish naturally around the margins and the broad area is likely to be colonised by annual grasses and forbs when water level in the inundation area is below FSL.

Strategies recommended to reduce visual impacts of the Glebe Option in the vicinity of the weir are to:

- design the weir control room and the weir pumping station control room building to make them sympathetic to the local landscape;
- plant trees native to the area to shield the above buildings and help them blend in with the scenery of the area;
- revegetate the constructed levees with naturalised and native grasses in areas where they are not protected by rock mattresses; and
- plant trees native in the area above the proposed FSL to broaden the riparian vegetation where the raised water level will appreciably reduce its thickness — particularly important in the 2.4 km above the weir where there is open water likely to attract the highest levels of boat use.

7.4.2.2 Pipeline

The pipeline route and associated access roads may be visible from Nathan Road along much of the route. Visual impacts along most of the route will be minor because:

- the line will be buried underground;
- the route from the weir to Nathan Road is almost entirely cleared;
- much of the Nathan Road reserve is cleared where (or if) the line will be sited in it; and
- visible pipeline infrastructure will only be very a minor part of the view as the SBR corridor will be near to the road for much of its length.

Visual impacts of the pipeline will arise from:

- access roads where required;
- signage notifying the location of the line;
- minor above-ground infrastructure such as vents and valves; and
- larger infrastructure such as the balancing storage — this may cause appreciable visual impacts as it will be on high ground but is likely to be behind a verge of trees.

Visual impacts of access roads, other than those to pumping stations that will carry appreciable traffic, will be minimised if any gravel pavements are allowed to revegetate with naturalised and native grasses and if maintenance is by slashing with very occasional grading.

Signage and minor above-ground infrastructure needs to be readily visible to avoid damage during farming operations, road works or rail maintenance so no strategies to reduce visual impacts can be recommended for this.

The site chosen for the balancing storage is elevated. Land to the east is cleared with no homesteads in the immediate vicinity. The area to the west, between the site and Nathan Road, is carrying natural or well-grown regrowth vegetation so the site is screened from passers-by. There may be minor visual impacts from some directions but appropriate design and revegetation of the surrounding areas will be the main strategies to minimise these.

7.5 Geology

7.5.1 Description of Environmental Values

The surface geology of the Glebe Option area, including the proposed pipeline route, is dominated by Jurassic sediments of the Surat Basin as is the Dawson River catchment upstream (DNRMW, 2006a and b; GSQ, 1967; GSQ, 1971). The Surat Basin rocks are generally underlain by older, Permian to Middle Triassic sediments of the Bowen Basin (Geoscience Australia, 2008b and c). The Bowen Basin is one of the structural elements of the Tasman Geosynclinal Zone and has been subjected to substantial folding and faulting, probably through the middle to upper Triassic, with intrusive activity as well (Wright, 1968b). The nearest outcrops of Bowen Basin sediments to the Glebe Option area lie to the north, towards the lower end of Nathan Gorge where the Late Permian sedimentary rocks of the Blackwater Group occur.

The Surat Basin is an extensive unit within the Great Artesian Basin. It is a large, intracratonic, Early Jurassic to Early Cretaceous basin where deposition commenced during a period of passive thermal subsidence of much of eastern Australia. Depositional environments within the basin include fluvial, lacustrine, paludal, and marine. Sediments are largely flat-lying and relatively uniform.

The Dawson River catchment above Glebe weir is dominated by the following Jurassic geological units of the Surat Basin:

- Injune Creek Group (sandstone);
- Hutton Sandstone (feldspathic at base, quartzose at top); and
- Evergreen Formation (a number of constituents including mudstones and sandstones)

Appreciable areas of Precipice Sandstone (quartzose sandstone), which is part of the Surat Basin Jurassic sedimentary sequence and frequently underlies the Evergreen Formation, and Quaternary Alluvium occur as well. The Hutton and Precipice Sandstones form important Great Artesian Basin aquifers in the area. A number of geological units from the Surat Basin outcrop in the vicinity of Glebe Weir or along the proposed pipeline route (
Table 7-3) but it appears that the alluvium at the Glebe Weir site is underlain by the Je_1 mapping unit which is a constituent of the Evergreen Formation.

Table 7-3. Geological units occurring in the vicinity of Glebe Weir and along the proposed pipeline route (DNRMW, 2006a and b; GSQ, 1967; GSQ, 1971)

Unit	Lithology	Age[1]	Occurrence
Qa	Clay, mud, silt, sand, gravel; mainly stream-channel and floodplain deposits	Quaternary	Alluvium associated with the Dawson River, Cockatoo Creek, Boggomoss Creek and Bentley Creek in the vicinity of Glebe Weir and a number of creeks and drainage lines along proposed pipeline route
Qpa	Sand, mud and gravel; alluvium on higher terraces, commonly with 'melon holes' (gilgai country)	Quaternary	Higher-lying alluvium on Lot 15 CP FT2 in the vicinity of Glebe Weir
Td	Indurated and ferruginised top of deep weathering profiles, locally including ferricrete	Tertiary	Plateaus on hills east of Dawson River at approximately 342.5 km AMTD and on hills north-east of Cockatoo Creek near the upstream limit of storage of Glebe Weir at the proposed 172.9 m AHD FSL
Ji (Injune Creek Group)	Sandstone, siltstone, mudstone, coal, conglomerate	Jurassic	Hills adjacent to Dawson River upstream of 361 km AMTD (above upstream limit of storage) and along proposed pipeline route from approximately 3 km south of Bungaban Creek to approximately 1.1 km from Leichhardt Highway
Jh (Hutton Sandstone)	Pale brown to white, or pale grey, poorly sorted, medium-grained, feldspathic sublabile sandstone (at base) and fine-grained, well sorted, quartzose sandstone (at top); commonly friable; minor dark grey carbonaceous siltstone, mudstone, rare pebble conglomerate	Jurassic	Hills and rises adjacent to Glebe Weir from approximately 332 km AMTD to above upstream limit of storage (unit ends at approximately 361 km AMTD), upper slopes of hills north-east of Cockatoo Creek near the upstream limit of storage of Glebe Weir at the proposed 172.9 m AHD FSL, and hills and rises along the proposed pipeline route between Cockatoo Creek and Bungaban Creek
Je_2 (Part of Evergreen Formation)	Mudstone, siltstone and fine-grained labile to sublabile sandstone	Jurassic	Mid-slopes of rises north-east of the Dawson River in the vicinity of 338 km to 342 km AMTD, mid-slopes of hills north-east of Cockatoo Creek near the upstream limit of storage of Glebe Weir at the proposed 172.9 m AHD

Unit	Lithology	Age[1]	Occurrence
			FSL and two occurrences on upper slopes and crests
Je_0 (Part of Evergreen Formation)	Yellowish brown to brown, oolitic or pelletal ironstone, sublabile sandstone, siltstone, mudstone	Jurassic	Narrow occurrence on undulating rises and hills north-west of approximate AMTD 329.5 km to 330.1 km AMTD on the Dawson River with second, wider, occurrence further from river opposite and five occurrences along proposed pipeline route between intersection of Nathan Road and Taroom — Cracow Road and Cockatoo Creek
Je_1 (Part of Evergreen Formation	Pale grey to greenish grey, flaggy, fine to medium-grained, micaceous, labile to sub-labile sandstone; pale green or khaki mudstone; minor white siltstone, shale, coal	Jurassic	Lower slopes south-west of Spring Creek and lower reaches of Boggomoss Creek and some lower slopes adjacent to Cockatoo Creek in the vicinity of Glebe Weir and along most of the proposed pipeline route from the pumping station to approximately 1.7 km south of the intersection of Nathan Road and Taroom — Cracow Road

Note 1. Descending in table order implies age relationships, youngest to oldest

Broad scale geological mapping does not reveal any structural features close to Glebe Weir or the proposed pipeline route (DNRMW, 2006a and b; GSQ, 1967; GSQ, 1971). Nevertheless, the form of the Dawson River and tributary creeks near the weir suggest that structural controls on stream location are likely. The features nearest to the weir shown are:

- the Mimosa Syncline running north-north-west to south-south-east approximately 40 km west;
- a fault running north-west to south-east approximately 25 km south-west;
- two faults running south-west to north-east approximately 35 km east-north-east; and
- a fault running north to south approximately 30 km east.

Occurrences of minor faulting or shearing were observed in exposures of sub-surface rock at 56J 208230E 7174170N and 56J 210200E 7169500N. Both occurrences appeared to be running north-west to south-east. The surrounding landscapes showed no evidence that there had been recent movement associated with these features.

Records show some minor seismic activity to the north and east of Glebe Weir and to the east of the pipeline route (Section 6.6) but seismic activity does not pose an appreciable risk to either.

7.5.2 Potential impacts and mitigation measures

Geological conditions should not affect either the raising of Glebe Weir or the pipeline. The existing weir shows no evidence of leakage below or around the structure so the raised structure should be equally sound provided that additional sheet piling is driven to similar depths to that already there. There are a number of exposures of sedimentary rock along the pipeline route and soil depth is shallow over rock in numerous

places. The nature of rock exposed in road cuttings indicated that it should be possible to excavate the trench for the pipeline after ripping with heavy machinery so blasting should not be required.

7.6 Soils

7.6.1 Description of Environmental Values

Soils across the entire Glebe Option study area have been described and mapped as part of a land systems study (Speck *et al*., 1968) and as part of an agricultural land evaluation study (Forster, 1985). More details of the distribution of soils considered in the Land System study are available in a description of land units in the region (Gunn and Nix, 1977). Soils in the vicinity of Glebe Weir were described and mapped as part of the Dawson Dam Impact Assessment Study and their suitability for a range of agricultural uses was assessed (Table 7-4) (Shields, 1997). Observations made in the vicinity of Glebe Weir and along the first few kilometres of the proposed pipeline route have resulted in one minor adjustment to the boundaries in the mapping of Shields (1997) as part of this study (Figure 7-2).

Almost all of the area to be inundated at the proposed FSL outside of the bed and banks of the Dawson River, creeks and gullies comprises Eucalypt Floodplains with Grey and Black Vertosols and has been assessed as suitable for irrigated cotton, broadacre crops and pastures (Shields, 1997).

Soils along the proposed pipeline route have been described and mapped on the basis of Land Resource Areas (LRAs) and the suitability of LRAs has been assessed (Table 7-5, Figure 7-3) (Forster, 1985). Notes on landforms and soils and landforms were made as part of this study as well (Appendix 5-A — *Pipeline Observations*) and observations were in general agreement with the information from the LRA study (Forster, 1985).

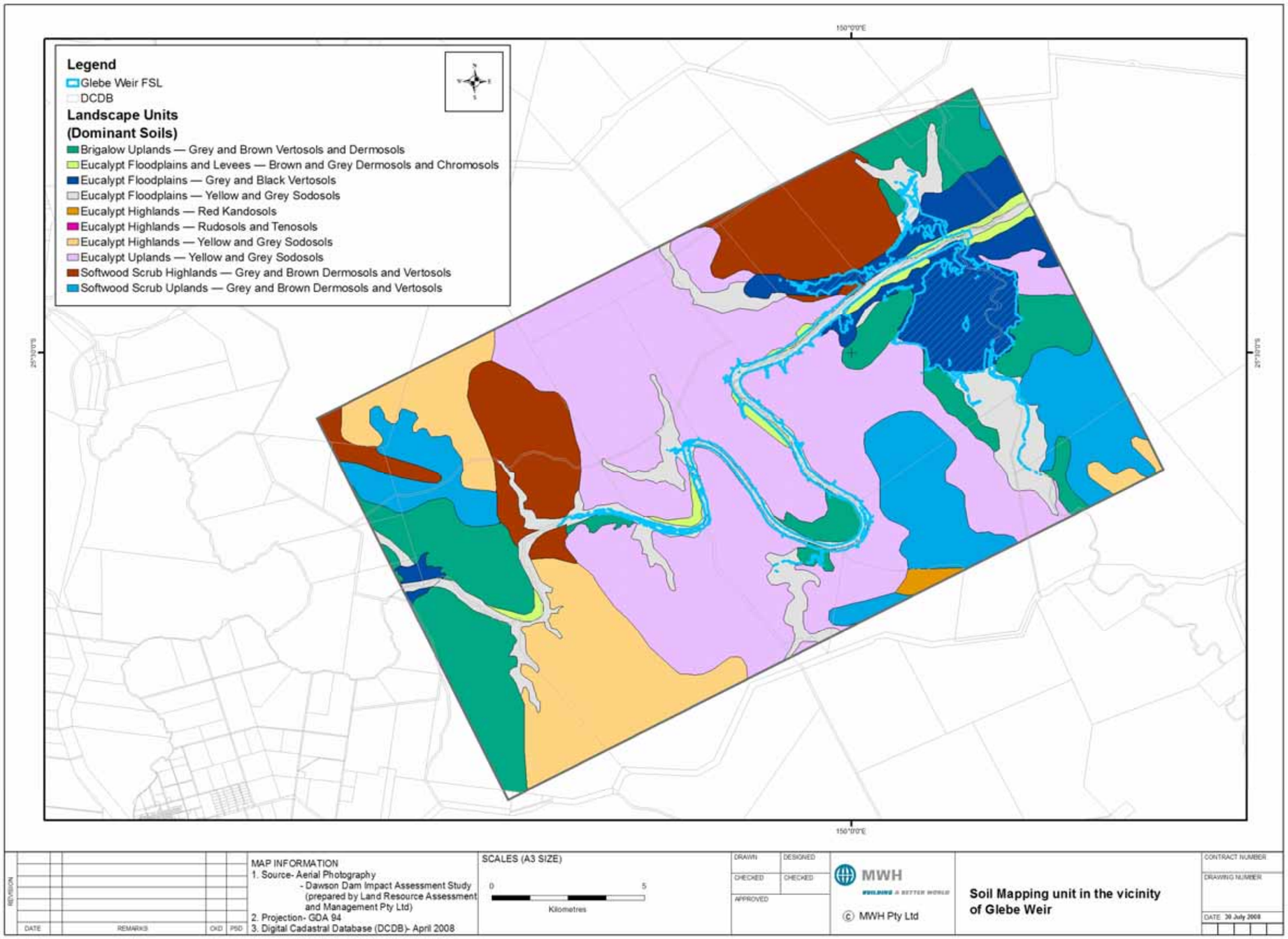

Figure 7-2. Landscape units and dominant soils in the vicinity of Glebe Weir

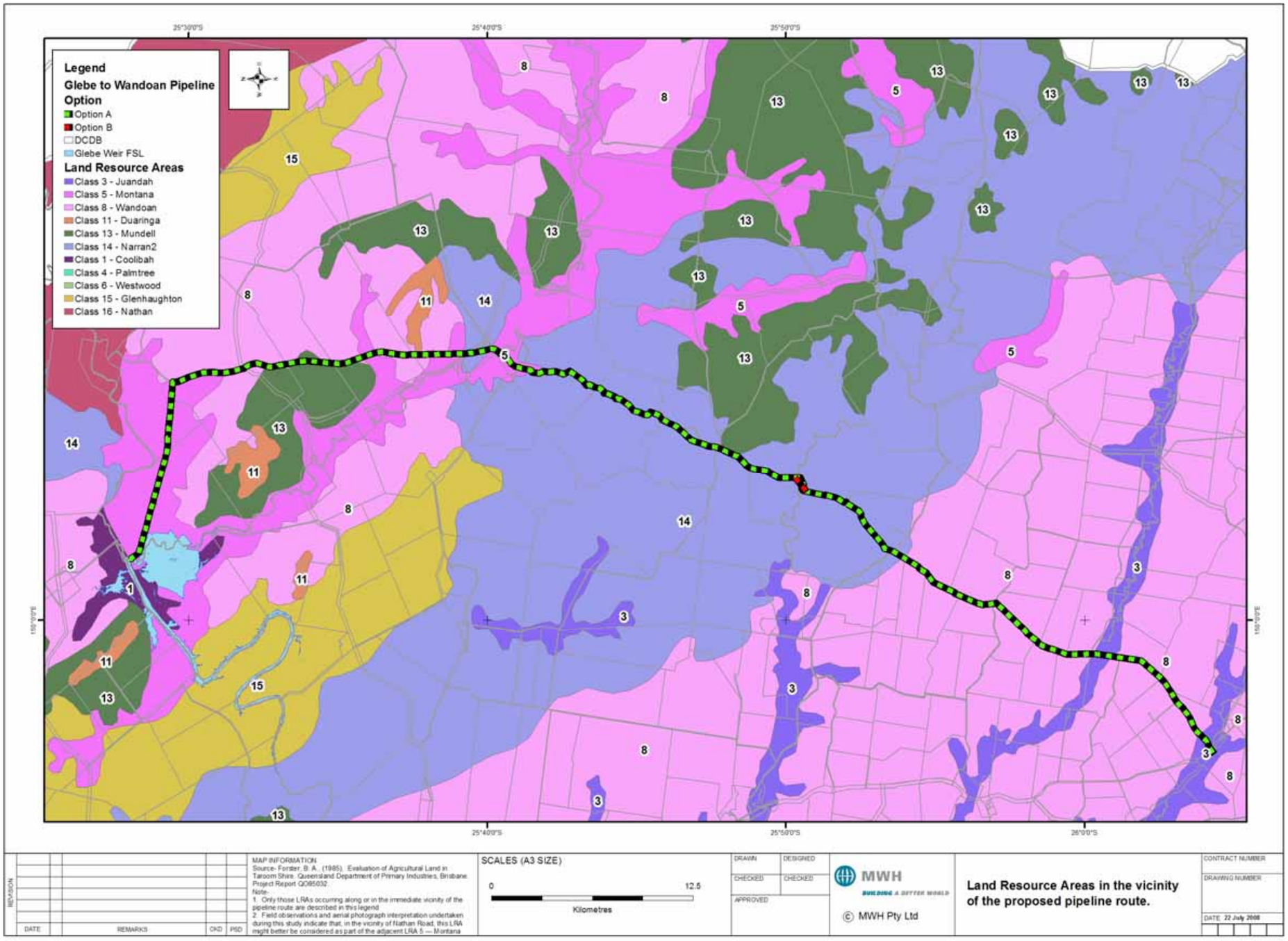

Figure 7-3. Land Resource Areas along the pipeline route

Table 7-4. Soil mapping units in the vicinity of Glebe Weir and the pipeline route (after Shields, 1997)

Soil Mapping Unit	Usual Occurrence	Dominant Soils	Associated Soils	Dominant Agricultural Suitability
Eucalypt Floodplains and Levees — Brown and Grey Dermosols and Chromosols	Levees of the Dawson River and adjacent floodplains	Soil texture at the surface varies from sandy loam to clay loam, gradually increasing with depth to sandy clay loam in the lighter soils and light-medium clay in the heavier soils. Soil structure is related to texture with the lighter soils being massive (no natural soil aggregates) and the heavier soils having moderate structure (at least one-third of the soil mass composed of natural aggregates). Soils are moderately well drained and overlie buried alluvial layers below 1 m. Water storage is moderate and fertility is quite high in the virgin state.	Brown, Yellow and Grey Chromosols — These soils have a clear or abrupt boundary between coarser textured surface horizons and finer textured subsoils which are not high in exchangeable sodium and are not strongly acid	Suitable for irrigated citrus, broadacre crops and pastures Marginal for peanuts
Eucalypt Floodplains — Grey and Black Vertosols	Floodplains of the Dawson River and some tributaries Some alluvial plains along pipeline route	These are heavy clay soils that shrink and swell with changing soil water status, developing vertical cracks at the soil surface when dry. They are strongly structured but the size of the aggregates at the surface varies from fine (self-mulching) to coarse. The soils are only slowly permeable but have high water storage capacity and high natural fertility.	Yellow and Grey Sodosols	Suitable for irrigated cotton, broadacre crops, and pastures
Eucalypt Floodplains — Yellow and Grey Sodosols	Valley flats of tributaries of the Dawson River Some alluvial plains along pipeline route	Soil texture at the surface varies from sandy loam to sandy clay loam with an abrupt boundary to a yellow or grey medium to heavy clay subsoil. A pale or white band may occur between the surface layer and the clay subsoil. The clay subsoil is coarsely structured (large soil aggregates) with few pores and voids for water and roots to penetrate. As well as being relatively impermeable, the clay subsoil has a high exchangable sodium percentage making it dispersible and highly erodible if exposed to running water. Water storage capacity is quite low but fertility is moderate where they occur on eucalypt floodplains.	Grey and Black Vertosols	Larger proportion suitable for irrigated pastures Marginal for irrigated cotton and broadacre crops Smaller proportion suitable for irrigated cotton, broadacre crops, and pastures
Eucalypt Uplands — Yellow and Grey Sodosols	Extensive areas of rises, particularly through the middle section of the Glebe Weir inundation	As for Eucalypt Floodplains — Yellow and Grey Sodosols	Grey and Brown Vertosols, Brown and Yellow Chromosols, occasional Rudosols and Tenosols — these soils have limited soil development and can occur where profile	Unsuitable for cropping Suitable for beef cattle breeding

Soil Mapping Unit	Usual Occurrence	Dominant Soils	Associated Soils	Dominant Agricultural Suitability
	area Rises along the pipeline route.		depth is very shallow (less than approximately 0.2 m)	
Brigalow Uplands — Grey and Brown Vertosols and Dermosols	Rises and some hills in the vicinity of Glebe Weir, particularly towards the upstream limit of storage Extensive areas of rises and some hills along the pipeline route	Vertosols — Very similar to Grey and Black Vertosols on Eucalypt Floodplains though brown colours are more common. Total soil depth is often shallower (<1.5 m) where soils overly sedimentary rocks. They are only slowly permeable but have a high water storage capacity and high fertility in the virgin state (most common). Dermosols — Soil texture at the surface varies from clay loam to light clay and gradually increases to medium-heavy clay at depth. Soil structure is moderate to strong throughout the profile with fine to medium aggregate sizes. Total profile depth can be <1 m where the soils overlie sedimentary rocks. The soils have moderate permeability and water storage capacity varies from moderate in very shallow profiles to high in deeper soils. Natural fertility is high	Yellow and Grey Sodosols, occasional Rudosols and Tenosols	Suitable for irrigated broadacre crops and pastures Marginal for irrigated cotton
Softwood Scrub Uplands — Grey and Brown Dermosols and Vertosols	Some rises north of Glebe Weir towards the upstream limit of storage Some rises and hills north-east and south-west of Cockatoo Creek Some rises and hills along the pipeline route	Dermosols — As for Dermosols in Brigalow Uplands unit (most common) Vertosols — As for Vertosols in Brigalow uplands unit	Occasional Rudosols and Tenosols	Suitable for irrigated cotton, broadacre crops, and pastures
Eucalypt Highlands — Yellow and Grey Sodosols	Some hills north and south of Glebe Weir towards the upstream limit of storage	As for Eucalypt Floodplains — Yellow and Grey Sodosols	Grey and Brown Vertosols	Unsuitable for cropping Marginal for cattle fattening

Soil Mapping Unit	Usual Occurrence	Dominant Soils	Associated Soils	Dominant Agricultural Suitability
	Hill crests north-east of Cockatoo Creek Some rises and hills along the pipeline route			
Softwood Scrub Highlands — Grey and Brown Dermosols and Vertosols	Hills, mostly north of the Dawson River Some hills along the pipeline route	Dermosols — As for Dermosols in Brigalow Uplands unit (most common) Vertosols — As for Vertosols in Brigalow uplands unit	Occasional Rudosols and Tenosols	Unsuitable for cropping Suitable for cattle fattening
Eucalypt Highlands — Red Kandosols	Plateau surface south of the Dawson River (Tertiary land surface remnants)	Soil texture at the surface is sandy loam to sandy clay loam and this gradually increases to light clay in the subsoil. The soils are massive with few, if any, natural soil aggregates and have a typical 'earthy' appearance. Total profile depth is generally greater than 2 m. The soils have high permeability, low water storage capacity and very low natural fertility		Unsuitable for cropping Marginal for cattle fattening
Eucalypt Highlands — Rudosols and Tenosols	Hills north of the Dawson River and in the vicinity of Nathan Gorge	These soils have limited soil development and can occur where profile depth is very shallow (less than approximately 0.2 m)		Unsuitable for cropping Suitable for cattle breeding

Table 7-5. Land Resource Areas occurring in the vicinity of the pipeline route

Land Resource Area	Mapped Occurrences	Landform	Dominant Soils	Associated Soils	Agricultural Suitability	GQAL Class
3 — Juandah	Alluvial plains associated with Juandah Creek and Roche Creek	Level plains	Predominantly deep Sodosols, low surface fertility, moderate water storage and saline subsoils	Grey and Brown Vertosols	Class B1 — Marginal arable land	Class B — Limited crop land
5 — Montana	From Glebe Weir to approximately for 9.7 km towards intersection of Nathan Road and Taroom — Cracow Road, valleys of Cockatoo Creek and its tributaries	Level plains to gently undulating rises with occasional rolling rises	Moderately deep Sodosols and Grey Vertosols	Shallow sodosols and Tenosols on sandstone on rises	Class C1 — Pastoral land	Class C — Pasture land
8 — Wandoan	From approximately 3.3 km north-west of intersection of Nathan Road and Taroom — Cracow Road to intersection, then to 3 km south, from 5.3 km south to 7.5 km south and from 8.5 km south to 11.5 km south then from 1 km south of Bullock Creek to intersection of Nathan Road and Leichhardt Highway excluding alluvium along Roche and Juandah Creeks (LRA boundary is along Nathan Road in some northern areas)	Undulating plains and rises	Moderately deep Grey , Brown and Black Vertosols, moderate to high fertility, high soil water storage for deeper profiles and some saline and sodic subsoils	Shallower soils on crests and steep upper slopes, sometimes with rock and stone	Class A2 — Arable land	Class A — Crop land
11 — Duaringa	Minor mapped occurrence on road and larger occurrence to east 10.7 km south of	Level plains to undulating rises and crests on dissected tablelands	Shallow Tenosols, Kandosols and Rudosols, low fertility and soil water	Sodosols and stony Brown Vertosols	Class C2 — Pastoral land	Class D — Non-agricultural land

Land Resource Area	Mapped Occurrences	Landform	Dominant Soils	Associated Soils	Agricultural Suitability	GQAL Class
	intersection of Nathan Road and Taroom — Cracow Road		storage			
13 — Mundell	Between 3 km and 5.3 km south of intersection of Nathan Road and Taroom — Cracow Road and for approximately 1.3 km immediately to the east of Nathan Road approximately 1 km south of Maidens Road	Rolling to steep low hills	Shallow Grey, Brown and Black Vertosols and Dermosols, moderate to high fertility and moderate soil water storage	Similar soil with stone soils	Class C1 — Pastoral land	Class C — Pasture land
14 — Narran	Between approximately 0.7 km and 2.3 km north of Cockatoo Creek[1] and from approximately 3.0 km to 27.3 km south of Cockatoo Creek	Rolling low hills	Shallow Sodosols and Rudosols on quartzose sandstone	Rudosols and shallow, stony Grey and Brown Vertosols	Class C2/C1 — Pastoral land (predominantly suitable for grazing of native pastures but some areas suitable for pasture improvement	Class D — Non-agricultural land

Note 1. Field observations and aerial photograph interpretation undertaken during this study indicate that, in the vicinity of Nathan Road, this LRA might better be considered as part of the adjacent LRA 5 — Montana

7.6.2 Potential Impacts and Mitigation Measures

The raising of Glebe Weir will not involve significant excavation work. Some excavation will be required to provide access to and across the bed of the Dawson River and to the downstream face of the existing structure, and some soil disturbance will result from establishment of the worksite. Also, a temporary crossing over the low flow channel will be required. The weir raising is likely to disturb only the Dermosols and Chromosols of the river levees and banks and clayey sediments of the river bed. Nevertheless, it is likely that some of the alluvial layers beneath the soils of the levee and banks will be dispersible, sodic clays.

Land use along the pipeline route will be disrupted during the construction period but, provided reinstatement is carried out correctly, there should be little long-term impact on soils and land suitability along the route. Nevertheless, there will be some impacts associated with:

- flow control structures and air valves;
- balancing storage;
- the Glebe Weir pump station;
- access tracks where required; and
- disposal of excess excavated material.

Pump station and pipeline construction will involve excavation and trenching with access track construction in some areas. Pipeline construction will affect a wide range of soils, many of which have dispersible, sodic, subsoils. Some of the soils along the pipeline route have saline subsoils as well.

All disturbed areas including the weir site, pump station and pipeline excavation areas and access tracks will require temporary erosion protection if they are in a disturbed state for more than approximately one week, or if rain is forecast or likely for the period when it is anticipated they will be open. Temporary erosion protection measures will be appropriate to the situation and could include:

- ensuring that the temporary crossing over the Dawson River and any other temporary stream crossings needed do not restrict natural flows and have downstream erosion protection where required;
- diverting overland or channel flow away from disturbed areas;
- installing flow and sediment control structures on and down slope of disturbed areas;
- designing landforms on disturbed areas to spread, not concentrate flows;
- ensuring that potentially dispersible clay subsoil materials are not left exposed;
- constructing and maintaining sedimentation ponds; and
- constructing any stockpiles so that the surface is reasonably level, but with sufficient roughness to trap water and aid infiltration as opposed to large conical or elongate crested stockpiles.

Long-term erosion protection for disturbed areas will include strategies such as:

- managing potential run-on so that flows are dispersed over the area;
- avoiding flow concentration within the area, particularly any flow concentration that may run down slope over the pipeline;
- shaping landforms to provide slopes similar to or lower than those of the surrounding landscape and establishing vegetative cover with species that will provide ground cover rapidly;
- placing anchored, biodegradable erosion protection or, in some cases, rock mattresses or rip rap in stream channels and on banks while establishing trees, shrubs or ground cover species similar to those that now occur in similar situation (note that trees and shrubs will not be planted within the pipeline maintenance easement);
- re-creating the natural soil profile as far as is practicable by placing a layer with appreciable water holding capacity, such as a non-sodic clay or clay loam, and covering this with the original topsoil from the site.

Natural fertility and other properties of the soils likely to be disturbed by weir and pipeline construction are variable (Table 7-4 and Table 7-5). The following recommendations for soil management have been developed within the Glebe EMP:

- topsoil should only be stripped and stockpiled for subsequent reinstatement or rehabilitation works down to the top of any clay layer or to any appreciable colour change (including any pale grey or white bleached layer) in texture contrast soils;
- topsoil should only be stripped and stockpiled for subsequent rehabilitation works down to approximately 0.15 m in uniform-textured soils;
- topsoil should be stockpiled for the minimum practical time before use for reinstatement or rehabilitation to minimise loss of soil biota;
- topsoil should be returned to the area from which it was stripped wherever practical to minimise the spread of propagules of undesirable plants;
- application of gypsum at rates equivalent to two to five tonnes per hectare should be considered on disturbed areas where the topsoil is clay because it will improve soil structure and water infiltration;
- deep subsoil (below approximately 0.8 m) from some Vertosols and Dermosols under brigalow may be acid and, if encountered, should be limed if it is to be placed less than 0.8 m below the surface of any reconstructed soil profile;
- advice should be sought from Queensland Government Department of Primary Industries as to appropriate fertiliser strategies for rehabilitated areas but it is likely that nitrogen, phosphorus and possibly potassium will aid grass establishment (generally, phosphorus should be applied sparingly or not at all to native trees and shrubs);

- works that will result in high levels of soil disturbance or high traffic should be timed for the April to September period when median rainfall is lowest to minimise erosion and soil compaction risk; and
- plantings for revegetation purposes should be in place, with adequate temporary erosion protection, by the end of September each year so that spring and summer rainfall will aid establishment.

7.7 Land Tenure

7.7.1 Description of Environmental Values

The present Glebe Weir inundation area is confined to the bed and banks of the Dawson River, Cockatoo Creek, Boggomoss Creek, Bentley Creek and minor tributary gullies (Figure 7-4). The Dawson River and Cockatoo Creek are boundary watercourses which means that their bed and banks are the property of the State of Queensland under the *Water Act 2000*. In total, thirteen land parcels will be directly or indirectly affected by the raising of Glebe Weir either by having the weir occupy more of the bed and banks of streams to which they are riparian or by having some low-lying areas in other stream channels or on floodplains inundated at the proposed FSL of 172.9 m AHD (Figure 7-4, Table 7-6).

Seven of the eleven parcels are currently owned by the State and are under short term leases to the current farmers.

The pipeline route is described in Chapter 5. The route between the Glebe Weir pumping station and the Nathan Road reserve crosses the Leasehold Lot 14 CP FT1 and the Freehold Lot 2 CP FT734 before reaching the Nathan Road reserve which is owned by the State of Queensland. Nathan Road has been gazetted along a path from Nathan Gorge heading generally South to intersect withTaroom — Cracow Road. Much of Nathan Road in this area is undeveloped and the road reserve is not readily accessible by the public. Nathan Road is controlled by Banana Shire north of the Maidens Road intersection and Dalby Regional Council south of this point.

Land tenure adjacent to Nathan Road is both Freehold and Leasehold, with three Reserves along the route, one reserve is predominantly to the west of the road in the vicinity of Cockatoo Creek and a second east of the road in the vicinity of Bullock Creek and a third at the termination of the pipeline adjacent to the Leichhardt Highway. There is also one permit to occupy along the route. East of the Nathan Road Reserve, there are thirteen Freehold and seven Leasehold Lots or part Lots while to the west there are twelve Freehold Lots and nine Leasehold Lots or part Lots. The balancing storage will be on the Freehold Lot 8 SP152696 which is currently undeveloped and wooded.

The area of the coarse sand deposit at Cockatoo Creek proposed as a source of construction sand is privately owned.

7.7.2 Potential impacts and mitigation measures

The bulk of the impacts of inundation associated with flooding outside the bed and banks is on State owned land (all of Boggomoss Ck flooding and 710ha of a total of 860ha related to Cockatoo Ck flooding). The latter has been minimised by the inclusion of levees that restrict flooding. For three of the four parcels in private ownership, impacts are restricted to increases in the length of bed and banks inundated by the storage. For the remaining property (Lot 14 CP FT1), the impact relates mainly to flooding of 150ha of land near Cockatoo Ck.

No road reserves will be affected by the raised Glebe Weir itself. The present private road access to Lot 14 CP FT1, will be below this FSL at the crossing on Cockatoo Creek.

Impacts of the raised Glebe Weir on the various land tenures are summarised in Table 7-6. Impacts will be managed by purchasing, leasing, subleasing, or resuming the areas inundated outside of the bed and banks of boundary watercourses and by fencing these areas off. Land acquisition strategies are considered in Chapter 5.

The weir pumping station on Leasehold Lot 14 CP FT1 and the balancing storage on Freehold Lot 8 SP152696 will require negotiated land purchases or leases or, failing this, compulsory land acquisitions where possible. Discussions to date have been positive.

The pipeline and associated access tracks will impact on a corridor approximately 30 m wide during construction and a corridor approximately 12 m wide during operation. Part of the required construction width will constitute the existing road verge or road, depending on the location. Easements will be negotiated with the landholders for the portion of the route across Leasehold Lot 14 CP FT1 and Freehold Lot 2 CP FT734.

The route current at September 2008 is primarily within the Nathan Road reserve south from the point where this reserve is first reached. Conditions of use of the road reserve will be negotiated with DNRW in consultation with Banana Shire Council and Dalby Regional Council. Easements will be negotiated with landholders where the portion of the route impinges on privately held land, such as at the crossing of Bungaban Creek where the road alignment does not suit a pipeline. It is also understood that the road may not always be located within the reserve and Council aims to rectify this situation over time. SunWater will discuss with Council any actions that may assist in this regard. If the route impinges on the corridor established for the proposed SBR, conditions of use will be negotiated with the asset owners.

Glebe Weir at the proposed FSL will impact on a small part (<5%) of an area in the vicinity of Boggomoss Creek that is listed in the Commonwealth Register of the National Estate (see Chapter 14) though this listing represents an interest rather than a tenure.

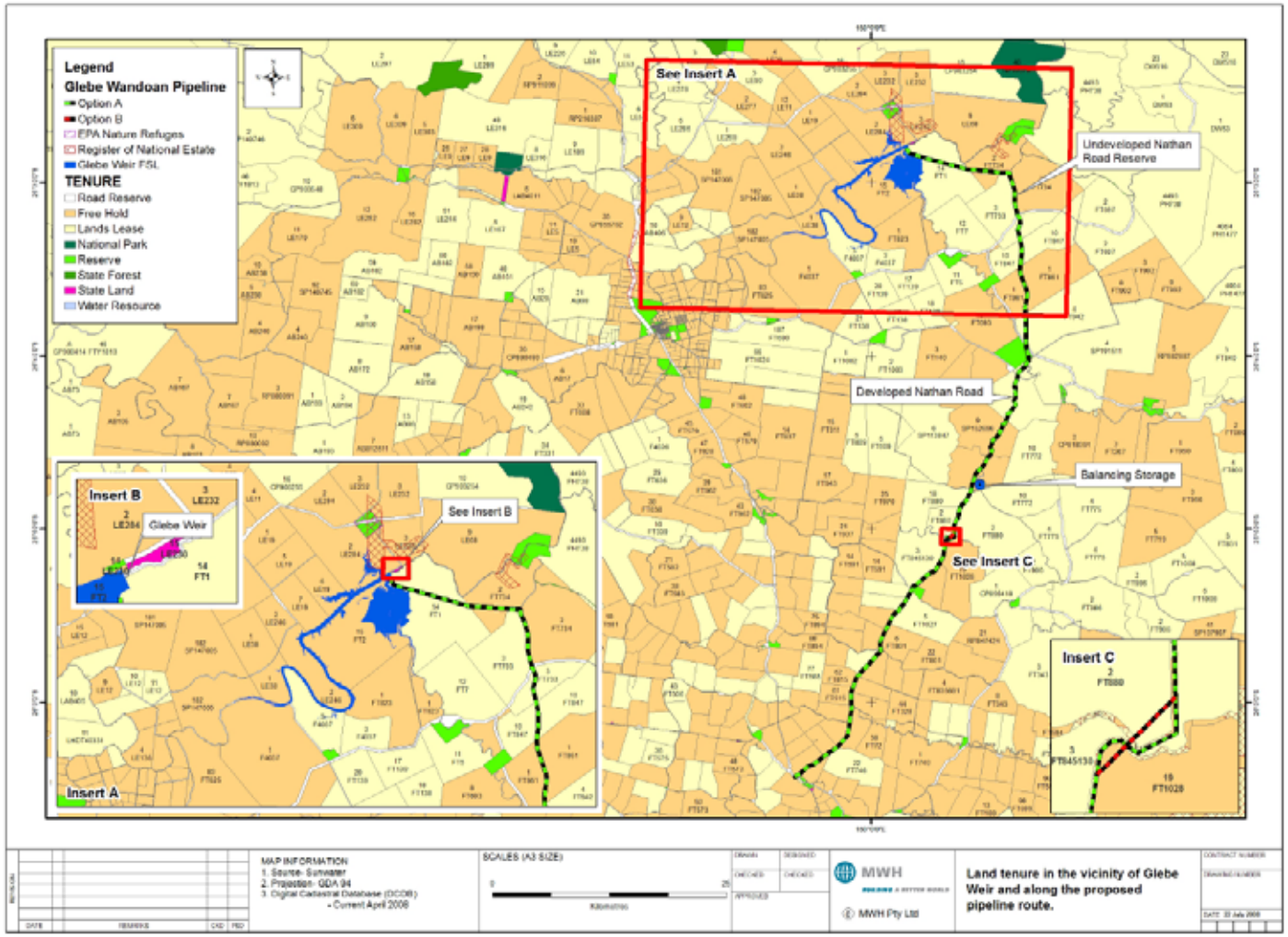

Figure 7-4. Land Tenure in the vicinity of Glebe Weir and along the proposed pipeline route

Table 7-6. Details of underlying land tenure, present ownership and control, present effects of Glebe Weir and effects of the raised Glebe Weir

Real property description	Underlying tenure	Present ownership and control	Present effects of Glebe Weir	Effects of Glebe Weir at FSL 172.9 m AHD
Lot 182 SP147005	Freehold	Private	Confined to Dawson River bed and banks over approximately 0.7 km at downstream end of property	Confined to Dawson River bed and banks for approximately 3.1 km into property
Lot 1 CP LE38	Freehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks through property	Confined to Dawson River bed and banks plus approximately 0.3 km of bed and banks of gully at approximately 348 km AMTD
Lot 2 CP LE246	Freehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks through property and distances of less than 0.1 km in gullies at approximately 335.0 km and 336.1 km AMTD	Confined to Dawson River bed and banks plus up to approximately 0.6 km of bed and banks of gullies at approximately 335.0 km and 336.1 km AMTD
Lot 7 CP LE19	Freehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks through property	Confined to Dawson River bed and banks
Lot 6 CP LE19	Freehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks through property and approximately 0.9 km in gully at approximately 330.0 km AMTD (backs up from Lot 2 CP LE284)	Confined to Dawson River bed and banks plus up to approximately 1.5 km of bed and banks of gully at approximately 330.0 km AMTD
Lot 2 CP LE284	Freehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks upstream of Glebe Weir, approximately 2.5 km of the bed and banks of Boggomoss Creek (not a boundary stream) and associated gullies and approximately 0.2 km in gully at approximately 330.0 km AMTD	Bed and banks of Dawson River upstream of weir, plus: ▪ 3.8 km of the bed and banks of Boggomoss creek and associated gullies ▪ approximately 40 ha of low-lying floodplain and flood runners along the right bank of Boggomoss Creek ▪ approximately 20 ha of low-lying floodplain and flood runners along the left bank of Boggomoss Creek (extent limited by construction of a proposed levee approximately 1 km long) ▪ approximately 0.2 km in gully at approximately 330.0 km AMTD (increased lateral extent)
Lot 14 CP LE230	Crown Land - Reserve	State of Queensland (Reserve with Banana Shire Council (previously Taroom Shire Council) as Trustee)	Confined to Dawson River bed and banks upstream of Glebe Weir	Confined to Dawson River bed and banks upstream of Glebe Weir
Lot 15 CP LE230	Crown Land - USL	State of Queensland (Under control of NRW)	Confined to Dawson River bed and banks upstream of Glebe Weir	Confined to Dawson River bed and banks upstream of Glebe Weir
Lot 1 CP F4037	Freehold	Private	Confined to Dawson River bed and banks over approximately 3.0 km at downstream end of property	Confined to Dawson River bed and banks for approximately 5.4 km into property
Lot 3 CP F4037	Leasehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks and approximately 0.4 km in Bentley Creek (joins Dawson River at approximately 342.3 km AMTD)	Confined to Dawson River bed and banks and approximately 1.4 km in Bentley Creek (joins Dawson River at approximately 342.3 km AMTD)
Lot 1 CP FT823	Freehold	Private	Confined to Dawson River bed and banks	Confined to Dawson River bed and banks and distances of less than

Real property description	Underlying tenure	Present ownership and control	Present effects of Glebe Weir	Effects of Glebe Weir at FSL 172.9 m AHD
				0.1 km in three tributary gullies at approximately 340.9 km, 341.4 km and 341.9 km AMTD and Cockatoo Creek bed and banks for approximately 0.6 km into the property
Lot 15 CP FT2	Freehold	State of Queensland (NRW) – Short-term lessee	Confined to Dawson River bed and banks through property and Cockatoo Creek bed and banks for approximately 7 km into the property plus: ▪ less than 0.1 km of the bed and banks of gullies joining the Dawson River at approximately 338.1 km, 333.6 km, 333.2 km and 339.8 km AMTD ▪ approximately 0.4 km of the bed and banks of a gully joining the Dawson River at approximately 331.1 km AMTD ▪ less than 0.1 km of a gully joining Cockatoo Creek at approximately 0.4 km AMTD ▪ approximately 0.8 km of a gully joining Cockatoo Creek at approximately 1.6 km AMTD ▪ approximately 0.7 km of an anabranch rejoining Cockatoo Creek at approximately 2.7 km AMTD	Confined to Dawson River bed and banks through property and Cockatoo Creek bed and banks through the property plus: ▪ less than 0.2 km of the bed and banks of gullies joining the Dawson River at approximately 339.6 km,338.1 km and 339.8 km AMTD ▪ less than 0.4 km of gullies joining the Dawson River at approximately 333.6 km and 333.2 km AMTD ▪ approximately 0.8 km of the bed and banks of a gully joining the Dawson River at approximately 331.1 km AMTD ▪ approximately 710 ha of low-lying floodplain, flood runners and an anabranch on the left bank of Cockatoo Creek
Lot 14 CP FT1	Leasehold	Private	Confined to Dawson River bed and banks upstream of Glebe Weir and the bed and banks of Cockatoo Creek for approximately 7 km into the property plus: ▪ less than 0.3 km of gullies joining Cockatoo Creek at approximately 1.6 km, 1.8 km. 2.0 km and 2.2 km and 3.6 km AMTD ▪ Approximately 0.9 km of a gully system joining Cockatoo Creek at approximately 2.5 km AMTD	Confined to Dawson River bed and banks upstream of Glebe Weir and Cockatoo Creek bed and banks through the property plus approximately 150 ha of low-lying floodplain, flood runners and an anabranch on the right bank of Cockatoo Creek (extent limited by construction of a proposed levee approximately 0.2 km long)

Table 7-7. Properties impacted by the pipeline route

Real property description	Underlying tenure	Present ownership and control	Impact
Lot 14 CP FT1	Leasehold	Private	Glebe Weir pumping station site, approximately 7.5 km of access track to pumping station and approximately 8.5 km of pipeline route and access track
Lot 2, FT734	Freehold	Private	Approximately 8 km of pipeline route and access track
Nathan Road reserve	Reserve tenures	DNRW managed by Banana Shire or Dalby Regional Council	Approximately 68.2 km of pipeline route, and some access tracks
Lot 8 SP152696	Freehold	Private	Approximately 1ha required for the balancing storage
Properties adjacent to Nathan Road reserve	Freehold, Leasehold and Reserve	Various	Minor areas where the pipeline or associated infrastructure cannot be accommodated within Nathan Road reserve or the SBR corridor

7.7.2.1 Native Title

A Native title claim has been registered by the Wulli Wulli People (QC00/007) over an area that includes the lower section of the weir impoundment and the upper section of the pipeline route from the weir to Cockatoo Creek. A Native Title claim has also been registered by the Iman People #2 (Iman) (QC97/055) over an area that includes the pipeline route from Cockatoo Creek to the Wandoan Coal Project. However, the major part of the weir impoundment area is not subject to a registered native title claim. The native title registered claims over the Glebe Option area and the area not covered by native title claims are shown in Figure 16-1 in Chapter 16 of the EIS.

7.8 Land Use Planning and Controls

7.8.1 Description of Environmental Values

All areas surrounding the existing and proposed Glebe Weir inundation and all areas along the proposed pipeline route from Glebe Weir to Wandoan Coal Project are within the area covered by the Taroom Shire Planning Scheme (Taroom Shire Council, 2006a). This Planning Scheme is still applicable although the area around Glebe Weir and the area along the pipeline route north of approximately 56J 208600E 7143800N (Maidens Road junction) is now part of Banana Shire. The area along the pipeline route south of this point is part of the Dalby Regional Council area.

The Taroom Shire Planning Scheme was prepared under the *Integrated Planning Act 1997* to advance the purposes of the Act by:

- identifying outcomes to be achieved as a context for development;
- identifying exempt, self-assessable and assessable development; and
- identifying specific measures to guide and regulate development.

The Taroom Shire Planning Scheme sets strategic direction for the area by identifying desired environmental outcomes and establishing strategies to achieve these. Also, the scheme has delineated zones that organise the area into broad land use allocations to ensure appropriate land uses that are in accordance with the environmental characteristics of the locality and that avoid conflict between incompatible uses.

Desired environmental outcomes under the Shire Planning Scheme include:

- managing development to minimise any adverse impacts on air and water quality, to prevent land degradation, loss of habitat and biodiversity and to protect riparian areas, ridgelines and escarpments;
- protecting and enhancing protected areas and areas of local significance to ensure their environmental, and landscape values and historic significance are protected and enhanced through compatible development;

- enhancing and diversifying the economy of the area through the sustainable use of natural resources (including land and mineral resources) and through a wide range of other economic activities that respect the hierarchy of the urban centres in the area; and
- developing the area in ways that are consistent with community expectations and needs, and contribute to community well-being through the enhancement of core community elements (including the built environment, services, facilities and infrastructure).

All of the area directly affected by the Glebe Option is within the Rural zone. The intents of the Rural zone include:

- maintaining the environment, including soil, air and water, compatible with healthy natural systems and ensuring public health and safety;
- protecting Good Quality Agricultural Land (GQAL) from fragmentation, alienation or encroachment of incompatible land use in accordance with *State Planning Policy 1/92 – Development and Conservation of Agricultural Land 1992* (DIP, 1992);
- ensuring that development is located, designed and operated in a manner that protects and enhances the predominant rural scale, intensity, form and character;
- maintaining the rural amenity; and
- minimising prejudice of or adverse impacts on other uses including those within other zones.

The Taroom Shire Planning Scheme maps Class A land, Class B land and Class C land according to the definitions for GQAL set out in State Planning Policy 1/92 Development and the Conservation of Agricultural Land and in the *Planning Guidelines: The Identification of Good Quality Agricultural Land* (DPI and DHLGP, 1993) and expressed as follows:

- Class A — Crop land — Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels.
- Class B — Limited crop land — Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
- Class C — Pasture land — Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but 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 be 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.

The mapping is based on a QDPI study and land identified as Class C (Pasture Land) in the Planning Scheme includes only the areas mapped as Class C2 — Land suitable for pasture improvement and grazing. Protective ground cover should be maintained (Forster, 1985).

Land use in the 19,423 km^2 (NRW, 2008a) catchment of Glebe Weir is predominantly grazing of native or naturalised pastures but includes appreciable areas of protected land such as National Parks, State Forest and Timber Reserve. Protected areas are concentrated in the north-west of the Glebe Weir catchment with many of them in the Palm Tree Creek subcatchment. Palm Tree Creek joins the Dawson River at approximately 372 km AMTD, upstream of the Glebe Weir impoundment.

Much of the Glebe Weir catchment area was cleared in association with the Brigalow Development scheme in the 1960s. Perusal of satellite imagery indicates that vegetation has been cleared or very substantially modified over more than 65% of the catchment. Substantial areas were cropped to aid regrowth control after clearing but most of this land is now under pasture. Seasonal patterns strongly influence cropping in the region. There is a general decrease in mean annual rainfall from north to south, due to a decrease in summer rainfall so summer crops are generally less successful in the south (Gray and Macnish, 1985).

Current land use on the land parcels adjoining Glebe Weir is dominated by grazing of improved, naturalised and native pastures. Only an estimated 1,040 ha were under cultivation in May 2008, however, based on interpretation of 2004 aerial photographs and satellite imagery, it appears that larger areas have been cultivated in the past (Table 7-8).

Estimates of the extent of clearing of the land parcels adjoining the Weir have been made based on inspection of satellite imagery and 2004 aerial photographs (Table 7-8). Lot 15 CP FT2 has the highest percentage of timber cover but the 2004 aerial photographs show that an appreciable proportion of this represents regrowth on previously-cleared areas.

Table 7-8. Estimated areas under cultivation and estimated percentage of clearing on adjoining Glebe Weir

Real property description	Estimated cultivated area May 2008 (ha)	Estimated area previously cultivated but not cultivated in May 2008 (ha)	Estimated percentage cleared
Lot 182 SP147005	0	0	85
Lot 1 CP LE38	0	0	95
Lot 2 CP LE246	0	0	90
Lot 7 CP LE19	0	180	95
Lot 6 CP LE19	0	0	95
Lot 2 CP LE284	0	600	70
Lot 14 CP LE230	0	0	60
Lot 1 CP F4037	0	0	85
Lot 3 CP F4037	0	0	90
Lot 1 CP F823	430	0	75
Lot 15 CP FT2	280	30	40
Lot 14 CP FT1	330	0	75
Total	1040	810	Not applicable

It is estimated that approximately 25 ha of previously cultivated land that was not cultivated in May 2008 will be inundated on Lot 2 CP LE284. A mitigation strategy developed to address potential waterlogging adjacent the levee on this parcel (Chapter 8) includes the cessation of irrigation at two centre pivot locations. This has been discussed with the lessee who suggested moving the location of irrigation upstream would be feasible. This will be undertaken at SunWater's cost. 150 ha of land under cultivation in May 2008 will be inundated on Lot 15 CP FT2 when Glebe Weir is raised.

The pipeline route crosses irrigated land for approximately 0.8 km from the pumping station on Glebe Weir but land use on the remaining distance to the intersection of Nathan Road and Taroom — Cracow Road is grazing. Land use to the east of Nathan Road reserve south to its intersection with the Leichhardt Highway is predominantly grazing but a small proportion of the land is cropped. Most of the land along the pipeline route will be reinstated and returned to its current use after construction of the pipeline.

The Taroom Shire Planning Scheme identifies two wetlands and a number of artesian springs (boggomosses) in the vicinity of Glebe Weir as Protected Areas, that will not be impacted by the Glebe Option. Small areas that will be inundated at the proposed FSL and very small areas along the pipeline route between the weir pumping station and the Nathan Road reserve are identified as having Biodiversity Planning Assessment significance (addressed in Chapter 12).

One wetland identified in the Shire Planning Scheme is a billabong in a meander scroll in a large bend in the river on Lot 2 CP LE246. The second wetland is a closed depression in a bend in the river on Lot 8 CP F4037. It is associated with what appears to be a former channel of the river at over 180 m AHD elevation.

The artesian springs identified in the Taroom Shire Planning Scheme are in the vicinity of Boggomoss Creek, Spring Gully and Cockatoo Creek. Some are within an area entered on the Register of the National Estate.
There are no Protected Areas identified in the Taroom Shire Planning Scheme along the pipeline route.

The Glebe Weir site and inundation area, and substantial proportions of the pipeline route are situated in an area which is subject to a granted Petroleum Exploration Permit. In addition, part of the southern portion of the pipeline route crosses the Santos Scotia Petroleum Lease Area and land under Exploration Permits for coal. There are no coal seam gas (CSG) exploration, appraisal or development wells in the area that would be directly affected by the Glebe Option though some development wells in Scoria Petroleum Lease Area are just to the east of the pipeline route. These will not be impacted.

7.8.2 Potential impacts and mitigation measures

According to the Planning Scheme map, areas outside of the bed and banks of streams or gullies that will be inundated by the raised Glebe Weir are classed as follows *under the Planning Guidelines: The Identification of Good Quality Agricultural Land* (DPI and DHLGP, 1993*)*:

- Lot 2 CP LE284 — 60 ha of predominantly Class A;
- Lot 15 CP FT2 — 710 ha of predominantly Class A; and
- Lot 14 CP FT1 — 150 ha of predominantly Class C.

The first two of these are currently owned by the State while the latter is private leasehold land. Field observations suggest that this area may in fact be smaller than this, and that the inundated area is overestimated due to the level of detailed topographic data available as at September 2008. This is currently being refined.

As land in a road reserve cannot be used for agricultural purposes, it is not classified as GQAL. The site proposed for the balancing storage is classed as non-agricultural land.

Neither of the wetlands listed in the Planning Scheme will be impacted because the first is well above the proposed FSL and for the second, this apparent former channel is separated from the present river by a substantial sandstone rise. It is very unlikely that this depression ever fills from the river and the Glebe Option will have no impact on it.

With respect to the boggomoss areas, Shire mapping suggests that several boggomosses are within the area that will be inundated at the proposed FSL outside the bed and banks of Boggomoss Creek and Spring Gully. However, mapping specifically undertaken as part of this study shows that only one artesian spring (or boggomoss) east of Cockatoo Creek will be inundated. A levee will be developed near Boggomoss Ck. to specifically exclude boggomosses from the inundation. Further consideration is given to these artesian springs in relation to groundwater, flora and fauna (Chapters 8, 12 and 13).

With respect to exploration permits and authorities to prospect, the enlarged Glebe Weir inundation area is largely confined to the bed and banks of the Dawson River and other streams and these areas would not tend to be explored. Other parts of the inundation area will have less than approximately 1 m of water over the ground surface at FSL so that any essential drilling for exploration purposes could be undertaken on raised earth platforms with formed earth access tracks. The pipeline is a linear feature and would not obstruct drilling or other exploration activities.

7.9 Land Contamination

7.9.1 Description of Environmental Values

Searches of the Contaminated Lands Register (CLR) and the Environmental Management Register (EMR) have been undertaken for all Lots riparian to Glebe Weir and the additional Lot crossed by the pipeline route between the Glebe Weir pumping station and the intersection of Nathan Road and the Taroom — Cracow Road. These searches revealed no records of contamination.

There is no similar information available for the Nathan Road Reserve where the pipeline route lies within it.

Field observations around the weir site and inundation area and along the pipeline route, and aerial photography interpretation undertaken for this study revealed no evidence of contaminated sites, such as former or current dip sites within the area affected by the Glebe Option. No further action on existing land contamination is proposed at this stage. Nevertheless, it is recommended that the Glebe EMP contain management measures for the construction and operation workforce involved in field operations associated with survey, design and construction in relation to identifying and reporting possible sources of contamination.

7.9.2 Potential impacts and mitigation measures

The construction process includes a number of potential avenues for land contamination, primarily associated with fuels, oils or waste water. Chapter 15 Waste and Chapter 21 EMP address mechanisms to reduce the risk of contamination and that address immediate clean up if spills occur. Sites within the construction footprint that may require specialised attention including decontamination, at the conclusion of construction include:

- concrete batch plant;
- concrete raw materials stockpiles;
- construction water storage tank facilities;
- water treatment plant;
- construction offices;
- workshops;
- ablutions facilities;
- storage areas;
- bulk fuel supply tanks; and
- refuelling areas.

The final treatment of potential areas of contamination including areas used for workshops, where spills of fuel, oil, and lubricants are likely to be at the discretion of the contractor but will be in accordance with the controlling regulations.