



Section F

The top of the Dividing Range comprises a narrow section of rolling hills at an elevation of about 320m, south of which the corridor and road descend through a steep, narrow valley which is the headwater of Dixons Creek, south of the Dividing Range. The elevation at the foothills on the south side of the Dividing range is approximately 180m (SPA 2007a).

Section G

Immediately south of the Great Dividing Range the topography gradually declines as the corridor follows on undulating terrain immediately west of Dixon's Creek, then southwards along Melba Highway, westwards along Gulf Road and south along Steels Creek Road towards Yarra Glen.

At Yarra Glen the elevation is approximately 90m.

Sections H

From the western side of Yarra Glen the pipe corridor follows along Glenview Road and then turns westwards and climbs steeply onto the Skyline Ridge to an elevation of about 270m. After this the topography declines gradually. The corridor turns southwards along a narrow ridge and travels directly to Sugarloaf Reservoir, which is at an elevation of 180m.

3.3 Drainage Systems

Meandering streams occur within the broad Yea River and Dixons Creek river valleys north and south of the Great Divide respectively. Beyond these, creeks and rivers are generally located within well defined, incised gullies. All streams and rivers are likely to rely on a component of base-flow from groundwater during dry months, although the exact significance of base-flow is unknown at this time (SPA 2007a).

3.4 Landforms

In the *Geomorphological Assessment* (SPA 2007b) a method of reporting on the land forms has been developed which brings together existing information on the different land systems (SPA 2007b). The characteristics of each of the land systems are described under the following headings:

- Location
- Geology
- Physiography
- Present land use
- Soils



- Landform stability
- Erosion risk

A series of maps delineating the extent of the land systems and management overlays is also presented (SPA 2007b).

The reader is referred to the *Geomorphological Assessment* (SPA 2007b) for a detailed overview of the geology and soils characteristics of the land systems along the pipeline corridor.



4. Geology

4.1 Regional Setting

The regional geological setting, stratigraphy, geological structure and corridor geology of the pipeline project is described in the *Hydrogeology Assessment* (SPA 2007a) as follows.

4.2 Stratigraphy

The pipeline corridor was identified on the Geological Survey of Victoria Melbourne 1:250,000 scale geological Mapsheet. In simple terms the Yea area is characterised by a continuous sequence of Ordovician to Middle Devonian quartz sandstones and mudstones that were simply folded and faulted during the Early to Middle Devonian. The sediments were intruded by granites during the Devonian and then subject to prolonged erosion (McDonald, 1997). Younger, Quaternary age sediments are principally alluvial and colluvial in origin and are derived from erosion of the older sediments and igneous intrusive rocks (SPA 2007a).

A simplified stratigraphy has been summarised in Table 1 below.

The older sediments (Silurian) constitute the geological basement of the area and as such are several kilometres in thickness. For this report the indurated Silurian and Devonian sediments have been grouped together and referred to as the geological basement as they generally have similar hydrogeological properties (SPA 2007a).

4.3 Geological Structure

The Silurian and Devonian sediments were deformed by east-west directed compression during the Middle Devonian. These sediments were faulted and folded into broad north-south trending regional synclines and anticlines. The faults coincide with the axial traces (McDonald, 1997) of regional folding (SPA 2007a).

The Yarra Fault has been mapped at the southern end of the pipeline corridor. The easterly dipping structure has been mapped from Wonga Park (south of Sugarloaf Reservoir) to Skenes Creek (north of Yarra Glen).

The influence of geological structure on the hydrogeology in the vicinity of the pipeline corridor is unknown, although elsewhere in Victoria fractures are often saturated and can store and transmit groundwater (SPA 2007a).



4.4 Geology of the Study Area

The geology of the study area is shown in Figure 2. The bulk of the study area traverses the Silurian – Devonian basement rocks. These rocks are visible in the bed and cuttings of a number of surface water systems (e.g. Yea River at Devlins Bridge) and road cuttings along the Melba Highway (SPA 2007a).

There are minor areas where these materials are overlain by Quaternary sediments, particularly along the northern section where the flatter topographies dominate the terrain (SPA 2007a).

■ **Table 1 - Stratigraphic Summary (SPA 2007a).**

Period	Sub-period	Formation	Lithological Description	Outcrop Areas ¹
Quaternary	Recent to Pleistocene	Undifferentiated alluvial sediments	River alluvium: variable mixtures of sands, silt clay and minor gravel.	Restricted to floodplains of the major surface water systems
		Undifferentiated colluvial sediments	Colluvial fan deposits, gravel, sand, minor silt, granitic sand.	North and southwest of Yarra Glen
Devonian	Upper	Undifferentiated	Granodiorite, adamellite, quartz diorite with associated metamorphic aureoles.	Isolated outcrops north and north east of Yarra Glen
	Lower	Broadford	Siltstone with interbedded sandstone, turbiditic sequences.	West and east of Yea
		Humevale	Siltstone with interbedded sandstone, turbiditic sequences. Locally bedded limestone lenses.	Bulk of the pipeline corridor
Silurian	Upper	Dargile	Laminated and current bedded sandstone, minor interbedded mudstone and shale.	East and west of region between Dixon Creek and Castella

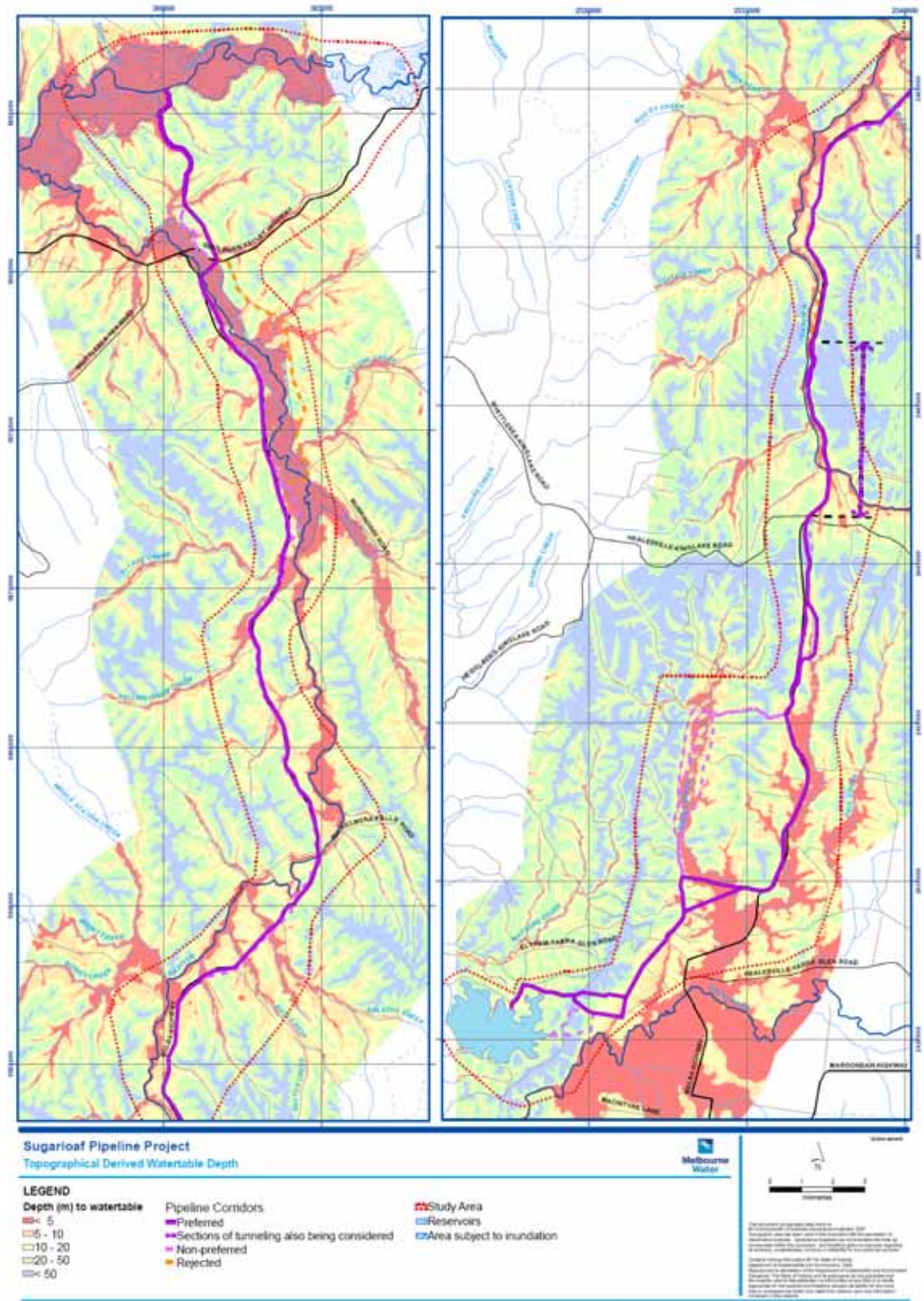
4.5 Hydrogeology

The hydrogeology of the project is described in the *Hydrogeology Assessment* (SPA 2007a) and may be summarised as follows:

Three primary groundwater flow systems exist (SPA 2007a):

- Alluvial/colluvial systems in which groundwater is restricted to unconsolidated sediments contained within well defined river valleys and in which groundwater flow is predominantly down-gradient as through-flow within the confines of the valleys (generally northwards north of the Great Dividing Range and southwards to the south of the Range) (SPA 2007a);

■ Figure 2 - Topographical Derived Watertable Depth (Groundwater Inflow Hazard)





- Bedrock fracture systems in which groundwater flows through interconnected fracture systems which are predominantly oriented north-west / south-east in line with regional structural features and which may or may not be hydraulically connected with the alluvial/colluvial aquifers (SPA 2007a);
- Regolith aquifers which occur where bedrock has been extensively weathered and is saturated. Groundwater flow occurs predominantly down-gradient under the influence of gravity as a subdued reflection of topography and is likely to be hydraulically connected to the alluvial/colluvial aquifers (SPA 2007a).

All three aquifers systems are principally recharged by infiltrating precipitation. The alluvial/colluvial aquifers are likely to receive recharge from the regolith aquifer and may or may not receive recharge from the fractured rock aquifers. Recharge rates are unknown (SPA 2007a).

4.6 Geomorphology

Landform Areas of Concern

Based on the description of the land systems in the *Geomorphological Assessment* (SPA 2007b) a number of areas have been identified that represent areas of particular concern. The areas of concern are described in the *Geomorphological Assessment* (SPA 2007b) and may be summarised as follows.

Yarra Range Escarpment – Section H

Due to its steepness, the escarpment of the Yarra Fault is likely to undergo periodic slope readjustments. Landslides are triggered by natural causes (rainfall, steepening of the slope by erosion at the base) or artificially through activities like the construction of cuts and trenches. In addition to the risk of landslides, colluvial areas may also be prone to gully erosion, particularly if there is clearing of vegetation and compaction of soils by construction activity (SPA 2007b).

Two sites of geological and geomorphological significance have been identified in the vicinity of the pipeline corridors (SPA 2007b).

Significant Landscape Overlay (SLO)

Significant landscapes are identified in the Yarra Ranges Planning Scheme for the southern part of the pipeline corridor – Sections F, G and H. The areas comprise the escarpment of the Yarra Ridge southwest of Yarra Glen (Land System 1.1HsP7-4). While it does not appear that these areas are particularly unstable, the visual quality of the landscape and any impact the pipeline construction would have on this escarpment, needs to be considered (SPA 2007b).



Although data being collected by these separate studies is being shared across disciplines, parallel geotechnical and hydrogeological investigations are also required.

Erosion Management Overlay (EMO)

In the Yarra Ranges Planning Scheme – Sections F, G and H, all land within the EMO is classified as having a sufficiently high risk of potential instability to make a review of the risk of any specific site mandatory prior to granting a planning approval (SPA 2007b). North of the Great Divide, only the crest areas of ridges are subject to the EMO. Within the designated study area, only the upper parts of the rises and hills northeast of Yea come under this overlay (SPA 2007b).

The Shire of Yarra Ranges, on the basis of the results of the Landslip Study by Coffey Partners (1999) in SPA (2007b), has prepared an EMO, to aid in the management of risk of landslip (Shire of Yarra Ranges 1999) in SPA (2007b).

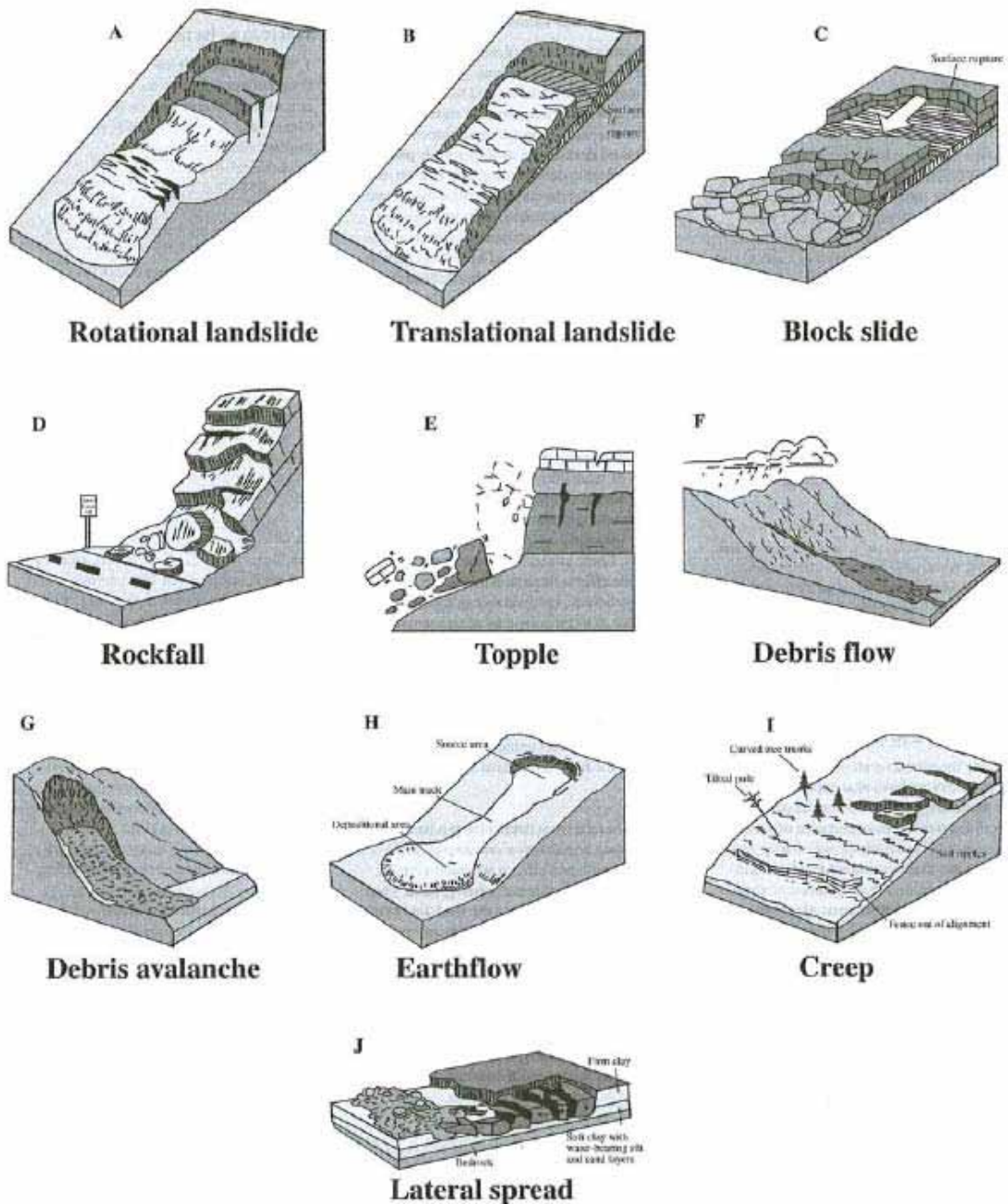
The present the EMO does not include these landslip risk categories. These landslip risk plans are available for inspection from the shire (Shire of Yarra Ranges 1999). The landslide risk assessment, according to the National LRM Framework for Australia (AGS, 2007a and b), will include examining these plans and a site specific assessment of Medium (M2) and High (H) risk sites will be required by a qualified geotechnical engineer (Shire of Yarra Ranges 1999) and engineering geologist.

Narrow, steep v-shaped valleys – Sections E and F

The pipeline corridor crosses two mountainous areas where the Melba Highway is located in narrow, v-shaped valleys with steep slopes and narrow floodplains. The road at both sites is excavated into the bedrock on the eastern slope of the valleys. The bedrock consists of folded sand, silt and mudstones with thin bedding. Currently the vegetation consists of native forest. Susceptibility to landslides will need to be evaluated, especially as trees will be removed within the 30m pipeline construction corridor. If a trench is cut, further consideration is also required to the impact that this cutting will have on the stability of the slopes (SPA 2007b).

There is potential for land slides to occur in the steep v-shaped valleys within the regolith and colluvial in the form of translational failures and debris flows. Translational failures could also occur along bedding or fracture planes in bedrock. Block slide, rock fall and toppling are possible mechanisms of failure in the bedrock, particularly if benching is undertaken in the steep v-shaped valleys. Figure 3 demonstrates these mechanisms of movement (AGS, 2007b). Significant risk mitigation measures will be required in these areas if benching is to occur, especially above the Melba Highway. Figure 4 outlines the investigation phase of a project incorporating the National LRM Framework (AGS, 2007a).

■ Figure 3 - Geohazard mechanisms of failure (AGS, 2007b)





The northern site (Section E) comprises the valley of the Yea River south of Glenburn (SPA 2007b). The southern valley is occupied by the headwaters of Dixons Creek, leading from the lower hills of the Yarra Glen area up the escarpment to Kinglake plateau (SPA 2007b).

Colluvial deposits

Most of the pipeline corridor north of the Great Dividing Range is located on colluvial slopes. The corridor closely follows the Melba Highway which has been built above the area affected by high flows of the Yea River and its tributaries. South of the Dividing Range significant colluvial deposits are also found along the Yarra Ranges fault escarpment (SPA 2007b). These steeper slopes on the south side of the Great Dividing Range is the result of the ridgeline migrating approximately 6km north since late Tertiary times due to a more erodable rock formations (Hills, 1959).

Colluvial deposits are susceptible to gully and tunnel erosion due to their unconsolidated nature. The duplex soils developed in these deposits are highly susceptible to gully and tunnel erosion. Tunnel erosion, which is initiated by erosion of a subsurface soil layer, ultimately leads to the development of gullies (SPA 2007b).

Areas where gully erosion may arise following construction works that lead to clearing of vegetation and compaction of soils are listed in SPA (2007b).

Waterways

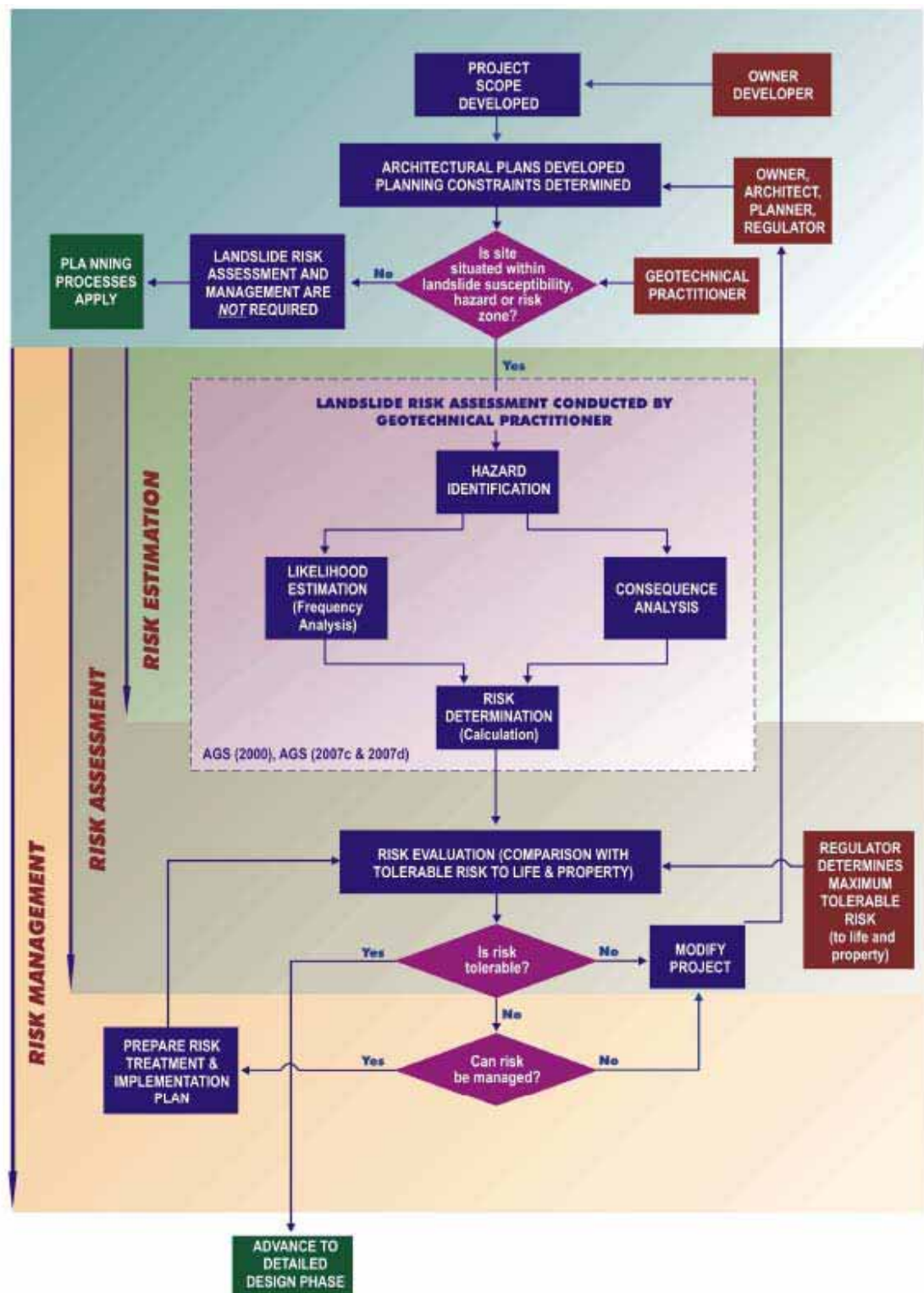
These represent areas of concern and geomorphological investigation is being undertaken in the field to assess the present state and the impact of construction activities (SPA 2007b).

Based on a review of previous studies, the proposed Goulburn River pump station structure has been assessed to be located within a stable section of the mid-Goulburn. A detailed geomorphological site survey was undertaken to confirm the stability of the site (SPA 2007b).

Bank erosion and avulsion represent a high risk along the Yea River. Further geomorphological field investigations are needed to clarify the stability of the Yea River at points where the pipeline alignment will cross the river and traverse the floodplain (SPA 2007b).

Parallel geotechnical and hydrogeological investigations will be undertaken in these areas of concern.

■ Figure 4 - Investigation phase of a project incorporating LRM (AGS, 2007a)





5. Geotechnical and Design Considerations

5.1 Key Issues

Several key issues have been identified in respect to the pipeline corridor, the possible construction methodology and the existing site conditions (Topographical, Geological and Environmental) including:

- Soil and rock excavatability;
- Geotechnical design parameters including; bearing capacity and the elastic modulus for soil and rock for pipeline design;
- Safe temporary and permanent benching during construction;
- Geotechnical aspects of the construction for road and waterway crossings;
- Geotechnical aspects of the construction for the Goulburn River pump station.

In conducting these assessments, consideration should also be given to the presence of the changing unconsolidated materials and geological rock units along the pipeline corridor.

5.2 Pipeline

The Sugarloaf Pipeline will predominately be constructed using open trenching techniques, preliminary designs indicate that a trench invert level of approximately 3m is required for pipe embedment and cover, this will be approximately 2m wide at the bottom of the trench and will be battered back to allow safe working access. Tunneling and other engineering designs may need to be considered in areas where significant concentrated geohazards exist and are identified under the National LRM framework as moderate to high risk.

The pipeline is predominately through areas of siltstones and sandstones, therefore excavatability is expected to be a major design consideration in planning construction cost and timing.

Excavation

Preliminary assessment of the corridors encountered widespread siltstones, mudstones and sandstones. A preliminary site inspection included assessment of road cuttings which reveal shallow soil layers overlying competent rock; this was present in both the Dargile Formation to the south of the corridors and the Humevale and Broadford Formations which extends from the south through to Yea in the north. Preliminary boreholes, surface mapping and seismic surveys indicate shallow weathered and low to medium strength rock within the likely trenching depth occurs over approximately 40% of the corridors. Shallow fresh and high strength rock is indicated to occur over less than 5% of the corridors. The trench profile along the majority of the corridors is indicated to be in alluvial, residual and colluvial soils, and extremely weathered low strength rock. It is



therefore expected that significant excavation in rock will be required to achieve the required trench dimensions.

GHD has previously undertaken assessment of the excavatability of the Humevale Formation at Winneke Water Treatment Plant (WTP), geotechnical investigations at Winneke WTP revealed moderately weathered rock at shallow depths, assessment of estimated rippability indicated that modest production rates could be achieved using ripping provided suitable sized plant is used. It is noted that the use of larger excavators (i.e. greater than 45t) may be limited in places due to access constraints.

Granodiorite outcrops are indicated on the geological map along Steels Creek roads, depending on the condition of the rock and the adopted construction methodology various construction issues can result. Due to higher strengths, fresh Granodiorite are generally difficult to excavate during trenching, in the extreme case, blasting may be required. Alternately weathered Granodiorite (sand) can be problematic during trenching and boring due to stability issues. Thermal metamorphism of the Humevale Formation from the emplacement of the Grandiote has produced hornfeling of the sedimentary rock in a metamorphic aureole. Blasting may also be required in these areas. The extent and nature of any Granodiorite and hornfeling along the alignment should be confirmed during ground investigations.

Characterisation of the surface profile in respect to depth to rock and associated excavation issues is an essential task in construction planning and costing. Due to the length of the pipeline it is likely that a series of typical profiles will be developed using existing geoscience data, geophysical techniques and field investigations for specific geological conditions across the site extents.

Geotechnical Parameters for Pipeline Design

Several geotechnical parameters are required for the design of the pipeline this includes Allowable Bearing Capacity and Elastic Modulus.

The pipeline will be predominately constructed through siltstone and sandstone rock, residual soils and colluvial soils, it is therefore not expected the allowable bearing capacity will be a major design issue. However several waterways crossings exist which may contain soft alluvial sediments, it is therefore recommended that specific investigations be completed at these locations, and this will be related to the assessment of potential construction methods for waterway crossings.

The Elastic Modulus of soil and rock ($E'n$) is an input to the structural design of the pipeline. This is related to the strength parameters of soil and rock which can be readily determined during geotechnical investigations. It is proposed that profiles be developed for specific geological conditions across the site extents in conjunction with soil and rock type and thicknesses.



Benching

Due to the steep nature of existing topography at several locations along the corridors (Sections E, F and H) it is expected that major earthworks will be required to create permanent and temporary benches for construction of the pipeline, this may include cutting and/or filling to create a flat construction platform.

As the existing topography rises and falls steeply, particularly through the Great Dividing Range, the creation of new benches or modification of existing benches will require large cuts or filling to intersect the steep natural surface.

The long-term and short-term stability of any benching is a critical geotechnical design issue. A landslide risk analysis was completed to consider identified hazards during and post construction of the pipeline, according to the National LRM Framework for Australia. Once the corridor is refined a comprehensive geotechnical and hydrogeological investigations will be required at sites where benching is required to assess the impacts on stability of the natural and constructed slopes and to make recommendations on risk mitigation and stabilization methods.

Trenchless Construction

The pipeline corridor crosses several major roads and significant waterways including the Yea River, Steels Creek and the Melba Highway. Depending on review of environmental, planning and other considerations it may be appropriate to install the pipe through open excavation. At some crossings, trenchless construction will be considered such as pipe jacking or microtunneling.

The highest risks to tunneling include loose or soft ground and mixed face conditions, (changes between hard to soft ground and vice versa); this is particularly relevant at waterways crossing where soft alluvial materials or sands and gravels can be present. Initial assessment of roads (Melba Highway) and river crossings (Yea River) indicated that shallow rock is still present even where overlain by softer ground.

The detailed assessment of the suitability of tunneling at select locations will depend on refinement of the pipeline alignment and the number, location, and length of any crossings and discussions with the Catchment Management Authorities.

Tunnelling

Tunnelling is also considered as an option through the Great Dividing Range to manage risk mitigation and reduce construction related environmental impacts through the Toolangi State Forest (parts of Sections E and F) Given the regional geology (faulted and folded siltstone and



mudstone bedrock) in this region, any tunnelling option would require significant geotechnical investigations to properly plan and cost.

The preliminary qualitative landslide risk analysis has indicated a moderate to high risk estimation for the two landslide zones within the Great Dividing Range. The Melba Highway is a narrow section of road which runs across the slope to the two hazard zones. Partial blockage of the highway could occur and the temporal probability of vehicles impacting is moderate to high. Thus the vulnerability for injury / Loss of life must be considered moderate. During construction rockfalls could be controlled by protection methods. (SPA, 2007d)

However, tunnelling would remove these hazards from the pipeline corridor and on going risk management (monitoring) would be avoided. Further work is required to determine whether tunnelling this section is suitable and viable.

5.3 Pump Stations

Goulburn River Pump Station

The Goulburn River pump station site is located in a region of the Humevale Formation which comprises siltstone and sandstones. Initial assessment of the pump station site access road, Killingworth Road, which has several road cuttings indicate a shallow soil profile underlain by competent rock. In the area of the pump station site however the soil profile is expected to be more than 10m deep, and the soils are likely to include clays and silts overlying granular materials such as sand and gravel.

In this respect it is unlikely that any major geotechnical issues will be encountered in respect to bearing capacity, settlement, reactivity and other foundation considerations. The potential for permeable and thick granular materials and high groundwater levels will however provide significant challenges for the excavation of subsurface structures and intake pipelines in the vicinity.

A comprehensive geotechnical and hydrogeological investigation has been initiated to provide geotechnical and hydrogeological parameters for site groundwater management, pump station foundation design and to assess the excavatability and support requirements where subsurface structures are required. Groundwater monitoring and pump test investigations will be required to assess construction dewatering requirements and to plan appropriate groundwater management measures.

High Lift Pump Station

The proposed high lift pump station site is located in a region of the Humevale Formation which comprises siltstone and sandstones. An initial assessment of the pump station site, based on several



road cuttings in the area, indicate a shallow soil profile underlain by competent rock. The soil profile is expected to be less than 4m deep, and the soils are likely to include clays and silts overlying weathered rock.

In this respect it is unlikely that any major geotechnical issues will be encountered in respect to bearing capacity, settlement, reactivity and other foundation considerations.

Intake and Inlet Structures

Intake and outlet structures will be required on the Goulburn River and Sugarloaf Reservoir respectively. It is expected that these structures will require construction through, and foundation in recent alluvial material. These materials can often be challenging in respect to determining a suitable founding strata and construction methodology. It is therefore essential that specific geotechnical and hydrogeological investigations be undertaken at these locations to define the geotechnical conditions. Provided these conditions are properly defined and accounted for it is not expected that any major problems will be encountered.



6. Geotechnical Impacts Assessment

6.1 Existing Conditions

The pipeline corridor is oriented generally in a north south direction and extends from the Goulburn River at Yea to the Sugarloaf Reservoir at Yarra Glen, a total length of approximately 70km. The corridor for the pipeline comprise predominantly cleared land (Sections A, B, C and D) forest (Sections E and F) and rural living areas. The topography is undulating with steep, low lying hills, gullies and waterways. The pipeline corridor south of Yea generally follows the path of the Melba Highway (Sections B, C, D and E) through the Yea River valley. The corridor (and the Melba Highway) cross the Great Dividing Range at approximately right angles to the south of Glenburn (SPA 2007c).

The study area is characterised by Ordovician to Middle Devonian quartz sandstones and mudstones that were simply folded and faulted during the early to Middle Devonian. The sediments were intruded by granites during the Devonian and then subject to prolonged erosion. Younger, Quaternary age alluvial sediments and colluviums derived from erosion of the older rocks have been deposited in valleys and low lying areas (SPA 2007a).

Three hydrogeological models have been recognised (SPA 2007a) and nine major land systems are mapped along the corridor (SPA 2007b). Parts of the pipeline corridor lie within Extractive Industries Interest Areas (EIIA), and are located close to or within current and proposed extractive industries operations. Parts of the corridor also lie within current mineral exploration licence areas and mineral regions.

6.2 Values

Two sites of geological and geomorphological significance have been identified in the vicinity of the preferred pipeline corridors (SPA 2007b). Both sites lie along the Yarra River, in the area southeast of Sugarloaf Reservoir. Some corridor options may interfere with one site which comprises colluvial gravels of the Yarra Fault.

The topography through which the Melba Highway passes contains numerous road cuttings which currently exhibit few signs of instability and slope creep. The mature trees adjacent to the highway exhibit few signs of stress due to land creep and soil instability, and there are no apparent significant rock fall zones along the highway. The colluvial slopes adjacent to the highway exhibit few signs of surface slumping and slope failure and currently appear to be inactive.



6.3 Threats

Existing Landslips and induced Instability

Numerous landslides have been identified by Coffey Partners Int (1999) in the Shire of Yarra Ranges, south of Kinglake plateau. Wilson (2002) outlines the methodology of the Coffey work and Appendix B contains Modelled Landslip Hazard Zones based on a criteria matrix developed from the Wilson (2002) methodology. The maps in Appendix B are based on 1:250 000 geology and will be refined using lower scale geology as it is compiled.

Land slides and rock falls are a potential threat along the steep slopes in the narrow valley sections of the Yea River at the Great Dividing Range in Section E, and Dixons Creek headwaters at the escarpment south of Kinglake plateau in Section F. Soil creep may occur on lower colluvial slopes (SPA 2007b). Translational failures have occurred on slopes around Sugarloaf Reservoir in Section H. Excavation across these slopes may trigger instability of both existing landslips and currently inactive stable colluvial and rock slopes.

Excavation of the Trench and Shafts

The pipeline corridor is predominately through areas underlain by siltstone and sandstone bedrock. Whilst in the alluvial areas the trench excavation will mainly be in soils and weathered rocks, in the hilly and mountainous areas excavatability is expected to be a major design issue in planning construction cost and timing. Trench excavation and shaft sinking (at stream crossings) in these areas may require blasting and heavy rock breaking. Blasting impacts such as ground vibrations, air blast and fly rock can readily be mitigated during construction.

Groundwater Inflows

Groundwater inflows into the trench and into shaft excavations will impact on dewatering requirements and trench stability during construction. Potential groundwater seepage should be controlled by simple excavation dewatering in the hills and mountains. As the trenches are constructed generally across-slope, there is likely to be a need for limited groundwater drainage upslope of the temporary and permanent slopes. In low lying areas and near the river flats significant groundwater inflows may be expected mainly where thick and clean gravel and sand materials are intersected.

A potential groundwater impact relates to the possible interception by and diversion of groundwater through flow along the comparatively high hydraulic conductivity material of the pipeline trench backfill material, and the consequent decline in groundwater levels down gradient of the trench. In areas of potentially acid generating materials, this may result in acid rock drainage.



The corridor of the pipe may pass through saline discharge areas, possibly along Killingworth Road. It will be important to identify these areas during the hydrogeological investigations, in order to assess the potential impacts and recommend appropriate groundwater management and control methods during construction. Pipeline alignment selection criteria will include the preference to avoid shallow groundwater areas.

Dewatering effort for construction purposes may be required. Dewatering effort is unknown at this time, however it is expected that greater dewatering effort would be required in the alluvial aquifers than the bedrock and perched regolith aquifers.

The influence of dewatering is unknown at this time; however it has the potential to have a number of impacts, as noted below (SPA 2007a):

- Groundwater dependent ecosystems;
- Subsidence of unconsolidated sediments;
- Settlement near trenches and shafts.

Spoil Management and Stability

It is likely that the development of the pipeline will generate significant quantities of spoil materials which will be required to be removed off-site and either re-used or contained in stable storage and fill areas. There will be a preference to utilise the spoil such that the need for offsite disposal and storage is minimised. This will include temporary and permanent fill areas, which will need to be managed with respect to landslide stability, embankment stability, drainage control, erosion protection and sediment. Spoil placement will need to be managed carefully. While there may be some scope to use spoil to rehabilitate erosion gullies, significant care must be taken to minimise the potential for downstream movement of sediment and soil.

Acid Sulphate Rock

The geology of the pipeline corridor comprises predominantly Humevale Siltstone, Dargile Formation and the Melbourne Formation. Sulphide enrichment is associated with Silurian aged siltstones (Vic EPA Pub 655). These rocks are Devonian or Silurian aged siltstones and sandstones generally from ancient marine depositional environments. The presence of Silurian and Devonian aged rocks indicate the potential for acid sulphate rocks, however in areas within the corridor which have exposed rocks, such as road cuttings, significant oxidation of the rocks does not appear to be occurring (SPA 2007c).



Soil Erosion

Soil erosion, especially gully and tunnel erosion, is a threat at inclined areas with little vegetation cover and significant soil depth. Duplex soils are particularly sensitive to gully and tunnel erosion. Once initiated, gully development is difficult to stop (SPA 2007b).

Erosion of excavated slopes, spoil stockpile areas, construction laydown areas, access roads and the pipeline alignment both during and after construction represent a significant threat. The number, layout and design of temporary access roads, construction laydown areas and working benches will be carefully assessed to mitigate erosion and sediment transport. These temporary structures will be removed and rehabilitated in accordance with the EMP. Vehicle washdown areas will require appropriate design at suitable locations to allow erosion management and sediment settlement control measures to be implemented.

The shaft sinking, pipe-jacking and trenching operations at the stream crossings represent an erosion and stability threat to the stream beds and banks, however appropriate construction methods shall be implemented to manage these operations. Temporary structures such as shafts, bunds, access roads and ramps will be removed and rehabilitated in accordance with the EMP.

Extractive Industries and Mineral Tenements

The majority of the study area consists of rural, cleared farmland used for either agricultural purposes such as cattle grazing or vineyards, vegetated areas such as state forest and conservation reserves, and residential areas. Although parts of the pipeline corridor pass through a current extractive industry operations area, the corridor does not appear to go through the two quarries. Parts of the corridor lie within current mineral exploration licence areas and mineral regions.

6.4 Key Issues

The study area is predominately through areas of siltstones and sandstones; therefore excavatability is expected to be a major design consideration in planning construction cost and timing. Characterisation of the surface profile in respect to depth to rock and associated excavation issues is an essential task in construction planning and costing.

The long-term and short-term stability of any benching is a critical geotechnical design issue. Once the alignment is refined comprehensive geotechnical and hydrogeological investigations will be required at sites where benching is required to assess the impacts on stability of the natural and constructed slopes.

The groundwater and alluvial sediments that occur at the stream crossings are potentially vulnerable to the proposed development. Detailed geotechnical and hydrogeological assessment of the suitability and stability of trench or trenchless excavation will be required at locations such as:



- Adjacent to the Goulburn River at the pump station;
- Within the Yea River Valley;
- Yea River crossing at Devlins Bridge;
- Kalatha Creek crossing;
- Yea River just north of Castella;

The conditions at the proposed crossings, extent of soft alluvial sediments and presence of more difficult excavation materials will require appropriate corridor selection and the optimisation of the number, location, and length of any crossings.

Groundwater quality, specifically high salinity, also has the potential to impact on pipeline materials including concrete/ and cement aggressivity and suitability of pipeline materials.

These key areas constitute significant data gaps which are being addressed by the site investigation program.

6.5 High level control measures

The identified impacts have been classified into those occurring during the construction phase, and those post construction. In most cases the impacts can be mitigated largely by engineering controls:

Excavation Methods

- Characterise the surface profile in respect to depth to rock and associated excavation issues during construction planning and costing.
- Optimise the corridor to avoid areas of difficult excavation and blasting.

Soft Alluvial and Poor Drainage Areas

- Carry out appropriate investigation of stream crossings, alluvial and poorly drained areas.
- Optimise the pipeline alignment, where practicable to avoid those areas requiring significant trench support and dewatering, thus minimising dewatering and construction effort (construction methods, complexity, durations).
- Select the pipeline alignment using information based on land systems, groundwater and engineering geology overlays.

Quality

- Carry out appropriate geotechnical and hydrogeological investigations to Industry Standards.
- Implement Environmental Management Plan in accordance with EPA Guidelines for construction and sediment control.