4.0 PLANNING SCHEME POLICY 4 – LANDSLIDE HAZARD

4.1 Relationship with the planning scheme

(1) This part sets out:

(i) information that may be request by Council where development of is proposed on land within the landslide hazard overlay; and

(ii) guidance for applicants on good engineering practices for hillside development to assist applicants, engineers and planners in the design and application of appropriate type and form of developments that best reflects the capability of the land.

(2) Hazard ratings depicted in the Landslide Hazard Overlay use a classification system consistent with the procedures detailed in the paper entitled "A Method of Zoning Landslide Hazards", prepared by McGregor and Taylor and are listed in the table below. They have been mapped based on a grid system of 25m squares for the mainland, and 5m squares for the islands. Each square is defined by a point at its centroid, and data related to the average slope instability.

Table 1 – Hazard Ratings

Hazard Rating	Description
Very High	The event is expected to occur
High	The event will probably occur under adverse conditions
Medium	The event could occur under adverse conditions
Low	The event might occur under very adverse conditions

4.2 Information that Council may request

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(1) A landslide assessment may be required to address PO1 of the Landslide Hazard Overlay Code. This must be undertaken by a suitably qualified Registered Professional Engineer Queensland (RPEQ).

4.2.1 Development within a very high or high landslide hazard area

(1) At minimum a geotechnical report must include:
(i) an extensive site investigation including subsurface investigation with groundwater measurements over at least one wet season;
(ii) the frequency of investigation locations should be no less than 1 location per 30m x 30m grid with an assessment of material strength by appropriate in-situ or laboratory testing. Investigations should establish a comprehensive geotechnical model over the whole site;
(iii) installation of groundwater monitoring points with measurements over at least one typical wet season and comparison of groundwater levels to rainfall events should be made;
(iv) a review of potential hazards; and
(v) an analysis of slope stability using a suitable model appropriate for the conditions.

(2) Where the analysis of slope stability indicates an unfavourable factor of safety, it is necessary to assess the risks to the community with regards to loss of life, injury and damage to infrastructure.

(3) The design of any proposed development must be reviewed and recommendations made by a suitably qualified RPEQ.

(4) Planning and implementation of a program of regular maintenance of slopes, cleaning of drainage course and monitoring of slope for signs of distress may also be required.

4.2.2 Development within a medium or low landslide hazard area

(1) At minimum a geotechnical report must contain:
- (i) a site walkover survey with investigations as required establishing a geotechnical model over the whole site. This may require moderate subsurface investigation or testing to provide subsoil material properties;
- (ii) a review of potential hazards; and
- (iii) an assessment of slope stability using a suitable model appropriate for the site conditions.

(2) Where the analysis of slope stability indicates an unfavourable factor of safety, it is necessary to assess the risks to the community with regards to loss of life, injury and damage to infrastructure.

(3) The design of any proposed development may need to be reviewed and recommendations made by a suitably qualified RPEQ.

4.3 Guidance for applicants

4.3.1 Road Design

(1) Roads on side slopes are usually formed by a combination of cut and fill operations. The design must incorporate effective drainage, and should incorporate good practices including:

- (i) the adoption of batter slopes appropriate to the engineering properties of the different materials exposed in the cut face. As a general rule batters in soil should be 2H:1V, in poor rock 1H:1V and in good rock 0.5H to 1V;
- (ii) where cuttings in rock are proposed, road alignments should be planned as not to coincide with major jointing orientations of the rock;
- (iii) the higher cut faces should include the provision of benches at vertical intervals of not greater than 10m. These benches are required to catch fallen material, to control drainage and to provide access for maintenance of the cut face;
- (iv) the provision of formed surface drains at the top of the cut slope, on the benches and at the toe of the cut slope;
- (v) the provision of slope protection, slope treatment or slope support in areas of potential concern. Slope protection against erosion may utilise a cover of topsoil and grass. On steeper slops treatment of erodible and closely joined rock is commonly by a cover mesh and shotcrete with rock bolts providing treatment of areas with adversely oriented joining. In areas of greater concern slope support can be provided by an engineered retaining wall. The design of the wall depends on the site conditions and cut dimensions but could include gabion crib, masonry and reinforced concrete wall designs.

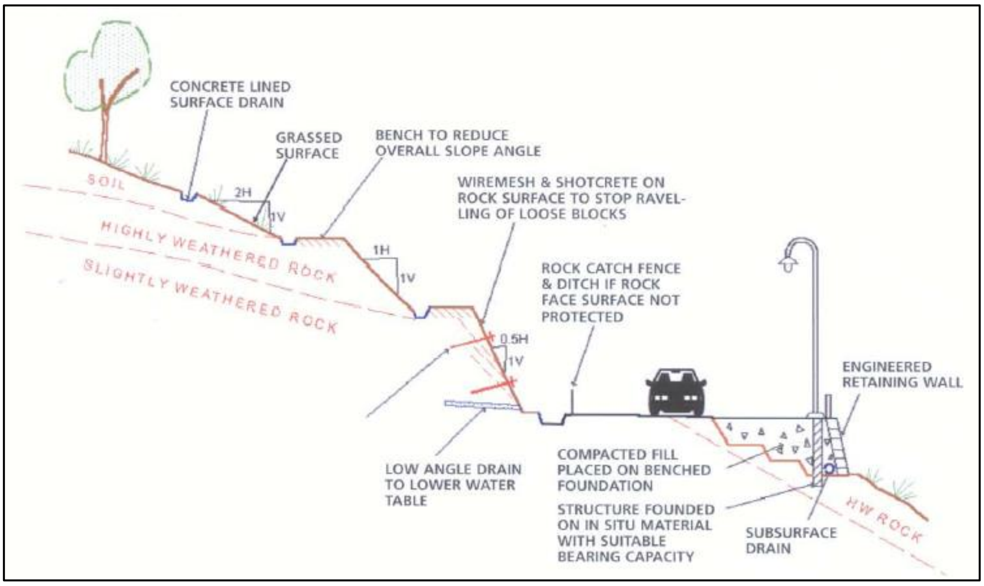
(2) The road fill embankment design should incorporate:
- (vi) the removal of all unsuitable material including trees, vegetation and topsoil from embankment foundation;
- (vii) the preparation of the embankment foundation by the formation of terraces across the slope. These terraces should be at least 2m wide with a maximum height of 0.6m;
- (viii) the installation of drainage, if required, in the foundation. This drainage may involve trench drains in areas of local seepage or a drainage blanket in an area that is generally wet;
- (ix) the embankment fill should be placed in an engineered manner. Placement of earth fill should be in layers – each not thicker than 300mm and compacted by roller to not less than 95% relative to Standard Compaction;

(x) the design of compacted earth fill slopes in soil should be no steeper than 1.5H:1V, and may often be lower subject to retained height, soil strength and maintenance considerations. Surface protection should be by grass or rock;

(xi) the provision of drainage at the crest and toe of the embankment as formed drains leading to an identified disposal area.

Examples of how to maintain slope stability for road design is illustrated in Figure 1.

Figure 1 – Possible methods of maintaining stability in road design



4.3.2 Examples of good hillside practices

Examples of good and poor hillside engineering practice are given in Table 1 and Figure 2 below.

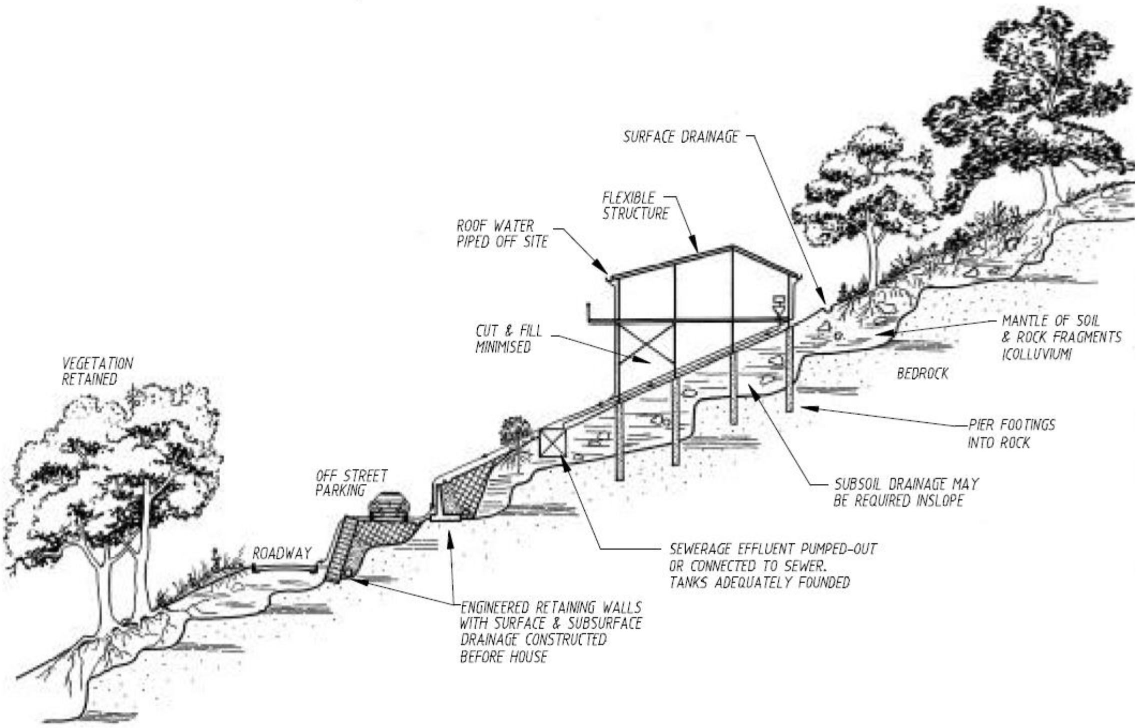
Table 1 – Guidelines for hillside construction practice

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminant bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

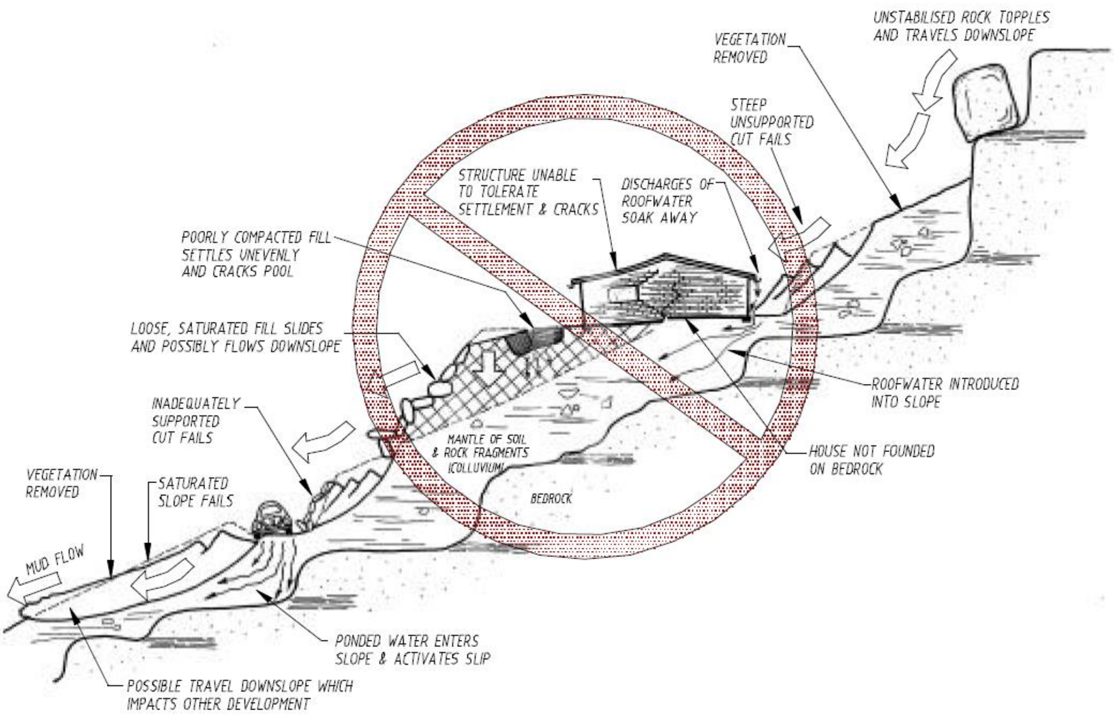
Extract from "Landslide Risk Management Concepts and Guidelines", Australian Geomechanics Society Journal, Volume 37 No. 2, May 2002, p43.

Figure 2 – Illustration of good and poor hillside practices

Examples of GOOD Hillside Practice



Examples of POOR Hillside Practice



Extract from "Landslide Risk Management Concepts and Guidelines", Australian Geomechanics Society Journal, Volume 32 No. 2, May 2002, P44.