SC6.3 City Plan policy – Bushfire management plans

1 Purpose

This City Plan policy provides guidance on how to prepare a Bushfire management plan.

1.1 Application

This City Plan policy assists with satisfying the assessment benchmarks in the City Plan which relates to the preparation of a bushfire management plan as outlined in the table below:

Table 1: Application – Bushfire management plans

<table>
<thead>
<tr>
<th>Section or table in the code</th>
<th>Assessment benchmark reference</th>
<th>Section in policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushfire hazard overlay code</td>
<td></td>
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</tr>
<tr>
<td>Table 8.2.3-2 – Bushfire hazard overlay code – for assessable development</td>
<td>Bushfire hazard AO1</td>
<td>Sections 3 to 45</td>
</tr>
<tr>
<td>Table 8.2.3-2 – Bushfire hazard overlay code – for assessable development</td>
<td>Land use AO2</td>
<td>Sections 3 to 45</td>
</tr>
<tr>
<td>Table 8.2.3-2 – Bushfire hazard overlay code – for assessable development</td>
<td>Clearing AO7</td>
<td>Sections 3 to 45</td>
</tr>
<tr>
<td>Table 8.2.3-2 – Bushfire hazard overlay code – for assessable development</td>
<td>Open space management plan AO8</td>
<td>Sections 3 to 45</td>
</tr>
<tr>
<td>Table 8.2.3-2 – Bushfire hazard overlay code – for assessable development</td>
<td>Fire trails PO9</td>
<td>Sections 3 to 45</td>
</tr>
</tbody>
</table>

2 Bushfire management areas

2.1 What are bushfire hazard areas?

Bushfire hazard areas (BHAs) are those areas of the city that the Council has identified as being subject to potential bushfire hazard. These areas are determined using a methodology consistent with the State Planning Policy – state interest technical manual that takes into account a vegetation class’s potential maximum fuel load, topography and fire weather severity. The locations of the BHAs are identified on the Bushfire hazard overlay map of the City Plan. A detailed site-specific assessment is required to verify the potential level of bushfire hazard on a given site.

2.2 What do bushfire hazard areas mean for development?

The City Plan sets requirements for development in Bushfire hazard areas. Development in bushfire hazard areas must achieve the following:

(a) all new developments are designed to have adequate bushfire radiation zones to bushfire hazard areas and road layouts to provide safe entry and exit for residents during emergencies;

(b) all new development is provided with adequate water supply and appropriate access arrangements for fire fighters and ongoing fire management;

(c) all new developments supports the ecological role of fire in the landscape and ensures that hazard reduction and conservation burns can be conducted in the city’s natural areas; and

(d) the bushfire hazard and risk mitigation treatments associated with all new developments do not have a significant negative impact on the biodiversity and health of the City’s ecosystems.

2.3 What are the development requirements?

In order to achieve the above outcomes, the City Plan sets out a number of requirements that development
proposals must meet. These are contained in the **Bushfire hazard overlay code** and summarised in Section 3.10.

3  **Preparing a Bushfire management plan**

3.1  **What is a Bushfire management plan?**

A Bushfire management plan must address how the development responds to each of the requirements set out in the City Plan, in particular, the assessment benchmarks stated in the **Bushfire hazard overlay code**. It is also an essential document for future residents of the site, as it clearly defines the level of bushfire hazard on the site and identifies actions (for example, vegetation management) required for the ongoing management of those hazards.

3.2  **Do you need one?**

You will need to submit a Bushfire management plan, needs to be submitted if: you meet the following criteria:

(a) where a material change of use or reconfiguration of lot is proposed on land located within a bushfire hazard area as identified on the Bushfire hazard overlay map;

(b) a site-based assessment confirms that your proposed development site is located wholly or partly within a Bushfire hazard area; and

(c) an approved Bushfire management plan has been conditioned to be prepared as part of a development application, that accords with the site based assessment criteria (Section 3.5) does not exist for the proposed development site, for example an approved bushfire management plan that was conditioned as part of the ROL.

3.3  **Who should prepare it?**

The Bushfire management plan should be prepared by a suitably qualified and experienced bushfire management consultant in consultation with relevant stakeholders. The consultant should have qualifications and/or experience in all aspects of bushfire management, including fire prevention and fire suppression. They should also have demonstrated experience in fire management planning activities in the Southeast Queensland - Northern New South Wales region.

3.4  **What area should it cover?**

The Bushfire management plan should address the whole of the proposed development site. During its preparation, consideration should also be given to:

(a) the site’s context within the broader area, particularly in relation to potential off-site sources of increased fire hazard (caused by land use type or physical features);

(b) the impact of the proposed land use on bushfire hazard for surrounding lots;

(c) the ecological role of fire in the landscape; and

(d) any implications the proposed mitigation measures may have for the conservation of matters of environmental significance both on and off the site.

3.5  **Requirements of site based assessment – what should it address?**

Taking into consideration the post development layout, the plan should:

(a) identify the location and severity of bushfire hazard by site-based assessment. This assessment should be based on detailed data collected at the local level and take into account factors such as vegetation type, slope, aspect, and fire history (if available, please contact the City’s Natural Areas Management Unit for further information). This assessment should also address on- and off site hazard implications of the development, including those posed by any nearby bushland (landscape level planning). In addition, the plan should consider any large tracts of forest (greater than approximately 500ha) up to 10kms away from the site, as these large forests will likely influence fire behaviour in the landscape proximate to the site;
(b) calculate the intensity of bushfire (for example, e.g. calculate potential maximum fuel loads, fire behaviour, radiant heat, flame zone, ember attack etc.) that may be experienced on the development site (or a selection of indicative sites within the development so as to provide a representative sample) prior to and after bushfire hazard reduction treatments (for example bushfire radiation zones) have been constructed (that is, what is the pre-development and residual post development hazard);

(c) consider the applicable assessment benchmarks contained within the Bushfire hazard overlay code;

(d) recommend remedial measures such as specific features of the development design (e.g. land use type, vehicular access, lot layout, bushfire radiation zones and house site location), proposed fire-fighting infrastructure (e.g. water supply and fire trails), landscaping, and advice to new future residents;

(e) with respect to extensions to existing buildings, the plan must detail the mandatory requirements so as to comply with the assessment benchmarks of the Bushfire hazard overlay code. It is recommended that if the existing building does not meet current standards then the plan will outline non-mandatory measures to reduce exposure to bushfire hazard for the existing structure;

(f) ensure that any proposed fire trails within land to be dedicated to the City are designed in accordance with the City's Classification of fire trails and specific standards of construction as detailed in section 5.4 - Fire trail construction guideline and/or the approved Open space management plan. In addition, fire trail construction standards should be discussed with the City's seconded QFES Bushfire Planning Assessment Officer;

(g) provide the basis for certification of the development’s bushfire mitigation treatments (bushfire radiation zones fire trails, water tanks etc.) to ensure that these treatments have been constructed and are functioning in accordance with the approved bushfire management plan;

(h) if the development proposes to dedicate public open space the Bushfire management plan must include a specific section that details ongoing management strategies for the proposed dedication that can be incorporated into the development's Open space management plan. This section should use a zone based approach similar to that used in the City’s natural area bushfire management plans, which can be found on the City’s bushfire management webpage on the following link:


Detail broad fire management guidelines based on fire regimes using State Government regional ecosystem information on vegetation types. Detail and map all required fire fighting infrastructure within the dedication;

(i) consider how future forest succession and proposed ecological restoration within the development site may influence the residual post development bushfire hazard and ensure this hazard is minimised whilst concurrently ensuring these ecological processes are maintained on the site. This is to conserve the site’s significant ecological values and minimise the impacts of the development; and

(j) clearly state any impact of the chosen bushfire hazard mitigation measures on the environmental and biodiversity values of the site and the measures taken to avoid/ minimise this impact and ensure that proposed mitigation treatments comply with the City Plan’s Environmental significance overlay code and Vegetation management code and all relevant state and federal legislation.

3.6 Who is the target audience?

The Bushfire management plan should be targeted at both the assessment manager and the end user, that is, the resident or operator of the business, etc. It should therefore be a ‘stand-alone’ document, written in simple language, and should clearly identify details of the level of bushfire hazard on-site, the actions to be taken to manage such hazard (including ongoing maintenance regimes), and who is responsible to take those actions. In addition, the plan will be used to provide the basis for certification of the proposed bushfire mitigation treatments (see point (g) above).

3.7 Relevant stakeholders - who should be consulted?

When preparing Bushfire management plans consultants should contact the City’s seconded Queensland Fire & Emergency Services (QFES) Bushfire Planning Assessment Officer to discuss how consultation should be managed and progressed. The local Rural Brigade should also be provided with a final copy of the approved Bushfire management plan.
Where development is proposed on land adjacent to the City reserves, State Government Protected lands, Seqwater land or other reserves managed for nature conservation, consultation should occur with the relevant land manager regarding bushfire management as it affects nature conservation values on that reserve.

Where development is proposed on land adjacent to any public land, the applicant should liaise with the relevant land manager to determine their requirements for the construction of fire trails and to ensure that the proposed trails integrate with the existing network.

3.8 What level of detail is required?

The above sections outline the minimum requirements for the preparation of a Bushfire management plan. It is recognised that some issues may not be applicable to some sites, and the detail with which issues are to be addressed may vary between sites, in response to site-specific characteristics.

3.9 Documentation

The Bushfire management plan is to be clearly documented in a written report submitted to the City as part of the development application. The text should be supported by appropriately scaled maps (e.g. showing areas of potential bushfire hazard, proposed water supplies and fire trails, bushfire radiation zones, preferred house site locations, etc.). The maps should clearly indicate the location and extent of the feature being shown, and either overlay, or be easily compared with, the proposed development design.

The Bushfire management plan should also include all relevant calculations (HILI, BAL, Vesta etc) and assumptions (e.g. Forest Fire Danger Index, fuel loads, including maximum likely fuel load, etc.) that were used to determine levels of hazard and radiant heat.

3.10 Checklist for development requirements

The following table is provided to help applicants check that they have met all the development requirements that are relevant to their proposed development site.

<table>
<thead>
<tr>
<th>Table 42: Checklist</th>
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<tbody>
<tr>
<td>Assessment benchmarks</td>
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<tr>
<td>Compliance with an approved Bushfire management plan</td>
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<tr>
<td>Building location minimises/mitigates bushfire hazard</td>
</tr>
<tr>
<td>Provision of adequate water supplies</td>
</tr>
<tr>
<td>Provision of bushfire radiation zones to bushfire hazard</td>
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<tr>
<td>Appropriate landscaping/ fuel reduction</td>
</tr>
<tr>
<td>Provision of fire trails</td>
</tr>
<tr>
<td>Advice to new residents</td>
</tr>
<tr>
<td>Adequate fire-fighting &amp; other emergency vehicle access</td>
</tr>
<tr>
<td>Lot and road layout minimises/mitigates bushfire hazard</td>
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<tr>
<td>Appropriate land use</td>
</tr>
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</table>
4 Fire trail construction guideline for Conservation estate areas

4.1 Introduction

This guideline provides a practical guide to the construction of functional and sustainable fire trails within land to be dedicated to the City as Conservation estate.

Fire trails constructed in the city’s managed natural areas are primarily used for fire management by Queensland Fire & Emergency Services (QFES) 4WD Medium & 4WD Light Response vehicles (refer Figure 1 and 2). Design criteria to ensure a fire trail can be safely traversed by ‘heavy response vehicles’ are not provided in this fire construction guideline.

These trails are maintained by the City and provide access for both wildfire suppression and hazard reduction burn operations. Additionally, many of these trails provide a dual purpose and may be used for providing access for nature based recreation opportunities.

<table>
<thead>
<tr>
<th>Medium Response Vehicle</th>
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<tbody>
<tr>
<td>Make</td>
</tr>
<tr>
<td>Weight</td>
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<tr>
<td>Length</td>
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<tr>
<td>Height</td>
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<tr>
<td>Width</td>
</tr>
<tr>
<td>Water Capacity</td>
</tr>
<tr>
<td>Pump</td>
</tr>
</tbody>
</table>

Figure 1: Typical example of QFES wildfire response vehicle: Medium response vehicle

<table>
<thead>
<tr>
<th>Light Response Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
</tr>
<tr>
<td>Weight</td>
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<tr>
<td>Length</td>
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<tr>
<td>Height</td>
</tr>
<tr>
<td>Width</td>
</tr>
<tr>
<td>Water Capacity</td>
</tr>
<tr>
<td>Pump</td>
</tr>
</tbody>
</table>

Figure 2: Typical example of QFES wildfire response vehicle: Light response vehicle

4.2 Purpose

The purpose of this guide is to:

(a) provide a framework to guide the construction of fire trails in the City’s Conservation estate areas;
(b) guide fire trail construction practices to ensure safe access for wildfire suppression and hazard reduction burn operations;
(c) provide the framework for construction techniques that ensure a sustainable outcome; and
(d) guide the construction of fire trails that can be safely traversed by medium and light response vehicles.

4.3 Environmental and legislative obligations
(a) Ensure all Cultural Heritage Assessments have been completed over the proposed footprint prior to undertaking work consistent with the requirements of the Aboriginal Cultural Heritage Act 2003.

(b) Dial Before You Dig. The Contractor must ensure Services such as Electricity, Telephone Water and Sewage are not affected by construction and all necessary service checks are undertaken prior to the beginning of construction.

(c) Ensure detailed flora and fauna assessments have been completed over the proposed fire trail alignment prior to undertaking work and consistent with the requirements of the Nature Conservation Act 1992 and the Vegetation Management Act 1999.

(d) Minimise all damage to vegetation adjacent to the fire trail footprint.

(e) All surplus introduced material must be removed from site.

(f) Ensure all relevant Local, State and Federal Environmental Legislative requirements are met and necessary approvals granted.

4.4 Design criteria for re-establishment of dormant fire trails

At times, it may be possible to use existing or renew disused trails. In some cases, these may have been established on a desirable contour and remain well grassed, well-shaped and adequately drained with negligible erosion impacts. In these cases, nothing further may need to be done to the trail surface. However, the trail may be covered by regrowth vegetation that will require removal. Some older, well-established trails may even contain larger trees within the Vegetation management Zone (VMZ) that should not be removed when they can be isolated from elevated fuels and design criteria for vehicle clearance can be achieved. However, all regrowth is to be removed consistent with the VMZ Guideline (refer Figure 16).

If an existing trail shows signs of any major erosion then all works must be undertaken in accordance with Section 4.5 of this document.

4.5 Design criteria for building new fire trails

New fire trails constructed in the City's hinterland, in most cases, will be constructed across and or on steep slopes. It is critical the cut batter height is minimised to maintain stability on both the up slope and down slope batters. Where a fire trail is to be constructed in conjunction with an Asset Protection Zone (APZ), the trail must have a minimum cleared width of 5.8m and minimum formed width of 3m. Where terrain contains steep grades exceeding 15%, deep natural drainage lines and side slopes exceeding 25%, it is preferable to realign the trail on more suitable grades to achieve a sustainable alignment.

Due to the steep grades associated with the City's hinterland, passing or turning bays must be available every 400m along the trail. These passing or turning bays do not need to be constructed if the topography and side slope does not exceed 8%, and the vegetation density allows safe passing or turning.

Links to other fire trails, public roads and water supply infrastructure are to be provided for in the planning stage. These links are to be designed on safe and sustainable alignments.

4.6 Drainage

Drainage is the key factor in constructing sustainable low maintenance fire trails. Drains of various types, as explained in this guideline, when constructed correctly on existing soil types will save both construction and maintenance costs.

Key elements for sustainable trail drainage and design include:

(a) avoiding the Fall Line;
(b) utilising Grade Reversal;
(c) ensuring Out-fall; and
(d) utilising Watersheds - Grade Dips or Spoon Drains.

Road drainage structures must be located, constructed and maintained in such a way that they will have sufficient capacity to convey the peak flow from a 1:5 year storm event.

Water bars are required on trails where sections of straight trail exceed 50m with trail gradients between 5% and 20%. When exceeding 8% on straight sections of trail use the detail in Table 2-3 as a reference.
Water’s erosive capacity is influenced by the catchment directed onto the trail and the gradient on which the trail is constructed. The primary means used to decrease erosion is to locate trails on shallower slopes while ensuring effective drainage is installed to cope with both the velocity and volume of water movement on the trail.

Consideration of the catchment and overland flow above the trail is essential to plan the placement of drainage elements along the trail. In some cases, drainage may only direct water to the trail below. This can be acceptable as at least the flow has been removed off the trail above. Where water is directed to the trail below suitable drainage at this new point must be inserted into the trail.

A small outfall of 5% is recommended to be maintained along the trail surface with water bars installed at intervals and angles consistent with Table 23. Soil type is a major consideration when constructing trails. Section 4.8-9 of this document classifies the soil types likely to be encountered within the city.

Other elements of drainage construction will be mentioned throughout the guideline. These elements of drainage will be used to improve drainage issues in specific locations where water bars would not be appropriate, effective or necessary.

4.7 The trail bench and outfall

The bench is the basic shape of the running surface of the trail and is constructed with 5 - 8% outfall (refer Figure 3). The bench will be a maximum of 3m wide with a vegetation clearance zone of 1.5m either side of the bench and vertical clearance as per Figure 16. Grasses and ground cover are to remain to stabilise down slope edges.

The out-fall is a critical component of the basic trail profile providing the primary element of drainage. The out-fall is to ensure water is leaving the trail regularly, not running for any great distance along the trail and not relying entirely on other drainage elements to remove overland water flow.

A 5% out-fall should be maintained along the nominal trail surface and gradually achieving a maximum of 8% to the drain mouth of the water bar, spoon drain or grade dip. When benching is complete, no spoil or vegetation is to remain along the outside edge of the trail. Water must be able to move freely off the trail. For vegetation clearances refer to Figure 16 – Vegetation encroachment management on fire trails. Vegetation Management Zone (VMZ) guideline (refer Figure 16).

4.8 Water bar construction

Where water bars are necessary to remove overland flow across and off the trail at regular intervals, the following information must be adhered to:
(a) The recommended orientation angles and intervals for the construction of water bars are governed by the grade of the trail surface and the topography that the trail has been constructed through. It is generally accepted that the steeper the trail, the more water bars that must be constructed into the trail utilising a shallower angle of orientation (refer Table 23).

(b) Where a water bar exits onto steep side slopes, silt traps must be constructed across the drain mouth or outlet. The length and grade of the outlet must be minimised to prevent water moving at speed over long steep distance before dispersing slowly into vegetation. It is imperative that soil types are considered.

(c) The trough of a water bar is not to be excavated as a trench across the trail and the crest of a water bar rising out of the trough is not to be constructed as a hump trail (refer Figure 4b).

(d) Water bars must be constructed so the crest of the water bar is a gradual slope downhill into the trough of the next water bar and should follow a simple saw tooth pattern trail (refer Figure 4a).

(e) The trough of the water bar must have an out-fall of at least 5% with a wide mouth to minimise blockage and facilitate self-cleaning. The trough should fan out towards the mouth or outlet and maintain a good out-fall ensuring no water pools within the trough.

(f) The crest must be constructed to withstand wheel ruts that will channel water over the water bar. The water bars compacted finished height will be governed by the grade of the trail. The height must be high enough to direct all water off the trail without topping over the crest and without impeding vehicle travel. In some soil types, the water bar crest will need to be hardened with a stabiliser or 25~40mm aggregate compacted into existing bulk material.

4.8.1 Water bars

Water bars must not be constructed primarily with road base or Cement treated-Treated base Base (ctbCTB) materials.

Figure 4a shows the correct shape of water bars and how they should be incorporated into the trail surface. As a rule of thumb, the excess material taken from the trough should be used to construct the crest and trail surface leading down to the following trough. Any material used to form the crest or trail surface must be keyed into the existing surface and compacted to ensure no separation of the layers can occur. All organic matter must be removed from between the layers.
4.9 Soil class definition

(a) **Class A** – Low susceptibility of soil erosion
Brown, red and yellow soils derived from finer sediments, metasediments including clays.

(b) **Class B** – High susceptibility of soil erosion
Red soils on fine granites and basalts, fine sandstone and basalt.

(c) **Class C** – Very high susceptibility of soil erosion
Grey and yellow soils derived from granites, sediments and metasediments. Especially coarse grained soil types.

The table below provides a guide for most situations likely to be encountered in the Gold Coast Hinterland.

**Table 23: Trail gradient based on soil class with nominal water bar spacing (refer Figure 35 for water bar orientation)**

<table>
<thead>
<tr>
<th>Trail grade</th>
<th>Water bar orientation</th>
<th>Soil class A Water bar spacing</th>
<th>Soil class B Water bar spacing</th>
<th>Soil class C Water bar spacing</th>
<th>Water bar height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 10%</td>
<td>35°</td>
<td>15 - 20m</td>
<td>10 - 12m</td>
<td>7 - 10m</td>
<td>0.3 - 0.4m</td>
</tr>
<tr>
<td>11% - 15%</td>
<td>25°</td>
<td>8 - 12m</td>
<td>7 - 10m</td>
<td>Undesirable</td>
<td>0.4 - 0.6m</td>
</tr>
<tr>
<td>15% - 20%</td>
<td>15°</td>
<td>5 - 8m</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete &amp; out-fall</td>
</tr>
<tr>
<td>21% - 25%</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete &amp; out-fall</td>
</tr>
<tr>
<td>26% - 30%</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Concrete &amp; out-fall</td>
</tr>
<tr>
<td>Above 30%</td>
<td>Relocate trail alignment</td>
<td>Relocate trail alignment</td>
<td>Relocate trail alignment</td>
<td>Relocate trail alignment</td>
<td>Relocate trail alignment</td>
</tr>
</tbody>
</table>

**Figure 4b: Incorrect formation of water bar.**

NOTE: SCALE EXAGGERATED FOR EFFECT

Figure 35: Water bar orientation.
Note: Relaxation of the trail surface gradients is possible when other on ground factors are taken into consideration, such as but not limited to the following:

- utilisation of existing farm or logging trail;
- size of upstream catchment and expected overland flow velocity and volume; and
- short linear length of trail (<50m).

4.10 Water bar orientation on the trail

The angle of orientation of a water bar is crucial. This angle will govern the self-cleaning ability of the water bar and the speed in which the water moves across the trail surface to the outside edge of the trail.

The out-fall along the trail should increase (at least, 5-6m out) as it approaches the Water Bar to ensure the water is shed from the trail prior to being concentrated at the Water Bar.

The outside or down slope edge of the trail is most vulnerable to erosion. This erosion can be minimised by decreasing the spacing between water bars and decreasing the orientation angle across the trail (see Table Figure 5 and Figure 14). The addition of silt traps at the outlet and minimising the outlet grade will also assist in erosion control.

![Flow direction is initiated by out-fall](image)

Figure 5: Water bar orientation.

4.11 Watersheds - grade dips and spoon drains

Watersheds are generally located on corners and are created by lowering the outside edge of the trail and gradually increasing from a minimum of 5% to an 8% out-fall. This will ensure water travelling along the trail is quickly diverted at the corner and off the trail (see Figure 6).

Grade dips are utilising natural dips in the trail surface or very shallow drainage lines to remove water from the trail replacing the need to construct a water bar. The drain mouth should be made at least 35% wider than where the dip enters on to the higher side of the trail. Create a minimum out-fall of 5% across the trail gradually increasing to approximately 8% at the mouth. This will ensure good flow and self-cleaning ability (refer Figure 6).
4.12 Table drains

The primary purpose of a table drain is to lower the water table within the trail body and keep the surface firm. Table drains must be constructed where sections of a trail remain wet due to long term or permanent soaks (see Figure 7a and 7b). The preferred outcome would be to design the trail on a different alignment. However, when this is unavoidable, the inside of the trail below the batter is boxed out to a width and depth of 600mm. It is then filled with 75~150mm aggregate wrapped with suitable geotextile material. This will allow water to flow over and through the aggregate within the drain to the next down slope box drain or water bar and then off the trail. An out-fall of a minimum 5% must be maintained along the trail.

Note: If water bars are used to move permanent water across the trail and the trail remains soft then the trough of these water bars are to be constructed as box drains while the simple saw tooth pattern described in Figure 24a is maintained (refer also Figure 6).
4.13 **Box drain**

These types of drains will be placed on trails where a section of the trail continually experiences ‘boggy’ conditions. A box drain is constructed at a lowered section of the trail that is excavated and filled with 75 – 150mm aggregate and shaped to ensure water flow is maintained on and through the aggregate and directed across and off the trail. These drains must be designed to allow movement of fire fighting vehicles.

A box drain width may vary to suit different locations and vary from a depth and width of 600mm x 600mm crossing the trail at appropriate intervals. Outfall locations will require the installation of rock mattresses (installed as per manufacturer’s specifications) extending along the full length and width of the wet section of trail (refer **Figure 8a and 8b**). On some occasions, the preferred outcome may be to design the trail on a different alignment. In locations where the trail is level and can only be located through an area with consistent sub surface soil moisture, an approved drainage cell system can be installed according to manufacturer’s specifications.
4.14 Trails on steep slopes greater than 20%

On occasions, it may be unavoidable to construct trails on slopes greater than 20%. It would always be preferable to alter the trail alignment to reduce the trail gradient. When trails exceed 20% gradient, concrete is an accepted surface material (refer Figure 9). Other erosion prone materials such as Cement Treatment Base (CTB) must not be utilised as a substitute.
4.15 Creek crossings

Where possible, creek and water crossings should be avoided at all times. Where this cannot be achieved, appropriate and approved vehicle crossing points may be installed through creeks and drainage lines. A sustainable outcome may typically require one or a combination of acceptable outcomes.

In addition, the design and construction must be undertaken in such a way as to minimise water quality and environmental impact. The original bank line and direction of a creek or drainage line should not be altered without consulting relevant authorities for approval.

Vehicle crossings will not be constructed where a bend exists in a creek or drainage line unless it is already in place and is functioning in a sustainable manner. Where creek or drainage lines are shallow, alteration to the bed and banks must be minimised. State and Federal approvals may be required to construct the creek crossing.

4.16 Soft bedded creek or drainage line

When the bed of the creek or drainage line combines soft soil and/or mobile surface material the crossing must be hardened to accept vehicular traffic. Concrete fords, rock filled mattress, large rock or approved drainage cell systems should be used (Figure 10). The construction methodology is determined by the volume and velocity of water flow which will determine the extent of engineering design required and material to be used. The flow of water must not be impeded upstream or diverted around the built structure or create turbulence that will effect water quality of downstream aquatic habitat. The outcome is to maintain water flow at the original levels, minimise erosion during and after construction and limit impacts to water quality and in stream environmental values.

If the adjoining embankments are slippery, soft or steep it may also be necessary to extend the material used up the bank to maintain vehicle traction and limit vehicular access and egress impact.
Where the soil type is stable 25/40mm aggregate may be scarified into the embank surface and compacted to ensure traction up and down shallow banks. Aggregate should not remain loosely spread on the finished trail surface.

**Figure 10: Example of a crossing in soft bedded creek.**

### 4.17 Constructed culvert crossings and headwalls

Culvert crossings must be avoided where possible to minimise the cost of both trail construction and maintenance. The preferred outcome is to redesign the alignment of the trail to a more stable crossing location.

In a situation where a very steep banked drainage line is not able to be avoided, it is critical the size of the culvert pipe and associated rock protection is designed and installed to effectively cope with the volume and velocity of water from the upstream catchment (Figure 11).

Concrete formed headwalls are to be avoided in these locations and rock mattress combined with larger rock gabion baskets should be fitted around the pipe structure and keyed effectively into the drainage line banks. Rock filled gabion baskets are preferred as they act as the finished trail surface, provide effective bank retention and also allow the percolation of water during rainfall events.

**Figure 11: Typical constructed culvert creek crossing.**

### 4.18 Stone or bedrock based creek and drainage lines

Where stony or bedrock crossings exist the bed must be left unaltered. Some larger rocks may need to be manipulated to allow vehicular movement across the creek to ensure safety and avoid any possible vehicle damage. These rocks should only be moved if they are above the surface by 200mm (Figure 12).
Bank entrances and exits should be hardened with rock mattress or (the preferred option) impregnated and compacted with 25/40mm aggregate to allow improved traction for vehicles whilst exiting the creek. On no occasions should the aggregate remain loosely spread on the finished trail surface. Shaping of entrance and exit ramps must be minimised but need to be designed to cater for the approach and departure angles of the fire fighting vehicles.

4.19 Steep drainage lines that cross narrow contours

Steep drainage line crossings should be avoided where possible to minimise cost of both construction and maintenance. At times, these drainage lines carry large volumes of fast flowing water. The preferred outcome is to redesign the route of the trail to a more suitable crossing location.

Where trails unavoidably run across steep contours and meet steep drainage lines, it will be necessary to minimise the width of the crossing to minimise the height of cut batters.

A 2.4m wide trail across the drainage line will be sufficient incorporating 1.5m of vegetation pruning each side of the trail to give good vehicular clearance. The crossing maybe constructed and retained with large rock of minimum 800mm diameter and filled with 75–150mm aggregate to provide a bed to place rock mattresses. The rock mattresses will form the trail surface. The outside edge of the trail is to be battered at maximum of 45 degrees to retain the lower side of the crossing. All rock must be well placed and stabilised to form and retain the lower side of the crossing (see Figure 13).

Rock baskets may also be used to form the crossings in place of large rock. The area below the retaining batter must be rock protected to prevent scouring during extreme rainfall events.
4.20 Fall line

Construction of fire trails along the fall line is not sustainable and must be avoided. The fall line is described as being the line of least resistance for water movement down a slope, or the line directly at right angles to the contours. Trails constructed on the fall line are expected to suffer from high levels of erosion (see Figure 13).

Fire trails must not be constructed along a ridgeline or spur. The trail should always be constructed down slope and off to the side of the ridge or spur line far enough to enable the installation of the nominal out-fall of 5% to ensure that water is shed. The trail may cross the ridge lines incorporating techniques such as grade reversals, watersheds and grade dips. Long straight sections of trail should be avoided, where this cannot be achieved, water bars must be used.

Contours should be used to design trails across slopes to minimise trail grades on steep country, utilising switchbacks to decrease in elevation. Trails must never be constructed in straight lines down steep slopes for long distances (typically should not exceed 20m). Where this becomes unavoidable, water bars will need to be constructed using Table 2.3 and Figure 24a of this construction guide.
4.21 Grade reversal

Grade reversal is the technique of using the rise and fall of the trail across the contours as it decreases in elevation. If this technique is adopted, then grade reversals are constructed into the trail at the same intervals as prescribed in Table 23. The trail can be constructed far more economically and sustainably utilising grade reversals rather than relying on the construction of water bars (see Figure 15).

Figure 14: Fire trails must not be constructed along the fall line.

Thick line demonstrates fall line. Trails should never be constructed on these alignments.

Dashed line shows correct trail position. Trail is designed down slope off the high point of the ridgetop or spur while utilising grade reversals, grade dips and watersheds.
Figure 15: Example of grade reversal.

Figure 16: Vegetation encroachment management on fire trails.

Notes:
- Remove all shrubs/saplings within vegetation management zone. These saplings are to be cut and poisoned at based.
- All cut debris is to be evenly dispersed >20m from the edge of the fire trail or mulched and used in onsite restoration or removed from site.
4.22 Glossary of terms

Asset protection zone (APZ)
A fuel reduced area surrounding or dividing built assets from potential bush fire risk. Vegetation within this planned zone is managed to minimise the transfer of fire to assets either from the ground level or through the tree canopy. The width of the APZ will vary with slope, aspect, vegetation and type of building construction.

Bank retention
A constructed wall to retain banks and the cut left after a trail bench is formed. This retaining wall maybe rock filled wire baskets or suitably placed large rock.

Batter
Where the high side of the trail has been cut leaving a vertical wall, the wall is battered or cut back at an angle to minimise collapse and subsequent erosion. The minimum angle will be 45 degrees in stable soils (refer Figure 1) (refer Figure 3).

Bench/benching
Achieving a basic trail profile and shaping the trail surface to create an out-fall (5% - 8%). This out-fall is to ensure overland flow is shed across and off the trail. In-falling trails are not to be constructed (refer Figure 53).

Box drain
An excavated trench or area of the trail that is filled with aggregate to catch and/or direct water across the fire trail and provide a firm trafficable surface (refer Figure 8a & 8b).

Conservation estate
Please refer to Schedule 1 – Definitions.

Cultural heritage
Historical or anecdotal evidence of Indigenous and European artefacts, infrastructure, cultural and spiritual sites.

Drain mouth or outlet
A drain mouth is the exit point for water being shed from the fire trail. The drain mouth should be at least 35% wider than the entrance point of the drain to ensure free flow and self-cleaning (refer Figure 86).

Fall line
A line that runs downhill at right angles to the contour lines, the path of least resistance for water to flow or the area over the topography most susceptible to erosion once disturbed (refer Figure 1614).

Fire trails
For the purpose of this guideline, fire trails are dedicated access trails, suitable for 4WD Medium & 4WD Light Response vehicles utilised by QFES. These trails are to provide access for wildfire suppression, hazard reduction burn and reserve management operations.

Grade reversal
Alignment of the trail to rise and fall over the topography in order to create a rolling contour that sheds overland flow from the trail at the lower points. Design will always include out-fall (refer Figure 4715).

Interface zone (iZone)
The iZone is the area of land where the bushland meets the infrastructure of the built environment. This is not a defined line but encompasses both the bushland and infrastructure development and defines an area of bushfire risk.

Natural areas management unit (NAMU)
The City of Gold Coast’s park estate is managed by the Parks & Recreational Services Branch. Within this branch, NAMU is the asset custodian charged with the management of all Parks and Reserves that are managed principally for nature conservation purposes. Natural areas should provide habitat for indigenous plant and animal species (and other taxa), connect large and small remnants, and may form part of a protected area network within the city. Natural areas may contain the only representative sample of a given biodiversity element and provide opportunities for showcasing the city’s natural assets.

Out-fall or cross-fall
The trail bench is shaped to slope down to the outside of the trail and will be a minimum of 5% (refer Figure 3).
Silt trap
A small dam or wall of spoil at the end of water bars and drains. The silt trap function is to catch silt and slow the water flow at the drain mouth or outlet. Simply formed by leaving fill at the end of the drain mouth to catch water and allow it to soak or evaporate. The high point or wall of the silt trap must be low enough to ensure trapped water does not back up onto the trail bench.

Table drain
A table drain assists in lowering the water table in the trail and keeps the surface dry and firm where the boggy conditions are encountered. A constructed drain or trench is filled with aggregate that runs parallel to the trail where it intercepts and carries both surface and sub-surface water to a point where the water crosses the trail and exits with aid of a box drain at a water bar or relief culvert (refer Figure 7a & 7b).

Vegetation encroachment management (VEM)
Defines the extent of vegetation clearing required along the fire trail corridor necessary to allow uninterrupted vehicle movement.

Water bars (Whoa Boys)
A combination of a raised and lowered area of the fire trail surface that directs water across and off the trail. It is constructed by shaping the existing surface material to form a water diversion bar across the trail at a given angle (see Figure 35). The surface material used may need to be mixed with a high clay content road base, 25~40mm aggregate or ‘geo-binder’ to bind and harden the water bar against wear and movement if soil types are not suitable (refer Figure 64a and Section 4.8).

Watersheds – Grade dips or spoon drains
A lowered section of the fire trail surface used to direct water across and off the trail. They are usually used on a curve, corner or at a natural change of grade (see Figure 88).