SUMMARY OF ISSUES

As discussed in the "Visual Assessment" section of this working paper, the main urban and landscape design and visual impacts in the Tinderbox Creek Valley precinct are associated with the large size of cuttings in the southern half of the precinct in particular and with the tunnel portals and associated cuttings around the tunnel opening.

From the point of view of the motorist and the driving experience along the proposed upgrade, the Tinderbox Creek Valley precinct is characterised by its low levels of development and its consistently open pastoral character which is in contrast to the much more heavily vegetated and varied landscape along the remainder of the proposed upgrade. This provides a pleasant contrast for the motorists as it allows for more distant views and gives the motorist more time to study and enjoy views before being enclosed by vegetation. Particular important views include views into the Tinderbox and Byron Creek floodplains north of the Byron Creek bridge, the views south when emerging from the tunnel in the St Helena ridge, and views into side valleys and along minor creeks and drainage lines (refer to Illustration 80).

In terms of how the proposed upgrade will be perceived by local residents and visitors to the area, views from the local road system are limited largely to middle-distance views from surrounding ridge line roads. The most important of these in terms of proximity to the upgrade would be St Helena Road and has been addressed in the urban and landscape design concept plan. In addition and as for all other precincts, the proposed upgrade would be visible from a number of residential dwellings. As most of the proposed upgrade would be located lower in the landscape than the majority of dwellings and farm houses in the precinct, attempting to screen the proposed upgrade with landscape planting would not be effective in concealing the upgrade from those higher elevated properties. Screen plantings at specific locations within individual properties might therefore be a more effective means of providing visual screening to residents in the precinct, while maintaining views and visual diversity for motorists on the proposed upgrade.

KEY AREAS FOR DETAIL DESIGN

In precinct 4, the key areas for further design investigation, resolution and development include:

> Shaping of cuttings and embankments

The precinct features a number of significant cuttings, in particular north or Tinderbox Road and around the tunnel portal (also refer to "Tunnel and tunnel portal design"). In order to reduce the impact of sharply defined cuttings against the gently rolling character of the natural landscape, consideration should be given to the shaping cuttings in a way that reduces this contrast and allows cuttings to blend into the natural landscape.

Similarly, embankments should be 'graded out' at the bottom, to reduce the visual impact of an obvious junction between fill embankments and the natural landform.

Combined with the establishment of vegetation over time, this will assist in reducing the 'artificial' character of cuttings and embankments (also refer to "Cutting and embankment stabilisation").

> Cutting and embankment stabilisation

The successful stabilisation and revegetation of the numerous cuttings and embankments will be an important factor influencing the character of the proposed upgrade, both from the point of view of motorists and when seen from surrounding areas.

Consideration should be given to the angle of cutting and embankment slopes with regard to short and long term soil stability, the potential for plants to successfully establish and long term maintenance (issues include mulch or small rocks being washed onto the road pavement).

Close liaison with geotechnical specialists is recommended in order to identify the need for and best means of soil amelioration and stabilisation to ensure good long-term vegetation cover.

> Tunnel and tunnel portal design

The tunnel under the St Helena ridge is prominently located in the side of the scenic escarpment and represents a major landmark along the proposed upgrade, as well as along the Pacific Highway as a whole. The current proposal involving major excavation of the natural hillside does not reflect the importance of the tunnel from an urban design and visual point of view.

Consideration should therefore be given to reviewing the tunnel design with the aim of increasing the length of the tunnel. This would significantly reduce the amount of excavation works which in turn would reduce the degree of engineering measures likely to be required to stabilise cutting faces (both potentially also representing a cost saving). Refer to the "Urban Design Elements" section of

this working paper for a further discussion of tunnel and tunnel portal design.

> Vertically independent carriageways

Investigate the potential for independent vertical grading of the two carriageways, in order to reduce the motorway character of the proposed upgrade while also potentially reducing the amount of earthworks required. The section of the proposed upgrade between the Tinderbox Creek bridge and the tunnel portal seems particularly suited for this (chainage 147,800 - 150,050), although the section between the Byron and Tinderbox Creek bridges may also offer some potential (chainage 147,000 - 147,700).

URBAN AND LANDSCAPE DESIGN CONCEPT PLAN AND SPECIFIC RECOMMENDATIONS

Building on the identified key areas for detail design and the strategic principles outlined in the urban and landscape design strategic concept, Illustration 80 provides a more detailed concept plan for precinct 4. It identifies a series of precinct-specific urban and landscape design measures, which have been developed in response to the urban design objectives and principles for the proposed upgrade, and to mitigate the identified visual impacts. The plan further identifies important views to be retained and protected, in order to enhance the experience of the motorist on both the existing and the upgraded highway.

The cross sections in Illustrations 81 to 83 further demonstrate the three-dimensional urban and landscape design treatments at a number of important locations within the precinct.

Specific recommendations to mitigate the potential visual impact of the proposed upgrade and to be investigated at a detailed level in the next design stages are:

1. Reinstate and complement existing riparian/ creekside vegetation with additional planting to reduce the visual impact of bridge piers in the Byron Creek floodplain (chainage 147,000 - 147,100).
2. Use planting to soften the appearance of bridge abutments in the Byron Creek floodplain by planting at the bottom of fill embankments (chainage 147,000 - 147,100).
3. Reinstate and complement existing riparian/ creekside vegetation along Tinderbox Creek and its tributary to reduce the visual impact of bridge piers (chainage 147,700 - 147,900).
4. Reinstate dense bushland on the western side of the proposed upgrade (chainage 147,700 - 147,900).
5. Provide dense boundary planting between the proposed upgrade road reservation and the piggery to provide a visual buffer to adjoining properties while maintaining views from the proposed upgrade (chainage 147,850 - 148,000).
6. Plant at the top of cuttings on the eastern side of the proposed upgrade to reduce the visual impact of the large western cutting face on the residents of the Tinderbox Valley (Chainage 148,000 - 148,300).
7. Provide low planting on the eastern side of the proposed upgrade to reduce the impact of headlight glare on surrounding properties while maintaining views from the proposed upgrade into the surrounding countryside (chainage 149,680 - 149,850).
8. Provide dense revegetation to the cutting faces and tops of cuttings surrounding the tunnel portals, to visually conceal the large excavation and cutting faces from St Helena Road (chainage 149,950 - 150,150).
9. Revegetate cuttings and embankments throughout the precinct, to soften and reduce their visual effect. A list of locally appropriate species is provided in Appendix 1.

* Notes:

1. All chainages are approximate.
2. "Planting" refers to the final outcome and not to any particular technique during construction: it includes both individual plantings and large-scale revegetation works.

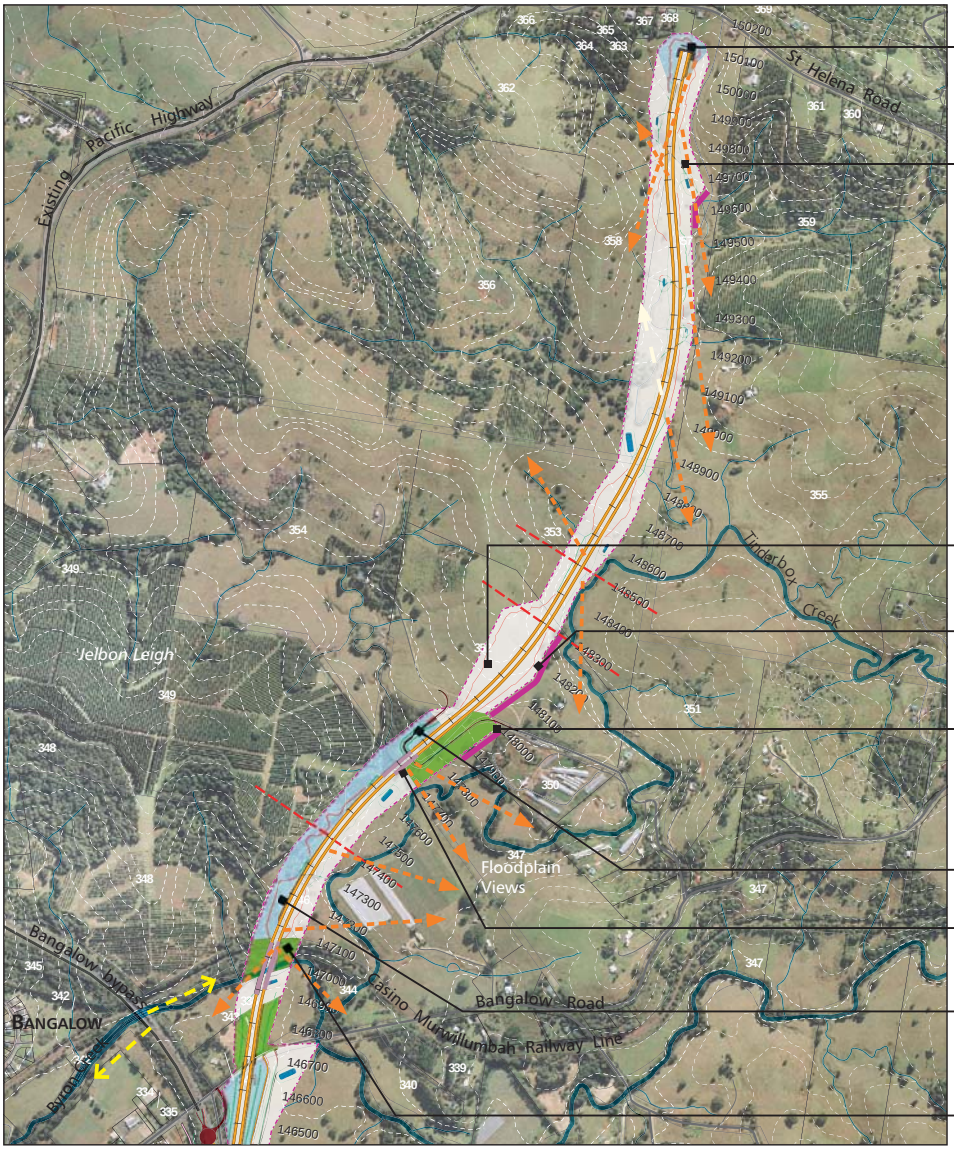


Illustration 80:
Urban and landscape design concept plan for precinct 4

Legend

- Proposed Highway upgrade: carriageways, on- and off-ramps
- New and modified local access roads
- Proposed road corridor acquisition boundary
- Property ID number
- Extent of proposed fill embankments
- Extent of proposed cuttings
- Proposed sedimentation basin
- Existing Pacific Highway alignment
- Existing local roads and driveways
- Views from the existing highway
- Views from the proposed upgrade
- Cross section location
- Proposed avenue or special purpose planting
- Planting and/or revegetation includes tree cover to complement surrounding planting patterns and provide an enclosed driving experience
- Planting and/or revegetation works with limited tree cover to allow for filtered views of the surrounding landscape
- Revegetation works limited to low planting or turfing as required to stabilise embankments and cuttings, and to allow open views into the surrounding countryside

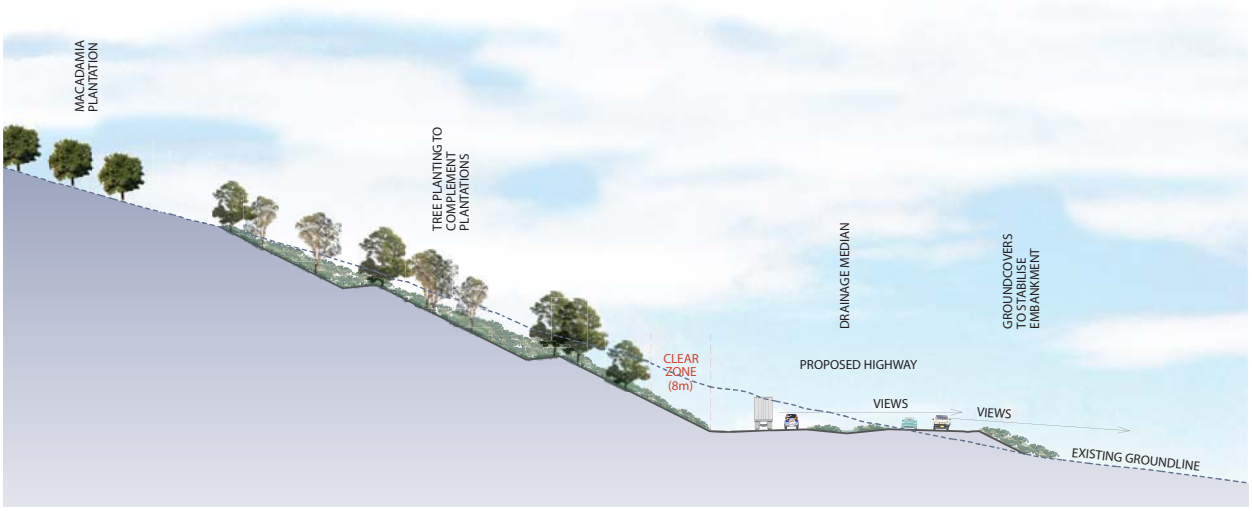


Illustration 81:
Cross section at chainage 147,400

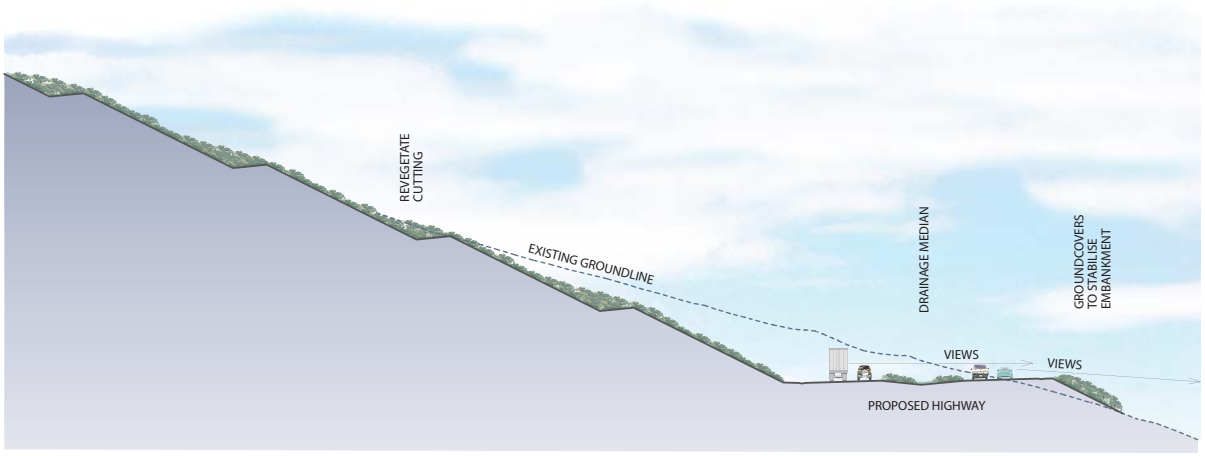


Illustration 82:
Cross section at chainage 148,300

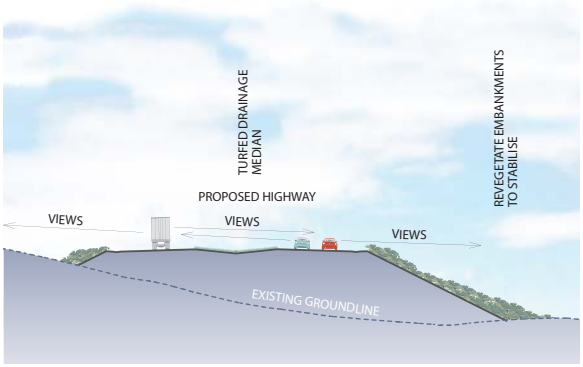


Illustration 83:
Cross section at chainage 148,500

SUMMARY OF ISSUES

As discussed in the "Visual Assessment" section of this working paper, the main urban and landscape design and visual impacts in the Ewingsdale precinct are associated with the large increase of road infrastructure on the Ewingsdale spur, the major fill embankment on the eastern side of the spur and the construction of the tunnel portals and associated cuttings around the tunnel openings.

From the point of view of the motorist and the driving experience along the proposed upgrade, the Ewingsdale precinct is characterised by dramatic change in topography associated with the climb up or descent down from the scenic escarpment. Associated with this are panoramic views along the face of the escarpment and towards Cape Byron, the Pacific Ocean and coastal plain (Illustration 84). They represent a landmark experience both along the proposed upgrade and along the Pacific Highway overall, contrasting with the coastal hinterland that dominates much of the Pacific Highway. Maintaining and maximising these views will therefore be important and ensure the experience of the highway in the study area remains a memorable one.

In terms of how the proposed upgrade will be perceived by local residents and visitors to the area, views from the existing highway and its visual relationship with the proposed upgrade are important factors and have been addressed by the urban and landscape design concept plan.

KEY AREAS FOR DETAIL DESIGN

In precinct 5, the key areas for further design investigation, resolution and development include:

> Tunnel and tunnel portal design

The tunnel under the St Helena ridge is prominently located in the side of the scenic escarpment and represents a major landmark. The current proposal involving major excavation of the natural hillside is not sympathetic to the significance of the scenic escarpment from an urban design and visual point of view.

Consideration should therefore be given to reviewing the tunnel design with the aim of increasing the length of the tunnel. This would significantly reduce the amount of excavation works which in turn would reduce the degree of engineering measures likely to be required to stabilise cutting faces. Refer to the "Urban Design Elements" section of this working paper for a further discussion of tunnel and tunnel portal design.

> Embankment stabilisation and revegetation

The successful stabilisation and revegetation of the large fill embankment will be important from the point of view of protecting the visual character of the prominent Ewingsdale spur, in particular its appearance when viewed from Ewingsdale and other areas to the east. The main aim of the design of the embankment would be to ensure a natural appearance of the embankment. This involves an overall shape that would blend in with the natural landform and a slope steepness that allows revegetation to the degree where it would match the established vegetation pattern of the spur over time.

Consideration should therefore be given to the angle of embankment slopes with regard to short and long term soil stability, the potential for plants to successfully establish and long term maintenance, reducing the 'artificial' character of the embankment.

> Reduce the visual impact of parallel areas of hard pavement

Reducing the amount of hard pavement visible from any one area or viewpoint will assist in reducing the potential visual impact resulting from the large concentration of parallel roadways around the Ewingsdale interchange. Planting, including planting of trees and shrubs, between the separate road and carriageways (including the proposed upgrade, the existing highway and its proposed diversion, on- and off-ramps and local access roads) should be maximised, in order to visually break up the wide area of hard pavement.

Further, road design development should seek to minimise hard paved areas as much as possible, in particular where pavement would only be required in the case of future road widening or the potential provision of additional traffic movements at intersections in the future. In shoulders, consideration should also be given to the use of alternative materials and/ or textures that reduce the width of the uniform driving surface.

On the upper sections of the spur, the existing and proposed highway would be visually separated by nature of their vertical alignments. In these areas, planting between the existing and proposed highway should remain low, in order to protect significant views from the existing highway alignment while stabilising embankments.

URBAN AND LANDSCAPE DESIGN CONCEPT PLAN AND SPECIFIC RECOMMENDATIONS

Building on the identified key areas for detail design and the strategic principles outlined in the urban and landscape design strategic concept, Illustration 84 provides a more detailed concept plan for precinct 5. It identifies a series of precinct-specific urban and landscape design measures, which have been developed in response to the urban design objectives and principles for the proposed upgrade, and to mitigate the identified visual impacts. The plan further identifies important views to be retained and protected, in order to enhance the experience of the motorist on both the existing and the upgraded highway.

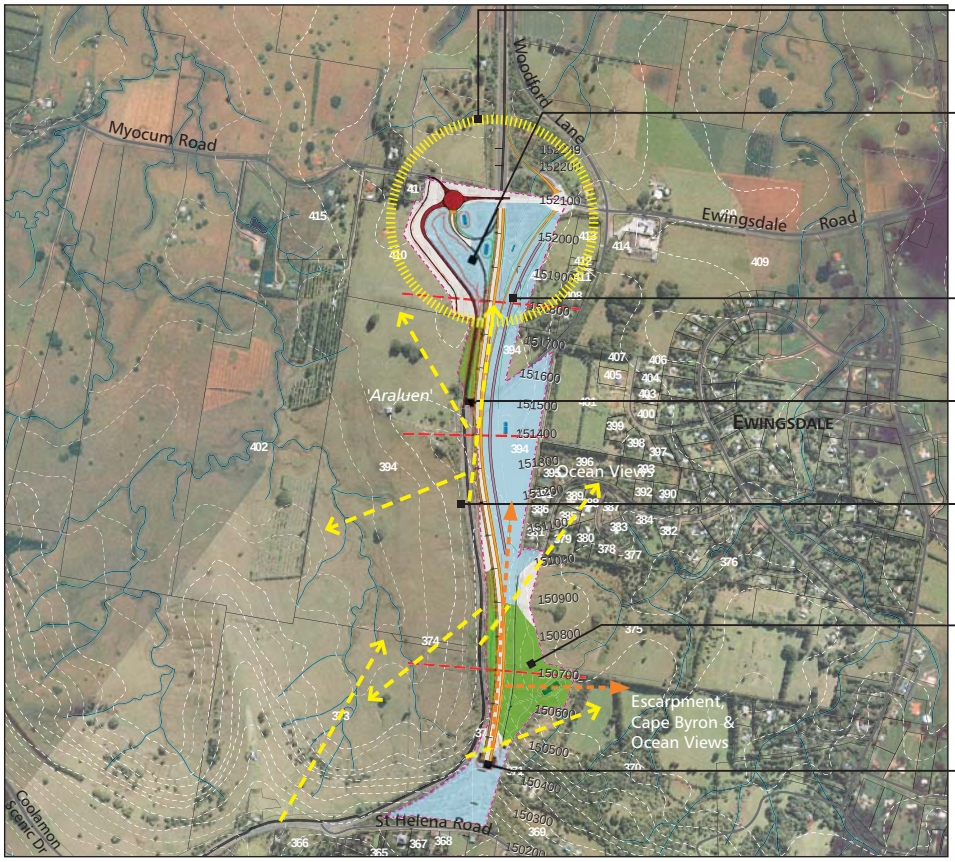
The cross sections in Illustrations 85 to 87 further demonstrate the three-dimensional urban and landscape design treatments at a number of important locations within the precinct.

Specific recommendations to mitigate the potential visual impact of the proposed upgrade and to be investigated at a detailed level in the next design stages are:

1. Maximise tree and shrub planting around the tunnel portals and above the tunnel portal cuttings to reduce the visual impact on Plantation Drive and on properties along St Helena Road (Chainage 150,300 - 150,450).
2. Complement and improve existing revegetation works on the western side of the fill embankment supporting the existing highway, to reduce the visually obvious transition between the embankment and the natural landform of the Ewingsdale spur and to soften the appearance of the embankment when seen from areas along the scenic escarpment. Design plantings to preserve views towards the escarpment from the existing highway (chainage 150,400- 151,400).
3. Provide low planting between the existing and proposed highway to stabilise embankments and to reduce the visibility of the proposed upgrade from the existing highway, while maintaining significant views from the existing highway open towards the east and north (chainage 150,450 - 151,200).
4. Densely revegetate the major fill embankment to reduce the visual impact of the artificial benched landform when seen from the east, including from Ewingsdale Road and distant viewers from Cape Byron. Limit tree planting to areas east of the realigned Plantation Drive and set out trees to ensure that views to the east from the existing highway are maintained (Chainage 150,500 - 150,950).
5. Densely plant the noise mound, including both sides of the mound, with trees, shrubs and groundcovers to reduce the visual impact of the noise barrier, to visually conceal the barrier from both residents in adjoining areas and from motorists on the existing highway and the proposed upgrade and to maintain the natural appearance of the Ewingsdale spur as much as possible, especially when seen from a distance. As much as possible, integrate the design of the noise mound with the natural landform of the Ewingsdale spur (chainage 151,050 - 152,000).
6. Maximise tree and shrub planting and embankment revegetation between the existing and the proposed highway, to visually separate the existing and proposed highway and reduce visual impact of large areas of hard pavement (Chainage 151,200 - 151,750).
7. Develop an individual planting scheme for the Ewingsdale interchange, including selective tree species to mark the arrival at the special destination of Byron Bay (chainage 151,200 - 151,750).
8. Maximise planting at the Ewingsdale interchange, including planting of trees and shrubs between on- and off-ramps and both the existing highway and the proposed upgrade, to reduce the visual impact of large areas of hard pavement and of the prominence of the interchange infrastructure when seen from the scenic escarpment and Ewingsdale spur (chainage 151,700 - 152,200).
9. Revegetate cuttings and embankments throughout the precinct, to soften and reduce their visual effect. A list of locally appropriate species is provided in Appendix 1.

* Notes:

1. All chainages are approximate.
2. "Planting" refers to the final outcome and not to any particular technique during construction: it includes both individual plantings and large-scale revegetation works.



Develop an individual planting scheme for the Ewingsdale interchange, including feature tree species to mark the arrival at the special destination of Byron Bay

Maximise planting/ revegetation works at the Ewingsdale interchange (subject to safety requirements and sight lines) to visually separate individual carriageways, reduce the impact of wide pavement areas and reduce the prominence of road infrastructure when seen from the scenic escarpment and the Ewingsdale spur.

Densely plant the noise mound, including both sides of the mound, to visually screen the barrier, and improve the visual amenity of both residents and motorists.

Maximise planting of trees, shrubs and groundcovers to visually separate the existing highway and the proposed upgrade

Complement existing revegetation works to reduce the visually obvious transition between the fill embankment supporting the existing highway and the natural landform of the Ewingsdale spur

Revegetate the major fill embankment to integrate with the natural landform and vegetation patterns of the Ewingsdale spur. Limit trees to areas east of Plantation Drive to provide views from the proposed upgrade to the east

Stabilise tunnel portal cuttings with vegetation and maximise planting to screen the portal and cutting from St Helena Road and to reinstate the vegetated character of the Ewingsdale spur

Illustration 84:
Urban and landscape design concept plan for precinct 5

Legend

- Proposed Highway upgrade: carriageways, on- and off-ramps
- New and modified local access roads
- Proposed road corridor acquisition boundary
- Property ID number
- Extent of proposed fill embankments
- Extent of proposed cuttings
- Proposed sedimentation basin
- Existing Pacific Highway alignment
- Existing local roads and driveways
- Views from the existing highway
- Views from the proposed upgrade
- Cross section location
- Proposed avenue or special purpose planting
- Planting and/or revegetation includes tree cover to complement surrounding planting patterns and provide an enclosed driving experience
- Planting and/or revegetation works with limited tree cover to allow for filtered views of the surrounding landscape
- Revegetation works limited to low planting or turfing as required to stabilise embankments and cuttings, and to allow open views into the surrounding countryside

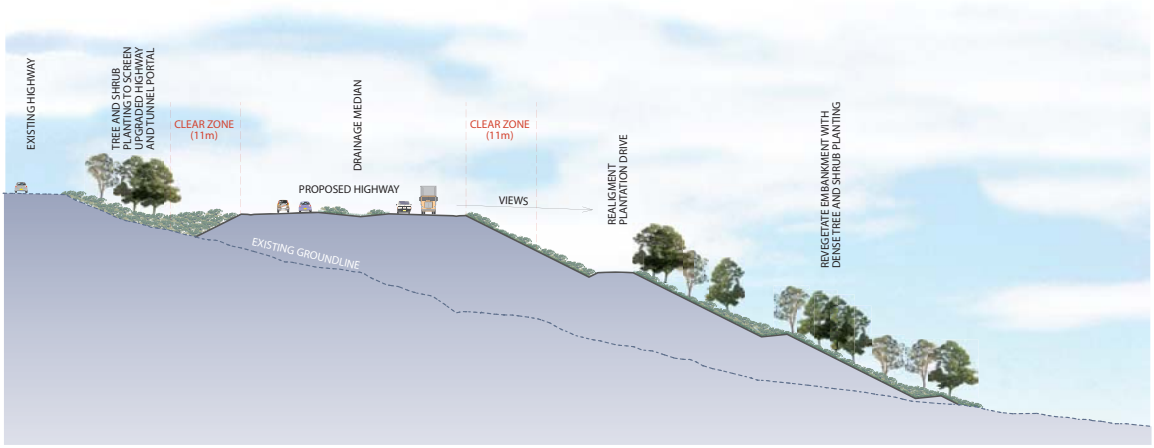


Illustration 85:
Cross section at chainage 150,700

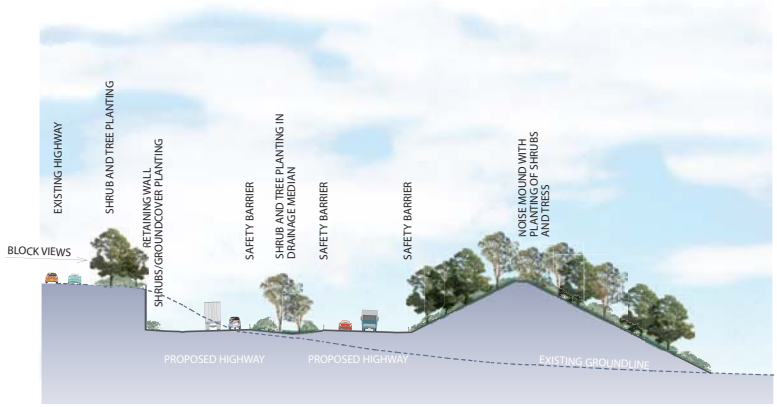


Illustration 86:
Cross section at chainage 151,400

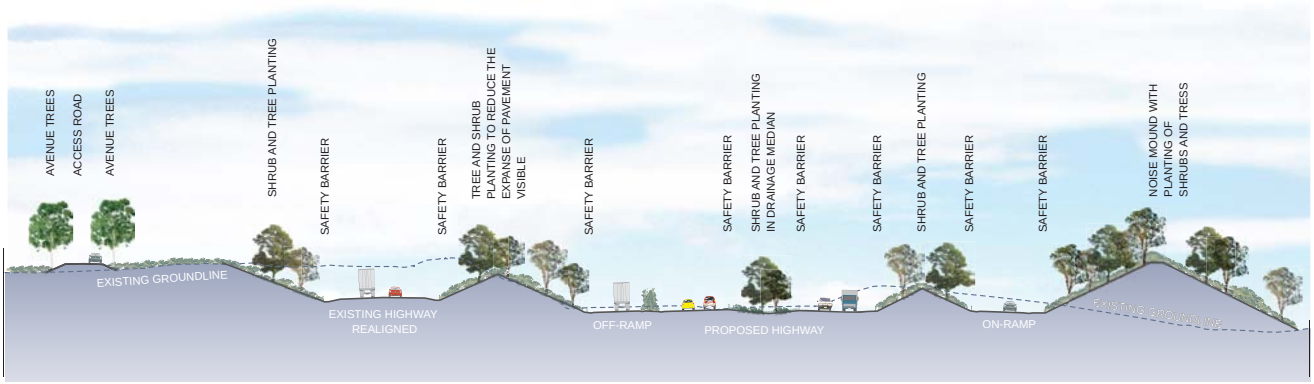


Illustration 87:
Cross section at chainage 151,800

While road infrastructure elements have been categorised according to their importance based on the visual contribution they make towards the proposed upgrade and the surrounding countryside, a key urban design objective for the Pacific Highway is the design of road infrastructure elements as a series of related elements. In the words of the '*Pacific Highway Urban Design Framework*', they "should belong to the same design family and should be considered as part of a suite of unified elements" (p. 32).

In order to achieve this objective, a series of urban design principles were developed for major road infrastructure elements, including the tunnel (portals and cuttings), the bridges, overbridges and noise walls. The design principles were developed building on the overall urban and landscape design vision, objectives and principles outlined earlier in this working paper and have taken into consideration other relevant RTA publications and design guidelines.

The following pages provide an overview of the key urban design principles for major road infrastructure elements.

BRIDGES

The proposed highway upgrade features a number of bridges spanning local roads and waterways. Specifically, they are located at 'Yarrenbool Place' (properties 89 and 92 in precinct 2), Emigrant Creek (precinct 2), Skinners Creek (precinct 3), Bangalow Road (precinct 3), Byron Creek (precincts 3 and 4) and a tributary to Tinderbox Creek (precinct 4).

With the possible exception of Bangalow Road, these bridges are generally of significant length, and a number are highly exposed to a large number of viewers. Many are associated with significant earthworks, in particular fill embankments. While this is necessary in order to meet the horizontal alignment design criteria, it will increase the visual exposure of the upgraded highway. Further, in many instances the bridge abutments are staggered, with the start and finish of north- and southbound bridge decks offset relative to one another. This has the potential to increase the visual effect of the bridge, as the offset nature of piers supporting the north- and southbound carriageways may give the impression of a larger number of piers. As a result, the bridge structure will be less transparent, appear "heavier" and more visually dominant in the landscape.

As a response to these challenges and in building on the principles outlined in the RTA's '*Bridge Aesthetics*' design guidelines, the following design principles were developed for bridges to be constructed as part of the proposed upgrade. They reflect the potential visual prominence of the bridges, as well as the need to respond to the highly scenic rural landscape along the proposed upgrade with simple, elegant and refined structures that remain subservient to the landscape setting.

> Design bridges and overbridges as a 'family' of designed structures.
  - As much as possible, employ consistent proportions between design elements in the design of all bridges and overbridges associated with the proposed upgrade.

> Design bridges as simple but elegant structures that subtly complement the surrounding rural landscape.
  - Minimise the complexity of bridges, in order for the rural landscape to remain the dominant visual feature.
  - Where possible, design the bridge with an uneven number of spans/ haunches (refer to Illustration 88). Integrate haunching with the pier design (refer to Illustrations 88, 89 and 91).
  - Use shadow lines in the short elevations to reduce the perceived thickness of piers (refer to Illustration 91).
  - Continue parapets beyond abutments in order to anchor the bridge to the surrounding landscape (refer to Illustration 92).
  - Conceal pile caps below the finished ground surface or low water line.

Illustrations 88-90:
Examples of haunching and pier design well integrated (88-89) and poorly integrated (90) (source: RTA 'Bridge Aesthetics', p 27)

> Minimise the thickness and perceived thickness of the bridge superstructure.
  - Design bridges to appear as long and thin elements in the landscape, with a high slenderness ratio (depth of superstructure to bridge span).
  - Minimise the thickness of bridge decks and use smoothly tapering haunched girders rather than single depth beams to provide an elegant bridge form that minimises the perceived thickness of the superstructure and allows the landscape setting to dominate the view (refer to Illustration 88).
  - Design girders and associated shadow lines to reduce the perceived thickness of the superstructure (refer to Illustration 88).

Illustration 91:
The thickness of the pier on this bridge has been broken up by the use of a shadow recess, reducing the perceived thickness of the pier (source: RTA 'Bridge Aesthetics', p 8)

Illustration 92:
The bridge is tied to the surrounding landscape by the parapet that continues past the abutments (source: RTA 'Bridge Aesthetics', p 26)

> Maximise the transparency of bridges.
  - Minimise the number of bridge piers by maximising the span.
  - Design bridge piers as open bridge piers with a reverse taper to eliminate the need for headstocks and to reduce the number of piles (refer to Illustration 93).
  - Maximise the transparency of the bridge substructure by providing spill through abutments (refer to Illustration 88) and by orienting bridge piers so that long elevations are parallel to the main viewing direction (refer to Illustration 94).
  - Avoid walled abutments or abutments stabilised with 'hard' materials.
  - Where possible, design bridge spans for the first span to meet the bottom of spill abutments (refer to Illustration 88).
  - Set out piers of the north- and southbound carriageways to be aligned relative to the predominant direction of viewing, to reduce the amount of piers visible and maximise transparency (refer to Illustration 94).
  - Design parapets, traffic barriers and railings as integrated structures (refer to Illustration 95) that maximise transparency and views of the landscape, assisting motorists in the recognition of landmarks along the route.
  - Use rounded bridge rails and maximise the use of rails over solid barriers, to maximise motorist views to the surrounding landscape (refer to Illustration 96).

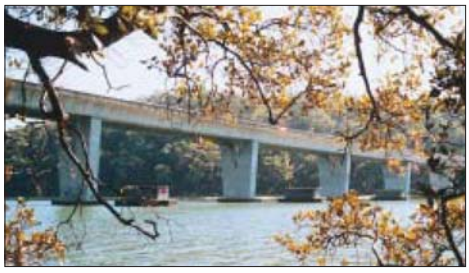


Illustration 93:
Reverse tapers on the long elevation of the Alfords Point Bridge (source: RTA 'Bridge Aesthetics', p 17)

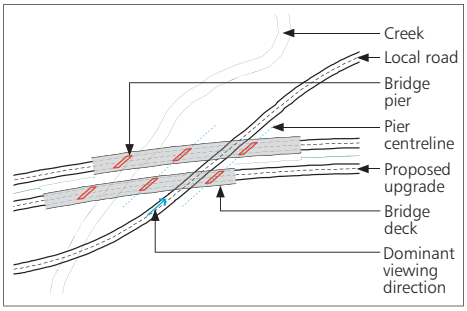


Illustration 94:
Diagram illustrating aligned bridge piers oriented with the long elevation parallel to the main viewing direction.

Illustration 95:
This design detail has successfully integrated a safety barrier and bridge parapet (source: RTA 'Bridge Aesthetics', p 43)

Illustration 96:
This transparent barrier along the F3 Freeway allows good views of the surrounding landscape. Using round instead of square sections would further reduce the perceived thickness of rails (image source: RTA)

The application of these design principles in the further design development of bridge structures should be consistent with the priority ranking assigned to the various bridges along the proposed upgrade in the urban and landscape strategic concept plan (refer to Illustration 65). Accordingly, the design of "Priority One" bridges should seek to realise a maximum number of these principles. The design of bridges of lower order priority may apply these principles less stringently, but should seek to mitigate any resulting visual impacts through other design measures, in particular in terms of the visual exposure of those bridges.

To date, design work for bridges has been limited to preliminary design investigations that would confirm that functional requirements for bridges can be achieved. This included the identification of potential span configurations for what were considered to be the two commercially most competitive options at the time:

- Option 1: pre-cast and prestressed (Super T) concrete superstructure with simply supported spans.
- Option 2: continuous variable span haunched steel trough superstructure.

Both design options featured spill through abutments and pilecaps concealed below the existing ground levels, to help reduce the visual impact.

The preliminary investigations revealed that haunched steel trough superstructures (Option 2) would allow for greater spans and would generally conform better to the urban design objectives and principles for the proposed upgrade, resulting in a more elegant structure. From an urban design and visual point of view, the adoption of this construction method (or of an alternative method that can be demonstrated to provide similar advantages and conformance to the identified design principles) would therefore be desirable for 'Priority One' bridges identified in the urban and landscape design strategic concept.

To achieve the objective of a 'family' of design structures, a consistent approach to bridge design and construction should ideally be adopted for the length of the proposed upgrade. This would offer the following advantages:

- Visual compatibility of structures along the upgrade, including compatibility and consistency of bridge span configurations.
- Less environmental disturbance during construction due to fewer piers, since the most significant environmental impact would be likely to occur during construction of the substructure.

- More elegant and structurally efficient bridges which may also prove to be economically justifiable as a result of continuity advantages, reduced material requirements and reduced substructure size.

OVERBRIDGES

> Integrate the design of overbridges with the design of bridges. As much as possible, employ consistent proportions in the design of overbridges along the route, in order to achieve a 'family of overbridges'.

> Design overbridges as simple but elegant structures that subtly complement the surrounding rural landscape.
  - Minimise the complexity of bridges, in order for the rural landscape to remain the dominant visual feature.
  - Where possible, design the bridges to feature a single haunched span over the upgraded highway.
  - If piers are required, design pier locations and bridge spans to achieve a symmetric overbridge design, relative to the upgraded highway/ median centreline and locate piers to meet the bottom of spill abutments (refer to Illustrations 97 and 98).
  - If piers are required, integrate haunching with the pier design to eliminate the need for headstocks (refer to Illustrations 89 and 91). Conceal pile caps below the finished ground surface.
  - Continue parapets/ bridge barriers and safety screens beyond the abutments in order to anchor the bridge to the surrounding landscape (refer to Illustration 92).
  - Design the underside of girders as simple smooth structures, consistent with the high degree of exposure to viewing by motorists on the upgraded highway.

> Minimise the thickness and perceived thickness of the bridge superstructure.
  - Design bridges to appear as long and thin elements in the landscape, with a high slenderness (depth of superstructure to bridge span) ratio.
  - Minimise the thickness of bridge decks and use smoothly tapering haunched girders rather than single depth beams to provide an elegant bridge form that minimises the perceived thickness of the superstructure and allows the landscape setting to dominate the view (refer to Illustration 88).
  - Design girders and associated shadow lines to reduce the perceived thickness of the superstructure (refer to Illustration 88).
  - Design bridge/ pedestrian barriers and safety/ throw screens as integrated structures (refer to Illustration 98) that minimise the perceived thickness of the superstructure and maximise transparency and views.

> Maximise the transparency of overbridges.
  - Maximise the transparency of the bridge substructure by providing spill through abutments (refer to Illustrations 97 and 98).
  - Avoid walled abutments or abutments stabilised with 'hard' materials.
  - Use rounded bridge rails and maximise the number of rails over solid barriers, to maximise views of the scenic landscape (refer to Illustration 96).

Illustrations 97 and 98:
Two examples of overbridges on the Pacific Highway with symmetrical pier layout and piers meeting the bottom of spill abutments, resulting in good transparency of the structure.

Illustration 99:
An example of an integrated barrier and safety/ throw screen design near Shell Corner, on the Great Western Highway.

TUNNELS AND TUNNEL PORTALS

The proposed highway upgrade features a tunnel under the St Helena ridge. As a significant engineering structure located in the side of the scenic escarpment, the tunnel will be a prominent new element, contrasting strongly with the rural landscape of the study area.

From the motorists point of view, the tunnel will represent a major landmark along the route, with tunnels generally being a rare feature along the Pacific Highway.

The design of the tunnel, the tunnel approaches and tunnel portals, as well as any other associated engineering works such as cuttings or retaining walls, will therefore play an important role in how the upgraded highway is perceived, both by viewers in surrounding areas and by motorists using the upgraded highway.

The current tunnel and tunnel portal design includes a relatively short tunnel, based on fire and other safety considerations and associated costs. As a result of this, major cuttings are required at both tunnel entrances, effectively excavating the hillside in order to accommodate the desired tunnel length. The current concept design proposes steep cutting faces, stepping through a series of benches to facilitate maintenance access. As discussed in the "Visual Assessment" section of this working paper, the potential visual effect, and associated visual impact, of these cuttings would potentially be moderate to high.

The following design principles were identified in order to reduce the potential visual impact associated with cuttings and tunnel portals:

- Use local materials (such as rock excavated from tunnels) to build retaining structures or to stabilise cutting faces and design cutting faces to avoid the use of shotcrete in both the short and long term, where possible (refer to Illustrations 100 and 101).
- Where geotechnical conditions indicate poor slope stability or limited potential for successful revegetation, stabilise cutting faces through the use of retaining walls, gabions or other 'hard' structures which avoid the use of shotcrete.
- Design the portal headwalls, portal openings, retaining walls and safety barriers leading up to the portal as an integrated series of elements (refer to Illustration 100).
- Design cuttings and benching to maximise the potential for cutting revegetation and visual "softening" of the portals.

From a visual amenity and urban and landscape design point of view, the further development of the concept design should include a review of the tunnel and portal design, in order to achieve a final outcome which would be visually better integrated into the surrounding landscape, reflecting the importance of the tunnel's landmark status, its landmark location in the side of the escarpment with its recognised scenic values and its high level of visual exposure. In addition to the above principles, the review or refinement of the tunnel during future design stages should consider the following:

- Minimise the amount of cut around tunnel portals by extending the tunnel length to correspond to the natural shape of the ridge line (refer to Illustration 102).
- Design the north- and southbound tunnels to be independent in length to correspond to the natural shape of the hillside.
- Design tunnel portals to follow the shape of the natural hillside (refer to Illustrations 102 and 103).

Illustration 100:
The Laerda tunnel in Norway is a good example of an integrated design of the tunnel portal, safety barriers, cuttings and retaining structures that is sympathetic to the surrounding landscape. A similar approach may be suitable for the prominent southern tunnel portal on the Ewingsdale spur.

Illustration 101:
Detail of the simple but refined suite of materials used around the portal of the Laerda tunnel. The smooth concrete tunnel creates an attractive contrast with the head wall made from local rock material.

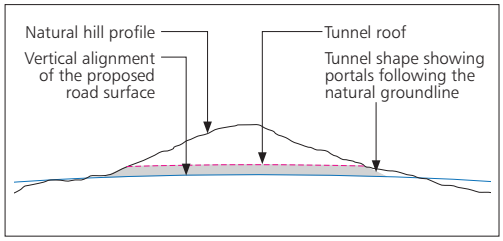


Illustration 102:
Tunnel length and portal shape designed to correspond to the natural land form.

Illustration 103:
Example of a tunnel portal shaped to correspond to the natural hill slope.

NOISE BARRIERS

Noise barriers are likely to be required in a number of locations along the upgraded highway. These are:

- at Newrybar, between Newrybar Public School and the proposed upgrade (precinct 2).
- between the proposed upgrade and residential development in Clover Hill, near Bangalow (precinct 3).
- at Ewingsdale, between the proposed upgrade and established residential areas, replacing the current noise wall along the existing highway (precinct 5).

As the design of noise barriers has the potential to influence the visual character of the upgraded highway, both when seen by motorists and by viewers from surrounding areas, the design of noise barriers is an important urban and landscape design consideration. In particular design resolution of noise barriers and the degree of integration with other landscape design measures, will have an influence on the perception of the visual effect and visual impact associated with the structures.

Guidance on the design of noise barriers is provided by the RTA's *Pacific Highway Urban Design Framework* and by its '*Noise Wall Design Guideline*'. Building on these, this working paper makes recommendations on the design of noise barriers, with regard to the aesthetics of the structures. Functional design (i.e. noise mitigation) considerations are dealt with in a separate specialist working paper.

In general, noise barriers are most commonly associated with major roads which run through highly developed urban or suburban areas. They are therefore likely to be perceived as unusual and visually uncharacteristic objects within the scenic rural landscape of the study area. The main aim of noise barrier design would be the reduction of the degree of visibility of noise barriers in general, and of structures made from 'hard' engineering elements such as walls, giving preference to landscape solutions such as vegetated acoustic earth mounds.

Based on the concept work completed to date, this would be able to be achieved for the noise barriers at Newrybar Public School and at Ewingsdale. On the visually widely exposed Ewingsdale spur in particular a landscape solution would be the preferred outcome, in order for the landscape to remain the dominant visual feature.

The same general principle would apply to the noise barrier at 'Clover Hill', and should be considered during the next design stages. However the likely height required in order for the

noise barrier to be effective, in particular near the Bangalow interchange, might make a landscape mound impractical. This is because of the large footprint that would result from the construction of a mound to achieve the necessary height, and the associated amount of clearing of established vegetation along the existing highway which currently provides a visual buffer. Depending on the ultimate height required, a vertical noise wall might therefore be the preferred solution, due to the smaller landtake associated with the structure. Dense vegetated screening should be provided to both sides of such a structure to reduce its impact on the rural countryside and to provide visual amenity to both residents and motorists.

The development of designs for noise barriers along the proposed upgrade should incorporate the following design principles which have been formulated building on the *Pacific Highway Urban Design Framework* and the RTA's '*Noise Wall Design Guideline*':

> Design noise walls to remain subservient to and integrate with the natural landscape.
  - Design noise walls as simple structures that remain subservient to the overall landscape experience.
  - Design noise walls as plain structures composed of a minimum number of materials and of dark colours that recede into the landscape.
  - Use landscape planting before and behind noise barriers to soften the visual appearance of the barrier and to allow the landscape to remain the dominant visual element.
  - Design the start of noise walls to integrate with any safety barriers that may be required or use earth mounding/ sculpting to tie noise barriers into the surrounding landscape.
  - Where noise barriers adjoining cuttings, integrate the design of the noise barriers with the design and treatment of cutting faces.
  - Consider the use of partially transparent wall panels to reduce overshadowing where walls are in close proximity to residential development (such as in Bangalow) and to maximise the motorists views of the surrounding landscape.
  - As much as possible, design the top of noise walls to provide a consistent form parallel to the road surface.
  - Where stepping of wall panels is required, design steps to create a regular rhythm and to align the horizontal joints of separate wall panels (where applicable).

> Reduce the perceived height of noise barriers.
  - Where possible (depending on land form and available road corridor width), use a combination of earth mounding and low barriers/ walling that reduces the height of wall structures.
  - Where particularly tall structures may be required and there is little or no potential for screening/ planting, consider visually breaking up the height of walls by a mix of solid and transparent horizontal wall panel layers.

In addition to these considerations, maintenance and access issues also pose important considerations in the design of noise barriers. These include the need for maintenance and maintenance access, the potential for graffiti and vandalism, and the creation of areas with poor passive surveillance which might inadvertently 'encourage' these and other anti-social activities, including the potential to break into properties adjoining noise barriers.

UNDERPASSES

Underpasses would be required in a number of locations within the study area, to facilitate local traffic movements and access across the upgraded highway. Underpasses would feature in precinct one, connecting the new local access road to the existing highway alignment between Carney Place and Martins Lane, in precinct two as a key component of the Ivy Lane interchange and in Watsons Lane, and in precinct three, where a private underpass would link the two portions of the severed property 198 ('Arundel').

Extending for the full width of the upgraded Highway and associated fill embankments, the length of these underpasses would be significant, ranging from about 50 metres at Watsons Lane to about 70 metres at the Ivy Lane interchange and in precinct one. As such they would be major structures and would have the potential to influence the landscape experience and perception of travellers along these routes. In this regard, the underpass at the Ivy Lane interchange will be of particular importance, as the interchange represents a major arrival point on the elevated plateau, providing a first impression for the motorist. The underpass in precinct one would also be of importance, providing the gateway to a number of properties on the western side of the proposed upgrade.

In this context, it will be important to resolve the design of underpasses to contribute to a positive experience of the overall landscape. The main urban design considerations will be:

> Maximise light access and visibility in underpasses.
  - Maximise natural light penetration.
  - Investigate the potential for the installation of light wells in the medians of the proposed upgrade above.
  - Provide artificial lighting to maximise visibility, ensure road safety and deter antisocial activities.
  - Use light wall colours and consider the use of Vitri panel cladding or similar to improve visibility.

> Allow adequate space for pedestrian and cycle access.

> Use materials which are either unsuitable for or resistant to graffiti and vandalism.

> Integrate the design of headwalls/ underpass entrances to complement the landscape.
  - Design underpass entrances to complement the landform of fill embankments.
  - Integrate the design of headwalls with the design of tunnel portals and headwalls to achieve a consistent family of urban design elements associated with the proposed upgrade.

SAFETY BARRIERS

For safety reasons, white wire-rope safety barriers have been adopted as the standard barrier type along the Pacific Highway. In order to achieve consistency with other upgrade projects, they should also be adopted along the proposed upgrade. If further investigations consider white unsuitable (for reasons such as frequent fog for example), black wire-rope safety barriers would be the preferred type of barrier. This is due to the transparent nature of the structure and the way black colours tend to recede into the surrounding context, rendering the barriers less noticeable and allowing the landscape to be the dominant visual element in turn.

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appendix 1

APPENDIX 1 - SPECIES LIST

The following species list was provided by Biosis Research, the consultant undertaking the ecological assessment of and recommendations for the proposed upgrade of the Pacific Highway between Tintenbar and Ewingsdale.

The species in the list reflect the specific local character of the study area and these species should be used as much as possible in order to visually tie the proposed upgrade to the surrounding landscape, especially in highly visual areas and where feature planting is required. The list may need to be complemented by species that have proven successful on similar, large scale highway revegetation projects.

PLANTS SUITABLE FOR ROAD VERGES

Trees

Acacia bakeri
Archontophoenix cunninghamiana
Araucaria cunninghamii
Alphitonia excelsa
Alphitonia petrei
Aphananthe philippinensis
Brachychiton acerifolius
Commersonia bartramia
Diploglottis cunninghamii
Ehretia acuminata
Elaeocarpus grandis
Euroschinus falcata
Ficus coronata
Flindersia bennettiana
Flindersia schottiana
Jagera pseudorhus
Macadamia tetraphylla
Mallotus discolor
Mallotus philippensis
Polyscias elegans
Polyscias murrayi
Schizomeria ovata
Sterculia quadrifida
Toona ciliata
Tristaniopsis laurina

Small Trees

Acacia irrorata
Acacia melanoxylon
Acmena smithii
Acronychia oblongifolia
Alchornea ilicifolia
Cassine australis
Claoxylon australe
Clerodendrum floribundum
Clerodendrum tomentosum
Cupaniopsis anacardioides
Cyclophyllum longipetalum
Drypetes deplanchei
Duboisia myoporoides
Elaeocarpus reticulatus
Elaeodendron australe
Ficus fraseri
Glochidion ferdinandi
Glochidion sumatranum
Guioa semiglauca
Hymenosporum flavum
Lenwebbia prominens
Melia azederach
Melicope elleryana
Pararchidendron pruinosum
Pittosporum multiflorum
Rapanea spp.
Rhodamnia rubescens
Scolopia braunii
Streblus brunonianus
Synoum glandulosum
Syzygium spp
Trema tomentosa

Shrubs

Alpinia caerulea
Breynia oblongifolia
Choricarpia leptopetala
Jasminum volubile
Maclura cochinchinensis

Groundcovers

Adiantum formosum
Dianella spp.
Doodia aspera
Doodia caudata
Hibbertia scandens
Pellaea falcata
Peperomia tetraphylla
Pollia crispata
Pteris umbrosa

Shrubs

Breynia oblongifolia
Jasminum volubile
Maclura cochinchinensis
Pittosporum multiflorum

Groundcovers

Dianella spp.
Hibbertia scandens
Lomandra longifolia

PLANTS SUITABLE FOR ROAD MEDIANS

Small Trees

Acacia irrorata
Acacia melanoxylon
Cupaniopsis anacardioides
Glochidion ferdinandi
Guioa semiglauca
Lenwebbia prominens
Melicope elleryana
Pararchidendron pruinosum
Pittosporum revolutum
Rapanea spp.
Scolopia braunii
Streblus brunonianus
Synoum glandulosum
Syzygium spp