4. HIGHWAY OUTCOMES

4. HIGHWAY OUTCOMES

DESIGN STATEMENT

The design of the motorway through the Moir Hill and Hīkauae sector presents some challenges to the achievement of the design principles set out in the ULDF. The landscape for much of the sector is characterised by steep terrain, with little natural or aesthetic value, whereas the southern and northern ends of the sector offer opportunities for the design to reflect and enhance. The design for this sector balances the sector specific features within the 'whole' motorway design features (barriers, signs etc.).

In general, the motorway has tried to hug the natural landform with a low vertical alignment in most places, minimising environmental impacts where possible, and as a result, impacts on the view of residents. As a consequence of the steep terrain through the centre of this sector, there are a number of places where the motorway must cut through a hill or fill in a gully. In part, the vertical alignment is dictated by the safety and design requirements for motorways (i.e. gradients, average speeds). This means there will be some dramatic rock cuts faces through this sector. The design treatment of rock cuts is somewhat dictated by geological conditions on site and final design will be determined by natural features in the rock. The preference is to maintain as-steep-as-possible, and avoid benching (stepping the slopes) in favour of slopes. The consistency and cohesion within this sector, and between the rest of the sectors leans heavily on the form and positioning of highway elements. The wire median barriers create a sense of continuity, being the dominant barrier type used along the motorway, with occasional breaks to respond to motorway structures. There are no gantries or lights in this sector and all stream crossings are via fill embankments, reducing large structures in the skyline, in an effort to maintain rural character for nearby residents and maintain the dark night sky. Low drainage features will sit flush with the road. The design supports a minimalistic road-scape.

The centrepiece of this sector will be Te Tapuwae o Kahumatamomoe, which is an effective highpoint of the motorway. This will be a feature that road users will use to mark their progress along Ara Tūhono. Following the minimalistic aesthetic, the bridge has been architecturally designed with minimal detailing. It will be slender in appearance with a single long span and elegant arc on the underside. The colour palette will be neutral grey, consistent with the other highway elements which are predominantly black, grey and white.

The cultural significance of the ridgeline route will likely be reflected in the naming of the bridge, as well as motifs or patterning on the bridge's external facing panels, aligning urban design and cultural outcomes.

The northern and southern ends of this sector provide the greatest opportunity for maximum ULDF outcomes for both urban and landscape design elements. At both ends the alignment is low and earth embankments have been chosen as the preferred design solution. For residents and those viewing the highway, this design will serve to 'anchor' the road, helping it merge with the surrounding landscape, with the objective to appear understated and unassuming.

Overall, this sector has been designed to reflect the aspirations sought in the ULDF. The architectural language employed is one of simplicity, using very clear and clean lines. The detailing, shaping and materiality of the motorway and bridge has been designed and selected on the basis of creating a crisp and simple motorway.

Example of a trailing end terminal along the Southern Motorway[1]

4.1 BARRIERS

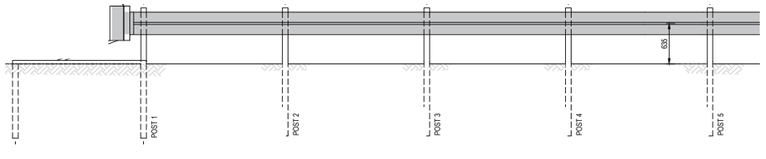
Project-wide Barrier Systems

The ULDF sets out the guidance in the use of a standardised layout of continuous wire rope barriers in order to achieve clean lines and a refined, minimalistic aesthetic. The exception being the provision of gaps in the barrier for maintenance access, emergency services and emergency stopping.

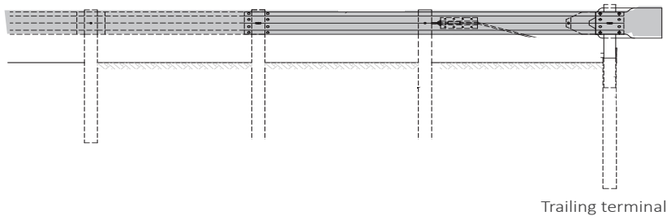
Median and side barriers will usually be wire rope, which is the first preference expressed in the ULDF and consistent with parts of the Northern Gateway Toll Road [ULDF section 4.3]. Road side barriers offer additional protection of structures or utilities adjacent to the motorway. Where there is a transition from wire rope to concrete barrier, such as on the end of a bridge, the changeover will be smooth and cohesive, with the wire rising to meet the height of the concrete barrier to provide a seamless line for the eye to follow. In order to create a clean aesthetic, signs and other fixtures have been designed to avoid the need for individual protective barriers for separate pieces of such 'furniture', instead these are placed outside the road barrier [D36(a)][D37].

The median and road side barriers have been designed together in this area to provide a clean, continuous line following the length of the motorway route to align with the ULDF outcomes. The consistent surface treatment and minimalist detail of the barrier gives effect to the uncluttered highway outcome [ULDF section 3.1, 4.4] and is also consistent with the adjoining motorway directly to the south (the Northern Gateway Toll Road)[D36(a)].

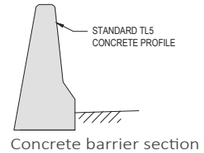
Audio tactile profiled markings (rumble strips) will be installed to alert drivers when vehicles begin to stray from lanes. This method is used to increase safety for road users. These will be visually indiscernible in blending in with the white lane markings.



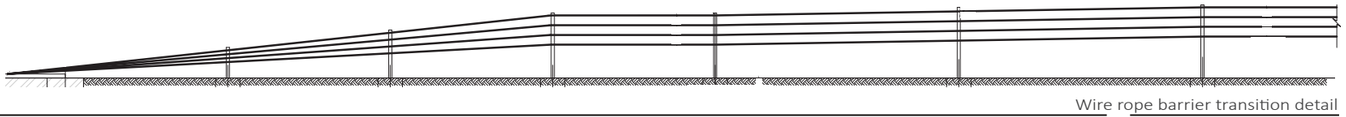
Leading terminal



Trailing terminal



Concrete barrier section



Wire rope barrier transition detail

Similar wire rope barriers along the road sides and medians will be used[2]

Medians

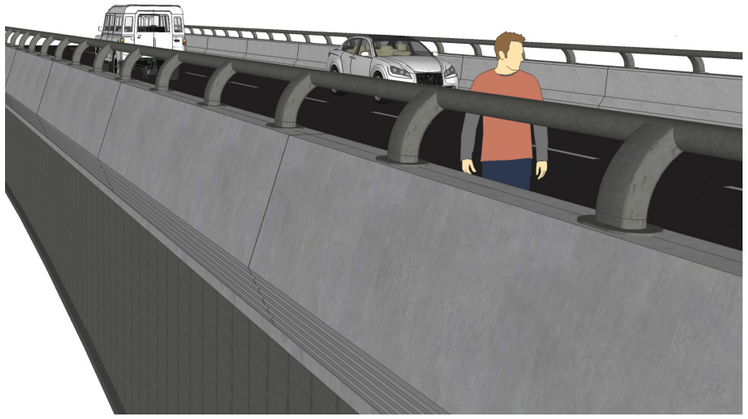
The median barrier will be wire rope held by galvanised steel posts, and the median area will be fully paved (not planted or grassed). The surface treatment will be consistent from road shoulder to shoulder, supporting a minimalistic and unobtrusive appearance that draws users attention to other urban design and landscape elements within the footprint of the motorway. Barriers perform best when located on a hard surface with consistent grading; the design provides a median width of 4-6m to reduce the likelihood of vehicle strikes. The paved median complies with the NZTA's Safe Systems approach and TM-2503 "Guidelines for Edge Protection and Medians on Dual Carriageway Roads, incorporating a Safe System Philosophy" [ULDF section 4, 4.4].

NZTA landscaping guidelines state; "avoid designs, such as narrow central grassed medians which require the closure of active traffic lanes to be mown and maintained." The paved central median, whilst not a ULDF preference, does achieve other ULDF outcomes, contributing to an uncluttered highway, a clean road scape and continuous unbroken surfaces [ULDF 4.3, 4.4, 4.13].

Benefits from the use of a paved median include:

- Less need for maintenance activities in the median, which also results in fewer lane closures for maintenance activities
- A safe road for users and maintenance workers
- Avoids issues of plant survival in engineered ground
- Paved medians (unlike grassed medians) are less likely to be prone to water-infiltration of the pavement
- Avoidance of weeds (and the need for spraying) – See also section 4.14 for further details on weed management

[1]Google Maps Street View @ 2015 [2]Google Maps Street View @ 2014



Te Tapuwae o Kahumatamomoe, bridge perspective with typical barrier

Night sky long exposure at Mahurangi West [2]

Example of a cantilevered sign gantry[1]

As well as the medians, The interface between the paved roadside median area and swale has been designed to minimise weed growth, by limiting areas where weeds might establish by the introduction of hard, engineered surfaces (See also section 4.12 and 4.14).

Bridge Barriers

The barrier form used on bridges along the alignment. Te Tapuwae o Kahumatamomoe utilises a steel top rail to reduce the height of the concrete portion of barrier and provide for wide, elevated views from the bridge for pedestrians and vehicles as well as supporting its 'light' and open appearance. The gap between the top of the concrete and the steel top rail provides a more transparent barrier form, giving the road user an optimised view from the bridge compared to the traditional 1100mm high concrete barrier [ULDF Section 4.3][D37(aa)].

4.2 BRIDGES

The Te Tapuwae o Kahumatamomoe is the only road bridge in this sector and is the only local road crossing above the motorway carriageway, which is located near the highest point of the route. The bridge traverses the motorway approximately 20m above the carriageway. The ULDF and aesthetic considerations have governed the bridge design. The bridge design uses four steel girders instead of three to minimise the depth of the bridge and provide an attractive arch shape which will be visible from the motorway below [D36(a)]. As the bridge is located within a high cut, this reduces the visual impact of the bridge from Moir Hill Road and the Moirs Hill Walkway. Furthermore, the slender bridge deck, long span, clean lines, refined and minimalist details, simple structural junctions and an elegant arc on the underside produce an aesthetically pleasing appearance where a bridge is considered necessary to connect Moir Hill Road[D37].

The bridge in this sector will be neutral grey in colour and have been similarly designed to create a cohesive and clean aesthetic. Te Tapuwae o Kahumatamomoe is addressed in detail in Section 5.4 [ULDF 4.1].

4.3 NAMING

The Transport Agency and Hōkai Nuku have worked in collaboration to name the highway features (e.g. viaducts and bridges). Moir Hill Road connectivity is maintained through a bridge over the motorway, this is to be named Te Tapuwae o Kahumatamomoe (route of Kahumatamomoe from east to west coasts). Discussions are underway with the Transport Agency and Hōkai Nuku, as to how the naming will be incorporated into the design of the bridge.

4.4 LIGHTS

This stretch of the motorway will not require lighting for operational or safety reasons, therefore retaining the natural and rural character of the area, as well as providing a naturalised night flight environment for bats, birds and other flora and fauna. The "dark night sky" as described in the ULDF will be achieved as a result [D75] [ULDF section 4.7].

4.5 NOISE MITIGATION

The predominant pavement surface type for the motorway is to be 'Open Graded Porous Asphalt' [ULDF section 4.11]. This type of surfacing treatment dampens road noise, therefore reducing tyre noise emitted from motorway traffic. Noise standards in the designation conditions will be met by the Project [D36(a)] [D71] [ULDF section 4.5].

Noise modelling has been provisionally undertaken for this section of the alignment. There have been no instances identified where permanent noise mitigation is required.

4.6 POLES AND GANTRIES

Highway furniture, which includes poles and gantries, is made up of different forms and shapes which fulfill different functions and have been designed to be part of a coherent family. The furniture is consistent with other NZTA roads and the ability to alter their form is limited by design standards.

At intermittent distances, there will be closed circuit television cameras (CCTV), which have been configured to cover the length of the sector, two cantilevered sign gantries marking the crawler lanes, and approximately 17 road signs (refer page 25). Other infrastructure utilities that road users can expect to see will include cameras, gates for some access tracks, roadside cabinets to house service equipment, and emergency telephones.

Poles and gantries are consistently set back from the road; their spatial arrangement has been guided by the 'Safe Systems Approach' to facilitate safety for road users and simpler maintenance [ULDF section 4]. All road signs will be consistently aligned behind the wire rope barrier. The galvanised steel poles that hold the wire rope will be consistently spaced a minimum of 3m apart and set back 3.1m from the outside edge of the traffic lane. Sign poles, CCTV camera poles and gantries will be setback a minimum of 1.54m behind the wire rope barrier.

Design has influenced the look and feel of the furniture through the use of the similar finishings, such as a uniform grey colour, the use of tubular steel material, and set back from the road. Sign poles and gantries are outside the wire rope deflection zone to prevent the need for further safety barriers or measures that would clutter the clean line aesthetic of the motorway.

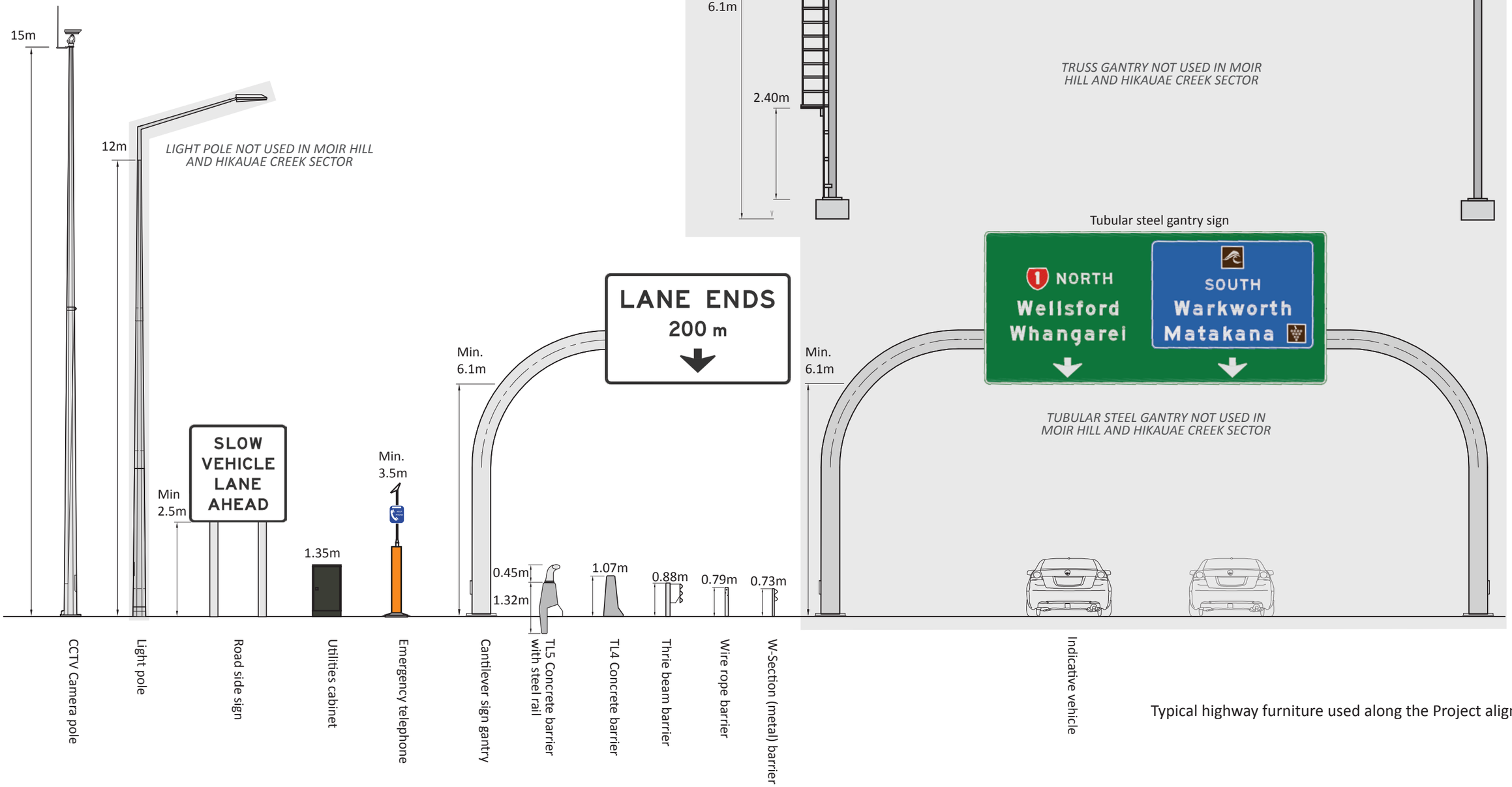
The minimisation of poles and gantries and standard appearance of all highway furniture will reduce visual motorway clutter, maintain clean lines, and contribute towards a 'clean, uncluttered highway' [ULDF section 3.1, 4.6].

[1]Google Maps Street View @ 2015 [2]Mahurangi West Wing Luxury Bed & Breakfast

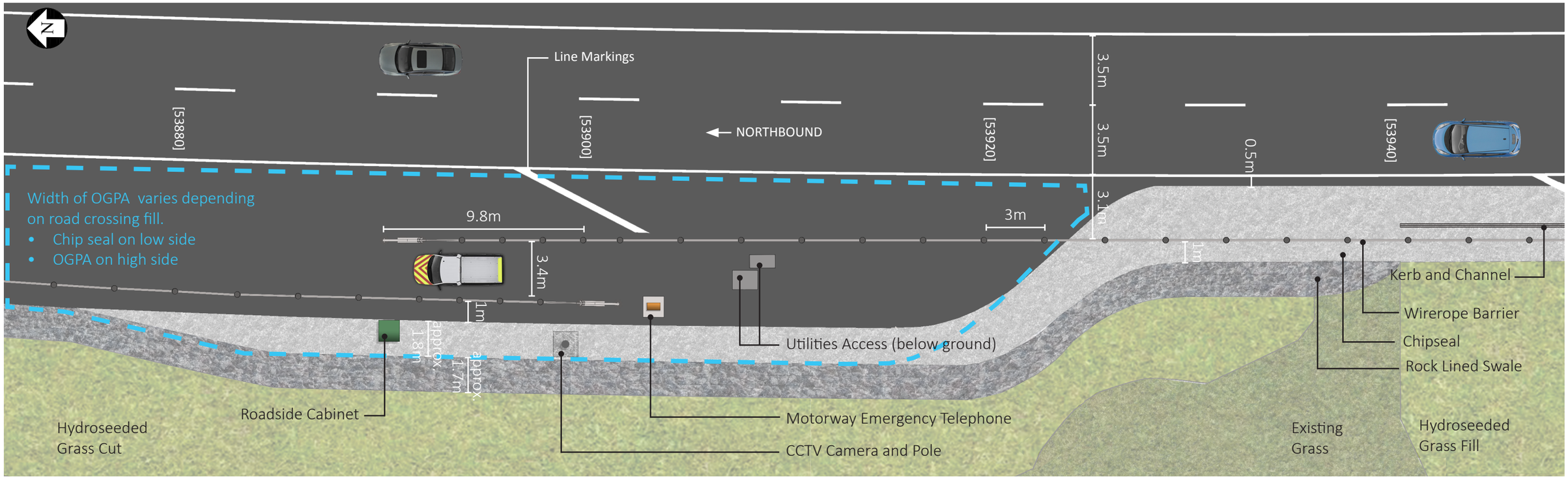
Suite of highway furniture

In this sector, there is a range of highway furniture. All road signs will be consistently aligned behind the wire rope barrier. CCTV camera poles and utilities cabinets are predominantly located in maintenance bays; other signage will be roadside.

The cohesion of the furniture is achieved through consistent use of materials and colours. The image below demonstrates the set of furniture used along the length of the motorway.

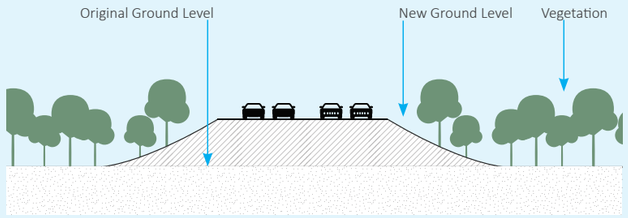


Typical highway furniture used along the Project alignment

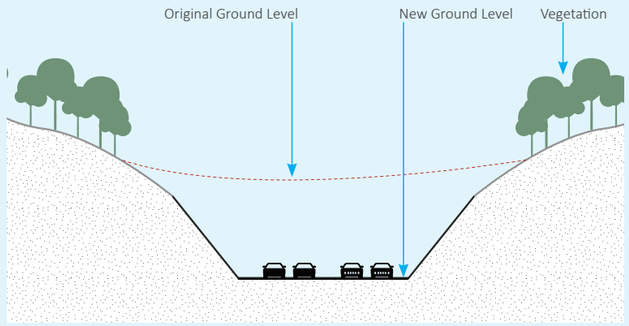


Typical maintenance bay details demonstrating the spatial relationship between highway furniture

Highway furniture element	Approximate Numbers
CCTV camera pole	11 poles
Road side sign	Approximately 17 signs (excluding signs for emergency stopping areas)
Cantilever gantry	2 gantries near Te Tapuwae o Kahumatamomoe
Concrete Barrier	Bridge barriers on the bridge that connects Moir Hill Road to Te Tapuwae o Kahumatamomoe
Wire rope barrier	Entire road alignment
Metal Barrier	2 lengths, either side of motorway, approximately at chainage 52300



Typical Cross Section of a Fill

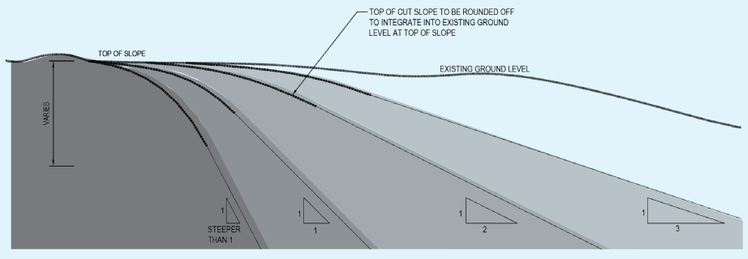


Typical Cross Section of a Cut

4.7 CUT AND FILL BATTERS

Cut and fill areas are required to level the motorway alignment and marry it with the existing ground level.

These cuts and fills result in a significant modification to the landform and slopes may need to change on site to respond to variation in rock location and bedding. Cuts are likely to be prominent through the sector, and contouring will be used to create a naturalised appearance as shown in the image below. The landscape treatments of these cuts will stitch these areas with the surrounding landscape, focussing ecological enhancements with adjacent areas of high value. A large proportion of this sector however, employs hydro-seeded grass, stitching with the adjacent farmland and forestry [D36(a)] [D37] [ULDF section 4.8].



Naturalised cut and fill batter slope angles

4.8 HIGH CUT BATTERS

Rock cut batters

Where there are steep rock cuts (such as where Te Tapuwae o Kahumatamomoe passes overhead), the rock will be left exposed to showcase the geology as a key feature of the journey, to create a minimalist and natural aesthetic [ULDF section 4.8 and 4.9].

A fixed drapery wire mesh will be used on the rock face to contain loose and falling debris. The mesh will allow the underlying rock to be visible and will have a uniform 'finish' height of 4.7m above the carriageway so as to not be in the direct line of site of road users and provide motorists with a consistent, uncluttered line. The only places


Cut slopes on the Northern Gateway Toll Road which are similar in nature to what will occur[1]

where this may vary will be where geotechnical conditions dictate the mesh to 'fall' further down the slope. To provide mesh transparency, the mesh will have uniform sized 'holes' it will be grey in colour, consistent with the underlying grey rock colour (note, the rock is expected to be a blue-grey at time of construction and will weather to a lighter grey colour – the mesh is also expected to 'weather' and fade to a slightly lighter grey colour). This is considered to be a good outcome where the rock face is not disguised. The mesh immediately below the Te Tapuwae o Kahumatamomoe will be secured with a uniform pattern on rock bolts. To the north and south of the bridge, the mesh will be draped across the rock face and only secured where required. The mesh will be suspended from a series of steel anchorages and wire ropes at the crest of the rock cut. The anchorages and rope is unlikely to be visible to road users due to its height above the carriageway.

Where poor quality rock is encountered during construction, additional stabilisation measures for rock faces may be necessary. Stabilisation is utilised to help prevent the risk of rock failure or rock fall onto the road, minimising the risk of road closure and injury to road users. The extent and type of stabilisation measures utilised will be determined on a case by case basis, using an "observational approach" for the specific design of the rock cuttings. Design evaluation processes will be used to determine which treatment from a toolbox of options are used. The tool to be used depends on a number of factors (geological conditions, durability, location, cost). The treatment options are as follows; (1) flattening the slope (to reduce failure risk), (2) wire mesh (similar to drapery mesh) which allows the underlying rock to be visible, (3) rock-bolts, or (4) spray on concrete (shotcrete). Shotcrete is the least favoured treatment option, both in terms of construction preference and in terms of the ULDF outcomes. If it is needed, it will be used sparingly and only where deemed necessary. If required, the shotcrete will be coloured to blend in with the surrounding rock [ULDF section 4.9, 4.11] [D36(a)] [D37].

Landscaped batters

High cut batters comprising stabilised soil embankments will be matched to the adjacent landscape as shown in Section 7.

As far as practical, where the highest point of the cut batter meets the natural landform the tops of the batters will be rounded and hydro-seeded with grass to soften and tie back into the landscape contours or planted dependent on the adjacent land uses, where the view from residential properties will be considered. The contours of these areas are to be naturalised to tie them into the natural landform [D36(a)] [D37] [ULDF section 4.8 and 4.9].


Wire mesh example[2]

4.9 HIGH FILL BATTERS

Areas of high fill batters will be of a constant slope with little variation and will be steeped where possible (1V:2H in most places) in order to minimise encroachment into existing riparian, indigenous vegetation areas and waterways, as required by the ULDF [section 4.8, 4.9 and 4.11]. Landscape intervention in the fill areas takes a minimalist approach and will include hydro-seeded grass and low flammability plant mixes. Refer to cross sections in Section 4.14 for detailed examples of cut and fill batters (not representative of any one place) [D36(a)] [D37].

Along Ara Tūhono, the majority of fill batters in close proximity to stream courses will be replanted as guided by the ULDF [section 4.11]. A key philosophy driving the design of Ara Tūhono has been to focus on landscape, ecology and mitigation responses and treatments on areas throughout the alignment where the investment offers the greatest opportunity for benefit. The ULDF promotes the replanting of all fill batters that coincide with stream courses [ULDF 4.11], which is in contrast to the design approach. The middle of this sector is characterised by pine plantation forestry, as such it has a lower visual amenity and ecological value than other parts of the sector. A number of culverted slopes in this sector have not been planted with vegetation, but have been hydro-seeded with grass. The most significant of these is at Chainage 54700 at the at the northern end. Despite the departure from the ULDF, the design


Shotcrete on the Waterview Connection


Rockbolts used on the Waterview Connection

[1] Google Maps Street View @ 2015 [2] Geofabrics New Zealand Limited

Kerb and channel on the Northern Gateway Toll Road, similar to that used on the Project[1]

at these locations remains largely consistent with its overall outcomes, maintaining a stitched together landscape and clean, uncluttered road. Further explanation of hydro-seeding and the design approach is covered in section 5.7 and 5.17.

4.10 ROADSIDE MARGINS AND DRAINAGE

The roadside drainage, which includes; swales, kerb and channel (a concrete structure at the edge of the road, designed to guide stormwater and provide an edge to the road), catchpits and sediment traps (containment areas that settle the sediment contained in stormwater before discharging it to the wetlands), has been designed as part of the coherent suite of highway elements as these make up part of the motorway aesthetic and contribute to the outcome of an 'uncluttered, clean highway'. The drainage features will be cohesive, linear, flush with the road surface and consistently spaced in relation to other motorway edge treatments, including the road side barriers and the road edge, to provide clean and uncluttered sight lines. This is preferred by the ULDF (section 4.13).

The stormwater conveyance infrastructure comprises pipes, and swales with lining materials of grass or rock. Rock lined swales are used in steep sections of roads and on steep gradients to collect stormwater runoff from the rock cut, and grass lined swales on flatter sections, reinforcing the adjacent landscape character. Kerb and channel is used at the top of soil fill slopes preferentially as it reduces the size (footprint) of the embankment, minimising visual impacts, earthworks and impacts to terrestrial and aquatic ecology. Swales and kerbs drain to sediment traps before entering the stormwater wetlands, traps are cleared of residual sediment as part of the maintenance regime. The design and layout of the infrastructure is consistent along the motorway alignment and provides clean lines. Section 4.12 outlines that the opportunity for weed growth will be minimised along the road edge due to the positioning of the roadside highway furniture and infrastructure.

Transition structures (such as spill over locations and pipe network inlets and outlets) are co-located at road transition locations (such as cut and fill interfaces) with other infrastructure transitions, to reduce foreground visual clutter and simplify maintenance and markings. Safe inspection and maintenance access is provided by maintenance bays.

A green roadside appearance will be provided by planting which runs parallel to the motorway. The road surface drainage design is consistent with that used on the adjacent Northern Gateway and other sectors, providing linear continuity along the motorway network, and minimising maintenance including the use of sprays [D36(c), D37(d)] [ULDF section 4.13].

Possum

4.11 PEST CONTROL

Mammalian pests can affect plant survivorship and inhibit natural regeneration processes through browsing foliage (e.g. possums) and the consumption of seeds (e.g. rats), therefore D36(c)]:

- Pest mammals will be controlled to facilitate plant growth
- Baiting will be employed to reduce possum and rats numbers in forest systems and along the edges of wet-land systems
- Regular monitoring for pest mammals will be undertaken

Hand removal of some species will be provided as a measure to prevent the spread of kauri dieback disease.

Example of landscape planting on earth batters to be similarly used in the Project

4.12 WEED MANAGEMENT

Project outcomes include the minimisation of weeds and herbicide maintenance along the road to produce a cleaner edge (refer to cross sections in Section 4.15). The interface area between the rock lined swales and chipseal (a pavement surface made up of layers of bitumen and aggregate) area has been designed to minimise weed growth. The chipseal will extend to the edge of the swales, which will be lined with geo-fabric/geotextile (strong manufactured fabric used to prevent erosion and stabilise soil) and rocks or grass.

The design of the road has been developed to minimise weeds as much as practical, and this design has been applied consistently on the project. Pre-emergent herbicide will be utilised, to prevent weeds from establishing in any sediment caught in the swales and will reduce the need for spraying. Sediment will be routinely removed from sediment traps to avoid a medium to promote weed growth. On the outside edge of the swale or kerb and channel landscaping will maintain green margins as guided by the ULDF. Where weeds are not minimised through the design, they will be managed and controlled with herbicide and manual removal. The planting and grass hydro-seeding will commence as cut and fill areas and weed control is completed along the motorway alignment through winter months [ULDF Section 4.14].

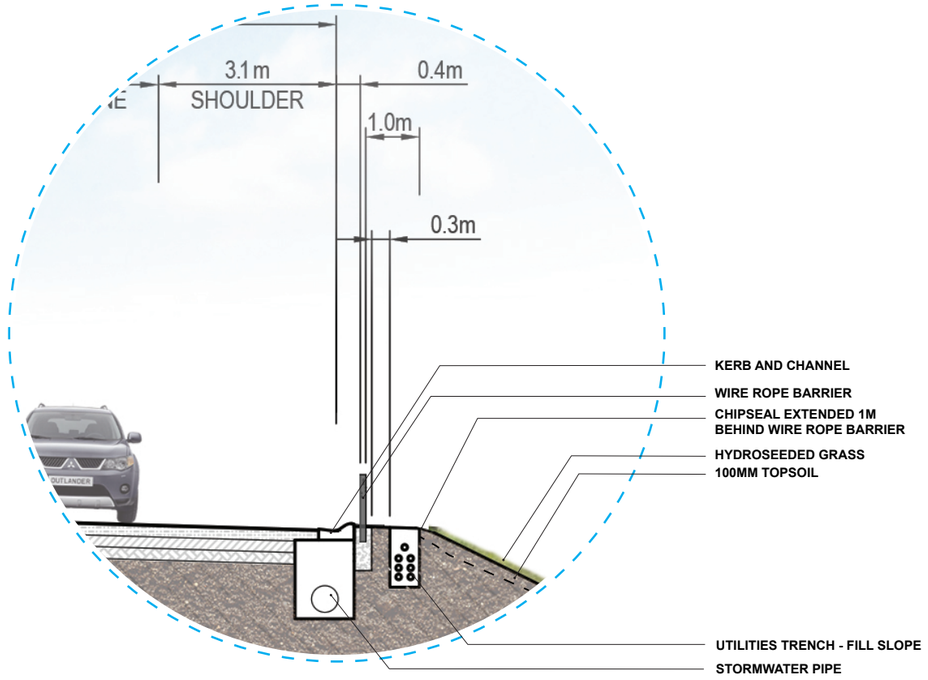
[3]Google Maps Street View @ 2015

4.13 ROAD ELEMENT CROSS SECTIONS

The following cross sections portray the combined result of the highway elements, demonstrating; a clean and uncluttered highway, that is understated and free of distraction, with the edges providing minimalist aesthetic and barriers maximising openness and clear, continuous lines [D37] [ULDF section 4.3].

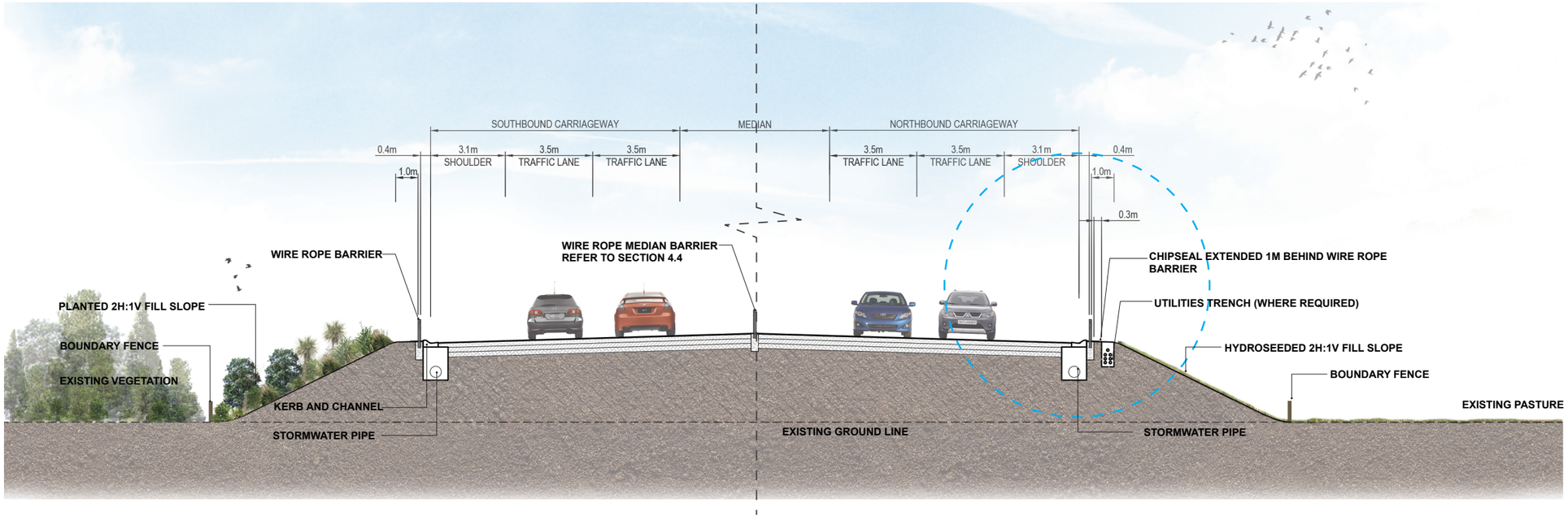
The expanded circular images emphasise the interface of highway elements such as swales, kerb and channel, barriers and vegetation, to demonstrate a clean road edge.

Kerb and Channel on Fill Slope



Planted

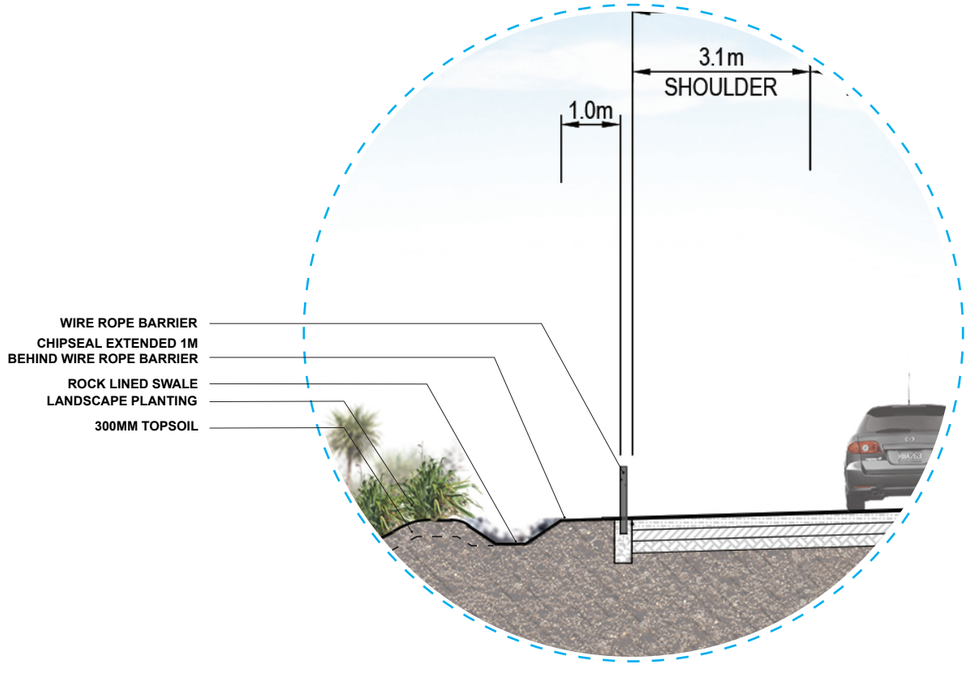
Hydroseeded Grass



Cross section - Typical 2H:1V fill embankment with kerbs showing examples of both Landscape Planting and Hydroseeding on low fill batter slopes without swales

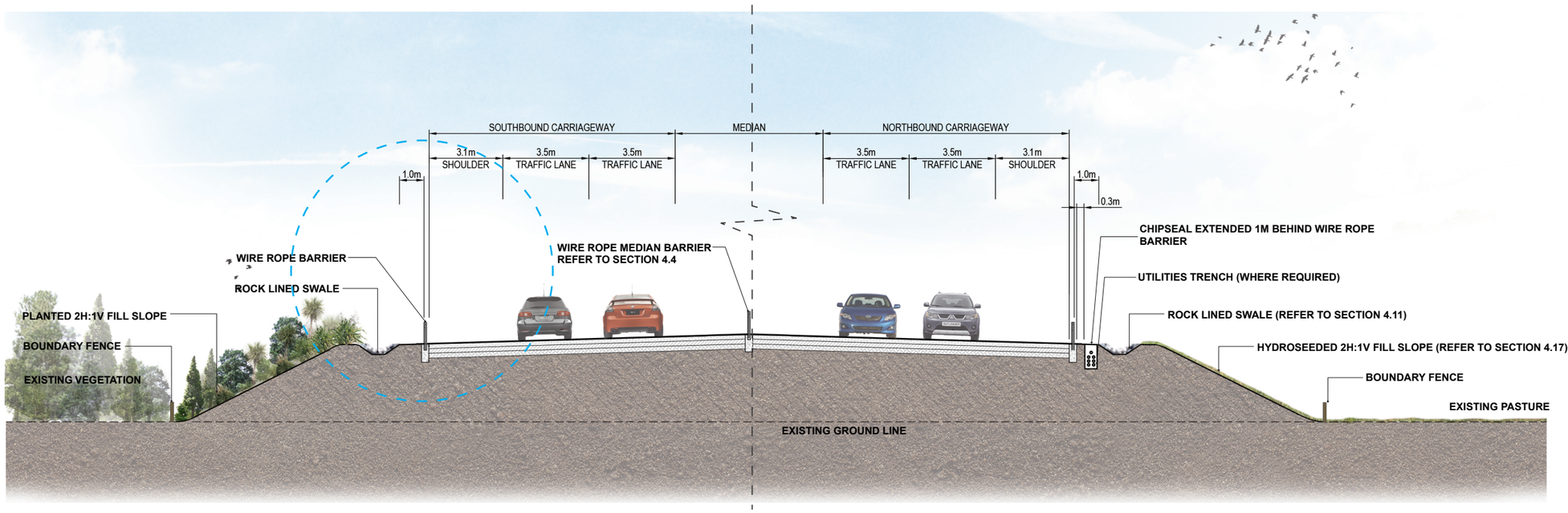
1:200 @ A3

Rock Lined Swale on Fill Slope



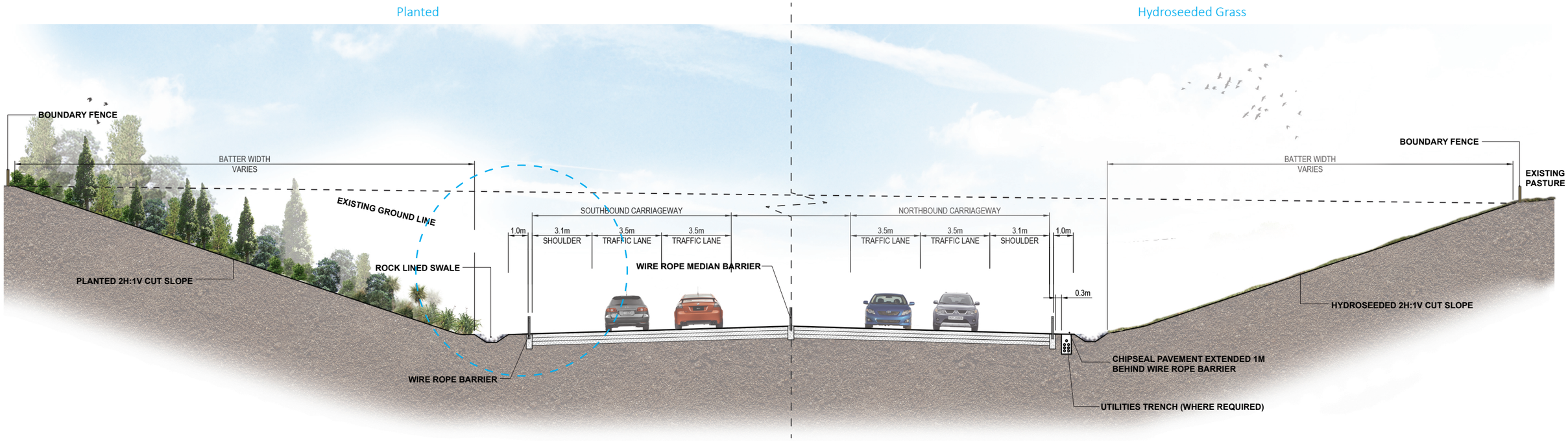
Planted

Hydroseeded Grass



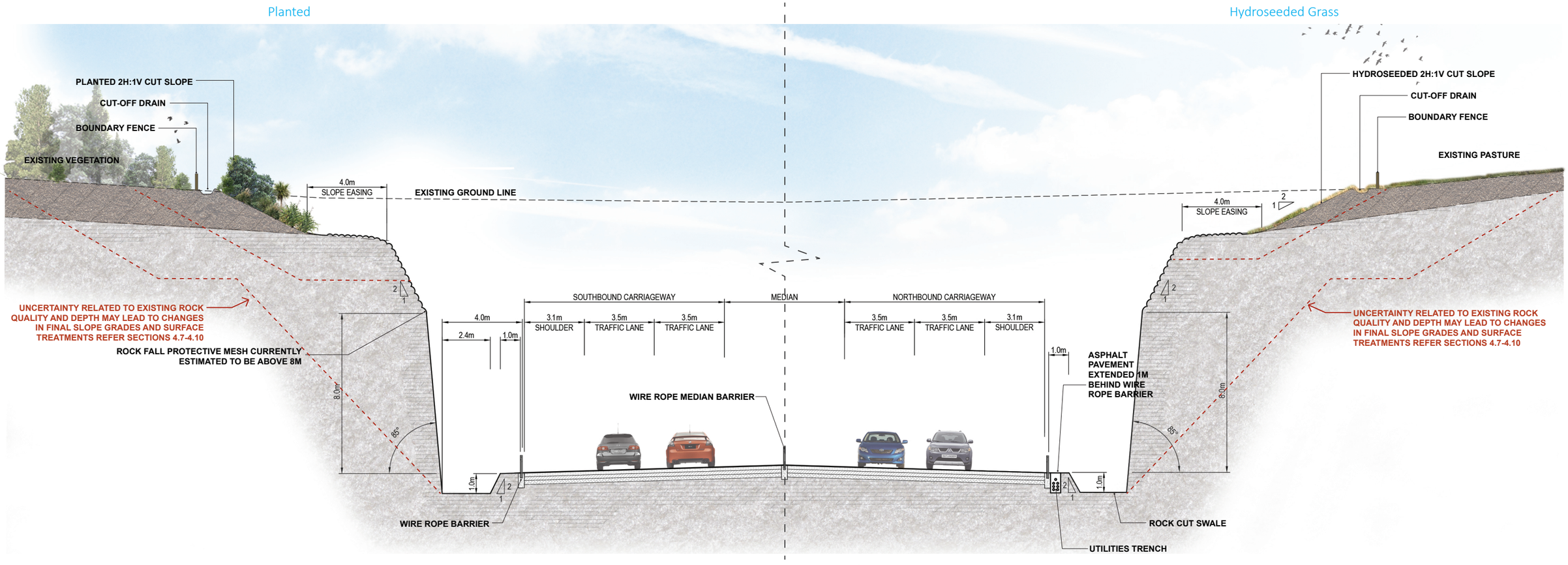
Cross section - Typical 2H:1V fill embankment with swales showing examples of both Landscape Planting and Hydroseeding on low fill batter slope with rock lined swale

1:200 @ A3



Cross section - Typical 2H:1V cut embankments showing examples of both Landscape Planting and Hydroseeding in area with low cut batters and swales

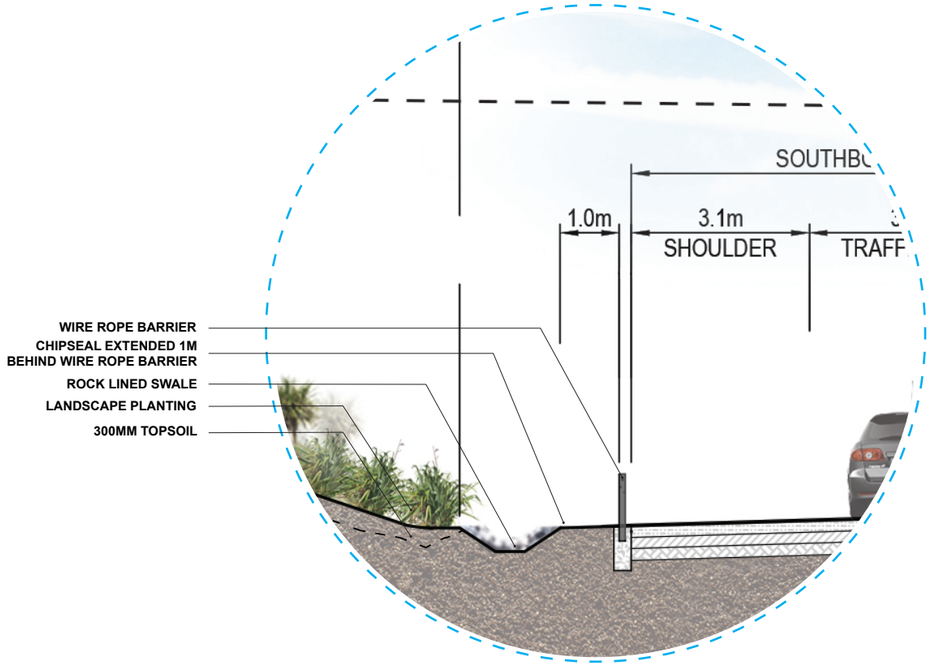
1:200 @ A3



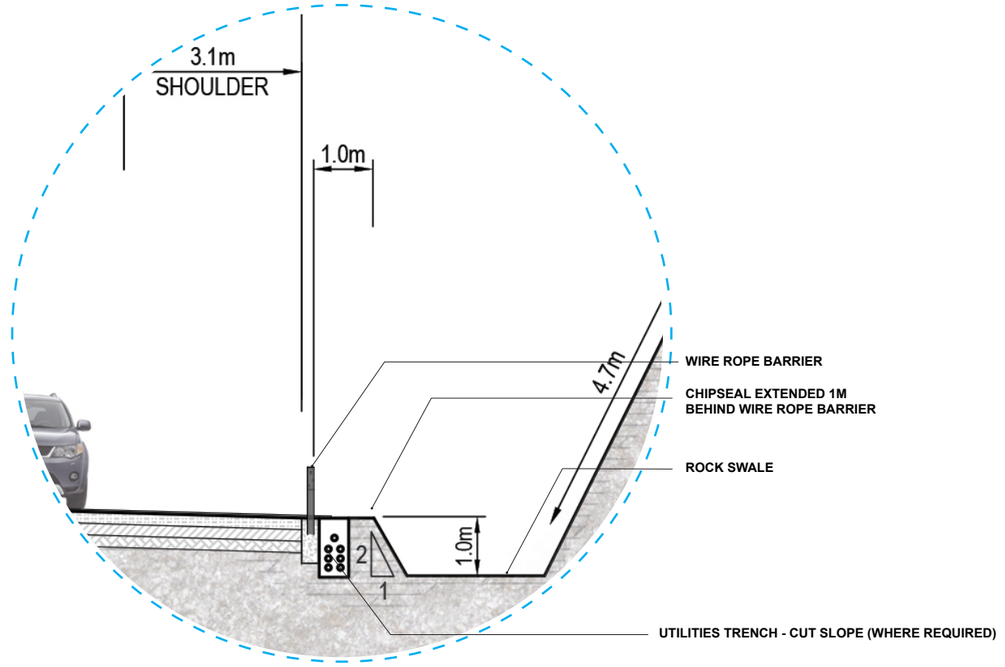
Cross section - Typical 85° rock cuts showing examples of both Landscape Planting and Hydroseeding in an area with high rock cut batters demonstrating continuous rock layback

1:200 @ A3

Rock Lined Swale on Soil Cut Slope

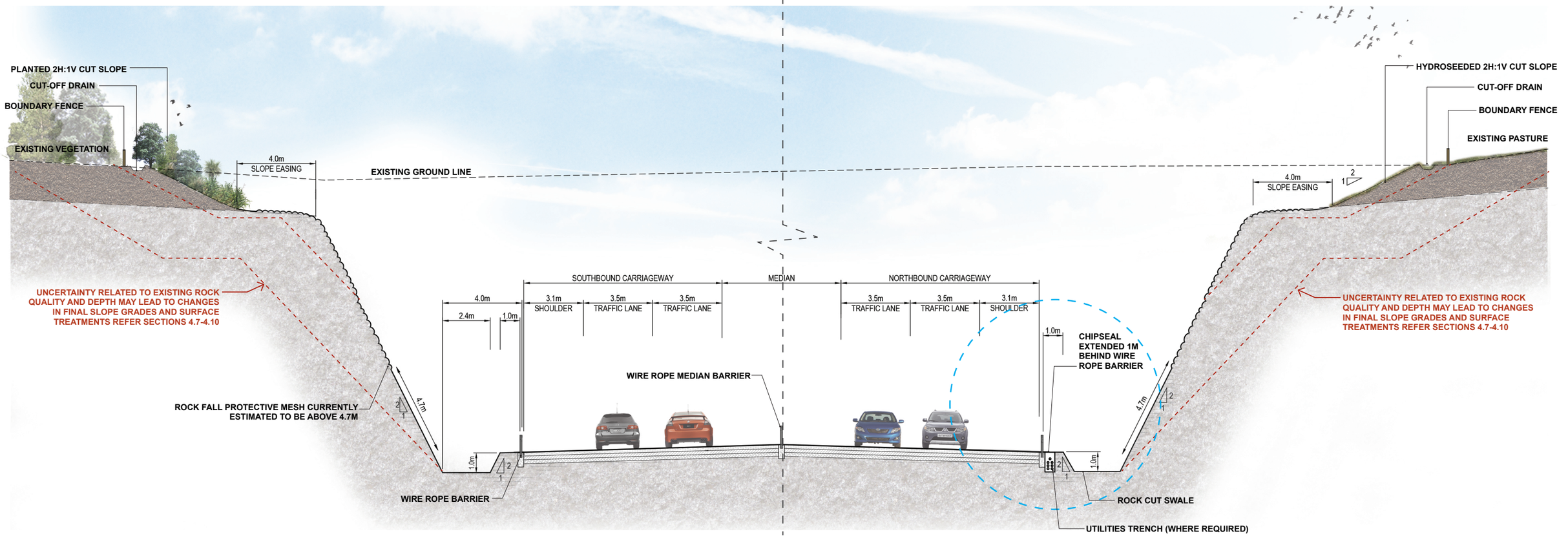


Rock Swale on Rock Cut Slope



Planted

Hydroseeded Grass

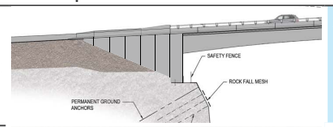
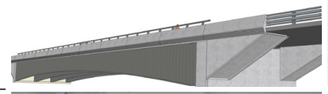
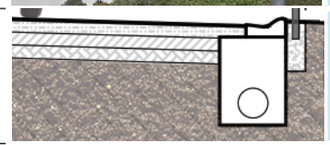
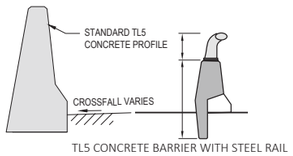
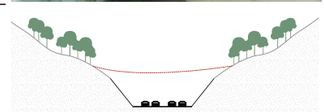
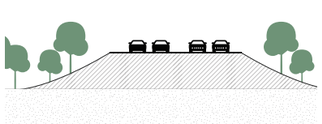


Cross section - Typical 1H:2V rock cuts showing examples of both Landscape Planting and Hydroseeding in an area with high rock cut batters demonstrating continuous rock layback

1:200 @ A3

4.14 TYPICAL HIGHWAY ELEMENTS

The highway furniture is a cohesive suite of elements, simple in profile and restricted in colour. This limited palette reinforces the ULDF outcome of a cohesive and understated highway [D36(a)]. Typical elements to be used in the design of Ara Tūhono.

Element	Example	Photo Reference	Definition	General Locations
Abutment		Section 5.4	A structure built to support the lateral pressure of a span at the ends of a bridge	Te Tapuwae o Kahumatamomoe, the bridge carrying Moir Hill Road Approximate chainage 57000
Barrier- Wire Rope		Section 4.1	These are flexible safety barriers, built from steel wire ropes and mounted on posts. They are designed to break on impact, with their main purpose being to prevent vehicles from leaving the road or crossing the centreline	Along the motorway, median and edge barriers are predominantly wire rope on galvanised steel posts
Bridge		Section 5.4	A structure carrying a road across a river, road, or other obstacle	Te Tapuwae o Kahumatamomoe, the bridge carrying Moir Hill Road (local road) over the motorway carriageway at approximate mainline chainage 57000m
Cantilever Gantry		Section 4.6	An overhead structure supporting equipment such as signs	There will be 2 cantilever type overhead signs in the Central Zone. The Locations are: The northbound sign location will be at CH 55920 The southbound sign location will be at CH57065
Catchpit manhole		Section 4.10	A chamber with a grated lid to capture stormwater runoff from the motorway carriageway. Runoff is then conveyed to a wetland for treatment	Along the edges of the motorway
Concrete Barrier		Section 4.1	A concrete barrier is a high rigid barrier. TL4 and TL5 refer to Test Levels 4 and 5, where the higher the test level, the greater the ability to contain vehicles. In this sector, the following concrete barriers are used: • Concrete TL5 Barriers (915mm high with a steel rail) used on bridges • Concrete TL5 barriers (1070mm high) used on the approach to and after bridges and to protect assets	On Te Tapuwae o Kahumatamomoe, barriers are concrete with a top rail to optimise views out into the wider landscape. They have been designed integral to the bridge parapet, with an extended skirt to conceal services below the bridge deck and minimal embellishment to reinforce a clean, horizontal emphasis
Culvert		The Constructor Civil Engineering Home	A pipe carrying a stream or open drain under a road	Approximate chainages; 53090, 53400, 53940, 54080, 54720, 55050, 55460, 56170, 56410, 56800, 57190, 57350, 57650, 57910, 58540, 58660 and 59020
Cut		Section 4.7	Terrain that is cut down from its present elevation to allow a smooth road gradient	Elevated areas
Embankment		Section 4.7	Fill that is placed over a low lying area e.g. gull to allow a smooth road gradient. Large fill embankments are present throughout this section	Along the alignment in low lying areas across gullies and streams
Open Graded Porous Asphalt		Section 4.6	An open graded blend of coarse and fine aggregates, mineral filler and a bitumen based binder. This mixture is intended to be used where there is a requirement for texture depth, noise suppression and/or splash reduction	Open graded porous asphalt (OGPA) has been selected as the final surfacing for the motorway carriageway. This will cover the entire carriageway width, except on shoulders on the “low side” of the carriageway and verge outside edge barriers

Element	Example	Photo Reference	Definition	General Locations
Reinforced Soil Slope		Section 4.8	Fill slopes which use artificial reinforcing such as High Density Polyethylene(HDPE) geogrids with a grassed or planted face	Bridge abutments or in areas which are spatially constrained e.g. close to designation
Rock Bolt		Section 4.8	A rock bolt is a steel or fibreglass rod that is grouted to the ground, used to anchor and stablise rock excavations	Used in areas of rock cut where the ground is deemed to require further stabilisation
Rock Fall Mesh		Section 4.10	Durable wire mesh used to stabilise the rock cut slopes and/or allow controlled movement of loose rocks to the base of the cut to be captured in the rock fall swale	Used in areas of rock cut where rock fall is deemed a risk
Rumble Strips (Audio Tactile Profiled Markings)		Section 4.1 New Zealand Transport Agency	Audio tactile profiled markings, commonly known as rumble strips, help prevent drivers from running of the road or straying across the centreline. Consisting of raised white ribs spaced at regular intervals along the edge of a road or down the centreline, they can be felt and heard when car wheels cross over them. The rumbling effect warns drivers that they are veering out of their lane	Used along the white painted lines both along the edges and lane lines of the motorway
Shotcrete		Section 4.8	Concrete that is sprayed onto a soil or rock face. Generally used in conjunction with rock bolts	Rock cut faces where necessary for stabilisation
Swale- Grass Lined		Thomas Engineering	A grassed swale is a constructed shallow, open channel appearing as a landscape feature. Grassed swales slow and control the rate of the conveyance of storm water and can act as a filter to remove pollutants	Grass lined swales are used on flatter sections, reinforcing the adjacent landscape character
Swale- Rock Lined		Section 4.11 - Google Maps Streetview @ 2014	A linear channel lined with erosion-resistant rock and designed to convoy runoff to an outlet	Rock lined swales are used in steep sections of roads and on steep gradients. These will feature predominantly in steep cuts found in the centre of this section
Terminal- Leading End		Section 4.1 - Google Maps Streetview @ 2014	A leading end terminal is used to absorb the kinetic energy of an impacting vehicle at a controlled rate	Leading end of the barriers- first point of contact for on-coming traffic
Terminal- Trailing End		Section 4.1 - Google Maps Streetview @ 2014	The purpose of the trailing terminal is to anchor the end of a W-section barrier to keep the tensile strength in the rail	Trailing end of the W-section barriers
Terminal- Wire Rope		Section 4.1 - Google Maps Streetview @ 2014	The purpose of the trailing terminal is to anchor the end of a wire rope barrier to keep the tensile strength in the rope system	Ends of the wire rope safety barriers
Utilities Trench		Section 4.13	A trench in the ground used to lay utility ducts	Along the entire motorway