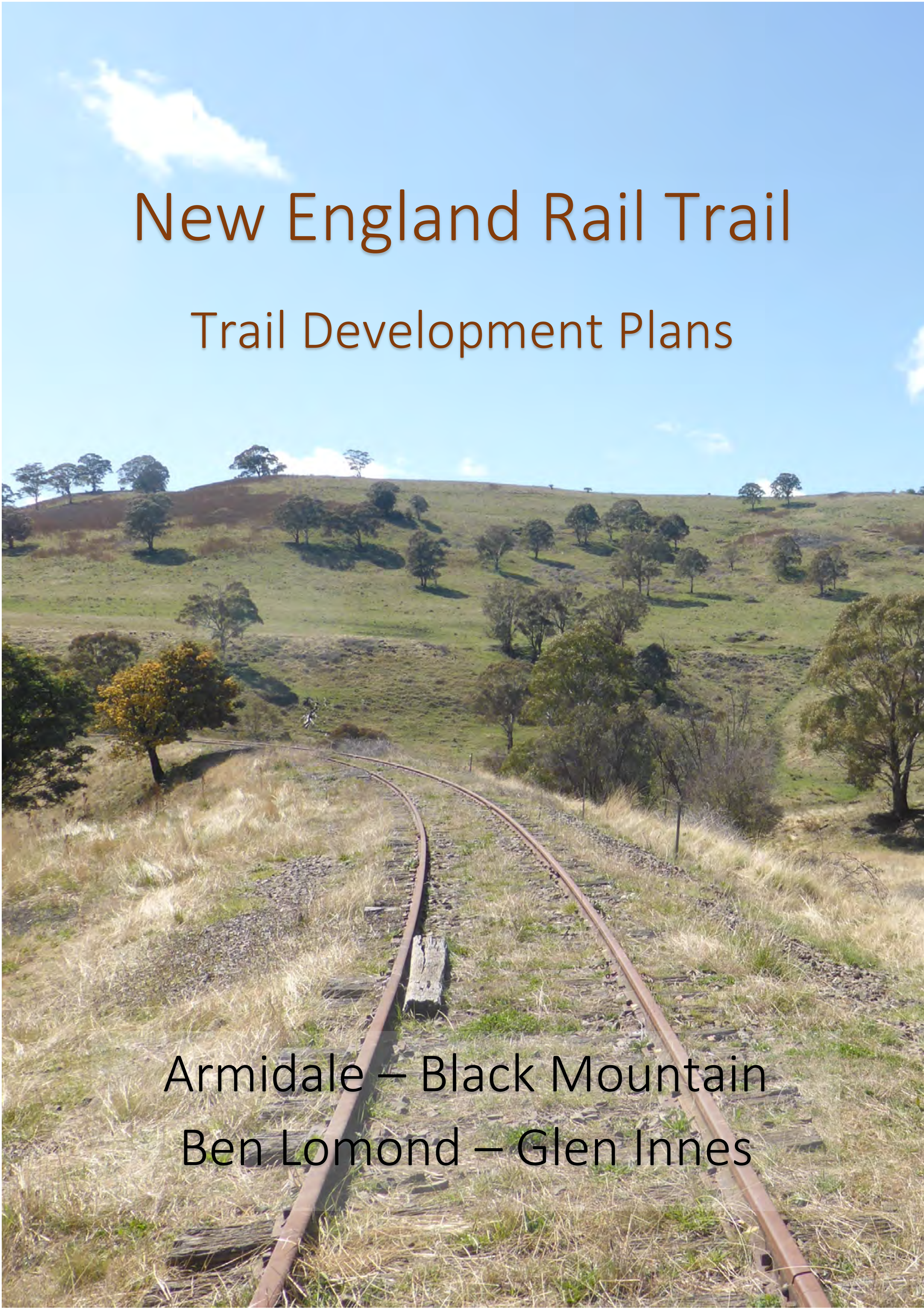

New England Rail Trail

Trail Development Plans

Armidale – Black Mountain

Ben Lomond – Glen Innes

NEW ENGLAND RAIL TRAIL
TRAIL DEVELOPMENT PLANS
ARMIDALE-BLACK MOUNTAIN
BEN LOMOND-GLEN INNES

FINAL REPORT

Prepared for

NERT Inc.

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TRANSPLAN PTY LTD
Planning and Design

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CONTENTS

EXECUTIVE SUMMARY

This Trail Development Plan sets out a detailed set of activities for the progressive construction of a trail on the disused railway corridor between Armidale and Black Mountain and between Ben Lomond and Glen Innes. The trail development plan for the remaining section of the proposed New England Rail Trail – between Black Mountain and Ben Lomond - was prepared in 2018. This Plan should be read in conjunction with the 2018 report.

Section 4.0 contains six tables where a comprehensive works list for each of the proposed stages of the rail trail development is set out, and an estimate of probable costs for each task.

The estimated detailed cost of the conversion of the corridor to a rail trail between Armidale and Black Mountain is **$5,654,013** (the comparative estimate in the 2018 report was $6,438,310).

The estimated detailed cost of the conversion of the corridor to a rail trail between Ben Lomond and Glen Innes is **$8,721,095** (the comparative estimate in the 2018 report was $11,107,230).

In preparing the detailed Trail Development Plan, the entire corridor was traversed by foot and as a result much more is known about the requirements to convert the former railway corridor to a rail trail. The primary difference between the estimated costs in 2018 and the costs provided in this report relate to the costs for removing the rail line. In the 2018 report, an allowance of $33/metre was included. However, since 2018, the Tumbarumba-Rosewood Rail Trail pilot project has been developed. The NSW Government granted the trail manager ownership of the track and sleepers as part of the project. A removal contract was organised and proceeds of the sale of the track remained with the trail manager (with the demolition contractor taking a percentage of the sale value). The track sale price was dependent on the market price for railway track at the time of removal. It is difficult to know what market conditions will be like at the time of track removal should the New England Rail Trail proceed. For a zero cost to be realised, the price of used steel in particular is such that a commercial demolition company will remove the track free of charge recovering their costs by selling it to an appropriate market. This partially depends on how much steel is available and the price of used railway steel at the time the contract for removal is let. For the purposes of estimating construction costs, the approach taken in this report is to assume the Tumbarumba Rosewood project sets a precedent for asset ownership. Research by NERT Inc at the time of report preparation has indicated that the track can be removed and sold at a price that allows some proceeds of sale to be returned to the asset owner (as it did in the case of the Tumbarumba Rosewood Rail Trail). A prudent approach is required, and a cost for rail removal of $8/metre has been included (rather than the $33/metre that was adopted in the 2018 report which reflected earlier costs). This represents a saving in the order of $3.4 million compared to the 2018 project cost estimate.

There are unknowns when dealing with the construction of rail trails such as this. The extent of approvals needed prior to development of the trail and the requirement for permits and additional studies is not known but an allowance has been made.

RECOMMENDATIONS

It is recommended that New England Rail Trail Inc., Armidale Regional Council and Glen Innes Severn Council use this Trail Development Plan, the 2018 Trail Plan and other documentation in future funding applications to the NSW Government and any other potential funding partners.

SECTION 1 – BACKGROUND

The proposed New England Rail Trail would be developed on the disused railway corridor between Armidale and Glen Innes – a distance of some 102 kilometres. The Main North Line was closed north of Glen Innes in October 1989, while October 1993 saw the closure of the line north of Dumaresq. The last regular services to operate north of Armidale was the *Northern Mail* which ceased in November 1988. Freight services continued to serve a fertilizer depot at Dumaresq until the mid-2000s, after which the line closed north of Armidale. In July 1992, the line to Glen Innes was used as a crew training service.
https://en.wikipedia.org/wiki/Main_North_railway_line,_New_South_Wales; https://www.nswrail.net/infrastructure/timeline.php; https://www.nswrail.net/lines/show.php?name=NSW:main_north).

The railway corridor between Armidale and Glen Innes remains in public ownership. Some important reminders of the former railway remain along the corridor. The railway stations along the entire section of corridor are amongst the most intact stations in NSW on disused railway lines. Many of the stations still have associated infrastructure (such as goods sheds and various signalling mechanisms) intact and in many cases restored. Cuttings and embankments are a common feature along the corridor.

Since the closure of the operating railway over 30 years ago, little maintenance has been carried out within the railway reserve – with the notable exception of the station grounds. In most locations, the steel railway track and old rotting sleepers remain. Some lengths of the steel railway track have been removed.

A study examining the merit of developing a 'rail trail' on the disused railway line was commissioned by Armidale Regional Council and Glen Innes Severn Council in 2018. A rail trail is the conversion of a disused railway into a multi-use recreation path, typically for walking, cycling and sometimes horse riding. The characteristics of abandoned railways - flat, long, and frequently running through historical areas - are appealing to numerous potential user groups.

The 2018 study had two elements:

1. To provide commentary on, and a strategic assessment of, the potential for a rail trail on the disused rail corridor between Armidale and Glen Innes. This included benefits and costs of undertaking the conversion.
2. To prepare a detailed trail development plan for the proposed rail trail along the disused rail corridor between Black Mountain and Ben Lomond (a distance of approximately 34 km).

In 2020, Armidale Regional Council and Glen Innes Severn Council determined to proceed to the next stage of work – a detailed Trail Development Plan for the remaining two sections – Armidale to Black Mountain, and Ben Lomond to Glen Innes.

Taken with the trail development plan element of the 2018 study, this report provides the Councils with a construction blueprint for the development of a rail trail on the rail corridor between Armidale and Glen Innes, enabling it to proceed with the establishment of the rail trail (should it determine this to be the appropriate course of action) once funds become available and legislative impediments are removed.

In the interests of brevity, this report should be considered a companion to the 2018 report. Some of the sections of this report (sections on design, implementation, construction management, and management and maintenance) contain information specific to the two sections under examination only, rather than more general information which is contained in the 2018 report.

The railway stations along this entire section of corridor are amongst the most intact stations on disused railway lines in NSW. Many of the stations still have associated infrastructure (such as goods sheds, switches and signalling equipment) intact and in some cases restored.

This interesting and historic road bridge over the railway just south of Glen Innes is another feature that will make the proposed rail trail an attractive recreation opportunity for local people and visitors to the region.

Rail trails in NSW are being progressed through the development of pilot projects. The Tumbarumba to Rosewood rail trail opened in April 2020 and has been an outstanding success – notwithstanding difficulties imposed on travel by COVID-19. Trail counters in place have registered 9,000 users in its first 5 months of operation. The Northern Rivers Rail Trail is another pilot project. Construction is yet to start but appropriate legislative action has occurred to close the railway line to allow conversion – a critical step towards trail construction. The *Transport Administration Amendment (Closures of Railway Lines in Northern Rivers) Bill 2020* was passed by both Houses of Parliament in October 2020.

The Beardy Waters bridge will be one of the highlights of the proposed rail trail. It will require significant refurbishment to make it safe for cyclists and walkers.

SECTION 2 – THE SCOPE OF WORKS FOR THIS PROJECT

This Trail Development Plan provides sufficient detail for a funding application to be prepared and to guide the actual construction once funding has been obtained. The Trail Development Plan is a construction blueprint. The primary focus is on the works necessary to convert the corridor to a rail trail and the ongoing maintenance and funding.

This Trail Development Plan provides detailed works lists and detailed cost estimates (item by item, location by location) covering all elements needed to convert the rail corridor to a rail trail - informed by a traverse of the corridor by foot. Construction plans with a list of necessary (and optional) construction items, quantity estimates, materials required, and construction schedules have been prepared.

The main elements of this Trail Development Plan are as follows:

- Fieldwork, which involved a traverse of the two corridors (by foot);
- Preparation of detailed works lists and calculation of quantities for construction;
- Preparation of detailed cost estimates for construction;
- Basic design and construction guidelines;
- Preparation of drawings and cross-sections;
- Mapping of corridor (illustrating construction activity); and
- Management and maintenance planning. A list of maintenance tasks that need to be attended to have been provided and innovative ways of addressing these tasks have been suggested.

The study brief does not include any formal community or landholder consultation in this project. The NSW Department of Premier and Cabinet has hosted two community forums on this project – more specifically on a broader project encompassing the future use of the rail corridor from Armidale to Wallangarra.

SECTION 3 – TRAIL DESIGN AND DEVELOPMENT CONSIDERATIONS

This section of the Trail Development Plan addresses a series of matters relating to trail design and development.

3.1 INTRODUCTION

In 2018, *the New England Rail Trail Plan* was prepared for Armidale Regional Council and Glen Innes Severn Council. It included an extensive commentary on a series of matters relating to trail design and development. The 2018 report covered the following design elements:

- trail width and height;
- trail surfacing;
- safety considerations;
- road crossings;
- signage;
- erosion control;
- bridges;
- trail furniture;
- trailheads and parking;
- fencing;
- stock crossings;
- encroachments in the trail corridor;
- use of the rail corridor by community groups;
- other users and trail etiquette;
- codes of conduct;
- heritage issues;
- environmental issues;
- clearing of the rail trail; and
- toilets.

The 2018 study noted that the relevant section of that study applied to both the section that was the subject of detailed study – Ben Lomond to Black Mountain – and the potential future development of the corridor north and south of this section (from Glen Innes to Ben Lomond, and Black Mountain to Armidale).

In the interests of brevity, this report should be considered a companion to the 2018 report. The following design notes cover fewer issues of design and focus on those of particular relevance to the Armidale to Black Mountain and Ben Lomond to Glen Innes sections, notably where these are different to the Ben Lomond to Black Mountain section.

3.2 GENERAL CONSIDERATIONS

This section of the Trail Plan addresses a series of matters relating to trail design and development of the New England Rail Trail – to achieve a rail trail that is constructed with minimal disturbance to the natural environment, is sustainable and that requires minimal maintenance.

During construction of the original Main North line, effective drainage was important, as it is with all public infrastructure. Locating a trail on the formation of the former railway is important, and reinstatement of bridges where they have fallen into disrepair, is vital for the success of the rail trail.

There are several bridges on the rail corridor. These range in size from less than 5 metres up to 116 metres (over Beardy Waters near Stonehenge Recreation Reserve). Many of these appear to be in reasonable condition and present the opportunity to be re-used.

Construction of the railway involved the cutting and filling of the landscape to create a surface that was relatively flat to enable the passage of steam trains. The result was a series of cuttings and embankments along the entire length of the rail corridor. Effective drainage will be required, especially within most cuttings, to ensure stormwater is quickly and effectively removed from the sides of the trail (as it was when the trains were running). Culverts and other drainage controls should be used to direct run-off away from the trail. Stormwater must drain freely, and where possible, pass beneath the trail without impact on either the base formation or the surface itself. Rail trails, by their very nature, tend to deal with these problems relatively well. Numerous culverts inspected during fieldwork were completely or partially block, thereby inhibiting the free flow of stormwater under and away from the railway embankment. Regular cleaning of blocked culverts is essential to avoid serious soil and water degradation problems.

The old drains of the many cuttings along the proposed rail trail will require attention to ensure they still perform the task of clearing water from the cuttings.

Particular care must be given to reinstating the side (cess) drains through cuttings.

Construction of the rail trail and associated signage should comply with relevant Australian Standards and Austroads guidelines. The works lists outlined in Section 4 delivers a trail to meet these requirements.

At some point in the future, (when the rail trail is funded) contractors will be engaged to remove the steel railway track and sleepers. Care will need to be taken by the contractors to ensure that the formation and bridges are left in as good a condition as possible to minimise rail trail construction difficulties.

3.3 TRAIL WIDTH AND HEIGHT

To function effectively as a shared use facility (for cyclists and walkers), the New England Rail Trail should have a width of 2.5 metres. A separate slashed bridle trail would be slashed to a width of 1 metre (if the trail is to be used by horse riders). Anything wider than 2.5 metres and the trail starts resembling a road, which is not what rail trail users want. The width of the existing embankment/formation of the original railway will ultimately determine the width that the proposed rail trail can be constructed in some locations.

The railway has been mainly disused since 1988 (though there were some limited freight services operating to Dumaresq since that time). During this time some sections of the corridor have become overgrown and will require clearing for the passage of trail users. However, overgrown sections are very limited in number and where these do occur, the species contributing to the overgrowth are primarily blackberries and black wattles. Where vegetation has regrown, overhead clearance should be maintained to approximately 2.4 metres from the rail trail surface. All overhanging vegetation – and that which intrudes from the sides into this 'corridor' - should be cut back on a regular basis. Care should be taken that sharp and dangerous 'points' are not left in this pruning process.

There are instances where side vegetation can be retained, as the trees are attractive and provide shade. They also provide an attractive vista along the cutting or embankment.

3.4 TRAIL SURFACING

The 2018 report covers this issue extensively. The key point worth re-iterating is the potential use of the trail by horse riders. Around 75% of rail trails across Australia are used by walkers and cyclists; the remaining 25% permit use by horse riders. If horses are to be permitted on this trail, it is important to keep horses off the main trail surface as the hooves of horses can do significant damage to unsealed trail – although the level of damage depends on the surfacing material used and the prevailing weather conditions. Some surfacing materials (such as "Lilydale Toppings" as used on the Lilydale Warburton Rail Trail in the Yarra Valley in Victoria) are very accommodating to horses' hooves.

The most effective method of accommodating horses is by the establishment of a separate bridle trail – usually a signposted, slashed single-track route off to the side of the main trail (but still within the original railway reserve). This is commonly done on rail trails such as the Great Victorian Rail Trail, the High Country Rail Trail (also in Victoria) and others. The bridle trail route can be simply

A considerable amount of ballast still remains along the proposed trail route and must be removed in the trail construction process.

constructed by slashing the low grass. The constant passage of horses will keep the 'single-track' clear of regrowth and clearly defined. Bridle trail signage will be required to show riders where to go and to keep them off the main trail. Horses will need to share bridges where they cross watercourses.

In the costs estimates that are included within this Trail Plan (Section 4), an allowance has been made for clearing of the trail corridor (vegetation and topsoil and ballast), further grading and shaping of the formation to create as smooth a surface as possible, and additional fill material. An allowance has also been included for slashing and flailing a separate horse trail.

3.5 ROAD CROSSINGS

Road / trail crossings always present a special hazard which must be addressed carefully. A crossing should have enough space cleared and levelled on both sides of the road to allow cyclists travelling together to gather in a group and cross en masse. One-at-a-time crossing greatly increases the overall time in the roadway and therefore increases the likelihood of encountering a vehicle. The crossing should ideally be at a straight, level area allowing both trail user and vehicle driver good visibility and the driver ample stopping distance (if possible). All trail crossings should be perpendicular to the road. All crossings will be 'at-grade', as is common with the overwhelming majority of road crossings on rail trails in Australia (as well as many other trails).

Road crossings often present a challenge. Crossing the New England Highway will be a key challenge for this project.

The 16 road crossing concept drawings that form part of this Trail Plan (see Appendix 1) illustrate the signage that is required at each road crossing and the positioning of gates (for management access vehicles and for trail users).

Generally, the road crossing treatment required includes:

- Installation of signage on the rail trail (both sides of the road crossing) advising (or warning) of the upcoming crossing of the road. The recommended treatment is the installation of (either or both) "Give Way" (or "Stop" signs if it is a major road) and "Road Ahead" signs on both sides of the crossing. Where the chicanes are close to the crossing, "Give Way" signs should be included on the railings of the chicane;

- "Trail Crossing Warning Signage" on the road (both sides of the trail crossing) alerting road users of the upcoming trail crossing;
- Management access gates and chicanes (permitting access by legitimate trail users and authorised vehicles, such as emergency services vehicles and management vehicles) in certain locations. A technical drawing setting out the specifications for chicane gates can be found in Appendix 2, as well as a concept drawing and a photo of such a gate on the Lilydale Warburton Rail Trail in Victoria. Experience from other projects is that the chicane system needs to have a significant concrete surrounding as this minimises necessary maintenance mowing. The experience has been that grass can grow immediately around the timber posts and is difficult to mow using slashers. A wider concrete apron means no mowing immediately around the whole gating system. There are many alternative gating systems which could be used. Appendix 2 also includes a concept drawing and a photo of a different system in use on a recently opened section of the Brisbane Valley Rail Trail. Use of the trail by horse riders would require the addition of a horse step-over or cavaletti gate to allow horses access to the corridor if this design is used.
- Installation of pipe culverts (where required); and
- Miscellaneous signage (including Rail Trail name and logo; distance signs; Emergency Marker signs; road name signs; "Unauthorised Vehicles Prohibited" signs; "Trail Bikes Prohibited" signs, etc.). Many of these can be included on the railings of the chicane.

The works lists in Section 4 provide for (and have costed) an "at-grade" crossing of the New England Highway adjacent to the old Stonehenge loading platform (the site of the old station). Sight lines at this location are very good with clear vision for some distance in both directions. Gating systems, trail design and signage are proposed that will see trail users slow as they approach the crossing (see the appropriate drawing in Appendix 1). This is the low-cost option and is used on a number of locations in Australia where a rail trail crosses a highway. The best examples are on the Brisbane Valley Rail Trail in South East Queensland. In two locations, the rail trail crosses the D'Aguilar Highway in high speed zones (100 km/hr). Both these crossings are at-grade. By way of contrast, the Port Fairy Warrnambool Rail Trail in western Victoria uses an underpass to cross under the highway in a high-speed zone. The trail manager may want to consider constructing an underpass either at the time of development or as a subsequent improvement. Using the Victorian example, an underpass can be constructed for between $300,000 and $500,000; design works will also be needed at either end of the underpass that will necessitate different trail construction and works items to those which are proposed for an at-grade crossing.

Above: Typical at-grade crossing treatment of D'Aguilar Highway on the Brisbane Valley Rail Trail in Queensland.

Above left: Port Fairy Warrnambool Rail Trail underpass of Princes Hwy in Victoria. Above right: Railway Reserves Heritage (Rail) Trail underpass of Great Eastern Highway near Clackline, WA.

3.6 EROSION CONTROL

Proper drainage is of considerable importance in constructing a lasting, maintenance-free trail. Water should be removed from trail surfaces as fast as possible, wherever possible. Given the flat terrain or gentle slopes involved on much of the proposed rail trail, erosion control should be relatively easy. As the railway has not operated for many years, maintenance of the formation and its drainage structures has been non-existent. Consequently, many of the culverts under the formation and drains along the formation have become overgrown with weeds, grasses and other vegetation. Most require cleaning out.

Those sections of the railway formation which do have blocked culverts or dysfunctional drains should be attended to in the trail construction process, as allowing water to stand on the proposed trail surface or run down even a gentle slope is to invite surface damage followed by costly repairs.

It may be necessary to clear existing drains on a regular basis, or to install additional culverts under the trail in some locations to remove standing water effectively – if this is done, care must be taken to ensure the surface is soundly patched afterwards.

While the cuttings appear to be in good condition, it may be necessary to focus attention on a number of cuttings. The two corridors have a significant number of cuttings – hence the need to identify and cost the work for all cutting treatments. The works tables allow for two options:

- In smaller cuttings, an allowance for cleaning side drains has been included. While this is a normal part of trail preparation, it has been costed separately to ensure it is done efficiently; and
- In larger cuttings, an allowance is included to build up the trail within the cuttings to ensure the cess (or side) drains operate effectively. It may be more effective to “build up” the trail formation to 300mm (rather than 150mm) rather than excavating

the cess drains in cuttings. While this can be determined at the time of construction, the works tables (Section 4) identify specific locations where this is the appropriate course of action.

3.7 BRIDGES

Bridges are one of the most obvious reminders of the heritage value of disused railways. They are also one of the most significant attractions of trails along disused railways and one of the costliest items in the development of trails on former railways.

3.7.1 THE ORIGINAL BRIDGES

There are:

- 5 bridges between Armidale and Black Mountain and Armidale (ranging in size from 3 metres to 11 metres). Included in this list is the viaduct over McLennan Street in Armidale.
- 14 bridges between Ben Lomond and Glen Innes and, ranging in size from 4 metres to 116 metres. Included in this list are three substantial bridges over Beardy Waters (116 metres), Manrowan Creek (51 metres), and Williams Creek (25 metres).

Whilst all the bridges have timber "topping" (sleepers, corbels), the construction of the lower sections varies. The majority of girders (the long single piece structures that span the length of the bridge) are timber though some are steel I-beams or brick arch. Abutments (the material used in stabilising the edge of the formation) are made either of timber, brick or concrete. The trestles are either directly anchored in the ground or in concrete footings.

The works list recommends the retention of the majority of the bridges (as indicated in the works lists in Section 4). The bridges should be retained on the assumption that they are structurally sound pending a structural engineering assessment to confirm their capability to carry trail users. It is worth noting that railway bridges were constructed to hold heavy locomotives – and that, provided the bridge structure is sound, weight is not a significant factor when considering the re-use of rail bridges for walkers and cyclists. Horses (if they are to be permitted on this rail trail) will need to share the bridges with other rail trail users.

There are disadvantages associated with not using the remaining bridges. Not using the bridges means the loss of an essential part of the rail trail experience. There is a strong case for retention of bridges for their heritage and convenience / utility value. Riding down a steep benched switchback or wheeling a bike down a set of steps to cross a creek then up an equally steep climb on the other side presents at least some trail users with daunting technical and physical challenges and necessitates careful design, construction and maintenance of gully / watercourse approaches to provide for safety and prevent erosion. Retention of the bridges also retains the positive experience of riding along the top of old bridges with panoramic views of the surrounding landscape and the watercourse below. The rail bridges were originally built in their locations primarily because railways need very gentle grades or slopes and the same principle applies to re-use of railway formations as recreation trails. Bridges also provide a safe crossing when water is flowing in gullies, creeks and rivers.

Engineering certification of bridge supporting structures and abutments is strongly recommended, to ensure the structural soundness of the bridges to be re-used. The services of a qualified bridge engineer will need to be utilised to assess the bridges recommended for retention for structural soundness (a Level 2 integrity test is sufficient), to provide drawings of, and specifications for, a typical bridge super-structure and re-decking.

3.7.2 BRIDGE ASSESSMENT (BEN LOMOND TO GLEN INNES)

Wood Research and Development was commissioned by Mike Halliburton Associates to complete a detailed visual inspection and refurbishment options report based on the current condition of the major bridges (Manrowan Creek, Upper Williams Creek, Williams Creek and Beardy Waters) along the proposed New England Rail Trail (Ben Lomond to Glen Innes section). The main objective of the investigation was to establish the general condition of the primary structural elements, and to assess what techniques could be utilised to safely repurpose the structure into a rail trail bridge for pedestrian and cyclist use. Two minor bridges were also investigated as an indication of other bridges along the corridor north of Ben Lomond (the small timber bridge immediately south of Old Ben Lomond Road crossing and the bridge over Stonehenge Creek). Appendix 3 contains the report of this investigation.

The detailed visual condition inspection of the bridges along the proposed trail was completed by a Wood Research and Development (WRD) Level II Certified Inspection Engineer in November 2020. A detailed visual inspection was commissioned and used in this investigation along with a brief, low density cavity test of several elements using non-destructive tests, including EPHOD® Stress Wave Technology.

All the bridges inspected (except the steel plated girder bridge over Stonehenge Creek) have ballasted top decks that consist of a full timber decking that supports the 300mm thick rock ballast that the timber transoms (sleepers/rail ties) bear on. The bridges are believed to be constructed from local hardwood species with no indication of maintenance works conducted since the line was closed in 1993.

The Condition State Rating (CSR) system has been developed by Wood Research and Development, through timber inspection experience, to clearly describe the condition of the elements inspected. Elements inspected were the substructure, the superstructure, and the deck, with an overall rating also included. The elements of the bridges inspected have all been classified as having a 3, 4 or 5 rating (note that 1 and 2 are also included in the rating system but apply to bridges in good and fair condition). Characteristics of the system are described below (for ratings 3,4 and 5 noting that ratings 1 and 2 are also included in the rating system but apply to bridges in good and fair condition).

- Rating 3 – Poor. Estimated remaining lifespan is 30% or 24 years (based on an 80 year lifespan). Defects affecting the durability/serviceability which may require monitoring and/or remedial action or inspection by a structural engineer are present. The component or element shows marked and advancing deterioration including loss of protective coating. Minor loss of section from the parent material is evident. Intervention is normally required.
- Rating 4 – Very Poor. Estimated remaining lifespan is 5% or 4 years (based on an 80 year lifespan). Defects affecting the performance and structural integrity of the structure which require urgent action as determined by a detailed structural

engineering inspection are present. The component or element shows advanced deterioration, loss of section from the parent material, signs of overstressing or evidence that it is acting differently to its intended design mode or function.

- Rating 5 – Unsafe. Estimated remaining lifespan is 1% or less than 2 years (based on an 80 year lifespan). The bridge should be closed. Structural integrity is severely compromised, and the structure must be taken out of service until a structural engineer has inspected the structure and recommended the required remedial action.

The following is a summary of the Condition State Rating (CSR) for each bridge:

Old Ben Lomond Rd Bridge (minor)

- Substructure: CSR 4
- Superstructure: CSR 4
- Deck: CSR 5
- Overall: CSR 4

Manrowan Creek Bridge (major)

- Substructure: CSR 4
- Superstructure: CSR 4
- Deck CSR: 4
- Overall CSR: 4

Upper Williams Creek Bridge (major)

- Substructure: CSR 3
- Superstructure: CSR 4
- Deck: CSR 4
- Overall: CSR 4

Williams Creek Bridge (major)

- Substructure: CSR 4
- Superstructure: CSR 4
- Deck: CSR 4
- Overall: CSR 4

Beardy Waters Bridge (major)

- Substructure: CSR 4
- Superstructure: CSR 4
- Deck: CSR 4
- Overall: CSR 4

Stonehenge Creek Bridge (minor)

- Substructure: CSR 3
- Superstructure: CSR 3
- Deck: CSR 3
- Overall: CSR 3

3.7.3 BRIDGE DESIGN FOR RAIL TRAIL USE

Reinstatement and refurbishment of the bridges (notably re-decking and installing handrails in compliance with Australian Standards for bridges) will be a major component of the cost of establishing the New England Rail Trail.

On the Brisbane Valley Rail Trail, the project manager was able to re-use a significant timber bridge over Jimmy's Gully at Harlin (see photo). The advice from the Project Manager was that the original timber bridge was in very poor condition. The superstructure (girders) were completely decayed with no useable timber. However, once the bad timber was cut away near the headstock connection, the substructure (piles) was in pretty good shape. To get a good engineering and affordable outcome, the bridge was shortened and reduced in height. The refurbished bridge was the cheapest option and a very nice feature on the rail trail as well as keeping the heritage significance with the reuse of the timber piles. The bridge is engineering certified to carry pedestrian loads (including horses) with a 75-year design life.

Renovating original railway bridges adds significantly to the trail user's experience. The bridge on the left is on the Brisbane Valley Rail Trail while the bridge on the right is on Tumbarumba-Rosewood Rail Trail. Both are restored in accordance with designs by WRD and both are good examples of restored railway bridges. Both use a combination of old (existing) and new timbers.

The WRD report sets out costs and options for re-using the bridges included within its report. Based on the information compiled from both the visual inspection and the brief SWT (NDT) testing conducted by the WRD technicians, several repairs/replacements will be required to repurpose the railway bridges as rail trail bridges for pedestrian, equestrian and cycle use. Two (2) options have been developed to refurbish the structures for use as rail trail bridges.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind-for-kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25 - 50 year design life along with a 5kPa load rating. A 5 kPa load rating also has the advantage over a 3 kPa loading in that it allows light duty service vehicles to cross the bridges for maintenance purposes on the trail.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure.

Another option was explored for repurposing these rail trail bridges that utilises the entire existing structure (minus the ballast, transom and railway line) in its 'current' condition with the existing poor (missing) deck planks being replaced and a new code-compliant handrail system installed to the exterior girders. Given the very poor condition of most of the elements in all the bridges, this option is not viable due to it being structurally unsafe and having a very limited life span with major maintenance costs.

Both options include diffusing the remaining hardwood elements with Borate salt rods to increase the life of the structure by preventing decay. It is also highly recommended that all exposed bright wood be treated with Copper Naphthenate and end-grains should be sealed with a paraffin wax sealant.

Option 2, which is the more expensive repair option in all cases but gives the longest lifespan, is our recommended option for refurbishment of all the bridges with the exception of the bridge south of Old Ben Lomond Road. This bridge was included in the inspection as an indicator of some of the other smaller bridges in this section (where the use of pre-fabricated bridges has been recommended). This bridge is more expensive to repair on a per metre basis than the other bridges included in the assessment. It is not of particular significance. A pre-fabricated bridge has been recommended at this location. Funds for bridge repairs will provide a better return if spent on the other 4 major bridges (as well as the bridges over Stonehenge Creek and Red Bank Creek).

The costs of the Option 2 repairs for each of the bridges is:

- Manrowan Creek Bridge (major) $523,250
- Upper Williams Creek Bridge (major) $186,875
- Williams Creek Bridge (major) $258,750
- Beardy Waters Bridge (major) $948,750
- Stonehenge Creek Bridge (minor) $123,625

(All costs noted above include a 15% contingency and assume piles below ground and the concrete foundations will support a 5kpa pedestrian load. Costs exclude GST).

In considering bridge re-use, the use by emergency vehicles and maintenance vehicles also needs to be considered. The bridge designs costed in the WRD report provide for a 5kPa loading which will allow light duty service vehicles to cross the bridges for maintenance purposes on the trail. This rating may not allow heavier emergency vehicles to use the bridges. However, the bridges in the Armidale to Black Mountain do not need to carry emergency vehicles given that the sections are not "isolated" i.e. road access is relatively simple. That is, emergency vehicles can get onto the trail very easily either side of any of the bridges. The situation is slightly different when considering the rail trail between Ben Lomond and Glen Innes. There are two bridges between Glencoe and Stonehenge Recreation Reserve – the bridges over Williams Creek and Beardy Waters. This means the section between these two bridges is potentially isolated if one bridge cannot carry vehicles (or "go arounds" cannot be found). It is recommended that the Williams Creek bridge (the smaller of the two) be re-furbished to carry vehicles. This will require decking to be suitable to carry vehicles. The bridge should sound enough to carry the weight of a 4WD emergency services vehicle (up to 4 tonnes) or a rural fire appliance (13 tonne). This has not been costed.

Notes for all bridges

Handrails will be required where the fall from the bridge decking to the ground is greater than 1 metre. This is a Standards Australia requirement. Handrails will help ensure the safety of users of the bridges, preventing people from falling over the sides and giving a sense of safety, uniformity and consistency along the trail. Timber handrails are best, providing a more aesthetic finish and are more in keeping with rail trail heritage values (although pre-fabricated bridges are unlikely to have timber handrails). One design option is to use galvanised chain link mesh (50mm diamond mesh) with support bracing to prevent children climbing through.

In dealing with bridge design, the Councils will need to consider use by horses. Unlike the bridges in the Ben Lomond to Black Mountain section which are not very high and should not concern horse riders, bridges between Ben Lomond and Glen Innes in particular are higher and may present concerns for horse riders. Concerns are sometimes raised about leading horses over high bridges. If horse riders are permitted to, and want to, use the entire trail (from Glen Innes to Armidale) , they will need to be confident that their horses can be led over these high bridges. If the users are not confident of their horses over such a height, they should not use sections of the rail trail where there are high bridges. If a trail is developed along the longer corridor, information should be included in trail literature, notifying users of the bridge height. On the corridor, a 'Dismount and Walk' policy on bridges should be implemented, with signage directing horse riders to dismount. This is recommended to guard against riders being thrown off horses on structures likely to be intimidating to horses (and young and novice riders). This policy should prove quite adequate to manage what is statistically likely to be a relatively small number of potentially dangerous situations.

There are designated standards for handrails for pedestrians and cyclists (1.0 – 1.1m high for walkers and 1.4m for cyclists with a number of detailed specifications regarding design). There are no standards for horses, although the UK has adopted a height of 1.8m where fall to ground is significant.

3.7.4 PREFABRICATED BRIDGES

There are six locations along the corridor between Ben Lomond and Glen Innes where small timber bridges are in place but have fallen into significant disrepair. A simple option (and the one included in the works lists) where bridges are in poor condition is to install pre-fabricated bridges. Landmark is one company that specialises in supplying such bridges but there are other suppliers.

In considering replacing timber bridges, an alternative is to recycle some of the salvaged timber and utilising appropriately skilled community members to construct some replacement bridges out of the recycled timber, thus reducing the requirement for pre-fabricated bridges. This may save some costs, though this approach will not be cost-free. The recycled timber could also be used elsewhere on the rail trail for seating, shelters, gates, fencing, etc.

The preferred option is always to re-furbish existing bridges. Given the large number of bridges along this corridor recommended for refurbishment, the use of a limited number of pre-fabricated bridges will not detract from the user experience.

3.7.5 BRIDGE OVER MCLENNAN STREET, ARMIDALE

When the 2018 New England Rail Trail report was prepared, Armidale Regional Council had passed a resolution asking for the McLennan Street to be removed. In September 2020, the bridge was still in place. The costings contained in Section 4 include a cost for re-decking and adding handrails to the existing structure (a cost of $60,000). Comments made by ARC in response to the draft 2020 report indicate a desire to consider removing the McLennan St bridge as it causes traffic issues with low clearance from the road to the bottom of the supporting I-beam. The rail trail would be unaffected if a replacement bridge is put in place. A pre-fabricated bridge suitable to carrying pedestrians and cyclists (it need not be rated to carry vehicles) could be used as a replacement bridge at this location with minimal concerns. A steel truss curved bridge (Landmark make such a bridge as do other companies) could be installed and it is likely that the lowest part of such a bridge would be much higher above the road than the current I-beam. This would mean the bridge decking need not be any higher than the exisiting railway line (or the level of the rail trail). Approaches to such a bridge would not need to “ramp-up” to deliver the necessary height clearance due to the design of the pre-fabricated bridge. It is anticipated that such a bridge would be of the order of $10,000/lineal metre for a total of $100,000. Allowing for “on-costs” included in each of the costs tables (approvals, contingency and project management) would mean a cost of **$122,500** (an additional $49,000 compared to a cost of $73,500 for re-decking and handrailing the existing bridge – this figure also includes the on-costs). **This figure does not include any provision for removal of the existing bridge – this is not properly a function of the rail trail project.**

3.8 TRAILHEADS AND PARKING

A trailhead is usually defined by the existence of a car parking area, often with picnic facilities, interpretive signage, a map panel of the trail showing sites of interest and distances to features along the trail and a Code of Conduct. It is a location where a (short or long) trail walk or ride can begin or end. Given that much of the usage of the New England Rail Trail is likely to come from users from other areas, formal 'trailheads' are important.

6 trailhead locations have been selected for the Trail between Armidale and Black Mountain, and between Ben Lomond and Glen Innes:

- Armidale station;
- Dumaresq station
- Exmouth station (at the site of the previous station – no evidence remains of its existence);
- Glencoe (at the site of the previous station – no evidence remains of its existence);
- Stonehenge (at the Recreation Reserve to make use of existing facilities such as parking and toilets); and
- Glen Innes station.

A typical trailhead interpretive shelter. Usually these shelters may contain two information panels (front and back, with general information, a map with the trail route and key features and important safety information for trail users.

Basic facilities such as parking, and a picnic table or seats in the shade, interpretive information (on a map panel) showing distances to features and towns along the rail trail is important and will prove useful to all rail trail users.

This is in addition to trailheads identified in the 2018 report at Ben Lomond Station, New England Highway Park in Guyra, and Black Mountain station (trailhead concept plans and costs for these were included in the 2018 report). With respect to the Black Mountain trailhead, the Black Mountain Preservation Society has sought input into the final design of the trailhead. The Society has also suggested moving some of the trailhead facilities - the trailhead signage, carpark and public toilet – to the old goods yard. Detailed design of the trailhead (noting the 2018 report included a concept drawing only) should be done in consultation with Black Mountain Railway Historical Society. Additional funds have been allocated in the works list to construct a toilet in the goods yard as the Society's notes suggest that using the existing toilet in the station building is not appropriate.

The works list in Section 4 also include provision for the retention of rail in the Ben Lomond station surrounds as far north as Inn Rd crossing (this was also not included in the 2018 trailhead concept drawing for Ben Lomond station).

Concept plans for the 6 trailheads are included in Appendix 4 of this Trail Plan. These are concept plans subject to more detailed design and appropriate consultation.

3.9 FENCING

Fencing along a rail trail is required for several reasons:

- To prevent unauthorised access onto the rail trail;
- To prevent authorised trail users (cyclists, walkers, horse riders) from attaining access onto adjoining properties, and to prevent unauthorised trail users (trail bikes, etc.) from illegally trespassing onto private property;
- To minimise disturbance of stock by trail users;
- To prevent encroachments by adjoining landowners;
- To delineate freehold (private property) from Crown land and to minimise encroachments and trespassing, unintended or otherwise;
- To prevent stock from straying (recognising that it is the landowner's responsibility to ensure stock does not stray); and
- To keep stock off the rail trail and away from trail users.

It is critical that the rail trail corridor be fenced on both sides of the trail where it passes through farms – for public liability insurance and risk reasons. The rail trail corridor cannot remain unfenced.

When preparing the 2018 report covering the section of the New England Rail Trail from Ben Lomond to Black Mountain, there was significant discussion about the best way to maintain the corridor as maintenance costs are one of the major concerns of the Armidale Regional Council.

There are three options for corridor maintenance that will impact significantly on fencing requirements:

- Option 1 requires the erection of new fences along the entire corridor so that there is a 6 metre trail corridor along the entire route (except through the town sections of Armidale and Glen Innes). Adjoining landholders are offered the opportunity to graze the "excess" corridor. Interest needs to be sought before this major cost exercise is undertaken. Use of permanent fencing to facilitate grazing the "remnant" corridor will involve installing new fencing closer into the trail (rather than at the property boundary). This ensures ongoing grazing access to the "remnant" corridor, even if land ownership changes. As the original railway corridor is mostly 30 – 60 metres wide, the excess corridor can be leased to adjoining landowners. This approach will minimise the reduction in land that they currently farm and enable stock to 'maintain' the corridor outside of the fenced trail corridor (noting that some landholders already have stock on the corridor – this factor has kept regrowth to a minimum in some locations).

  This option will involve a high capital cost. The recommended fencing alignment will follow the edge/top of any embankments (at the edge of the railway formation) and along the top of any cuttings.

  Under this option, fencing accounts for some 16% of construction costs along the corridor. This option provides for low maintenance costs in terms of reduced slashing requirements (though human resources will be required to manage this process). This is the preferred option and is costed within the works tables in Section 4 and the option considered when calculating maintenance costs (Section 7). Under the maintenance costings, the only slashing costed is the 6 metre corridor width.

If this option is pursued, the installation of the fencing should be undertaken in close consultation with the adjoining landowners who wish to graze the corridor.

- Option 2 would allow stock to graze the "remnant" parts of the corridor at given times of the year to manage vegetation growth. The best approach to temporary seasonal grazing may be to allow grazing by the use of temporary electric fencing delineating the grazing areas. This is a low-cost solution and the payment for electric fencing can be negotiated between the landowner and the relevant council. Livestock could be permitted on the corridor at certain times of the year for a limited period of time. Under this management scenario, stock should be moved off the corridor on weekends (this is anticipated to be the highest use time). This approach reduces the opportunities for negative interactions between stock and trail users (though none are anticipated). The grazing opportunity is offered to adjoining/nearby landholders as needed. This approach needs the trail manager to actively seek and manage temporary licences. This option offers a low capital cost, and relatively low maintenance cost (falling between Option 1 and Option 3). This option has not been included in any cost calculations (either capital or maintenance).
- Option 3 is basically a 'do nothing' option. No new fencing would be erected (none is needed). The trail manager would manage the entire corridor width, slashing up to 5 - 6 times/year depending on growing seasons. This has effectively no capital cost but a very high maintenance cost. It also means that no stock would be permitted on the corridor due to public safety and public liability concerns. Again, this option has not been included in any cost calculations (either capital or maintenance).

3.10 STOCK CROSSINGS

A number of 'private' level crossings were encountered during field work for this report– these crossings allow adjoining landowners to move their stock or machinery from one side of the rail trail corridor to the other.

Any such crossings should be retained, and the development of any trail will need to make allowance for their retention. These facilities are only required where landholders own parcels on both sides of the corridor. They may also be needed where an adjoining landholder expresses an interest in grazing the "remnant" corridor as discussed in 3.9 above.

Such crossings can be either 'open' meaning that stock are able to cross the rail trail to the other side of the corridor at all times, unhindered by gates – with trail users having to open gates to get across the stock crossing, or they can be gated either side of the corridor meaning that the adjoining landowners would be responsible for opening the gates when needed.

By having 'open' stock crossings, the matter of stock being cut off from water supplies on the other side of the fenced corridor is negated. In this scenario, trail users will need to open self-closing gates at each side of the crossing and pass across from one side to the other. The gates need to be 1200mm spring-loaded gates opening into the crossing in order to prevent stock pushing them open. Gate design needs to ensure that the gate closes against the adjoining fence post (i.e. the opening for the gate is to be less than 1200mm). While not favoured by rail trail users as this is somewhat inconvenient (especially when there are many gates to open/close) it is regarded as one of the best compromise designs. By allowing stock from adjoining farms to cross from one side of the corridor to the other at all times, the interruption to current farming practices is minimised and adjoining landowners are much more favourably disposed to the prospect of the rail trail.

Another alternative is to use stock grids either side of the crossing that trail users must pass over. This does away with the need for gates to be opened (and closed) by trail users. Care must be taken in the design and fabrication of the grids to ensure they are safe for trail users, particularly cyclists. If horse riders are to be permitted on the corridor, this solution does not work. (See photos next page).

A more expensive option – in use on the Tumbarumba-Rosewood Rail Trail – uses underpasses made using large 3000mm x 2700mm concrete box culverts. This completely removes interactions between stock and machinery, and trail users. These are placed where there are cuttings to minimise earthworks. At a cost of $36,000 each, the trail manager needs to carefully consider their use if this is a preferred option.

Cement stabilisation of the rail trail surface at each 'stock crossing' is strongly recommended to ensure the regular passage of stock across the rail trail does minimal damage to the trail surface and is long-lasting.

Individual discussions with landholders at the time of construction would work out the most appropriate system. The works lists (Section 4) has identified a number of locations where such systems may be needed based on observations rather than discussions with landholders. The costings are for the first system discussed above – the 'open' and 'closed' systems.

Above: a typical example of a grid on a rail trail – from the Busselton to Flinders Bay Rail Trail near Margaret River in Western Australia.

Above: a slightly different system on the Tumbarumba-Rosewood Rail Trail (this system has been designed by the Riverina Highlands Rail Trail Committee). Both designs (Margaret River and Tumbarumba) cost approximately the same as the gating system described above.

Above: an underpass on the newly developed Tumbarumba Rosewood Rail Trail in NSW.

There are several options for moving stock across a rail trail. Top: crossings that are gated either side of the corridor allow the controlled passage of stock and/or machinery at certain times (referred to as a Type B in the works lists). Bottom: crossings where gates are across the rail trail, where trail users need to open/close the gate (referred to as a Type A in the works lists.

Above and below: two styles of stock crossings on the Otago Central Rail Trail in New Zealand.

3.11 ENCROACHMENTS IN THE TRAIL CORRIDOR

Between the closure of the railway in 1988 and the present, several encroachments on to the former railway corridor have been made. Grazing of livestock occurs in several locations. Cross fences abound – their purpose is no longer clear. A private landing strip has been constructed on the corridor between Glencoe and Stonehenge, though only the very end of the strip impinges on the railway corridor. This is not considered a major issue and the works list include some signage and better fencing to manage any potential interactions. Along the same section of corridor (north of Williams Creek), the embankment appears to have been bulldozed through in two locations. Reinstatement has been allowed for in the works tables. In other locations, water pipes run across the corridor and formation and pumps are located on the corridor. In these cases, the trail manager needs to work with the owners of the equipment to ensure satisfactory outcomes for both parties.

3.12 TOILETS

With respect to the trail sections covered by this report, proposed trailheads at Armidale, Glencoe, Stonehenge and Glen Innes have existing toilets. The Black Mountain Preservation Society has advised (via a submission to the 2018 report) that the toilet at that station is most likely unsuitable for use and construction of a modern toilet would require destruction of the station building's heritage values. The group has suggested a new toilet be built elsewhere on site. This comment has been accepted and costing for a new toilet has been included in Section 4 of this report. This may also be the case at Ben Lomond but no cost provision has been included in this report.

There is no standard accepted distance between toilets on a trail. The costings in Section 4 provide for new toilets at Dumaresq and Exmouth trailheads. It is not known whether Dumaresq has on-site power and water but a composting toilet could be added to the trailhead. The Exmouth trailhead site is somewhat remote but accessible by vehicle. In order to minimise risk of passing vandalism, it is recommended that a composting toilet be installed south of the trailhead away from, and not visible to, the road crossing. An allowance has been included in the works list, but a specific site has not been nominated as site conditions would need to be taken into account.

3.13 CONNECTING TRAILS

There are likely to be opportunities to establish connecting trails between the rail trail and adjacent attractions (both community and commercial facilities). For example, Table 6 identifies such an opportunity to connect the trail to the Glencoe camp draft grounds. Armidale Regional Council and Glen Innes Severn Council should pursue those opportunities with interested parties. A simple connection would most likely require a connecting trail, a self-closing pedestrian gate in the rail trail fence, and appropriate signage. In some instances, agreements to traverse the "trail envelope" in instances where there is excess land between the rail trail corridor and the facility may be required, though, if these opportunities are identified during the construction process, an "trail envelope" can be left in place. The costs of these provisions can be negotiated between the trail manager and the provider.

SECTION 4 - WORKS LIST AND PROBABLE COSTS

4.1 INTRODUCTION

Investigations undertaken during the fieldwork associated with this project enable a reasonably accurate picture of the work required to bring about the development of a rail trail within the disused railway corridor between Armidale and Black Mountain, and between Ben Lomond and Glen Innes.

4.2 LANDHOLDER CONSULTATION

The study brief does not include any formal community consultation in this project.

There will be a range of issues raised by adjoining landholders. Many of these were raised in the consultation conducted by the Department of Premier and Cabinet. Many of these issues and solutions have been covered by the endorsed NSW Government position as laid out in the *Strategic Risk Assessment – Biosecurity Risks Associated with Rail Trails*.

In response to possible questions, this report includes a number of specific solutions that are recommended to address issues that are likely to arise. There is also a generic allowance in the tables for each section of the rail trail for other items that may be requested by landholders in the future.

4.3 SECTION COSTS

For the purposes of determining costs, the per unit construction rates set out below have been used:

- Trail construction. Construction includes stripping of top soil, boxing out, cleaning side drains, compacting subgrade (to 150mm), filling with road base, levelling, trimming, shaping and compacting: \$60/lineal metre (for 2.5m trail width). Assumes formation is clean and reasonably level (subsequent to steel track and sleeper removal). In response to the 2018 report, Glen Innes Severn Shire Council had advised that due to a number of factors, this cost is too high (at least in the section between Glen Innes and Ben Lomond). The Council believes there should be no need for stripping of topsoil. Once the line and sleepers are removed, a grader would be able to level the existing ballast material, which seems to be uniformly in place and will provide a substantial existing formation material. This would mean that around 0.45 m^3/lineal metre of pavement gravel mix would be required (at 150mm depth). The Council has suggested an allowance of \$20/lineal metre for construction which would result in a cost of \$20,000/km compared with \$60,000/km. Should this be found to be the case in preparation for construction, the cost for that section would be reduced by \$1.811 million (a figure that includes the 27.5% on-costs), giving a total estimated construction cost of **\$6,910,095** (compared with \$8,721,095).
- Clearing. Clearing costs (prior to earthworks) vary:
    - Slashing or side pruning (no heavier clearing will be required along some of the corridor). The cost varies from \$1,000/km for slashing of cleared trail route (prior to earthworks), to side pruning at \$2,000/km (i.e. track may exist but needs to be

widened). An average cost of $1,500/km has been included. (The slashing costs for construction purposes are much higher than ongoing slashing covered in Section 7 as the initial slashing for construction will be a much more complicated operation).

- Minor clearing is $3,000/km;
- Moderate clearing (most notably the removal of small trees in the formation) is $6,800/km; and
- Heavy clearing (large trees and/or significant undergrowth in the formation) is $14,000/km.

**An option for slashing and flailing a separate bridle trail has been included within the works/costs tables. This is the preferred option if horse riders are to be allowed to use the rail trail. The works tables provide an option for slashing a parallel bridle trail alongside the trail from Old Inverell Rd to Black Mountain, and from Ben Lomond station to Glen Innes station (a slashed bridle trail was included in the plan for the Ben Lomond to Black Mountain section prepared in 2018).*

- Removal of steel track and sleepers. The ownership of the track and responsibility for removal (and any sale proceeds) is part of the Tumbarumba-Rosewood Rail Trail pilot project. On the Tumbarumba project, the NSW Government granted the trail manager ownership of the track and sleepers as part of the project. A removal contract was organised and proceeds of the sale of the track remained with the trail manager (with the demolition contractor taking a percentage of the sale value). The track sale price was dependent on the market price for railway track at the time of removal. It is difficult to know what market conditions will be like at the time of track removal should the New England Rail Trail proceed. For a zero cost to be realised, the price of used steel in particular is such that a commercial demolition company will remove the track free of charge recovering their costs by selling it to an appropriate market. This partially depends on how much steel is available and the price of used railway steel at the time the contract for removal is let. For the purposes of estimating construction costs, the approach taken in this report is to assume the Tumbarumba Rosewood project sets a precedent for asset ownership. Research by NERT Inc at the time of report preparation has indicated that the track can be removed and sold at a price that allows some proceeds of sale to be returned to the asset owner (as it did in the case of the Tumbarumba Rosewood Rail Trail). **However, a prudent approach is required, and it has been agreed to include a cost for rail removal of $8/metre (rather than the $33/metre that was adopted in the 2018 report which reflected earlier costs).**
- Bridge Costs
  - Installing pre-fabricated bridges (Landmark or similar) - $4,000/lineal metre. Handrails will be required as fall to ground exceeds 1m.
  - $6,000/lineal metre for re-decking and erecting handrails on existing timber bridges (where the bridge is sound). It should be noted that, in the instances where bridges are to be maintained, it is assumed that they are sound (based on visual inspections in October 2020). Detailed engineering inspections are needed

to confirm this is the case. This should occur as part of the construction management process.

- Bridge Inspections were carried out for five bridges – bridges over Beardy Waters, Manrowan Creek, Williams Creek, Upper Williams Creek, and Stonehenge Creek. Costings have been provided in the report by Wood Research and Development (see Section 3.7).

- Purchase and installation of "Trailhead" sign pointing into the trailhead from road(s) - $1,600/unit.
- Research, writing, manufacturing and installation of "Trailhead" map panels at trailhead - $5,500/unit.
- Purchase and installation of "Trail crossing" signs on roads - $600/sign.
- Purchase and installation of Trail Directional Markers (incorporating emergency markers) - $600/unit installed.
- Research, writing, manufacturing and installation of interpretive panels - $3,000/panel.
- Chicane gate and management access gate (primarily at road crossings) - $3,540/set.
- Fencing - $15/metre installed. It is proposed to provide a trail corridor of 6 metres wide (with the formation in the middle forming the basis of the trail) along the entire length of the rail corridor. This allows the remaining corridor beyond the 6 metre "envelope" to be grazed by adjoining or other landholders thus reducing the maintenance costs. This adds to the construction costs but significantly reduces the maintenance costs. The trail manager may choose other less costly construction options that do not involve fencing the entire corridor (discussed in Sections 3 and 7) but this would increase the maintenance costs. From observations of the corridor, fencing would appear to be a choice of six-strand wire (2 strands of barb wire with 4 strands of plain wire) where cattle are present and hinge joint mesh fencing where sheep are present.

4.4 ADDITIONAL NOTES

The works tables have been divided into two separate sections – Armidale to Black Mountain (Section 4.5) and Ben Lomond to Glen Innes (Section 4.6).

The following notes are relevant when reading Tables 1 to 9:

Map references shown in the tables refer to works items shown on Plans in Appendix 6:

- Plan 1 covers the section from Armidale to Dumaresq.
- Plan 2 covers the section from Dumaresq to Exmouth.
- Plan 3 covers the section from Exmouth to Black Mountain.
- Plan 4 covers the section from Ben Lomond to Glencoe.
- Plan 5 covers the section from Glencoe to Stonehenge (the Recreation Reserve where the trailhead is located).
- Plan 6 covers the section from Stonehenge to Glen Innes.

Only major and significant works items are shown on the maps. These are generally in the precise location (though measurements may vary slightly on the ground).

Optional items are included within each of the tables:

- Each of the 6 section tables includes the option of the development of a parallel bridle trail. Option 1 is a trail for walkers and cyclists with no separate bridle trail. Option 2 is a trail for walkers and cyclists with a separate bridle trail.
- For ease of understanding, the maximum expenditure in each section is used as the basis for calculating associated costs – accessibility factors, approvals, contingency, and project management.

4.5 WORKS TABLES – ARMIDALE TO BLACK MOUNTAIN

Table 1: Armidale Station to Dumaresq Station (9,828 metres) (refer Plan 1 in Appendix 6)

Ref #	GPS Reference	Works Item	$
1		Construct trail between Armidale Station and Dumaresq Station (9,828 m).	589,680
2		Slashing/side clearing (station ground to McLachlan St overpass) (400 m).	600
3	S 30° 30.930’ E 151° 39.155’	Trailhead: Armidale Station. (See Trailhead plan – Appendix 3). • Install trailhead sign (brown chevron) on Brown St ($1,600). • Prepare and install trailhead map panel ($5,500). • Install Trail Directional Marker (Straight Ahead arrow on both faces) ($600) • Install trailhead sign ($1,000). • Construct connecting concrete footpath from parking area to trail (35m) ($7,000). • Construct bitumen carpark (30m x 30m) ($27,000) • Construct connecting driveway – Road to carpark (25m) ($1,875)	44,575
4	S 30° 30.895’ E 151° 39.107’	Install Trail Directional Marker (Straight Ahead arrow on both faces).	600
5	S 30° 30.887’ E 151° 39.085’	Install Trail Directional Marker (Straight Ahead arrow on both faces).	600
6	S 30° 30.868’ E 151° 39.066’	Install Trail Directional Marker (Straight Ahead arrow on both faces) ($600) Existing security fence adjacent to “Inspector of Permanent Way” cottage. Remove fence ($200). Construct trail on raised platform to eastern locked gate of storage sheds.	800
7	S 30° 30.840’ E 151° 39.035’	(*Approximate location – detailed location to be negotiated*). Take trail off platform (via wheeling ramp) onto rail formation ($4,000). Several railway lines in this location. Choose suitable formation in consultation with track/station manager. Construct trail to McLachlan St overpass (costed in WI1).	12,500

		Install 1.5 m chain mesh fence on both sides to WI 8 to separate trail users from infrequent low speed train movements (340m) ($8,500).	
8	S 30º 30.700’ E 151º 38.884’	Bridge – McLennan St overpass. Install handrails and new decking.	60,000
9	S 30º 30.700’ E 151º 38.884’	Install steep embankment signs and delineators along 100 m of trail (to WI 12).	3,500
10	S 30º 30.700’ E 151º 38.884’	Moderate clearing – allows for some necessary tree clearing (McLachlan St overpass to WI 17) (1,455m).	9,895
11	S 30º 30.665’ E 151º 38.850’	Retain/renovate/repaint railway sign.	200
12	S 30º 30.653’ E 151º 38.837’	End installation of steep embankment signs.	0
13	S 30º 30.515’ E 151º 38.698’	Retain timber bridge - Martins Gully (3m). Bridge is a transom bridge with brick abutments. Install decking and handrails (the assumption is that the bridge structure is sound).	18,000
14	S 30º 30.431’ E 151º 38.618’	Retain/renovate/repaint railway sign ($200) Start - Clear side drains (both sides) for 370 m (to WI 15) ($3,700).	3,900
15	S 30º 30.287’ E 151º 38.473’	End - Clear side drains.	0
16	S 30º 30.247’ E 151º 38.432’	Rectangular concrete culvert. Clean out and maintain.	200
17	S 30º 30.110’ E 151º 38.342’	End moderate clearing. Start minor clearing to WI 65 – Dumaresq trailhead (7,973m).	23,920
18	S 30º 29.948’ E 151º 38.131’	Road crossing – Old Inverell Road. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “Give Way” sign on south eastern side of road ($200). • Install “trail crossing on side road” signs on Old Inverell Road and Boorolong Rd (4 in total) ($2,400). • Install trail user chicane and management access gate (north western side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540). • Remove existing fence ($200).	29,440

		Develop minor trailhead on-site: • Prepare and install trailhead sign (double-sided brown chevron) on Boorolong Rd ($1,600). • Construct gravel carpark (30m x 20m) ($15,000). • Construct short connecting trail from parking area to trail (10m) ($600). • Prepare and install trailhead map panel ($5,500).	
19		Erect fencing along the corridor (both sides) to create a 6 metre trail envelope – Old Inverell Rd crossing to Dumaresq trailhead (7,573 m).	227,190
20		*Slash and flail bridle trail alongside main trail (if horses are to be permitted – recommend this be the horse commencement point if horses permitted (7,573 m).*	*15,146*
21	S 30° 29.816' E 151° 38.005'	Rectangular concrete culvert. Clean out and maintain.	200
22	S 30° 29.650' E 151° 37.843'	2 pipe culvert - steel pipes in concrete wall. Clean out and maintain.	300
23	S 30° 29.434' E 151° 37.655'	Road crossing – Rowlands Street. (See road crossing drawing - Appendix 1). • Install "road ahead" signs on both sides ($400). • Install "trail crossing" sign (2 locations) ($1,200). • Install "trail crossing on side road" sign (2 locations) ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080) • Remove existing fence ($200). • Retain/renovate/repaint railway sign (immediately west of road crossing) ($200)	10,280
24		Additional allowance for tree clearing and blackberry clearing - Rowlands Rd to Redgum Lane (1,920 m).	23,040
25	S 30° 29.308' E 151° 37.596'	2 pipe culvert - steel pipes in concrete wall. Clean out and maintain.	300

26	S 30º 29.217’ E 151º 37.575’	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 265m (to WI 29).	5,300
27	S 30º 29.166’ E 151º 37.567’	Retain/renovate/repaint distance peg (583 km).	200
28	S 30º 29.135’ E 151º 37.562’	Allow screen planting (280m x 3m) on eastern side of rail corridor (to WI 31).	5,040
29	S 30º 29.086’ E 151º 37.554’	Northern end of cutting. End – clear side drains.	0
30	S 30º 29.039’ E 151º 37.548’	Retain timber bridge (11m). Bridge is a steel transom bridge with brick abutments. Install decking and handrails (the assumption is that the bridge structure is sound).	66,000
31	S 30º 29.135’ E 151º 37.562’	End screen planting.	0
32	S 30º 28.840’ E 151º 37.514’	Road crossing – Bellewood Road. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “trail crossing” signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Remove existing fence ($200).	8,880
33	S 30º 28.802’ E 151º 37.506’	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 190m (to WI 34).	3,800
34	S 30º 28.705’ E 151º 37.458’	Northern end of cutting. End – clear side drains.	0
35	S 30º 28.633’ E 151º 37.398’	Rectangular concrete culvert. Clean out and maintain.	200
36	S 30º 28.612’ E 151º 37.375’	Retain timber bridge (3m). Bridge is a steel transom bridge with brick abutments. Install decking and handrails (the assumption is that the bridge structure is sound).	18,000
37	S 30º 28.516’ E 151º 37.215’	Road crossing – Redgum Lane. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400).	8,880

		• Install "trail crossing" signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Remove existing fence ($200).	
38	S 30° 28.492' E 151° 37.167'	Retain/renovate/repaint 3 railway signs.	600
39	S 30° 28.462' E 151° 37.102'	Brick culvert. Clean out and maintain.	200
40	S 30° 28.413' E 151° 37.004'	Eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 200m (to WI 41).	4,000
41	S 30° 28.358' E 151° 36.892'	Western end of cutting. End – clear side drains. Allow screen planting (400m x 3m) on northern side of rail corridor (to WI 43) ($7,200). Retain/renovate/repaint distance peg (585 km – note 584km marker is missing) ($200).	7,400
42	S 30° 28.282' E 151° 36.727'	Brick culvert. Clean out and maintain.	200
43	S 30° 28.266' E 151° 36.692'	End screen planting.	0
44	S 30° 28.226' E 151° 36.618'	Retain/renovate/repaint railway sign.	200
45	S 30° 28.195' E 151° 36.557'	Eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 400m (to WI 46).	8,000
46	S 30° 28.092' E 151° 36.347'	Western end of cutting. End – clear side drains Retain/renovate/repaint railway sign.	200
47	S 30° 28.043' E 151° 36.234'	Renovate/paint existing sign (yellow speed sign).	200
48	S 30° 28.010' E 151° 36.165'	Brick culvert. Clean out and maintain. Headwall broken on southern side – needs repair (allow $1,000).	1,200
49	S 30° 27.995' E 151° 36.137'	Allow screen planting (50m x 3m) on northern side of rail corridor (to WI 50).	900
50	S 30° 27.980' E 151° 36.118'	End screen planting. South eastern end of deep cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (325m) (to WI 51).	9,750

51	S 30º 27.837’ E 151º 35.985’	North western end of cutting. Retain/renovate/repaint railway sign.	200
52	S 30º 27.799’ E 151º 35.934’	Brick culvert. Clean out and maintain.	200
53	S 30º 27.773’ E 151º 35.868’	Retain/renovate/repaint distance peg (587 km – note 586km marker is missing) ($200). Allow screen planting (100m x 3m) on northern side of rail corridor (to WI 54) ($1,800).	2,000
54	S 30º 27.754’ E 151º 35.805’	End screen planting. Eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 265m (to WI 55).	5,300
55	S 30º 27.768’ E 151º 35.643’	Western end of cutting. End – clear side drains. Retain/renovate/repaint railway sign (possibly Dumaresq Yard sign) ($200). Remove cross fence ($200).	400
56	S 30º 27.772’ E 151º 35.592’	Brick culvert (with concrete headwalls). Clean out and maintain.	200
57	S 30º 27.808’ E 151º 35.466’	Retain/renovate/repaint railway sign.	200
58	S 30º 27.840’ E 151º 35.265’	Eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 580m (to WI 62) ($11,600). Install trail user chicane and management access gate. Set in concrete/asphalt apron for ease of maintenance (nearest practical point to Dumaresq Road crossing and trailhead for vehicle exclusion device to work) ($3,540).	15,140
59	S 30º 27.840’ E 151º 35.252’	Retain/renovate/repaint distance peg (588 km).	200
60	S 30º 27.790’ E 151º 35.027’	Retain restored railway signal.	0
61	S 30º 27.775’ E 151º 34.995’	Retain restored existing railway switch. Existing railway splits into 2 tracks – northern one runs to good shed.	0
62	S 30º 27.735’ E 151º 34.930’	Western end of cutting. End – clear side drains. Allow screen planting (70m x 3m) on northern side of rail corridor (to WI 63).	1,260
63	S 30º 27.717’ E 151º 34.889’	End screen planting.	0

64	S 30° 27.694' E 151° 34.854'	Dumaresq Railway Station. Allowance for works items around station (negotiate with owner and caretaker).	10,000
65	S 30° 27.661' E 151° 34.820'	Trailhead: Dumaresq Station. (See Trailhead plan – Appendix 3). • Install trailhead sign (brown chevron) on Dumaresq Road ($1,600). • Prepare and install trailhead map panel ($5,500). • Install trailhead sign ($1,000) • Construct gravel carpark (40m x 20m) ($20,000). • Construct connecting gravel driveway – Dumaresq Road to carpark (90m x 3m) ($6,750). • Construct short connecting path from parking area to trail (15m) ($900). • Install 80m of bollards (at 1.4m spacing) ($6,670). • Install toilet ($50,000) – not included on drawing.	92,020
		Allowance for additional landowner requests (e.g. fencing and vegetation screening).	10,000
		Allowance for preparation and installation of interpretive signage (at locations to be determined by trail manager and local historians) (6 signs).	18,000
		Allowance for Trail Directional Markers (incorporating emergency markers) to be placed along trail every 1 km.	6,000
		Allowance for installation of trailside furniture (e.g. seats) at locations to be determined by trail manager.	3,000
		Allowance for marking trees to be cleared, pruned or left untouched.	2,400
		Allowance for marking centreline of trail with flagging tape prior to clearing and construction.	3,600
		Allowance for purchase and installation of: • Regulatory signage (Shared Path; "No Trail Bikes"; "Authorised Users Only"); • Road name signs;	2,400

		• Trail name signs; • "No Trespassing" signs; • Local attractions sign; • Miscellaneous signs (Keep Out etc.).	
		Allowance for traffic management (4 road crossings).	8,000
		Allowance for cable locators at road crossings (4 road crossings).	4,000
		Option 1: Sub-total (Section 1)	*1,393,390*
		Option 2: sub-total (Section 1) (maximum estimated expenditure)	*1,408,536*
		Approvals, permits, applications, designs, specifications, assessments (2.5% of maximum estimated expenditure - $1,408,536).	35,215
		Contingency amount (15% of maximum estimated expenditure - $1,408,536).	211,280
		Project management (5% of maximum estimated expenditure - $1,408,536).	70,425
		Contingency allowance for removal of steel track and sleepers and shaping of basic track by contractor ($8/metre).	78,624
		TOTAL (NOT INCLUDING GST)	***1,804,080***

Option 1: walker/cyclist trail: no separate bridle trail.
Option 2: walker/cyclist trails; separate bridle trail.

Table 2: Dumaresq Station to Exmouth Station (11,378 metres) (refer Plan 2 in Appendix 6)

Ref #	GPS Reference	Works Item	$
1		Construct trail between Dumaresq Station and Exmouth Station (11,378m).	682,680
2		Slashing required. Dumaresq Trailhead to WI 13. (975m).	1,460
3		Erect fencing along the corridor (both sides) to create a 6 metre trail envelope (11,378m).	341,430
4		*Slash and flail bridle trail alongside main trail (if horses are to be permitted) (11,378m).*	*22,758*
5	S 30° 27.661' E 151° 34.820'	Trailhead: Dumaresq Station. (detailed in Table 1)	0
6	S 30° 27.638' E 151° 34.755'	Road crossing – Dumaresq Road. (See road crossing drawing - Appendix 1). • Install "road ahead" sign on western side of road ($200). • Install "trail crossing" signs on both sides of trail ($1,200). • Install trail user chicane and management access gate (western side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540). • Remove existing fence ($200).	5,140
7	S 30° 27.615' E 151° 34.717'	Retain restored existing railway switch. Retain/renovate/repaint railway sign (10 m west of switch).	400
8	S 30° 27.562' E 151° 34.622'	Retain timber bridge (4m). Bridge is a steel transom bridge with brick abutments. Install decking and handrails (the assumption is that the bridge structure is sound).	24,000
9	S 30° 27.494' E 151° 34.509'	Trail crosses access road (2 properties). Install trail user chicane and management access gate (western side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540). South eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 230m (to WI 11) ($4,600).	8,140
10	S 30° 27.447' E 151° 34.443'	Retain restored existing railway switch.	200

11	S 30° 27.416' E 151° 34.398'	North western end of cutting. End – clear side drains.	0
12	S 30° 27.368' E 151° 34.341'	Rectangular concrete culvert. Clean out and maintain.	200
13	S 30° 27.314' E 151° 34.273'	Remove cross fence (where rail corridor meets road reserve) ($200). Minor clearing to WI 50 (4,365m) ($13,095).	13,295
14	S 30° 27.275' E 151° 34.230'	3 pipe culvert - steel pipes in rock and sandbagged wall. Clean out and maintain.	300
15	S 30° 27.262' E 151° 34.218'	Retain/renovate/repaint distance peg (590 km - note 589km marker is missing). Wooden stop and galvanised post also at this location (not original).	200
16	S 30° 27.038' E 151° 34.012'	Retain/renovate/repaint railway sign (10 m west of switch).	200
17	S 30° 26.910' E 151° 33.920'	Road crossing – Warrane Road. (See road crossing drawing - Appendix 1). • Install "road ahead" signs on both sides ($400). • Install "trail crossing" signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Install pipe culverts under trail at junction with road (both sides) ($3,000). • Remove existing fence ($200).	11,880
18	S 30° 26.910' E 151° 33.920'	Additional allowance for blackberry clearing - Warrane Rd to Claremont Rd (WI 47) (3,150m).	31,500
19	S 30° 26.870' E 151° 34.902'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 540m (to WI 22).	10,800
20	S 30° 26.816' E 151° 33.071'	Retain/renovate/repaint distance peg (591 km).	200
21	S 30° 26.758' E 151° 33.839'	Retain/renovate/repaint railway signs. 2 speed signs in location – 1 has the numbers intact while 1 needs a new number.	600
22	S 30° 26.540' E 151° 33.727'	Northern end of cutting. End – clear side drains. Renovate/paint existing sign.	200

23	S 30° 26.521' E 151° 33.719'	Rectangular concrete culvert. Clean out and maintain ($200). Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (490m) (to WI 25) ($9,800).	10,000
24	S 30° 26.303' E 151° 33.712'	Geological feature (land slump) or some form of borrow pit for railway. Prepare and Install interpretive sign ($3,000). Retain/renovate/repaint distance peg (592 km) ($200).	3,200
25	S 30° 26.258' E 151° 33.730'	Northern end of cutting. Allowance for removal of trees growing adjacent to formation.	1,000
26	S 30° 27.226' E 151°35.744'	Brick culvert. Clean out and maintain.	200
27	S 30° 26.199' E 151° 33.761'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 60m (to WI 28).	1,200
28	S 30° 26.174' E 151° 33.782'	North eastern end of cutting. End – clear side drains.	0
29	S 30° 26.146' E 151° 33.796'	Brick culvert. Clean out and maintain.	200
30	S 30° 26.088' E 151° 33.862'	1 pipe culvert - steel pipe in rock and sandbagged wall. Clean out and maintain.	200
31	S 30° 26.087' E 151° 33.865'	Remove cross fence.	200
32	S 30° 26.070' E 151° 33.881'	Underpass - Boorolong Rd. New bridge in place.	0
33	S 30° 26.062' E 151° 33.893'	Underpass - Boorolong Rd. Old timber bridge in place.	0
34	S 30° 26.060' E 151° 33.895'	South western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (90m) (to WI 35).	2,700
35	S 30° 26.020' E 151° 33.931'	North eastern end of cutting.	0
36	S 30° 26.007' E 151° 33.940'	Renovate/paint existing sign (double sided speed sign) ($200). 1 pipe culvert - steel pipe in rock and sandbagged wall. Clean out and maintain ($200).	400

37	S 30º 25.951’ E 151º 33.973’	Brick culvert. Clean out and maintain.	200
38	S 30º 25.936’ E 151º 33.997’	South western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (140m) (to WI 39).	4,200
39	S 30º 25.873’ E 151º 33.033’	North eastern end of cutting.	0
40	S 30º 25.851’ E 151º 34.045’	Retain/renovate/repaint distance peg (593 km).	200
41	S 30º 25.841’ E 151º 34.047’	Brick culvert. Clean out and maintain.	200
42	S 30º 25.706’ E 151º 34.107’	Brick culvert. Clean out and maintain. Embankment is very steep and culvert is quite overgrown.	400
43	S 30º 25.646’ E 151º 34.107’	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (370m) (to WI 45).	11,100
44	S 30º 25.586’ E 151º 34.115’	Retain/renovate/repaint railway sign.	200
45	S 30º 25.452’ E 151º 34.109’	Northern end of cutting.	0
46	S 30º 25.394’ E 151º 34.095’	Brick culvert. Clean out and maintain. Embankment is very steep and culvert is quite overgrown.	400
47	S 30º 25.322’ E 151º 34.076’	Road crossing – Claremont Rd. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “trail crossing” signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Install pipe culverts under trail at junction with road (both sides) ($3,000). • Remove existing cross fence ($200).	11,880
48	S 30º 25.292’ E 151º 34.066’	Renovate/paint existing sign (1 double sided speed sign).	200
49	S 30º 25.241’ E 151º 34.054’	Brick culvert. Clean out and maintain.	200

50	S 30º 25.185' E 151º 34.013'	Remove cross fence ($200). Slashing to WI 70 (2,410 m) ($3,615). Renovate/paint existing sign ($200).	
51	S 30º 25.068' E 151º 33.961'	Retain/renovate/repaint railway sign.	200
52	S 30º 25.156' E 151º 33.995'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 315m (to WI 54).	6,300
53	S 30º 25.068' E 151º 33.961'	Retain/renovate/repaint railway sign.	200
54	S 30º 24.981' E 151º 33.970'	Northern end of cutting. End – clear side drains.	0
55	S 30º 24.930' E 151º 33.986'	Brick culvert. Clean out and maintain.	200
56	S 30º 25.830' E 151º 34.086'	Retain/renovate/repaint distance peg (595 km – note 594km is missing).	200
57	S 30º 24.791' E 151º 34.124'	Start - Clear side drain (one side only) for 205 m (to WI 58).	2,050
58	S 30º 24.697' E 151º 34.266'	End – clear side drain.	0
59	S 30º 24.672' E 151º 34.336'	Retain/renovate/repaint railway sign.	200
60	S 30º 24.649' E 151º 34.436'	Brick culvert. Clean out and maintain. Note that topside is blocked with galvanised sheet and posts.	400
61	S 30º 24.621' E 151º 34.473'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 295m (to WI 63).	5,900
62	S 30º 24.521' E 151º 34.582'	Retain/renovate/repaint distance peg (596 km).	200
63	S 30º 24.500' E 151º 34.392'	Northern end of cutting. End – clear side drains.	0
64	S 30º 24.453' E 151º 34.617'	Brick culvert. Clean out and maintain.	200
65	S 30º 24.396' E 151º 34.602'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (130m) (to WI 66).	3,900
66	S 30º 24.330' E 151º 34.578'	Northern end of cutting.	0

67	S 30º 24.287’ E 151º 34.560’	Brick culvert. Clean out and maintain. Note collapsed over-structure (brick framing) - allow $1,000 for repairs.	1,200
68	S 30º 24.268’ E 151º 34.528’	Retain/renovate/repaint railway sign. Renovate/paint existing sign (2 x double sided speed sign).	600
69	S 30º 24.224’ E 151º 34.487’	Brick culvert. Clean out and maintain.	200
70	S 30º 24.169’ E 151º 34.455’	Remove cross fence ($200). Start minor clearing to WI 99 – Exmouth trailhead (3,628m). An additional allowance for clearing blackberry and fallen trees ($47,164). Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (240m) (to WI 71) ($7,200).	54,564
71	S 30º 24.063’ E 151º 34.492’	Northern end of cutting. Landslip in about 25% of cutting. Cutting is quite wide so landslip not encroaching on formation. Monitor over time – no action required in construction.	0
72	S 30º 24.521’ E 151º 34.582’	Retain/renovate/repaint distance peg (597 km).	200
73	S 30º 23.981’ E 151º 34.613’	Brick culvert. Clean out and maintain.	200
74	S 30º 23.947’ E 151º 34.651’	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (175m) (to WI 75).	5,250
75	S 30º 23.852’ E 151º 34.655’	Northern end of cutting.	0
76	S 30º 23.824’ E 151º 34.650’	Retain/renovate/repaint railway signs (2). Renovate/paint existing sign (1 x double sided speed sign).	600
77	S 30º 23.804’ E 151º 34.652’	Brick culvert. Clean out and maintain.	200
78	S 30º 23.769’ E 151º 34.639’	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (80m) (to WI 79).	2,400
79	S 30º 23.730’ E 151º 34.632’	Northern end of cutting.	0

80	S 30º 23.696’ E 151º 34.624’	Brick culvert. Clean out and maintain.	200
81	S 30º 23.624’ E 151º 34.633’	Rectangular concrete culvert. Clean out and maintain.	200
82	S 30º 23.607’ E 151º 34.625’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 280m (to WI 84).	5,600
83	S 30º 23.561’ E 151º 34.636’	Retain/renovate/repaint distance peg (598 km).	200
84	S 30º 23.472’ E 151º 34.686’	North eastern end of cutting. End – clear side drains. Remove cross fence.	200
85	S 30º 23.444’ E 151º 34.718’	1 pipe culvert - steel pipe in rock and sandbagged wall. Clean out and maintain.	200
86	S 30º 23.368’ E 151º 34.817’	Brick culvert. Clean out and maintain.	200
87	S 30º 23.861’ E 151º 34.832’	Retain/renovate/repaint railway sign.	200
88	S 30º 23.326’ E 151º 34.952’	Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 70m (to WI 89).	1,400
89	S 30º 23.320’ E 151º 34.993’	Northern end of cutting. End – clear side drains. Small elevated platform/bridge. Install pipe and fill over (2m long x 2.5m wide x 1m deep).	1,500
90	S 30º 23.317’ E 151º 35.009’	Western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (515m) (to WI 94) ($15,450). Renovate/paint existing speed sign (1 only) ($200).	15,650
91	S 30º 23.302’ E 151º 35.077’	Renovate/paint existing speed sign (1 only).	200
92	S 30º 23.302’ E 151º 35.077’	Renovate/paint existing speed sign (1 only).	200
93	S 30º 23.290’ E 151º 35.132’	Retain/renovate/repaint distance peg (599 km).	200
94	S 30º 23.205’ E 151º 35.299’	North eastern end of cutting. Remove cross fence ($200). Install trail user chicane and management access gate. Set in concrete/asphalt apron for ease of maintenance (nearest practical point to	3,740

		Exmouth Road crossing for vehicle exclusion device to work) ($3,540).	
95	S 30° 23.176' E 151° 35.335'	Rectangular concrete culvert. Clean out and maintain.	200
96	S 30° 23.140' E 151° 35.357'	Rectangular concrete culvert. Clean out and maintain.	200
97	S 30° 23.115' E 151° 35.369'	Retain/renovate/repaint railway sign.	200
98	S 30° 22.954' E 151° 35.393'	Brick culvert. Clean out and maintain.	200
99	S 30° 22.825' E 151° 35.330'	Trailhead: Exmouth Station. (See Trailhead plan – Appendix 3). • Install trailhead sign (single-sided brown chevron) on Exmouth Road ($1,000). • Prepare and install trailhead map panel ($5,500). • Install trailhead sign ($1,000). • Install picnic table ($8,000). • Construct gravel carpark (20m x 10m) ($5,000). • Install composting toilet ($50,000) – not included on drawing. Toilet should not be at trailhead due to risk of vandalism – it should be installed on trail at appropriate location south of trailhead.	70,500
		Allowance for additional landowner requests (e.g. fencing and vegetation screening).	10,000
		Allowance for preparation and installation of interpretive signage (at locations to be determined by trail manager and local historians) (6 signs).	18,000
		Allowance for Trail Directional Markers (incorporating emergency markers) to be placed along trail every 1 km.	7,200
		Allowance for installation of trailside furniture (e.g. seats) at locations to be determined by trail manager.	3,000
		Allowance for marking trees to be cleared, pruned or left untouched.	2,400
		Allowance for marking centreline of trail with flagging tape prior to clearing and construction.	3,600

		Allowance for purchase and installation of: • Regulatory signage (Shared Path; "No Trail Bikes"; "Authorised Users Only"); • Road name signs; • Trail name signs; • "No Trespassing" signs; • Local attractions sign; and • Miscellaneous signs (Keep Out etc.).	2,400
		Allowance for traffic management (3 road crossings).	6,000
		Allowance for cable locators at road crossings (3 road crossings).	3,000
		Allowance for construction access – management access gates in fence alongside road and access track onto rail corridor (allow 2 access points in addition to existing road crossings).	4,400
		Option 1: Sub-total (Section 2)	*1,422,459*
		Option 2: sub-total (Section 2) (maximum estimated expenditure)	*1,445,217*
		Allowance for additional construction costs. This section of corridor is less accessible from nearby roads than the corridor from Armidale to Dumaresq (and also from Ben Lomond to Black Mountain as discussed in the 2018 report). More time will be spent hauling material from stockpile sites created where the railway corridor crosses a publicly accessible road. One way to reduce this cost is negotiate access agreements with landholders who adjoin the corridor. Some may be willing to provide access (material can be stockpiled on the railway corridor). An allowance of 5% of construction costs has been included to allow for this additional time.	72,260
		Approvals, permits, applications, designs, specifications, assessments (2.5% of maximum estimated expenditure - $1,445,217).	36,130
		Contingency amount (15% of maximum estimated expenditure - $1,445,217).	216,785

		Project management (5% of maximum estimated expenditure - $1,445,217).	72,260
		Contingency allowance for removal of steel track and sleepers and shaping of basic track by contractor ($8/metre).	91,024
		TOTAL (NOT INCLUDING GST)	***1,933,676***

Option 1: walker/cyclist trail: no separate bridle trail.
Option 2: walker/cyclist trails; separate bridle trail.

Table 3: Exmouth Station to Black Mountain Station (11,854 metres) (refer Plan 3 in Appendix 6)

Ref #	GPS Reference	Works Item	$
1		Construct trail between Exmouth Station and Black Mountain Station (11,854m).	711,240
2		Start moderate clearing to WI 14 (mainly involves black wattles that have grown on the side of formation and fallen across formation – 1,135m).	7,720
3		Erect fencing along the corridor (both sides) to create a 6 metre trail envelope (11,854m).	355,620
4		*Slash and flail bridle trail alongside main trail (if horses are to be permitted) (11,854m).*	*23,708*
5	S 30° 22.825’ E 151° 35.330’	Trailhead: Exmouth Station. (detailed in Table 2)	0
6	S 30° 22.819’ E 151° 35.330’	Road crossing – Exmouth Road. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “trail crossing” signs on both sides of trail ($1,200). • Install “Give Way” sign (southern side of road) ($400). • Install trail user chicanes and management access gates (northern side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540). • Remove existing fence – north side only ($200).	5,740
7	S 30° 22.801’ E 151° 35.318’	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (710m) (to WI 12) ($21,300). 200 metres at southern end requires extra drainage treatment as it is very sandy and boggy (allowance - $5,000).	26,300
8	S 30° 22.783’ E 151° 35.308’	Retain/renovate/repaint distance peg (601 km). Numbers missing on sign. Note 600km marker is missing.	400
9	S 30° 22.662’ E 151° 35.251’	Remove large rock on formation.	400

10	S 30° 22.607' E 151° 35.248'	Retain/renovate/repaint railway sign.	200
11	S 30° 22.580' E 151° 35.252'	Small break in cutting. Rectangular concrete culvert. Clean out and maintain.	200
12	S 30° 22.438' E 151° 35.339'	North eastern end of cutting.	0
13	S 30° 22.399' E 151° 35.401'	Renovate/paint existing railway sign.	200
14	S 30° 22.322' E 151° 35.560'	Collapsed drain. Install pipe and fill over (4m length by 2m deep) ($5,000). End moderate clearing. Start minor clearing (to WI 20 - 835m) ($2,505).	7,505
15	S 30° 22.299' E 151° 35.560'	South western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (400m) (to WI 18).	12,000
16	S 30° 22.247' E 151° 35.642'	Clear fallen rocks on formation over 10 metres.	1,000
17	S 30° 22.212' E 151° 35.702'	Small break in cutting. Rectangular concrete culvert. Clean out and maintain.	200
18	S 30° 22.168' E 151° 35.771'	North eastern end of cutting.	0
19	S 30° 22.077' E 151° 35.915'	Retain/renovate/repaint distance peg (602 km). Brick culvert. Clean out and maintain.	400
20	S 30° 22.036' E 151° 35.982'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 315m (to WI 21) ($6,300). Slashing to WI 21 (315 m) ($475).	6,775
21	S 30° 21.933' E 151° 36.146'	North eastern end of cutting. End – clear side drains. Start minor clearing to Black Mountain trailhead- WI 105 (9,569m).	28,707
22	S 30° 21.910' E 151° 36.183'	Driveway crossing: Install Give Way sign on both sides of trail ($800). Retain/renovate/repaint railway signs (2 railway crossing signs and an additional marker post) ($400).	1,200
23	S 30° 21.816' E 151° 36.335'	Brick culvert. Clean out and maintain.	200

24	S 30° 21.797' E 151° 36.366'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 290m (to WI 27).	5,800
25	S 30° 21.760' E 151° 36.423'	Retain/renovate/repaint distance peg (603 km).	200
26	S 30° 21.706' E 151° 36.511'	North eastern end of cutting. End – clear side drains.	0
27	S 30° 21.672' E 151° 36.581'	Brick culvert. Clean out and maintain.	200
28	S 30° 21.634' E 151° 36.617	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 260m (to WI 29).	5,200
29	S 30° 21.519' E 151° 36.711'	North eastern end of cutting. End – clear side drains.	0
30	S 30° 21.449' E 151° 36.742'	Brick culvert. Clean out and maintain.	200
31	S 30° 21.377' E 151° 36.756'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (270m) (to WI 33) ($8,100). Remove cross fence ($200). Allow extra funds for tree clearing within cutting ($2,000).	10,300
32	S 30° 21.335' E 151° 36.758'	Retain/renovate/repaint distance peg (604 km).	200
33	S 30° 21.251' E 151° 36.747'	North eastern end of cutting.	0
34	S 30° 21.192' E 151° 36.733'	Brick culvert. Clean out and maintain.	200
35	S 30° 21.086' E 151° 36.655'	Retain/renovate/repaint railway sign.	200
36	S 30° 21.041' E 151° 36.606'	Renovate/paint existing railway sign ($200). Brick culvert. Clean out and maintain ($200).	400
37	S 30° 21.010' E 151° 36.569'	South eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 320m (to WI 39).	6,400
38	S 30° 20.860' E 151° 36.512'	Retain/renovate/repaint distance peg (605 km).	200
39	S 30° 20.837' E 151° 36.519'	Northern end of cutting. End – clear side drains.	0
40	S 30° 20.812' E 151° 36.535'	1 pipe culvert - steel pipe in concrete wall. Clean out and maintain.	200

40	S 30° 20.812’ E 151° 36.535’	1 pipe culvert - steel pipe in rock and sandbagged wall. Clean out and maintain.	200
41	S 30° 20.719’ E 151° 36.726’	Renovate/paint existing railway sign.	200
42	S 30° 20.718’ E 151° 36.733’	1 pipe culvert - steel pipe in rock and sandbagged wall. Clean out and maintain.	200
43	S 30° 20.717’ E 151° 36.746’	Retain/renovate/repaint railway sign.	200
44	S 30° 20.712’ E 151° 36.770’	Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 170m (to WI 45).	3,400
45	S 30° 20.692’ E 151° 36.869’	Eastern end of cutting. End – clear side drains.	0
46	S 30° 20.690’ E 151° 36.883’	1 pipe culvert - steel pipe in concrete wall. Clean out and maintain.	200
47	S 30° 20.682’ E 151° 36.928’	Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 180m (to WI 48).	3,600
48	S 30° 20.661’ E 151° 37.042’	Eastern end of cutting. End – clear side drains.	0
49	S 30° 20.658’ E 151° 37.055’	Retain/renovate/repaint distance peg (606 km).	200
50	S 30° 20.657’ E 151° 37.066’	1 pipe culvert - steel pipe in concrete wall. Clean out and maintain.	200
51	S 30° 20.637’ E 151° 37.179’	Brick culvert. Clean out and maintain.	200
52	S 30° 20.626’ E 151° 37.217’	Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 140m (to WI 53).	2,800
53	S 30° 20.594’ E 151° 37.281’	Eastern end of cutting. End – clear side drains.	0
54	S 30° 20.502’ E 151° 37.300’	Brick culvert. Clean out and maintain.	200
55	S 30° 20.554’ E 151° 37.333’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 180m (to WI 57) ($3,600). Retain/renovate/repaint railway sign ($200).	3,800
56	S 30° 20.657’ E 151° 37.066’	Small break in cutting. Install pipe and fill over (5m (long) x 3m (wide) x 1m deep.	1,500
57	S 30° 20.479’ E 151° 37.384’	Northern end of cutting. End – clear side drains.	0

58	S 30° 20.455' E 151° 37.393'	Rectangular concrete culvert. Clean out and maintain.	200
59	S 30° 20.358' E 151° 37.404'	Brick culvert. Clean out and maintain.	200
60	S 30° 20.298' E 151° 37.405'	Retain/renovate/repaint distance peg (607 km).	200
61	S 30° 20.284' E 151° 37.408'	Southern end of cutting. Attend to drainage in cutting: Attend to drainage in cutting: Clear side drains (both sides) for 195m (to WI 62).	3,900
62	S 30° 20.191' E 151° 37.439'	Northern end of cutting. End – clear side drains Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner.	8,000
63	S 30° 20.161' E 151° 37.459'	1 pipe culvert – concrete pipe in concrete wall. Clean out and maintain.	200
64	S 30° 20.000' E 151° 37.566'	Retain/renovate/repaint railway sign.	200
65	S 30° 20.036' E 151° 37.686'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 140m (to WI 66).	2,800
66	S 30° 20.008' E 151° 37.749'	Northern end of cutting. End – clear side drains.	0
67	S 30° 19.951' E 151° 37.841'	Retain/renovate/repaint distance peg (608 km) ($200). Prepare and install interpretive panel in this stretch of trail to take advantage of great views to the east ($1,800). Install trailside seat with interpretive panel ($2,000).	4,000
68	S 30° 19.901' E 151° 37.897'	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing	8,200

		gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point ($5,000). Negotiate precise location with landowner. Additional allowance for black wattle clearing to WI 81 (845m) ($3,200).	
69	S 30° 19.895' E 151° 37.905'	South western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (265m) (to WI 71).	7,950
70	S 30° 19.850' E 151° 37.946'	Small bridge structure. 4 abutments but only 1 metre high. Replace with pipes and fill over – 3m long x 3m wide x 1m deep ($1,500). Renovate/paint existing railway sign ($200).	1,700
71	S 30° 19.795' E 151° 37.012'	Northern end of cutting.	0
72	S 30° 19.787' E 151° 38.024'	Rectangular concrete culvert. Clean out and maintain.	200
73	S 30° 19.781' E 151° 38.037'	Start - Clear side drains (western side) for 40m.	400
74	S 30° 19.769' E 151° 38.065'	Retain/renovate/repaint railway sign.	200
75	S 30° 19.763' E 151° 38.080'	Rectangular concrete culvert. Clean out and maintain.	200
76	S 30° 19.761' E 151° 38.089'	Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 210m (to WI 79)	4,200
77	S 30° 19.747' E 151° 38.153'	Small bridge structure. 4 abutments but only 1 metre high. Replace with pipes and fill over – 3m long x 3m wide x 1m deep. Renovate/paint existing railway sign.	1,700
78	S 30° 19.747' E 151° 38.162'	Retain/renovate/repaint railway sign. Large tree growing over formation – may need removal.	200
79	S 30° 19.742' E 151° 38.226'	Eastern end of cutting. End – clear side drains.	0
80	S 30° 19.731' E 151° 38.297'	1 pipe culvert – concrete pipe in concrete wall. Clean out and maintain.	200

81	S 30° 19.725’ E 151° 38.371’	Mid-point of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 20m ($400). Retain/renovate/repaint distance peg (609 km) ($200).	600
82	S 30° 19.712’ E 151° 38.443’	1 pipe culvert – concrete pipe; no headwalls. Clean out and maintain.	200
83	S 30° 19.714’ E 151° 38.473’	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point ($5,000). Negotiate precise location with landowner. Remove cross fence ($200). Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 370m (to WI 85) ($7,400).	12,600
84	S 30° 19.656’ E 151° 38.670’	Retain/renovate/repaint railway sign.	200
85	S 30° 19.643’ E 151° 38.693’	North eastern end of cutting. End – clear side drains.	0
86	S 30° 19.516’ E 151° 38.816’	Brick culvert. Clean out and maintain.	200
87	S 30° 19.455’ E 151° 38.875’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 290m (to WI 89) ($5,800). Retain/renovate/repaint distance peg (610 km) ($200).	6,000
88	S 30° 19.439’ E 151° 38.890’	Retain/renovate/repaint railway signs (2).	400
89	S 30° 19.326’ E 151° 38.989’	North eastern end of cutting. End – clear side drains.	0
90	S 30° 19.315’ E 151° 38.998’	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point ($5,000).	11,200

		Negotiate precise location with landowner. Remove cross fence ($200). Additional allowance for black wattle clearing to Black Mountain Trailhead (1,560 m) ($6,000).	
91	S 30º 19.295’ E 151º 39.012’	1 pipe culvert – steel pipe in concrete wall. Clean out and maintain.	200
92	S 30º 19.270’ E 151º 39.037’	South western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (270m) (to WI 94).	8,100
93	S 30º 19.239’ E 151º 39.064’	Retain/renovate/repaint railway signs (3).	600
94	S 30º 19.153’ E 151º 39.141’	North eastern end of cutting.	0
95	S 30º 19.117’ E 151º 39.177’	Brick culvert. Clean out and maintain.	200
96	S 30º 19.023’ E 151º 39.255’	Retain/renovate/repaint distance peg (611 km).	200
97	S 30º 19.021’ E 151º 39.250’	Renovate/paint existing railway sign.	200
98	S 30º 18.921’ E 151º 39.336’	1 pipe culvert – steel pipe in rock wall. Clean out and maintain.	200
99	S 30º 18.892’ E 151º 39.368’	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner.	5,000
100	S 30º 18.879’ E 151º 39.384’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 215m (to WI 102).	4,300
101	S 30º 18.800’ E 151º 39.425’	Retain/renovate/repaint railway sign.	200
102	S 30º 18.783’ E 151º 39.433’	Northern end of cutting. End – clear side drains.	0
103	S 30º 18.656’ E 151º 39.430’	Brick culvert. Clean out and maintain.	600

104	S 30° 18.606′ E 151° 39.410′	Remove gate at southern boundary of Black Mountain railway yard.	200
105	S 30° 18.581′ E 151° 39.396′	Black Mountain station – see 2018 report for trailhead concept drawing and costings. Please note that the Black Mountain Preservation Society has sought input into the final design of the trailhead. The Society has also suggested moving some of the trailhead facilities - the trailhead signage, carpark and public toilet – to the old goods yard. Detailed design of the trailhead (noting the 2018 report included a concept drawing only) should be done in consultation with Black Mountain Railway Historical Society. An additional allocation of funds is included here to construct a toilet in the goods yard as the Society's notes suggest that using the existing toilet in the station building is not appropriate.	50,000
		Allowance for additional landowner requests (e.g. fencing and vegetation screening).	10,000
		Allowance for preparation and installation of interpretive signage (at locations to be determined by trail manager and local historians) (6 signs).	18,000
		Allowance for Trail Directional Markers (incorporating emergency markers) to be placed along trail every 1 km.	7,200
		Allowance for installation of trailside furniture (e.g. seats) at locations to be determined by trail manager.	3,000
		Allowance for marking trees to be cleared, pruned or left untouched.	2,400
		Allowance for marking centreline of trail with flagging tape prior to clearing and construction.	3,600
		Allowance for purchase and installation of: • Regulatory signage (Shared Path; "No Trail Bikes"; "Authorised Users Only"); • Road name signs; • Trail name signs; • "No Trespassing" signs; • Local attractions sign; and • Miscellaneous signs (Keep Out etc.)	2,400

		Allowance for traffic management (1 road crossing).	2,000
		Allowance for cable locators at road crossings (1 road crossing).	1,000
		Option 1: Sub-total (Section 3)	*1,404,857*
		Option 2: sub-total (Section 3) (maximum estimated expenditure)	*1,428,565*
		Allowance for additional construction costs. This section of corridor is less accessible from nearby roads than the corridor from Armidale to Dumaresq (and also from Ben Lomond to Black Mountain as discussed in the 2018 report). More time will be spent hauling material from stockpile sites created where the railway corridor crosses a publicly accessible road. One way to reduce this cost is negotiate access agreements with landholders who adjoin the corridor. Some may be willing to provide access (material can be stockpiled on the railway corridor). An allowance of 5% of construction costs has been included to allow for this additional time.	71,430
		Approvals, permits, applications, designs, specifications, assessments (2.5% of maximum estimated expenditure - $1,428,565).	35,715
		Contingency amount (15% of maximum estimated expenditure - $1,428,565).	214,285
		Project management (5% of maximum estimated expenditure - $1,428,565).	71,430
		Contingency allowance for removal of steel track and sleepers and shaping of basic track by contractor ($8/metre).	94,832
		TOTAL (NOT INCLUDING GST)	***1,916,257***

Table 4: Total Costs: Armidale Station to Black Mountain Station (33,060 metres)

(For Option 2: walker/cyclist trail; separate bridle trail. The maximum estimated expenditure)

Section	Cost
Section 1: Armidale Station to Dumaresq Station	*$1,804,080*
Section 2: Dumaresq Station to Exmouth Station	*$1,933,676*
Section 3: Exmouth Station to Black Mountain Station	*$1,916,257*
Total (excluding GST)	*$5,654,013*

4.6 WORKS TABLES – BEN LOMOND TO GLENN INNES

Table 5: Ben Lomond Station to Glencoe (14,205 metres) (refer Plan 4 in Appendix 6)

Ref #	GPS Reference	Works Item	$
1		Construct trail between Ben Lomond Station and Glencoe Station (14,205m).	852,300
2		Start minor clearing to WI 12 (1,540m).	4,620
3		*Slash and flail bridle trail alongside main trail (if horses are to be permitted) (14,205m).*	*28,410*
4	S 30° 01.286’ E 151° 39.612’	Trailhead: Ben Lomond Station. Details of work in 2018 report. Retain rail in station surrounds as far north as Inn Rd crossing.	0 (costed in 2018 report)
5	S 30° 01.248’ E 151° 39.599’	Road crossing – Inn Road. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “trail crossing” sign (1 location) ($600). • Install “trail crossing on side road” sign (2 locations) ($1,200). • Install “Give Way” sign (southern side of road) ($400) • Install trail user chicane and management access gate (northern side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540) • Install pipe culverts under trail at junction with road (both sides of road) ($3,000) • Remove existing fence – north side only ($200). • Retain/renovate/repaint distance peg (646 km) ($200).	9,540
6	S 30° 01.174’ E 151° 39.524’	4 pipe culvert – steel pipes in sandbagged wall. Clean out and maintain.	500
7	S 30° 00.713’ E 151° 39.546’	Remove cross fence.	200
8	S 30° 00.695’ E 151° 39.568’	Rectangular concrete culvert. Clean out (extra work needed) and maintain.	500
9	S 30° 00.618’ E 151° 39.686’	Brick culvert. Clean out and maintain.	200

10	S 30° 00.606' E 151° 39.706'	Erect fencing along the corridor (both sides) to create a 6 metre trail envelope (12,840m).	385,200
11	S 30° 00.567' E 151° 39.767'	Retain/renovate/repaint railway sign.	200
12	S 30° 00.561' E 151° 39.771'	South western end of deep cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (685m) (to WI 14) ($20,550). Start moderate clearing to WI 13 (685m) ($4,660).	25,210
13	S 30° 00.340' E 151° 40.127'	North western end of cutting. Trail to divert to south eastern edge of corridor to ensure furthest distance from existing house. Allow screen planting (280m x 10m) on north western side of rail corridor (to WI 15) ($16,800). Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point ($5,000). Negotiate precise location with landowner. Start minor clearing to WI 21 (565m) ($1,695).	23,495
14	S 30° 00.306' E 151° 40.184'	Brick culvert. Clean out and maintain.	200
15	S 30° 00.249' E 151° 40.270'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 155m (to WI 16) ($3,100). Retain/renovate/repaint railway sign ($200). End screen planting.	3,300
16	S 30° 00.201' E 151° 40.339'	North eastern end of cutting. End – clear side drains.	0
17	S 30° 00.198' E 151° 40.346'	Brick culvert. Clean out and maintain.	200
18	S 30° 00.180' E 151° 40.366'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 60m (to WI 19)	1,200
19	S 30° 00.160' E 151° 40.388'	North eastern end of cutting. End – clear both side drains.	1,350

		Start – clear 1 side drain only (1-sided cutting) (135 m) to WI 21.	
20	S 30° 00.141' E 151° 40.414'	1 pipe culvert – steel pipe in sandbagged wall. Clean out and maintain.	200
21	S 30° 00.116' E 151° 40.458'	Western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (115m) (to WI 23) ($3,450). Start moderate clearing to WI 24 (115m) ($780).	4,230
22	S 30° 00.103' E 151° 40.524'	Retain/renovate/repaint distance peg (649 km – note 647 km and 648 km missing).	200
23	S 30° 00.103' E 151° 40.532'	Eastern end of cutting.	0
24	S 30° 00.103' E 151° 40.532'	Start minor clearing to WI 127 – Glencoe trailhead (11,300m).	33,900
25	S 30° 00.072' E 151° 40.616'	Brick culvert. Clean out (extra cleaning needed) and maintain.	400
26	S 30° 00.068' E 151° 40.619'	Clear 1 side drain only (1-sided cutting) (170 m) to WI 27.	1,700
27	S 30° 00.002' E 151° 40.690'	End clear side drain.	0
28	S 29° 59.988' E 151° 40.723'	Brick culvert. Clean out (extra cleaning needed) and maintain.	400
28	S 29° 59.971' E 151° 40.762'	Brick culvert. Clean out (extra cleaning needed) and maintain.	400
29	S 29° 59.963' E 151° 40.778'	Western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 130m (to WI 30) ($2,600). Retain/renovate/repaint railway sign ($200).	2,800
30	S 29° 59.942' E 151° 40.849'	Eastern end of cutting. End clear side drains.	0
31	S 29° 59.938' E 151° 40.853'	Brick culvert. Clean out (extra cleaning needed) and maintain. Major repairs needed.	1,000
32	S 29° 59.921' E 151° 40.897'	Clear northern side drain only (1-sided cutting) (25 m) to WI 33.	250
33	S 29° 59.913' E 151° 40.910'	End clear side drain. Western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (305m) (to WI 35).	9,150

34	S 29° 59.878' E 151° 41.071'	Retain/renovate/repaint distance peg (650 km).	200
35	S 29° 59.875' E 151° 41.097'	Eastern end of cutting.	0
36	S 29° 59.827' E 151° 41.206'	Large brick culvert. Clean out and maintain (limited cleaning needed due to water flowing through at time of report).	200
37	S 29° 59.756' E 151° 41.228'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (410m) (to WI 39).	12,300
38	S 29° 59.691' E 151° 41.212'	Retain/renovate/repaint railway sign.	200
39	S 29° 59.567' E 151° 41.287'	North eastern end of cutting.	0
40	S 29° 59.539' E 151° 41.314'	Brick culvert. Clean out and maintain.	200
41	S 29° 59.507' E 151° 41.355'	Brick culvert. Clean out and maintain.	200
42	S 29° 59.492' E 151° 41.370'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 175m (to WI 44).	3,500
43	S 29° 59.475' E 151° 41.388'	Retain/renovate/repaint distance peg (651 km).	200
44	S 29° 59.424' E 151° 41.446'	North eastern end of cutting. End clear side drains.	0
45	S 29° 59.420' E 151° 41.455'	Brick culvert. Clean out and maintain.	200
46	S 29° 59.357' E 151° 41.524'	Brick culvert. Clean out and maintain.	200
47	S 29° 59.337' E 151° 41.550'	Clear southern side drain only (1-sided cutting) (85 m) to WI 48.	850
48	S 29° 59.312' E 151° 40.599'	End clear side drain. Western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (285m) (to WI 50). (note existing fence on top of cutting on northern side – no need for new fencing.	8,550
49	S 29° 59.307' E 151° 41.627'	Retain/renovate/repaint railway sign.	200
50	S 29° 59.338' E 151° 41.781'	Eastern end of cutting. Clear cross fence ($200).	8,200

		Install livestock/machinery crossing point: Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner ($8,000)	
51	S 29° 59.367' E 151° 41.849'	Large brick culvert. Clean out and maintain.	200
52	S 29° 59.361' E 151° 41.910'	Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner (crossing obviously in use).	8,000
53	S 29° 59.353' E 151° 41.921'	Western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (355m) (to WI 54) ($10,650). Retain/renovate/repaint distance peg (652 km) ($200).	10,850
54	S 29° 59.288' E 151° 42.231'	Eastern end of cutting.	0

55	S 29° 59.249' E 151° 42.312'	Large brick culvert. Clean out and maintain (limited cleaning needed due to water flowing through at time of report).	200
56	S 29° 59.150' E 151° 42.321'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 105m (to WI 57).	2,100
57	S 29° 59.094' E 151° 42.297'	Northern end of cutting. End clear side drains.	0
58	S 29° 59.094' E 151° 42.297'	Clear eastern side drain only (1-sided cutting) (200 m) to WI 60.	2,000
59	S 29° 59.069' E 151° 42.283'	Retain/renovate/repaint distance peg (653 km).	200
60	S 29° 59.003' E 151° 42.246'	End clear side drain.	0
61	S 29° 58.948' E 151° 42.215'	Brick culvert. Clean out and maintain.	200
62	S 29° 58.929' E 151° 42.198'	Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner.	8,000
63	S 29° 58.908' E 151° 42.183'	South eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 30m (to WI 64).	600
64	S 29° 58.893' E 151° 42.174'	North western end of cutting. End clear side drains.	0
65	S 29° 58.860' E 151° 42.155'	Brick culvert. Clean out and maintain.	200
66	S 29° 58.848' E 151° 42.149'	South eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 200m (to WI 68).	4,000

67	S 29º 58.830’ E 151º 42.136’	Retain/renovate/repaint railway sign.	200
68	S 29º 58.752’ E 151º 42.101’	North western end of cutting. End clear side drains.	0
69	S 29º 58.748’ E 151º 42.101’	Rectangular concrete culvert. Clean out and maintain.	200
70	S 29º 58.737’ E 151º 42.099’	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 110m (to WI 71).	2,200
71	S 29º 58.676’ E 151º 42.096’	Northern end of cutting. End clear side drains.	0
72	S 29º 58.656’ E 151º 42.101’	Brick culvert. Clean out and maintain.	200
73	S 29º 58.644’ E 151º 42.103’	Renovate/paint existing signs (yellow speed signs).	400
74	S 29º 58.625’ E 151º 42.097’	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 140m (to WI 75).	2,800
75	S 29º 58.557’ E 151º 42.099’	Northern end of cutting. End clear side drains. Retain/renovate/repaint distance peg (654 km).	200
76	S 29º 58.548’ E 151º 42.100’	Brick culvert. Clean out (extra cleaning needed) and maintain.	400
77	S 29º 58.531’ E 151º 42.100’	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 50m (to WI 78).	1,000
78	S 29º 58.503’ E 151º 42.101’	Northern end of cutting. End clear side drains.	0
79	S 29º 58.468’ E 151º 42.101’	Brick culvert. Clean out and maintain.	200
80	S 29º 58.461’ E 151º 42.102’	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (170m) (to WI 81). (Note: land slip in middle of cutting but not significant).	5,100
81	S 29º 58.373’ E 151º 42.105’	Northern end of cutting.	0
82	S 29º 58.373’ E 151º 42.105’	Clear eastern side drain only (1-sided cutting) (30m) to WI 83.	300
83	S 29º 58.354’ E 151º 42.106’	End clear side drain.	0

84	S 29° 58.295’ E 151° 42.113’	Retain/renovate/repaint railway sign.	200
85	S 29° 58.290’ E 151° 42.115’	Brick culvert. Clean out and maintain.	200
86	S 29° 58.271’ E 151° 42.115’	Clear eastern side drain only (1-sided cutting) (70m) to WI 87.	700
87	S 29° 58.239’ E 151° 42.121’	End clear side drain.	0
88	S 29° 58.205’ E 151° 42.127’	Brick culvert. Clean out and maintain.	200
89	S 29° 58.271’ E 151° 42.115’	Clear eastern side drain only (1-sided cutting) (205m) to WI 90.	2,050
90	S 29° 58.239’ E 151° 42.121’	End clear side drain.	0
91	S 29° 58.033’ E 151° 42.179’	Retain/renovate/repaint distance peg (655 km) ($200). Brick culvert. Clean out and maintain ($200). Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner. (crossing in use) ($8,000).	8,400
92	S 29° 58.015’ E 151° 42.186’	South western end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (210m) (to WI 93).	6,300
93	S 29° 58.917’ E 151° 42.230’	North eastern end of cutting.	0
94	S 29° 57.904’ E 151° 42.236’	Brick culvert. Clean out and maintain.	200

95	S 29° 57.897' E 151° 42.241'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 300m (to WI 98).	6,000
96	S 29° 57.811' E 151° 42.290'	Rectangular concrete culvert. Clean out and maintain.	200
97	S 29° 57.785' E 151° 42.307'	Retain/renovate/repaint railway sign.	200
98	S 29° 57.748' E 151° 42.328'	North eastern end of cutting. End clear side drains. Remove cross fence ($200). Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail ($8,000) • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner. (crossing in use).	8,200
99	S 29° 57.659' E 151° 42.384'	Brick culvert. Clean out and maintain.	200
100	S 29° 57.617' E 151° 42.412'	Remove cross fence.	200
101	S 29° 57.537' E 151° 42.446'	Remove bridge and install 20m Landmark (or similar) bridge.	80,000
102	S 29° 57.510' E 151° 42.473'	Remove cross fence ($200). Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail ($8,000). • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate	8,200

		• Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner. (crossing in use).	
103	S 29° 57.444' E 151° 42.521'	Brick culvert. Clean out and maintain.	200
104	S 29° 57.307' E 151° 42.605'	Rectangular concrete culvert. Clean out and maintain.	200
105	S 29° 57.911' E 151° 42.612'	Retain/renovate/repaint railway sign.	200
106	S 29° 57.222' E 151° 42.655'	2 pipe culvert – steel pipes in sandbagged wall. Clean out and maintain.	200
107	S 29° 57.155' E 151° 42.688'	Remove cross fence ($200). Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. ($5,000) Negotiate precise location with landowner (not clear if crossing in use) South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 395m (to WI 108) ($7,900)	13,100
108	S 29° 56.961' E 151° 42.805'	North eastern end of cutting. End clear side drains. • Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point.	8,000

		• Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner. (crossing in use).	
109	S 29° 56.900' E 151° 42.843'	Brick culvert. Clean out (extra cleaning needed) and maintain. Note collapsed over-structure (brick framing) - allow $3,000 for repairs.	3,500
110	S 29° 56.823' E 151° 42.889'	Retain/renovate/repaint railway sign.	200
111	S 29° 56.723' E 151° 42.950'	8 m bridge over un-named water body south of Old Ben Lomond Rd. Replace with pre-fabricated bridge ($32,000). Remove cross fence ($200).	32,200
112	S 29° 56.694' E 151° 42.969'	Road crossing – Old Ben Lomond Road. (See road crossing drawing - Appendix 1). • Install "road ahead" signs on both sides ($400). • Install "trail crossing" signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Remove existing fence ($200).	8,880
113	S 29° 56.603' E 151° 43.016'	2 m bridge on concrete abutments. Remove bridge and install 2m Landmark (or similar) bridge.	8,000
114	S 29° 56.486' E 151° 43.099'	2 pipe culvert – steel pipes in rock wall. Clean out and maintain.	200
115	S 29° 56.327' E 151° 43.194'	3 pipe culvert – steel pipes in rock wall. Clean out and maintain.	300
116	S 29° 56.044' E 151° 43.279'	51 m bridge over Manrowan Creek. Preferred option is to repair and re-deck and add handrails in accordance with report by Wood Research and Development.	523,250
117	S 29° 55.936' E 151° 43.305'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (165m) (to WI 118) ($4,950). Extra allowance for rock removal in cutting ($5,000).	9,950

118	S 29° 55.858' E 151° 43.323'	Northern end of cutting.	0
119	S 29° 55.858' E 151° 43.323'	Clear eastern side drain only (1-sided cutting) (35m) to WI 120.	350
120	S 29° 55.839' E 151° 43.328'	End clear side drain.	0
121	S 29° 55.828' E 151° 43.331'	Road crossing – Ingle Vale Road. (See road crossing drawing - Appendix 1). • Install "road ahead" signs on both sides ($400). • Install "trail crossing" signs on both sides of trail ($1,200). • Install "Give Way" sign (northern side of road) ($400). • Install trail user chicane and management access gate (southern side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540). • Install pipe culverts under trail at junction with road (both sides of road) ($3,000) • Remove existing fence ($200).	8,740
122	S 29° 55.820' E 151° 43.331'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 220m (to WI 123) ($4,400) Extra allowance for clearing trees in cutting ($2,000)	6,400
123	S 29° 55.700' E 151° 43.364'	North eastern end of cutting. End clear side drains. • Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. ($8,000). • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system.	9,800

		• Negotiate precise location with landowner. (crossing in use) • On northern side of crossing point, allow screen planting (100m x 3m) on eastern side of rail corridor (to WI 124) ($1,800).	
124	S 29° 55.654' E 151° 43.375'	• Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail ($8,000). • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner. • On northern side of crossing point, allow screen planting (120m x 3m) on eastern side of rail corridor (to WI 125) ($1,080).	9,080
125	S 29° 55.590' E 151° 43.390'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 175m (to WI 126).	3,500
126	S 29° 55.530' E 151° 43.403'	Connecting trail to Glencoe trailhead. End clear side drains (note side drain clearing continues north of this point. See Table 6).	Costed in WI 127
127	S 29° 55.543' E 151° 43.419'	Trailhead: Glencoe Station. (See Trailhead plan – Appendix 3). • Install trailhead signs (brown chevron) on New England Highway – 2 locations single sided ($2,000). • Prepare and install trailhead map panel ($5,500). • Install trailhead name sign ($1,000) • Construct gravel carpark (40m x 15m) ($15,000). • Install picnic table ($8,000). • Construct short connecting path from parking area to trail (20 metres) ($650).	32,150

		Allowance for additional landowner requests (e.g. fencing and vegetation screening).	10,000
		Allowance for preparation and installation of interpretive signage (at locations to be determined by trail manager and local historians) (6 signs).	18,000
		Allowance for Trail Directional Markers (incorporating emergency markers) to be placed along trail every 1 km.	9,000
		Allowance for installation of trailside furniture (e.g. seats) at locations to be determined by trail manager.	3,000
		Allowance for marking trees to be cleared, pruned or left untouched.	2,400
		Allowance for marking centreline of trail with flagging tape prior to clearing and construction.	3,600
		Allowance for rock clearing in various cuttings.	5,000
		Allowance for purchase and installation of: • Regulatory signage (Shared Path; "No Trail Bikes"; "Authorised Users Only"); • Road name signs; • Trail name signs; • "No Trespassing" signs; • Local attractions sign; • Miscellaneous signs (Keep Out etc.).	2,400
		Allowance for steep embankment signs and delineators as appropriate (allow 500m).	17,500
		Allowance for post and rail fencing along steep embankments as appropriate (allow 1,000m).	100,000
		Allowance for traffic management (3 road crossings).	6,000
		Allowance for cable locators at road crossings (3 road crossings).	3,000
		Option 1: Sub-total (Section 1)	*2,427555*
		Option 2: sub-total (Section 1) (maximum estimated expenditure)	*2,455,965*
		Allowance for additional construction costs. This section of corridor is less accessible from nearby roads than the corridor from Armidale to	122,800

		Dumaresq (and also from Ben Lomond to Black Mountain as discussed in the 2018 report). More time will be spent hauling material from stockpile sites created where the railway corridor crosses a publicly accessible road. One way to reduce this cost is negotiate access agreements with landholders who adjoin the corridor. Some may be willing to provide access (material can be stockpiled on the railway corridor). An allowance of 5% of construction costs has been included to allow for this additional time.	
		Approvals, permits, applications, designs, specifications, assessments (2.5% of maximum estimated expenditure - $2,455,965).	61,400
		Contingency amount (15% of maximum estimated expenditure - $2,633,965).	368,395
		Project management (5% of maximum estimated expenditure - $2,455,965).	122,800
		Contingency allowance for removal of steel track and sleepers and shaping of basic track by contractor ($8/metre).	113,640
		TOTAL (NOT INCLUDING GST)	***3,245,000***

Table 6: Glencoe Station to Stonehenge Recreation Reserve (9,850 metres) (refer Plan 5 in Appendix 6)

Ref #	GPS Reference	Works Item	$
1		Construct trail between Glencoe Station and Stonehenge Recreation Reserve (9,850m).	591,000
2		Minor clearing – Glencoe Station to Stonehenge Recreation Reserve.	29,550
3		Existing appropriate fencing in place until WI 10.	0
4		*Slash and flail bridle trail alongside main trail (if horses are to be permitted) (9,850m).*	*19,700*
5	S 29° 55.543' E 151° 43.419'	Trailhead: Glencoe Station. (Detailed in Table 5).	0
6	S 29° 55.590' E 151° 43.390'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 115m (to WI 1) (Note this is a continuing item from Table 5 WI 126).	2,300
7	S 29° 55.490' E 151° 43.420'	End clear side drains.	0
8	S 29° 55.470' E 151° 43.420'	Rectangular concrete culvert. Clean out and maintain.	200
9	S 29° 55.411' E 151° 43.437'	Remove cross fence with gate.	200
10	S 29° 55.233' E 151° 43.463'	Road crossing – Munsies Road. (See road crossing drawing - Appendix 1). • Install "road ahead" signs on both sides ($400). • Install "trail crossing" sign (1 location) ($600). • Install "trail crossing on side road" sign (2 locations) ($1,200). • Install "Give Way" sign (southern side of road) ($400). • Install trail user chicane and management access gate (northern side of road). Set in concrete/asphalt apron for ease of maintenance ($3,540). • Install pipe culverts under trail at junction with road (both sides of road) ($3,000). • Remove existing fence ($200).	9,340

11	S 29º 55.233' E 151º 43.463'	Erect fencing along the corridor (both sides) to create a 6 metre trail envelope (9,350m).	280,500
12	S 29º 55.224' E 151º 43.473'	Retain/renovate/repaint railway sign.	200
13	S 29º 55.177' E 151º 43.487'	1 pipe culvert – steel pipes in rock and sandbag wall. Clean out and maintain.	200
14	S 29º 55.031' E 151º 43.519'	Retain/renovate/repaint distance peg (661 km – note 655 – 660km pegs are missing).	200
15	S 29º 54.973' E 151º 43.532'	Retain railway signal tower (note signal no longer in place).	0
16	S 29º 54.860' E 151º 43.557'	Rectangular concrete culvert. Clean out and maintain.	200
17	S 29º 54.764' E 151º 43.576'	Retain/renovate/repaint railway sign.	200
18	S 29º 54.738' E 151º 43.580'	Retain timber bridge (5m). Bridge is a steel transom bridge with brick abutments. Install decking and handrails (the assumption is that the bridge structure is sound).	30,000
19	S 29º 54.686' E 151º 43.598'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 480m (to WI 21) ($9,600). Extra allowance for clearing trees in cutting ($2,000). *Option: Construct connecting trail to adjacent cemetery and camp draft grounds – mid-point of cutting (not costed).*	11,600
20	S 29º 54.500' E 151º 43.638'	Retain/renovate/repaint distance peg (662km).	200
21	S 29º 54.608' E 151º 43.618'	Northern end of cutting. End clear side drains.	0
22	S 29º 54.375' E 151º 43.672'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 150m (to WI 23) ($3,000). Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point ($5,000). Negotiate precise location with landowner.	8,000

23	S 29° 54.292' E 151° 43.692'	Northern end of cutting. End clear side drains. Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. • Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. • Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. • Install appropriate warning signs about agricultural activity on both sides of trail gating system. • Negotiate precise location with landowner. (crossing obviously in use).	8,000
24	S 29° 54.265' E 151° 43.700'	1 pipe culvert – steel pipes in rock and sandbag wall. Clean out and maintain.	200
25	S 29° 54.375' E 151° 43.672'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 125m (to WI 27).	2,500
26	S 29° 54.234' E 151° 43.705'	Retain/renovate/repaint railway sign.	200
27	S 29° 54.180' E 151° 43.720'	Northern end of cutting. End clear side drains. Water access pipe (farm use) over formation. Place under trail when constructed.	200
28	S 29° 54.089' E 151° 43.755'	15 m bridge over Upper Williams Creek. Preferred option is to repair and re-deck and add handrails in accordance with report by Wood Research and Development ($186,875). Remove cross fence ($200).	187,075
29	S 29° 54.069' E 151° 43.766'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 60m (to WI 30) ($1,200). Additional allowance for blackberry clearing and tree removal in cutting ($1,000).	2,200
30	S 29° 54.040' E 151° 43.781'	Northern end of cutting. End clear side drains.	0
31	S 29° 54.007' E 151° 43.796'	Brick culvert. Clean out and maintain.	200

32	S 29° 53.982’ E 151° 43.814’	Retain/renovate/repaint distance peg (663km).	200
33	S 29° 53.925’ E 151° 43.848’	Brick culvert. Clean out and maintain.	200
34	S 29° 53.918’ E 151° 43.857’	Clear western side drain only (1-sided cutting) (240m) to WI 36.	2,400
35	S 29° 53.833’ E 151° 43.903’	Rectangular concrete culvert. Clean out and maintain.	200
36	S 29° 53.803’ E 151° 43.914’	End clear side drain. Remove cross fence.	200
37	S 29° 53.729’ E 151° 43.940’	Brick culvert. Clean out and maintain.	200
38	S 29° 53.601’ E 151° 43.957’	Remove bridge and install 5m Landmark (or similar) bridge.	20,000
39	S 29° 53.572’ E 151° 43.964’	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner. (crossing obviously in use).	5,000
40	S 29° 53.565’ E 151° 43.965’	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 405m (to WI 44).	8,100
41	S 29° 53.471’ E 151° 43.999’	Retain/renovate/repaint distance peg (663 km).	200
42	S 29° 53.461’ E 151° 44.004’	Underpass – New England Highway. New bridge in place.	0
43	S 29° 53.403’ E 151° 44.026’	Underpass – old New England Highway. Old “brick wall” bridge in place. Remove cross gate on northern side of underpass.	200
44	S 29° 53.357’ E 151° 44.045’	Northern end of cutting. End clear side drains.	0
45	S 29° 53.347’ E 151° 44.046’	Brick culvert. Clean out (extra work needed) and maintain.	500
46	S 29° 53.240’ E 151° 44.084’	Brick culvert. Clean out and maintain.	200

47	S 29° 53.203’ E 151° 44.104’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 260m (to WI 48).	5,200
48	S 29° 53.074’ E 151° 44.153’	North eastern end of cutting. End clear side drains.	0
49	S 29° 52.941’ E 151° 44.204’	Brick culvert. Clean out and maintain.	200
50	S 29° 52.825’ E 151° 44.249’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 530m (to WI 54).	10,600
51	S 29° 52.698’ E 151° 44.301’	Install livestock/machinery crossing point. Farm gates in fence on either side of crossing point suggest use previously. Only cost under these circumstances is cement hardening of trail crossing point and appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner.	1,000
52	S 29° 52.702’ E 151° 44.293’	Retain/renovate/repaint railway sign.	200
53	S 29° 52.630’ E 151° 44.318’	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point ($5,000). Negotiate precise location with landowner. (Existing – a hardened gravel track perpendicular to railway line suggests machinery crossing point).	5,000
54	S 29° 52.552’ E 151° 44.353’	North eastern end of cutting. End clear side drains.	0
55	S 29° 52.487’ E 151° 44.378’	Remove cross gate ($200). Small (5 m) bridge with brick abutments – utilised as cattle underpass. Re-deck and install handrails ($30,000).	30,200
56	S 29° 52.431’ E 151° 44.398’	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 375m (to WI 58).	7,500

57	S 29° 52.405' E 151° 44.410'	Cross-trail water pipe in place. Install pipe and fill over (3m long x 2.5m wide x 1.5m deep).	1,500
58	S 29° 52.236' E 151° 44.478'	North eastern end of cutting. End clear side drains.	0
59	S 29° 52.229' E 151° 44.478'	Cross fence. Landholder has created an airstrip across corridor. End of airstrip on eastern edge of corridor. Formalise arrangement – trail to divert to eastern edge of corridor to align as per current fencing arrangements. New exclusion fencing required (approximately 30 m) to replace existing simple fence – recommend post and rail fence.	3,000
60	S 29° 52.207' E 151° 44.487'	Northern edge of airstrip. South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 120m (to WI 61).	2,400
61	S 29° 52.150' E 151° 44.508'	North eastern end of cutting. End clear side drains.	0
62	S 29° 52.150' E 151° 44.508'	Clear western side drain only (1-sided cutting) (35m) to WI 63.	350
63	S 29° 52.137' E 151° 44.514'	End clear side drain.	0
64	S 29° 52.084' E 151° 44.535'	25 m bridge over Williams Creek. Preferred option is to repair and re-deck and add handrails in accordance with report by Wood Research and Development (proponent may determine to re-construct bridge to carry vehicles – see Section 3.7.3 for details).	258,750
65	S 29° 52.068' E 151° 44.540'	Remove cross gate (northern end of bridge).	200
66	S 29° 51.993' E 151° 44.591'	Retain/renovate/repaint distance peg (667 km – note 664km, 665km and 666km missing).	200
67	S 29° 51.691' E 151° 44.626'	Formation has been bulldozed through. 7m long gap in formation (x 2.5m high approximately). Pipes removed but left on site. Install pipe and fill back over trail to create new embankment.	3,000
68	S 29° 51.633' E 151° 44.640'	1 pipe culvert – steel pipe with no surrounding headwall. Clean out and maintain.	200

69	S 29° 51.621' E 151° 44.643'	Formation has collapsed under rail (but not significant). Allow extra fill and build small retaining wall – 10m long x 1m high.	1,500
70	S 29° 51.602' E 151° 44.644'	1 pipe culvert – steel pipe with no surrounding headwall. Clean out and maintain.	200
71	S 29° 51.592' E 151° 44.646'	Formation has collapsed under rail (but not significant). Allow extra fill and build small retaining wall – 5m long x 1m high.	750
72	S 29° 51.578' E 151° 44.648'	1 pipe culvert – steel pipe with no surrounding headwall. Clean out and maintain.	200
73	S 29° 51.526' E 151° 44.657'	Driveway crossing: Install Give Way sign on both sides of trail ($800). Remove cross fence – southern side ($200).	1,000
74	S 29° 51.407' E 151° 44.669'	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner. (Note – water pump is within corridor – formalise arrangement and protect water pump).	5,000
75	S 29° 51.128' E 151° 44.718'	Retain/renovate/repaint railway sign.	200
76	S 29° 51.002' E 151° 44.735'	Formation has been bulldozed through. 10m long gap in formation (x 2m high approximately). Pipes removed but left on site. Install new box culvert and fill over.	10,000
77	S 29° 50.778' E 151° 44.775'	116 m bridge over Beardy Waters. Preferred option is to repair and re-deck and add handrails in accordance with report by Wood Research and Development.	948,750
78	S 29° 50.592' E 151° 44.792'	Retain/renovate/repaint railway sign.	200
79	S 29° 50.519' E 151° 44.786'	Clear western side drain only (1-sided cutting) (85m) to WI 80.	850
80	S 29° 50.478' E 151° 44.780'	End clear side drain.	0

		Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 140m (to WI 81).	
81	S 29º 50.409’ E 151º 44.765’	Northern end of cutting. End clear side drains.	0
82		Undertake safety audit of gun club activities to ensure safe practices in the vicinity of rail trail users	5,000
83	S 29º 50.375’ E 151º 44.750’	Construct connecting trail from trail to Stonehenge trailhead (500 metres) ($16,250). Within railway corridor, install pipe and fill over ((3m long x 2.5m wide x 0.5m deep) adjacent to and on western side of formation to travel across drain line ($1,500).	17,750
84	S 29º 50.449’ E 151º 44.462	Trailhead: Stonehenge Recreation Reserve (See Trailhead plan – Appendix 3). • Install trailhead sign (brown chevron) on New England Highway ($1,600). • Prepare and install trailhead map panel ($5,500). • Install trailhead name sign ($1,000). • Construct gravel carpark (30m x 30m) ($22,500). • Construct connecting trail from parking area to trail (500 metres) (costed in WI 83). • Install 3 Trail Directional Markers (straight ahead arrows on both faces) on connecting trail. One to be installed at junction of connecting trail and road to gun club; the other 2 between this location and the rail trail ($1,800).	32,400
		Allowance for additional landowner requests (e.g. fencing and vegetation screening).	10,000
		Allowance for preparation and installation of interpretive signage (at locations to be determined by trail manager and local historians) (6 signs).	18,000
		Allowance for Trail Directional Markers (incorporating emergency markers) to be placed along trail every 1 km.	7,800

		Allowance for installation of trailside furniture (e.g. seats) at locations to be determined by trail manager.	3,000
		Allowance for marking trees to be cleared, pruned or left untouched.	2,400
		Allowance for marking centreline of trail with flagging tape prior to clearing and construction.	3,600
		Allowance for purchase and installation of: • Regulatory signage (Shared Path; "No Trail Bikes"; "Authorised Users Only"); • Road name signs; • Trail name signs; • "No Trespassing" signs; • Local attractions sign; and • Miscellaneous signs (Keep Out etc.).	2,400
		Allowance for traffic management (1 road crossing).	2,000
		Allowance for cable locators at road crossings (1 road crossing).	1,000
		Option 1: Sub-total (Section 2)	*2,605,565*
		Option 2: sub-total (Section 2) (maximum estimated expenditure)	*2,625,265*
		Allowance for additional construction costs. This section of corridor is less accessible from nearby roads than the corridor from Armidale to Dumaresq (and also from Ben Lomond to Black Mountain as discussed in the 2018 report). More time will be spent hauling material from stockpile sites created where the railway corridor crosses a publicly accessible road. One way to reduce this cost is negotiate access agreements with landholders who adjoin the corridor. Some may be willing to provide access (material can be stockpiled on the railway corridor). An allowance of 5% of construction costs has been included to allow for this additional time.	131,265
		Approvals, permits, applications, designs, specifications, assessments (2.5% of maximum estimated expenditure - $2,625,265).	65,630

		Contingency amount (15% of maximum estimated expenditure - $2,625,265).	393,790
		Project management (5% of maximum estimated expenditure - $2,625,265).	131,265
		Contingency allowance for removal of steel track and sleepers and shaping of basic track by contractor ($8/metre).	78,800
		TOTAL (NOT INCLUDING GST)	***3,347,215***

Table 7: Stonehenge Recreation Reserve to Glen Innes Station (11,460 metres) (refer Plan 6 in Appendix 6)

Ref #	GPS Reference	Works Item	$
1		Construct trail between Stonehenge Recreation Reserve and Glen Innes Station (11,460m).	687,600
2		Start minor clearing to WI 17 (2,020m).	6,060
3		Erect fencing along the corridor (both sides) to create a 6 metre trail envelope to WI 88 – Oliver Rd crossing, Glen Innes (11,460m).	343,800
4		*Slash and flail bridle trail alongside main trail (if horses are to be permitted) (11,460m).*	*22,920*
5	S 29° 50.449’ E 151° 44.462’	Trailhead: Stonehenge Recreation Reserve. (Detailed in Table 6).	0
6	S 29° 50.375’ E 151° 44.750’	Construct connecting trail from trail to Stonehenge trailhead (500 metres). (Detailed in Table 6).	0
7	S 29° 50.329’ E 151° 44.741’	Retain/renovate/repaint distance peg (670 km - note 668km and 669km missing).	200
8	S 29° 50.293’ E 151° 44.726’	Remove existing timber drainage and stock/vehicle underpass and install 6m Landmark (or similar) bridge.	24,000
9	S 29° 50.191’ E 151° 44.691’	Brick culvert. Clean out and maintain.	200
10	S 29° 50.179’ E 151° 44.687’	South eastern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 390m (to WI 12).	7,800
11	S 29° 50.068’ E 151° 44.648’	Retain/renovate/repaint railway sign.	200
12	S 29° 49.972’ E 151° 44.618’	North western end of cutting. End clear side drains.	0
13	S 29° 49.725’ E 151° 44.528’	Large rectangular concrete culvert. Clean out and maintain ($300). Remove gate across corridor ($200).	500
14	S 29° 49.547’ E 151° 44.468’	Retain/renovate/repaint railway sign.	200
15	S 29° 49.427’ E 151° 44.425’	Rectangular concrete culvert. Clean out and maintain.	200

16	S 29° 49.353’ E 151° 44.398’	Construct new trail on eastern side of railway formation to New England Highway road crossing.	Costed in WI 17
17	S 29° 49.311’ E 151° 44.386’	Road crossing – New England Highway. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “trail crossing” signs on both sides of trail ($1,200). • Install “Stop” signs on both sides ($400). • Install trail user chicanes and management access gates (both sides of crossing but at some distance from the road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Install pipe culverts under trail at junction with road (both sides of road under new embankments ($6,000). • Remove existing fence ($200). • Construct new trail (110 metres) on eastern side of crossing (see WI 16 for start point). This work will include a pipe under the embankment where the embankment crosses a drain line running parallel with the railway formation ($7,600). • Construct new trail (25 metres) on western side on 2m high embankment ($1,500). • Install barriers to redirect users – both sides of crossing ($2,000).	26,380
18	S 29° 49.285’ E 151° 44.374’	Old Stonehenge Station (loading platform remains on south western side). Prepare and install interpretive panel. Enhance existing public art ($6,000). Start moderate clearing to WI 22 (230m) ($1,565). Allow screen planting (130m x 3m) on eastern side of rail corridor to WI 21 ($2,340).	9,905

19	S 29º 49.236' E 151º 44.354'	Southern end of loading platform on north eastern side of corridor. Start - Clear side drains (north eastern side between formation and loading platform) for 55 m (to WI 20).	550
20	S 29º 49.209' E 151º 44.346'	End - Clear side drains. End – north eastern loading platform. Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 75m (to WI 22).	1,500
21	S 29º 49.215' E 151º 44.354'	End – screen planting.	0
22	S 29º 49.171' E 151º 44.334'	Northern end of cutting. End clear side drains. Remove cross fence ($200). End moderate clearing. Start minor clearing to Glen Innes trailhead (9,210m) ($27,630).	29,630
23	S 29º 49.030' E 151º 44.282'	Retain/renovate/repaint railway sign.	200
24	S 29º 49.007' E 151º 44.276'	Remove cross fence.	200
25	S 29º 48.994' E 151º 44.273'	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner.	5,000
26	S 29º 48.906' E 151º 44.228'	Allow screen planting (190m x 3m) on eastern side of rail corridor (to WI 27).	3,420
27	S 29º 48.837' E 151º 44.216'	End – screen planting.	0
28	S 29º 48.773' E 151º 44.192'	Retain/renovate/repaint distance peg (673 km - note 671km and 622km missing).	200
29	S 29º 48.513' E 151º 44.102'	Retain/renovate/repaint railway sign.	200
30	S 29º 48.310' E 151º 44.033'	15m bridge over Stonehenge Creek. Preferred option is to repair and re-deck	123,825

		and add handrails in accordance with report by Wood Research and Development ($123,625). Extra fill needed on north side behind abutment – 10m (long) x 2.5m (wide) x 0.5m (deep) ($200).	
31	S 29º 48.247’ E 151º 44.008’	Retain/renovate/repaint distance peg (674 km).	200
32	S 29º 48.102’ E 151º 43.962’	Install livestock/machinery crossing point. Install Type A (open to livestock 24/7) crossing and signage to manage trail user interaction and to prevent access off trail. ($8,000) Install gating system on trail. Gating system across trail to have management access gate, and self-closing pedestrian and bike access gate. Machinery access point to be 5m wide. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both. Negotiate precise location with landowner. Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 235m (to WI 33) ($4,700).	12,700
33	S 29º 47.975’ E 151º 43.917’	Northern end of cutting. End clear side drains.	0
34	S 29º 47.970’ E 151º 43.917’	Road crossing – West Pandora Rd. (See road crossing drawing - Appendix 1). • Install “road ahead” signs on both sides ($400). • Install “trail crossing” signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Install pipe culverts under trail at junction with road (both sides of road) ($3,000). • Remove existing cross fence ($200).	11,880

35	S 29° 47.967' E 151° 43.914'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 260m (to WI 36).	5,200
36	S 29° 47.829' E 151° 43.868'	Northern end of cutting. End clear side drains.	0
37	S 29° 47.701' E 151° 43.829'	15m bridge over Red Bank Creek. Preferred option is to repair and re-deck and add handrails.	123,625
38	S 29° 47.494' E 151° 43.885'	South western end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 145m (to WI 38).	2,900
39	S 29° 47.446' E 151° 43.900'	Remove cross gate.	200
40	S 29° 47.408' E 151° 43.907'	Northern end of cutting. End clear side drains.	0
41	S 29° 47.403' E 151° 43.907'	Pipe culvert – steel pipe in sandbagged wall. Clean out and maintain.	200
42	S 29° 47.400' E 151° 43.907'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (155m) (to WI 43).	4,650
43	S 29° 47.324' E 151° 43.902'	Northern end of cutting.	0
44	S 29° 47.319' E 151° 43.902'	Elevated sleepers on concrete "stands". Pipe and fill over 3m x 2.5m x 0.5m.	1,500
45	S 29° 47.317' E 151° 43.902'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 145m (to WI 46).	2,900
46	S 29° 47.241' E 151° 43.897'	Northern end of cutting. End clear side drains.	0
47	S 29° 47.702' E 151° 43.893'	Retain/renovate/repaint distance peg (676 km – note 675km is missing).	200
48	S 29° 47.105' E 151° 43.895'	Brick culvert. Clean out (extra work needed) and maintain.	500
49	S 29° 46.952' E 151° 43.872'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (585m) (to WI 52).	9,000
50	S 29° 46.920' E 151° 43.868'	Retain/renovate/repaint railway sign.	200

52	S 29° 46.795' E 151° 43.860'	Bridge – Crotty Road/Winters Rd bridge overpass.	0
52	S 29° 46.632' E 151° 43.847'	Northern end of cutting.	0
53	S 29° 46.530' E 151° 43.847'	Remove cross-gate.	200
54	S 29° 46.488' E 151° 43.845'	Rectangular concrete culvert. Clean out and maintain.	200
55	S 29° 46.474' E 151° 43.845'	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner.	5,000
56	S 29° 46.413' E 151° 43.841'	Allow screen planting (170m x 3m) on eastern side of rail corridor (to WI 58).	3,060
57	S 29° 46.393' E 151° 43.842'	Retain/renovate/repaint railway sign.	200
58	S 29° 46.321' E 151° 43.841'	End – screen planting.	0
59	S 29° 46.267' E 151° 43.845'	Replace drain with new small rectangular concrete culvert.	6,000
60	S 29° 46.231' E 151° 43.844'	*Option: Possible link trail/side gate to caravan park on east of trail. Location/permission to be discussed with caravan park managers. Connecting trail to be 10 m from formation to property boundary. Option not costed.*	0
61	S 29° 46.209' E 151° 43.845'	Remove cross fence (location appears to be proximate to northern boundary of caravan park).	200
62	S 29° 46.136' E 151° 43.845'	Allow screen planting (105m x 3m) on both sides of rail corridor (to WI 64).	2,490
63	S 29° 46.124' E 151° 43.845'	Retain/renovate/repaint distance peg (678 km – note 677km is missing).	200
64	S 29° 46.069' E 151° 43.844'	End screen planting. Road crossing – Fawcett Rd. (See road crossing drawing - Appendix 1).	12,080

		• Install "road ahead" signs on both sides ($400). • Install "trail crossing" signs on both sides of trail ($1,200). • Install trail user chicanes and management access gates (both sides of road). Set in concrete/asphalt apron for ease of maintenance ($7,080). • Install pipe culverts under trail at junction with road (both sides of road) ($3,000). • Remove existing cross-fences ($400).	
65	S 29° 46.064' E 151° 43.845'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 280m (to WI 67).	5,600
66	S 29° 45.988' E 151° 43.846'	5 m bridge on concrete abutments. Remove bridge and install 5m Landmark (or similar) bridge.	20,000
67	S 29° 45.915' E 151° 43.846'	Northern end of cutting. End clear side drains.	0
68	S 29° 45.851' E 151° 43.849'	Retain/renovate/repaint railway sign.	200
69	S 29° 45.825' E 151° 43.847'	Existing drain. Replace with small concrete culvert.	6,000
70	S 29° 45.613' E 151° 43.848'	Large concrete cattle and water underpass. Clean out and maintain.	500
71	S 29° 45.579' E 151° 43.852'	Retain/renovate/repaint distance peg (679 km).	200
72	S 29° 45.519' E 151° 43.851'	Install livestock/machinery crossing point: Install Type B (open to trail 24/7) crossing - dual swing gates to be closed across trail when livestock crossing. Trail surface to be cement-hardened across the access point. Install appropriate warning signs about agricultural activity on both sides of crossing point. Negotiate precise location with landowner.	5,000
73	S 29° 45.475' E 151° 43.855'	Rectangular concrete culvert. Clean out and maintain	0
74	S 29° 45.463' E 151° 43.854'	Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of	4,950

		300mm (rather than a standard 150mm) (165m) (to WI 75).	
75	S 29° 45.372' E 151° 43.853'	Northern end of cutting.	0
76	S 29° 45.349' E 151° 43.854'	Large brick culvert (brick arch construction) 10 m below formation (over Rocky Ponds Creek). Install post and rail fence over length (6m) on both sides of trail.	1,200
77	S 29° 45.315' E 151° 43.855'	Remove cross fence ($200). Southern end of cutting. Attend to drainage in cutting: Construct trail to a depth of 300mm (rather than a standard 150mm) (165m) (to WI 79) ($4,950).	5,150
78	S 29° 45.285' E 151° 43.855'	Note: Fence erected on eastern side 3m from rail centreline. Also close on western side. Unclear if fence marks boundary of railway corridor – leave in place.	0
79	S 29° 45.234' E 151° 43.857'	Northern end of cutting.	0
80	S 29° 45.081' E 151° 43.832'	Allow screen planting (180m x 3m) on both sides of rail corridor (to WI 83).	3,240
81	S 29° 45.044' E 151° 43.809'	Retain/renovate/repaint distance peg (680 km).	200
82	S 29° 45.027' E 151° 43.811'	Brick culvert. Clean out and maintain.	200
83	S 29° 44.993' E 151° 43.782'	End screen planting.	0
84	S 29° 44.930' E 151° 43.756'	Brick culvert (rock-reinforced). Clean out and maintain.	200
85	S 29° 44.920' E 151° 43.748'	Retain/renovate/repaint old signal set.	1,000
86	S 29° 44.881' E 151° 43.727'	Brick culvert (rock-reinforced). Clean out and maintain.	200
87	S 29° 44.801' E 151° 43.683'	Retain/renovate/repaint railway sign.	200
88	S 29° 44.795' E 151° 43.681'	Road crossing – Oliver St. (See road crossing drawing - Appendix 1). • Install "road ahead" signs on both sides ($400). • Install "Give Way" signs on both sides ($400).	2,800

		• Install "trail crossing" signs (3 locations) ($1,800). • Remove existing cross-fence (southern side) ($200). End new boundary fencing from Stonehenge Trailhead.	
89	S 29° 44.792' E 151° 43.678'	Southern end of cutting. Attend to drainage in cutting: Clear side drains (both sides) for 460m (to WI 91).	9,200
90	S 29° 44.555' E 151° 43.570'	Retain/renovate/repaint old signal set ($500). Retain/renovate/repaint distance peg (681 km) ($200).	700
91	S 29° 44.555' E 151° 43.570'	Northern end of clear side drains. More work needed on drainage north to WI 93. Construct trail to a depth of 300mm (rather than a standard 150mm) (200m) (to WI 93).	6,000
92	S 29° 44.506' E 151° 43.567'	Lang Street overpass.	0
93	S 29° 44.506' E 151° 43.567'	Northern end of cutting. Retain and renovate existing railway switch.	500
94	S 29° 44.429' E 151° 43.584'	Restore existing water tank and pump.	5,000
95	S 29° 44.408' E 151° 43.602'	Trailhead: Glen Innes Station. Access trail off northern end of station platform. (See Trailhead plan – Appendix 3). • Install trailhead sign (brown chevron – single sided) in 3 locations ($3,000). • Install 1 Trail Directional Marker (Straight Ahead arrow on both faces) ($600). • Prepare and install trailhead map panel ($5,500). • Upgrade existing bitumen carpark (30m x 20m) ($18,000). • Construct short connecting trail (ramps down) from parking area to trail (10 metres) ($600).	27,700
		Allowance for additional landowner requests (e.g. fencing and vegetation screening).	10,000

		Allowance for preparation and installation of interpretive signage (at locations to be determined by trail manager and local historians) (6 signs).	18,000
		Allowance for Trail Directional Markers (incorporating emergency markers) to be placed along trail every 1 km.	7,200
		Allowance for installation of trailside furniture (e.g. seats) at locations to be determined by trail manager.	3,000
		Allowance for marking trees to be cleared, pruned or left untouched.	2,400
		Allowance for marking centreline of trail with flagging tape prior to clearing and construction.	3,600
		Allowance for purchase and installation of: • Regulatory signage (Shared Path; “No Trail Bikes”; “Authorised Users Only”); • Road name signs; • Trail name signs; • “No Trespassing” signs; • Local attractions signs; and • Miscellaneous signs (Keep Out etc.).	2,400
		Allowance for traffic management (4 road crossings).	8,000
		Allowance for cable locators at road crossings (4 road crossings).	4,000
		Option 1: Sub-total (Section 3)	*1,646,795*
		Option 2: sub-total (Section 3) (maximum estimated expenditure)	*1,669,715*
		Allowance for additional construction costs. This section of corridor is less accessible from nearby roads than the corridor from Armidale to Dumaresq (and also from Ben Lomond to Black Mountain as discussed in the 2018 report). More time will be spent hauling material from stockpile sites created where the railway corridor crosses a publicly accessible road. One way to reduce this cost is negotiate access agreements with landholders who adjoin the corridor.	83,485

		Some may be willing to provide access (material can be stockpiled on the railway corridor). An allowance of 5% of construction costs has been included to allow for this additional time.	
		Approvals, permits, applications, designs, specifications, assessments (2.5% of maximum estimated expenditure - $1,669,715).	41,740
		Contingency amount (15% of maximum estimated expenditure - $1,669,715).	250,455
		Project management (5% of maximum estimated expenditure - $1,669,715).	83,485
		Contingency allowance for removal of steel track and sleepers and shaping of basic track by contractor ($8/metre).	91,680
		TOTAL (NOT INCLUDING GST)	***2,128,880***

Table 8: Total Costs Ben Lomond Station to Glen Innes Station (35,515 metres)

(For Option 2: walker/cyclist trail; separate bridle trail. The maximum estimated expenditure)

Section	Cost
Section 1: Ben Lomond Station to Glencoe Station	***$3,245,000***
Section 2: Glencoe Station to Stonehenge Station/Recreation Reserve	***$3,347,215***
Section 3: Stonehenge Station/Recreation Reserve to Glen Innes Station	***$2,128,880***
Total (excluding GST)	***$8,721,095***

SECTION 5 – AN IMPLEMENTATION PROGRAM

5.1 NSW GOVERNMENT PROCESSES

Previously, the NSW Government has set out a number of steps (in public meetings) that proponents need to go through before the development of rail trails can occur (in addition to the necessary legislation to officially close a railway passing Parliament). It is not known whether this list of actions is still relevant.

These steps appear to include:

- the preparation of trail feasibility studies and trail development plans (or similar) both of which have been done for this proposed trail (for all three sections);
- public workshops facilitated by the NSW Government (done for this proposal though covering the corridor between Armidale and Wallangarra);
- a gauge of public support for a rail trail (including but not limited to the public workshops); and
- agreements with affected adjoining landholders about works that are needed on the trail as it passes their property.

Whilst the NSW Government offered the opportunity for adjoining landholders to nominate issues via the thorough community consultation event it hosted, it is reasonable to state that not all landholders have provided input on the specifics of issues they have (such as location of stock crossings etc). The brief for this project did not include any direct landholder consultation (neither did the brief for the 2018 report). The works lists in Section 4 have provided for a number of items designed to satisfy adjoining landholders based on observations about how the two sections of the corridor appear to be used presently. An allowance is included for any additional requests (a similar approach was taken in the 2018 report). The Councils and NERT Inc should consider how best to approach this matter – seeking direction on the NSW Government's current position would provide some indication of any future steps required.

In terms of the legislative processes, the process in NSW is progressing based on the experience of the pilot project – the Tumbarumba-Rosewood Rail Trail. The Northern Rivers Rail Trail was previously identified as the next pilot project. The *Transport Administration Amendment (Closures of Railway Lines in Northern Rivers) Bill 2020* was passed by both Houses of Parliament in October 2020.

This is a critical step toward trail construction.

The bill is a simple bill with 4 clauses. These clauses:

- specify the geographic extent of the closure;
- allows the rail infrastructure owner to sell or otherwise dispose of the land and remove the railway tracks and other works;
- specifies that the land remains in public ownership (by prescribing what entities the land can be sold or given to); and
- specifies that the land may be leased for recreation, tourism or community and related purposes only.

The Bill closely resembles the *Transport Administration Amendment (Closure of Railway Line Between Rosewood and Tumbarumba) Act 2017.* It is believed that an Act to close the New England railway line from Armidale to Glen Innes would be very similar to the preceding two pieces of legislation; it should be relatively easy to draft once a decision is made to proceed.

5.2 TRAIL CONSTRUCTION STAGES

Development of trails can often be staged so that parts of trails are developed in line with available funding sources. It is often not possible to open the full length of a trail simultaneously as significant physical, financial, community and institutional work needs to be undertaken. This is the case in many rail trails (and indeed many recreational trails) around Australia. Opening a new trail in stages also allows those who are opposed or undecided about a project to see a clear demonstration of its use and lack of issues (almost inevitably, problems identified by concerned people do not arise).

A staged approach to planning and development is often the best approach as it better suits the capacity of the entity charged with delivering the project.

The New England Rail Trail – as defined by this report and the 2018 *New England Rail Trail Plan* – consists of three roughly equal sections being Armidale to Black Mountain (approximately 33 kms), Black Mountain to Ben Lomond (approximately 34 kms), and Ben Lomond to Glen Innes (approximately 35.5 kms). Each of these sections is a good day's bike ride and a long day's walk (though many walkers would take 2 days). Taken together, the trail provides a 3-4 day bike ride and a 5-6 day walk opportunity.

A staged approach to planning and development is often the best approach as it better suits the capacity of the entity charged with delivering the project. Trails can take up to 10 years to develop from initial planning stages. The "new" Bibbulmun Track in WA was some 4 years in the detailed planning and construction. This was a significant trail project with backing by the State Government – it stands out as a track planned and built relatively quickly. Other rail trail projects provide better illustrations of a realistic timeframe. A Feasibility Study for the Great Victorian Rail Trail was prepared in 2004; the trail opened in 2012. Interestingly, this trail was completely developed in one stage as the result of a large Commonwealth Government grant after the tragic Black Saturday bushfires in 2009. The Port Fairy Warrnambool Rail Trail (a 37km trail) was subject to various studies and plans from 2002; it was opened in 2010 – again all in one stage.

There will always be arguments about where construction of a trail should commence, especially if it is a long trail (as this proposed 102 km rail trail is) and it passes through a number of towns and villages.

The criteria used to determine the recommended stages of development for the trail were:

- Trail sections anchored in trailheads (preferably near to major population centres).
- Trail sections enabling local people to use the facility for local walks and rides and for commuting purposes.
- Construct cheaper sections earlier than expensive ones (affordability).
- Construct most attractive sections first.
- Probable economic impacts.

- Finished product logic.
- Ease of access for users.
- Ease of trailhead development.
- Numbers of rural properties through which the rail trail would pass.

Assessment of potential stages was done in a broad sense against all these criteria, rather than assessing each section against each individual criterion. Combined with the field assessment, consideration of these elements allows the determination of the implementation schedule.

Given there are two Councils likely to be involved in construction (if this is the way trail implementation and management works out), it is logical to start construction in both Local Government areas. The priority sections (based on an overall consideration of the above factors) would be the Armidale to Guyra section (a distance of some 44 kms) and the Ben Lomond to Glen Innes section (some 35.5 kms). It is recommended that each task (such as fencing, trail surfacing etc) be completed before moving on to the next task for each section. That way the entire trail construction (44 kms at the southern end and 35.5 kms at the northern end) would be completed in its entirety before embellishments such as signage and gating systems are installed.

The section from Guyra to Ben Lomond (some 23.9 kms) should be constructed in one stage but it need not be the first step taken. However, if funding is available and the trail manager believes they have the capacity to construct the entire trail in one stage, this can be done. Under this scenario, project management will be a significant and major task. Care needs to be taken if this is the approach – short cuts in construction will manifest themselves in expensive repairs and refurbishment very quickly as has been the experiences on other trails.

5.3 IMPACTS ON NATIVE VEGETATION

Trail construction will require the removal of vegetation along the length of the former railway corridor. Clearing will be required. Generally speaking, much of the corridor has been kept free of vegetation – in some sections, there has been regrowth though this is not extensive.

The Office of Environment and Heritage (OEH), in partnership with Local Land Services (LLS), manages the implementation of the *Native Vegetation Act 2003* and *Native Vegetation Regulation 2013.*

The *Native Vegetation Regulation 2013* makes provision for and with respect to the following:

- development consent for clearing of native vegetation;
- the form and content of property vegetation plans (PVPs), the variation and termination of PVPs and a register of PVPs;
- the assessment of broad scale clearing, including the adoption of an Assessment Methodology for determining whether proposed broad scale clearing will improve or maintain environmental outcomes;
- clearing for private native forestry;

- routine agricultural management activities;
- special provisions for vulnerable land; and
- miscellaneous and savings and transitional matters.

It is unclear whether the clearing of regrowth vegetation for the purposes of constructing the trail will be required. The Councils will need to liaise with the OEH to determine whether permits will be required and/or whether offset revegetation will be required.

SECTION 6 – CONSTRUCTION MANAGEMENT

Should the trail proceed, prior to the construction of the rail trail between Armidale and Black Mountain, and between Ben Lomond and Glen Innes, the project manager should prepare a Construction Management Plan (CMP).

The purpose of a Construction Management Plan is to provide a framework reference document detailing how the Councils and any contractors will manage and control aspects of the trail construction. The CMP will be used as a working document to ensure that obligations and commitments provided in the relevant licences, permits and approvals are made known to all site personnel and implemented effectively as an integral part of trail construction.

It also aims to detail processes to minimise impacts associated with the construction of the rail trail on adjacent areas. Given sufficient thought and consideration prior to construction, risks can be mitigated, and impacts can be minimised.

The 2018 *New England Rail Trail Plan* included an extensive commentary on a series of matters relating to construction management. In the interests of brevity, this report should be considered a companion to the 2018 report. The following notes focus on those matters for inclusion in the Construction Management Plan of particular relevance to the Armidale to Black Mountain and Ben Lomond to Glen Innes sections, particularly where these are different to the Ben Lomond to Black Mountain section.

6.1 DEALING WITH ADJOINING LANDHOLDERS

The 2018 report set out a series of actions for dealing with adjoining landholders during construction. These apply equally to the Armidale to Black Mountain and Ben Lomond to Glen Innes sections.

6.2 BROAD STAGES OF TRAIL CONSTRUCTION

The 2018 report covered the following construction stages, setting out the elements contained in each. These apply equally to the Armidale to Black Mountain and Ben Lomond to Glen Innes sections.

- Pre-construction;
- Field identification works;
- Clearing corridor;
- Drainage measures;
- Trail surfacing;
- Signage and road crossings; and
- Final steps.

6.3 CONSTRUCTION MANAGEMENT PLAN

The 2018 report set out the elements needed for a Construction Management Plan. These apply equally to the Armidale to Black Mountain and Ben Lomond to Glen Innes sections. Any significant variations pertinent to these two sections is included below with the relevant element (if there is no additional comment, the 2018 report provides the relevant information).

- Preparation of a Landholder Communication Plan to ensure that all adjacent landowners are aware of the construction program well in advance and are individually consulted regarding exact placement of recommended works items;
- Preparation of a Safe Work Method Statement (SWMS) identifying and controlling health and safety hazards and risks.
- Preparation of other works method statements addressing a range of potential concerns such as the spread of weeds during vegetation clearing (on and offsite), water pollution or sedimentation due to working near to watercourses, and the discovery or impact to any new sites of Aboriginal or non-Aboriginal heritage or archaeological sites.
- Preparation of environmental and other surveys (e.g. flora if required, site pegging and on ground delineation).
- Geotechnical/engineering investigations at and around watercourses prior to refurbishment / adaptation of the bridges and culverts.
- Utility Identification/Relocation (if required) not limited to road crossings.
- Installation of new gates and fences and stock crossings in order to ensure stock are kept out of the rail trail corridor. Cooperation and consultation with adjoining landowners will be required to ensure any new fencing is installed in the appropriate location and that stock and machinery crossings are located in the optimum locations.
- Fencing and stock control during construction.
- Selection of material stockpile sites. Numerous stockpile sites will be required along the alignment to enable the management of surfacing material, culvert materials, fill and potentially topsoil and vegetation. It is imperative that access to the corridor be via public land, unless agreement has been obtained from neighbouring landowners. The works tables (Section 4) have allowed for additional construction costs associated with relatively long haulage from stockpile sites to construction sites as the Exmouth to Black Mountain section, and the Ben Lomond to Glen Innes section have relatively limited public access sites. Negotiated access with adjoining landholders will mean additional stockpile sites and reduced construction time.
- Construction of access points to the corridor. The corridor is easily directly accessible between Armidale and Dumaresq, either directly off Shambrooke Avenue and Boorolong Road, or directly from 4 road crossing points. The section between Dumaresq and Exmouth provides for four additional gates and access tracks These new access points will be sited off existing public roads and they will consist of a management access gate in the boundary fence and formed access track (built to 5m

wide). The precise locations have not been included within the Plan; precise locations will depend upon having direct access to the railway corridor off an adjoining public road (rather than via an adjoining private property). Upon completion of the trail these additional gates can be used for access by emergency vehicles and maintenance vehicles. They will require identical locking mechanisms to the gates at each road crossing. (Sections from Exmouth to Black Mountain, and from Ben Lomond to Glen Innes are far less accessible from public roads; consequently, no provision for "side access" has been included in works tables).

- Remediation of contaminants in sleepers and along formation. The CMP should specify how potential contamination is to be dealt with.
- De-contamination of construction equipment. The CMP should specify the process by which construction equipment will be kept clean of potential diseases, weeds and contaminants.
- Management of fire risk (incl. spark control). The CMP will identify the general requirements regarding fire prevention and management during construction, especially at times of total fire ban.
- Weed Management – control and eradication. The CMP will need to ensure that construction of the rail trail does not cause weeds to spread. Blackberries will be the key weed management issue, particularly in the southern section between Armidale and Black Mountain.
- Marking trees for retention or removal. Prior to construction commencing trees that are to be retained (for their shade and aesthetic values) should be marked with flagging tape. The CMP should specify the process for marking trees for retention.
- Clearing, mulching and disposal of waste vegetative material. The CMP will address the process for clearing, and the manner in which vegetative material will be removed from the corridor (such as by mulching and spreading in the immediate area or by other methods).
- Disposal, re-use or recycling of sleepers. The CMP should specify where poor sleepers can be used and where the good ones will be used and other methods of disposal. There appears to be very few in good condition.
- Erosion control and drainage along corridor. The railway (when operating) had functional erosion control techniques in place. The construction of the rail trail must ensure that no damage is done to existing drainage channels and erosion control devices and that erosion is mitigated rather than exacerbated. This is particularly important when working in and around the numerous watercourses, along embankments and through cuttings. The CMP will need to address how erosion will be controlled, both during the construction of the rail trail and afterwards.
- Pollution control at watercourses/bridges. The CMP will need to specify the installation of erosion and sediment controls, such as silt fences, to be deployed at sensitive locations such as bridges and other watercourses.
- Access considerations. The CMP will need to determine the most efficient means of access to all parts of the corridor (and to stockpile sites), with minimal noise, dust and inconvenience to nearby residents.

- Traffic control. There are 8 road crossings along the proposed rail trail between Armidale and Black Mountain, and 8 road crossings along the proposed rail trail between Ben Lomond and Glen Innes. The CMP will need to address the issue of traffic management and control to ensure the safety of contractors involved in construction activity in the vicinity of each road crossing – particularly at major roads such as the New England Highway at Stonehenge and Old Inverell Road at Armidale.

SECTION 7 – CORRIDOR MANAGEMENT AND OPERATIONS PLAN

7.1 INTRODUCTION

In 2018, *the New England Rail Trail Plan* was prepared for Armidale Regional Council and Glen Innes Severn Council. It included an extensive commentary on a series of matters relating to corridor management and operation. The 2018 report covered the following management and operation elements:

- A corridor management plan, including guiding principles and initial decisions;
- A trail management plan;
- General risk management;
- An emergency response plan; and
- A trail maintenance plan.

General notes on management and operation as included in the 2018 report are as relevant to the Armidale to Black Mountain, and Ben Lomond to Glen Innes sections as they were to the Ben Lomond to Black Mountain section. As indicated in the 2018 report, as the trail development planning moves towards completion and the various landowner and development issues are resolved, a number of decisions need to be made about the ongoing management, operation and maintenance of the rail trail.

The best approach to deal with these issues is through a Corridor Management Plan, which forms the basis for ongoing trail management, operation and maintenance. A well-prepared and comprehensive corridor management plan (undertaken in close consultation with the community and neighbouring landowners) serves to ensure the rail trail functions and operates as a high-quality experience. NERT Inc and the two Councils should use the 2018 report as a basis to prepare the Corridor Management Plan.

In the interests of brevity, this report should be considered a companion to the 2018 report. The following section focusses on the trail maintenance plan which is a key factor in consideration of the trail development and differs in specifics from the companion section in the 2018 report.

7.2 A TRAIL MAINTENANCE PLAN

7.2.1 INTRODUCTION

Ongoing trail maintenance is a crucial component of an effective management program – yet it is often neglected until too late. Countless quality trails have literally disappeared because no one planned a maintenance program and no one wanted to fund even essential ongoing repairs. It is therefore essential that funds be set aside in yearly budgets for maintenance of this trail - to ensure user safety and enjoyment, and to minimise liability risks for land managers.

7.2.2 THE MAINTENANCE TASK

Ongoing maintenance can be minimised by building a trail well in the first place. A well-constructed trail surface will last considerably longer than a poorly built trail. Signs, gates, and posts installed in substantial footings stand less risk of being stolen or damaged. Well designed, well-built and well installed management access gates and trail user gates (as proposed) will keep motor vehicles and motorised trail bikes off the trail with a consequent lessened need for surface repairs. Trail furniture (such as bench seats, trail directional marker posts and interpretation) should be installed in substantial footings sufficient to withstand high winds and theft. These should require minimal ongoing maintenance. Care needs to be taken by maintenance vehicles when travelling along the trail so as not to damage the surface.

Trail managers and "Friends of ..." groups often arrange 'Adopt-a-Trail' programs to ensure the rail trail is well maintained – by volunteers. The majority of some trails, such as the Bibbulmun Track, are maintained by volunteers.

The presence of trees along some of the trail means that time will be spent removing damaged and fallen trees and branches in the aftermath of a storm.

The most frequent maintenance task will be attending to fallen branches and limbs, repairing trail surfaces, replacing stolen or damaged signs (including road signs), clearing culverts and under bridges and ensuring gates and fences are functioning as intended.

As noted above, building good trails in the first place is the very best way of minimising future problems and costs. As a second line of defence, a clear and concise Management Plan with a regular maintenance program written into it will aid significantly in managing ongoing resource demands.

The goals of a Trail Maintenance Plan are to:

- Ensure that trail users continue to experience safe and enjoyable conditions;
- Guard against the deterioration of trail infrastructure, thereby maintaining the investment made on behalf of the community;
- Minimise the trail manager's exposure to potential public liability claims arising from incidents which may occur along the trail; and
- Set in place a management process to cover most foreseeable risks.

Erosion (caused by weather and unauthorised users), regrowth of vegetation (including grass and weeds on the trail corridor but not on the trail surface), fallen trees and branches, and damage to signage and fences are likely to be the greatest maintenance activities on the trail. Providing these effects are attended to early, they are largely labour intensive rather than capital expensive. Calamitous events such as fire or major flood will naturally generate significant rebuilding activity and consequent costs. These events are generally unmanageable and should simply be accepted as part of the longer-term reality of trail management.

7.2.3 PUBLIC LIABILITY AND RISK MANAGEMENT

It is important that both the Armidale Regional Council and the Glen Innes Severn Council be aware that – whether or not visitors are actively encouraged to come to the trail – they carry a significant duty of care towards those visitors accessing the trail. The maintenance of a quality trail is therefore critical from this perspective. Liability generally rests with the land managers and hence, every attempt should be made to minimise the risk of accident or injury to trail users (and therefore the risk of legal action).

While public liability is certainly an issue for all land managers, it is not a reason to turn away from providing safe, sustainable and enjoyable resources. It is simply a mechanism by which to recognise the responsibilities inherent in managing natural and built resources. Dealing with a perceived liability threat is not about totally removing that threat – it is about doing all that is manifestly possible to provide safe access opportunities for visitors, thereby minimising the risk of liability claims.

A formal Hazard Inspection process is crucial in the ongoing maintenance plan. Not only will this define maintenance required and/or management decisions to be addressed, but it is also vital in ensuring safe conditions and therefore in dealing with any liability claim which may arise in the future. Courts are strongly swayed by evidence of a clear and functional program, and a regular series of reports, with follow-up actions, will go a long way to mitigating responsibility for injuries. Further, clearly defined ‘User Responsibility’ statements in brochures, maps, policy documents, plans and public places will assist this process.

7.2.4 TRAIL MAINTENANCE

The following information is provided as general maintenance guidance. An inventory of works and locations needs to be prepared for maintenance purposes – this cannot be prepared until construction is completed. An example of a checklist for a trail is included in Appendix 5. The Councils will need to create a specific checklist based on this example once the trail is completed.

Maintenance on the trail should be divided between regular inspections and simple repairs, a one (or two) person job, and quarterly programs undertaking larger jobs such as significant signage repairs or weed / vegetation control. A range of basic machinery, tools and equipment will be required for this work.

At the core of any trail maintenance program is an inspection program. The relevant Australian Standards sets out the basis for frequency of trail inspections. It only covers walking tracks and provides for inspections every 30 days (or less) for Class 1 trails, every 90 days for Class 2 trails, and annually for Class 3-6 trails. This sets the minimum standard for inspections and is a guide only. What the Australian Standards do not include but should include is an inspection of any trail after significant weather events such as storms, fire, floods, and high winds in addition to the regular inspection program. The proposed inspection regime recommends inspections every 90 days.

Clear records of each activity/inspection will be kept by the body with responsibility for maintenance. Pro-formas serve to maximise user safety and minimise liability risks. It will also provide a valuable record of works undertaken and make for efficient use of maintenance resources over time.

Volunteers organised by the Committee of Management at a busy bee to undertake maintenance work along the rail trail near Port Fairy in Victoria.

In general, Maintenance Plans are based around regular inspections, at which time simple maintenance activities should take place concurrently. More time-consuming maintenance activities should take place every six months, while detailed Hazard Inspections should occur annually. Further, the capacity to respond immediately to random incoming reports of hazards or major infrastructure failures should be built into the Plans. Table 9 gives a suggested schedule for general maintenance activities to achieve acceptable maintenance levels and provides explanatory notes pertaining to each Activity.

Table 9: General Maintenance Activities

Activity	*Activity Description*	*Site*	*Frequency*
Undertake full inspection of the trail.	***At Trailheads*** The trailhead should be carefully checked to ensure that all signage is present, and that all signs are clearly visible and legible. An inventory needs to be prepared to assist in regular maintenance. Surface of access tracks and parking areas need to be checked and potholes eliminated. Inspect and check trailhead facilities and infrastructure: o Parking areas and access tracks (check surfaces) o Trailhead (map) panel o interpretive panel o Seating/shelter/picnic tables o Trailhead signage (on road) o Trail directional marker posts ***At Road Crossings*** Particular attention needs to be given to signs at road crossings or junctions. Each crossing should be carefully checked to ensure that all signage is present, and that all signs are clearly visible. Particular attention must be given to ensuring that "Trail Crossing ahead" signs (on roadside at approach to trail crossing) are not obscured by overhanging vegetation. Replace damaged and/or missing signs. Check management access gates and trail user chicanes for structural stability and function.	Entire trail	Every third month

	Fencing Check and make repairs to side fencing. To be done by arrangement with adjoining landowners.		
Check signage and clean, replace or repair as required esp. road crossing signage and directional markers. **All signage should be checked for vandalism and cleaned if necessary. If damage is too great, replacement is essential.** **An inventory of locations of all signs needs to be prepared to assist in regular maintenance.**	Check, repair or replace all trail signage, including interpretive signage, trail distance and directional markers (logo/arrow plates). Replace missing and/or damaged signs.	All locations	Every third month - at each trail inspection.
Slashing of trail environs.		Various locations	Timing dependent on seasonal growth patterns. Allowance for up to 6 times per year.
Check trail surface and arrange repair as required.		Entire trail	Every third month. Arrange repairs immediately if acute, or schedule maintenance for six monthly work sessions if not.
Maintenance of trail surface.	Check condition of trail surface for damage and arrange repairs if necessary; trim off regrowth vegetation.	Entire trail	Every six months.

Sweep or rake debris from trail surfaces, especially at road crossing points.		Various locations	Every six months.
Maintenance of culverts and other drainage measures.	Check and clear drains and culverts. Drains need to be checked and cleared once or twice/year and after heavy rainfall events. Regular maintenance especially after heavy rainfall is essential. Most maintenance will involve clearing of material from silted up or blocked drains. Drain blockages should be cleared as urgent priority. Silt traps at culvert discharges or entry points should be cleared regularly. Cess drains in cuttings should be checked to ensure they function effectively.	Entire trail	Every six months.
Cut back regrowth, intruding and overhanging vegetation.	Check overhanging or intruding vegetation. Cut back where required. Clear fallen trees and branches. Undergrowth vegetation grows quickly, and over time will continue to intrude into the trail 'corridor'. Such intruding vegetation needs to be cut back to provide clear and safe passage for trail users. "Blow-downs" - trees or limbs that have fallen across the trail – need to be cleared as/when required. Sight lines must be kept clear either side of road crossings, to ensure that users can clearly see a safe distance either way at road crossings.	Entire trail	Every six months, unless obviously requiring attention at regular inspections.
Check structural stability of interpretive signage, and interpretive shelters.	Interpretive panels should be checked for vandalism and cleaned if necessary. If damage is too great, replacement is essential. An inventory of locations needs to be prepared to assist in regular maintenance.	Entire trail	Every six months.

Check structural stability of seating, distance posts. Inspect and replace when needed.	Furniture alongside trails, if installed, needs to be checked regularly for damage to ensure safety and comfort of trail users.		
Undertake Hazard Inspection and prepare Hazard Inspection Report.	This should be done annually. Inclusion of a formal Hazard Inspection process, crucial in addressing risk, is necessary in the ongoing maintenance plan. Not only will this define maintenance required and/or management decisions to be addressed, but it is also vital in ensuring safe conditions and therefore in dealing with any liability claim which may arise in the future. Courts are strongly swayed by evidence of a clear and functional program, and a regular series of reports, with follow-up actions, will go a long way to mitigating responsibility for injuries. Further, clearly defined 'User Responsibility' statements in brochures, maps, policy documents, plans and public places will assist this process.	Entire trail	Annually.
Check structural integrity of bridges. **Inspect and maintain bridges.** **Check for obstructions and clearing under bridges.**	Visual inspection is appropriate though detailed inspection should follow storm and flood events. After floods, bridge should be inspected, and damaged components replaced as soon as possible. Handrails and surface decking on bridge should be inspected for damage at regular intervals.		Annually.

It should be noted that this schedule does not allow for repair works above and beyond 'normal' minor activities. For example, if a section is subject to heavy rain, and erosion control fails, additional repair works will need to be undertaken.

7.2.5 MAINTENANCE COSTS

Resourcing a maintenance program is crucial, and funds will be required on an ongoing basis to enable this essential maintenance. It would be short sighted to go ahead and build the New England Rail Trail and then baulk at the demands of managing and maintaining it.

Estimating the cost of maintaining a trail is difficult due to the unpredictability of events such as floods, fires, high winds and stormwater runoff, as well as the tenure and management arrangements for the trail. Deliberate and willful damage and vandalism can also contribute significantly to the need for ongoing maintenance and replacement of infrastructure. Volunteers can be organised (through a coordinated program) to carry out much of the work at a limited cost to the trail manager.

Evidence of actual trail maintenance costs for individual items along a rail trail, or any trail for that matter, is scarce. The Rail to Trails Conservancy in the USA (*Rail-Trail Maintenance and Operation – Ensuring the Future of Your Trails – A Survey of 100 Rail-Trails, July 2005*) provides two general answers for why it is difficult to estimate maintenance costs. First, the trail may be part of a larger budget for a single park or even an entire parks and recreation department. Specific costs for the trail are not separated out. Second, small trail groups, though run by competent and extremely dedicated volunteers, tend to be 'seat-of-the-pants' operations. Maintenance is done "as needed," funds are raised "as needed," and the people are volunteering because they love the trail, not because they love doing administrative tasks like budgeting.

Maintenance responsibility does appear to significantly affect cost. Approximately 60% of the surveyed trails reporting costs were maintained primarily by a government agency, implying paid staff and/or contractors. The other 40% of trails were primarily maintained by a non-profit or volunteer organisation. Adjusting for exchange rates and inflation since 2005, annual costs for government-run trails were just over $2,465/km. This is not much more than the overall average of $1,855/km, but it nearly triples the average for volunteer-run trails of $868/km.

In Victoria, the Murrindindi Shire Council manages and maintains approximately 85% of the (134km) Great Victorian Rail Trail. It spends around $2,000/km on maintenance activities each year which the trail manager believes is insufficient. Anecdotal information indicates that initial construction issues necessitate an increased level of maintenance of the trail surface (and drainage through cuttings). A higher level of (initial) construction quality (i.e. better trail surfacing) would mean less ongoing maintenance.

The Kilkivan Kingaroy Rail Trail in South East Queensland opened in September 2017. In October 2019, representatives of the South Burnett Regional Council (responsible for approximately half the trail) advised that maintenance costs were in the order of $500/km/year.

A 2016 study of the Great Rides of New Zealand (*The Great Rides of the New Zealand Cycle Trails 2016*) examined the 22 "great bike rides" of New Zealand and reported an average maintenance cost of $1,285 per kilometre (adjusted for exchange rates and inflation). This figure is based on the actual reports of 9 of the 22 trails. It is difficult to know precisely what items have been included in these figures as the 9 individual trail reports are not available.

Verbal advice to NERT Inc. from Indigo Shire Council was that maintenance for the Murray to the Mountains Rail Trail costs in the order of $915/km/year.

There are significant variations across the available research costs and it is not clear from available data what has been included and what has not been included in consideration of costs. There are two issues when considering the quoted costs and what has been included and not included.

- The "age" of the trail. The Kilkivan Kingaroy Rail Trail (KKRT) was only 2 years old at the time the data was sourced. Early life maintenance costs tend to be very limited. The $500/km/year cited for the KKRT reflects actual expenditure on maintenance to date. Very little maintenance beyond slashing and minor repairs would have been needed. Figures for the other trails reflect trails that are a little more mature and may need more minor maintenance done. Whist there is appeal in setting aside the minimal amount for maintenance in the first 2-3 years, a more appropriate approach would be to set aside higher amounts from trail inception. The likely maintenance costs in the first few years of a trail's life will focus on sign damage and inspections. These "day to day" costs can and should be funded by the trail manager (using their own resources including volunteers).

- The more critical element is the treatment of replacement of major assets over time. It is highly likely that the available figures from the research do not provide for how replacement of major capital items is considered. The biggest "maintenance costs" are maintenance and replacement of the items that initially cost the most to install – surfacing, fencing and, particularly in the northern section, bridges. Maintenance on three critical elements is less likely to be needed in the first 5-10 years if the trail is built well in the first place. Allowance for repair and replacement of these items should be treated differently. It is worth noting that calculations for maintenance costs for this project show that surfacing, bridge repair and fencing replacement account for over 50% of the maintenance cost. In addition to maintenance, there will be a requirement for asset renewal – particularly of surfaces, bridges, and fences. The timing of this renewal will generally be between 10 and 50 years – an Asset Management Plan is the appropriate method for dealing with these items. Good asset management practice suggests money be put aside every year for renewal of these major items, even though much of it will not be spent initially. Funding for these items could be sourced from external funding programs as compared with ongoing minor repairs for which major external funding is hard to find. **Little maintenance will be required on newly built trail surfaces, bridge structures and other elements of the rail trail for several years after construction.** There will be very limited need for surface repairs in the first 5 years. Bridges are even less likely to need repair for the first 10 years of a trail's life. Re-constructed and refurbished bridges will require little or no maintenance for many years. However, after perhaps a decade of use they will require more and more maintenance of decking timbers (if used) and more scrutiny of fixings (depending on what materials are used for decking). Pre-fabricated bridges require less maintenance over time. The same comments apply to fencing (though its active life is probably shorter than bridges and surfacing). There should be very limited need for fencing repairs in the first 10 years. It may be appropriate to share ongoing repair costs with adjoining landholders once the initial investment is made. This is a matter for the trail manager to consider.

It is difficult estimating the costs involved in maintaining a trail until every last bridge and other infrastructure items have been installed. As stated earlier, ongoing maintenance can be minimised by building a trail well in the first place.

The use of volunteers to undertake many of the routine repairs and cleaning tasks can substantially reduce the costs.

The estimates that follow (7.2.6 and 7.2.7) should also be read in conjunction with the estimates for the maintenance of the Black Mountain to Ben Lomond section included in the 2018 report (though the 2018 report did not separate out the two different elements – day to day maintenance and infrastructure renewal).

7.2.6 ESTIMATE OF MAINTENANCE COSTS FOR ARMIDALE TO BLACK MOUNTAIN

Table 10 provides an estimate of the amounts that may be required on an annual basis for maintaining the proposed 33km section of the New England Rail Trail from Armidale to Black Mountain for regular "day to day" maintenance.

Table 10: Estimate of "Day to Day" Maintenance Costs for Armidale to Black Mountain – 33km

Task	*Frequency/note*	*Possible costs*
Inspect and check trailhead facilities and infrastructure (Armidale, Dumaresq, Exmouth): - parking areas (check surfaces) - interpretive panel - picnic tables - trailhead signage (on road) - trailhead (map) panel - trail directional marker posts	3 trailheads at average repairs of $1,000 per site/year.	$3,000
Check side vegetation growth and overhead vegetation and cut back where required. Clearing of fallen trees and branches.	Allowance of 10 person days per year (@ $500/day).	$5,000
Slash corridor both sides of trail to reduce weeds and fire load/risk. *(See Note 1).*	Allowance for 80% corridor, both sides of trail (= 53 km) (@ $100/hr). Corridor slashed 6 times a year.	$10,600
Inspection of bridges (all timber components, decking, handrails, etc.). Check for obstructions and clearing under bridges.	Allowance of 10 hours for inspections and minor repairs.	$2,000
Check and clear culverts.	Allowance of 20 hours for checking and cleaning.	$1,600

Check road crossings. Replace damaged and/or missing signs and undertake other tasks: - Give Way and Road Ahead signs - Trail Crossing warning signs - Road name signs - Regulatory signs - Check sight distances and clear vegetation if necessary	8 crossings at average repairs of $500 per crossing/year.	$4,000
Allowance for replacement of trail directional marker logo/arrow plates and trail kilometre posts.	10 replacements per year.	$4,000
Allowance for repairs to trailside furniture and occasional replacements (when required).	Inspection and minor repairs every 6 months. 1 replacement per year.	$2,000
Check miscellaneous signs along trail (e.g. trail name, distance signs, "No Trespassing", bridge load signs, etc).	10 replacements per year.	$2,000
Check management access gates and fences at road crossings. Make repairs where necessary.	Allowance of $8,000 per year for repairs.	$8,000
Check interpretation along trail for damage and structural stability.	Allowance for repair of 1 panel per year.	$1,000
Inspection of rail trail (3 times/year). *(See Note 2).*	Allowance for 3 inspection trips per year.	$4,500
Preparation of annual Hazard Inspection Report.	1 person days @ $1000/day.	$1,000
		$48,700 excl GST (per annum)

This equates to a rate of approximately $1,475 per kilometre per annum.

Note 1: The necessity to slash will be much reduced if the rail trail is located within a narrower, fenced corridor and adjoining landowners graze stock within that part of the corridor deemed 'surplus to requirements'. Slashing costs are based on Option 1 (as discussed in Section 3.9) whereby the trail and its immediate environs (rather than the entire corridor) is fully fenced (resulting in a 6m wide trailway). Any other options will mean higher maintenance costs.

Note 2: Reporting of routine maintenance requirements by trail users will obviate need for many scheduled inspections. Appointment of a Trail Manager, with responsibility for regular inspections of entire trail, will substantially reduce need for unscheduled and expensive maintenance.

Asset renewal provisions should be provided for separately and cover replacement of surfacing, fencing and bridges. These provisions would have separate timeframes for replacement with fencing and surfacing requiring renewal in a shorter time than bridges.

7.2.7 ESTIMATE OF MAINTENANCE COSTS FOR BEN LOMOND TO GLEN INNES

Table 11 makes an attempt at estimating an amount that may be required on an annual basis for maintaining the proposed 35.5 km section of the New England Rail Trail from Ben Lomond to Glen Innes.

Table 11: Estimate of "Day to Day" Maintenance Costs for Ben Lomond to Glen Innes – 35.5km

Task	*Frequency/note*	*Possible costs*
Inspect and check trailhead facilities and infrastructure (Glencoe, Stonehenge, Glen Innes): - parking areas (check surfaces) - interpretive panel - picnic tables - trailhead signage (on road) - trailhead (map) panel - trail directional marker posts	3 trailheads at average repairs of $1,000 per site/year.	$3,000
Check side vegetation growth and overhead vegetation and cut back where required. Clearing of fallen trees and branches.	Allowance of 10 person days per year (@ $500/day).	$5,000
Slash corridor both sides of trail to reduce weeds and fire load/risk. *(See Note 1).*	Allowance for 80% corridor, both sides of trail (= 57 km) (@ $100/hr). Corridor slashed 6 times a year.	$11,400
Inspection of bridges (all timber components, decking, handrails, etc.). Check for obstructions and clearing under bridges.	Allowance of 30 hours for inspections and minor repairs.	$6,000
Check and clear culverts.	Allowance of 30 hours for checking and cleaning.	$2,400
Check road crossings. Replace damaged and/or missing signs and undertake other tasks: - Give Way Road Ahead signs - Trail Crossing warning signs - Road name signs - Regulatory signs - Check sight distances and clear vegetation if necessary	8 crossings at average repairs of $500 per crossing/year.	$4,000
Allowance for replacement of trail directional marker logo/arrow plates and trail kilometre posts.	10 replacements per year.	$4,000

Allowance for repairs to trailside furniture and occasional replacements (when required).	Inspection and minor repairs every 6 months. 1 replacement per year.	$2,000
Check miscellaneous signs along trail (e.g. trail name, distance signs, "No Trespassing", bridge load signs, etc).	10 replacements per year.	$2,000
Check management access gates and fences at road crossings. Make repairs where necessary.	Allowance of $8,000 per year for repairs.	$8,000
Check interpretation along trail for damage and structural stability.	Allowance for repair of 1 panel per year.	$1,000
Inspection of rail trail (3 times/year). *(See Note 2)*	Allowance for 3 inspection trips per year.	$4,500
Preparation of annual Hazard Inspection Report.	1 person days @ $1000/day.	$1,000
		$54,300 excl GST (per annum)

This equates to a rate of approximately $1,529 per kilometre per annum.

Note 1: The necessity to slash will be much reduced if the rail trail is located within a narrower, fenced corridor and adjoining landowners graze stock within that part of the corridor deemed 'surplus to requirements'. Slashing costs are based on Option 1 (as discussed in Section 3.9) whereby the trail and its immediate environs (rather than the entire corridor) is fully fenced (resulting in a 6m wide trailway). Any other options will mean higher maintenance costs.

Note 2: Reporting of routine maintenance requirements by trail users will obviate need for many scheduled inspections. Appointment of a Trail Manager, with responsibility for regular inspections of entire trail, will substantially reduce need for unscheduled and expensive maintenance.

Asset renewal provisions should be provided for separately and cover replacement of surfacing, fencing and bridges. The renewal and replacement of bridges will be a more significant issue in the Ben Lomond to Glen Innes section as there are longer bridges involved – again, spending money on refurbishment at the beginning of the project will yield long-term benefits in terms of longer life spans before major works are needed. The costs of surface replacement will depend on the initial costs of construction. Section 4.3 discussed the differing views on the costs of surface provision for the Ben Lomond-Glen Innes section. These provisions would have separate timeframes for replacement with fencing and surfacing requiring renewal in a shorter time than bridges.

A number of observations are relevant to Tables 10 and 11:

- The likely maintenance costs in the first few years of a trail's life will focus on sign damage and inspections.
- Costings are at full commercial rates (but of course this would be far less if volunteers are involved). US evidence suggests significant savings using volunteer maintenance (trails maintained by volunteers cost one-third of those maintained by Government entities).
- The maintenance estimate provided in the report is an estimate only based upon certain design parameters and construction standards. For example, it is recommended that timber bridges be restored using timber decking and timber

handrails because it more fully provides the rail trail experience. However, bridges could be re-purposed using other material such as expanded steel mesh or fibreglass reinforced plastic for the decking which would have a different maintenance regime and costing. It is impossible to estimate maintenance costs to the most accurate possible level until construction is finished and every construction item is catalogued (noting that events like wildfires and major floods are events that maintenance budgets never account for).

7.2.8 REDUCING MAINTENANCE COSTS

Using volunteers is the key element in reducing the maintenance costs. Volunteers could undertake much of the ongoing maintenance of the trail if a volunteer maintenance programme is arranged. It should be ensured that whoever is charged with ongoing responsibility for managing the trails has genuine and specific trail knowledge. It is not sufficient to be a skilled gardener, conservationist or environmental scientist. If training is required to bring staff knowledge levels up to a high standard, this should be seen as a priority to be undertaken early in the construction process. Trail skills are better learned over a longer time, with hands-on practice, than in short briefing sessions.

- The Munda Biddi Trail Foundation assists with planning, developing, marketing and maintaining the trail. It enlists paid memberships, enrolls and manages volunteers, holds trail and community events, and provides information and resources to enhance the quality of the trail experience. **Over 85% of that trail is maintained by volunteers.**
- Activities of the Friends of the Lilydale to Warburton Rail Trail include revegetation, weed eradication, protection of remnant species, and building and restoration work.
- Parklands Albury Wodonga a community-based, not for profit organisation focused on undertaking the conservation of "bush parks" in and around Albury-Wodonga from an ecological perspective, whilst allowing sympathetic recreational access. One of the Group's projects is managing and maintaining the High Country Rail Trail.

The Bibbulmun Track is Western Australia's premier long-distance walking track. The Track's success can be put down in large part to the efforts of the Bibbulmun Track Foundation. The Bibbulmun Track Foundation is probably the most successful 'Friends of' Group in Australia, with a paid-up membership in excess of 2,200 (in a number of categories).

The Bibbulmun Track Volunteer Program relies on the bushwalking community, and Bibbulmun Track walkers in particular, to commit their time to assist in the maintenance and delivery of the Foundation's Programs and services (the Bibbulmun Track is 1,000 kms walking track from Perth to Albany). **It is estimated that around 80% of the Bibbulmun Track in maintained by volunteers in this program.** An enormous amount of money is saved as the volunteers carry out many of the inspections and minor repair work.

Volunteers:

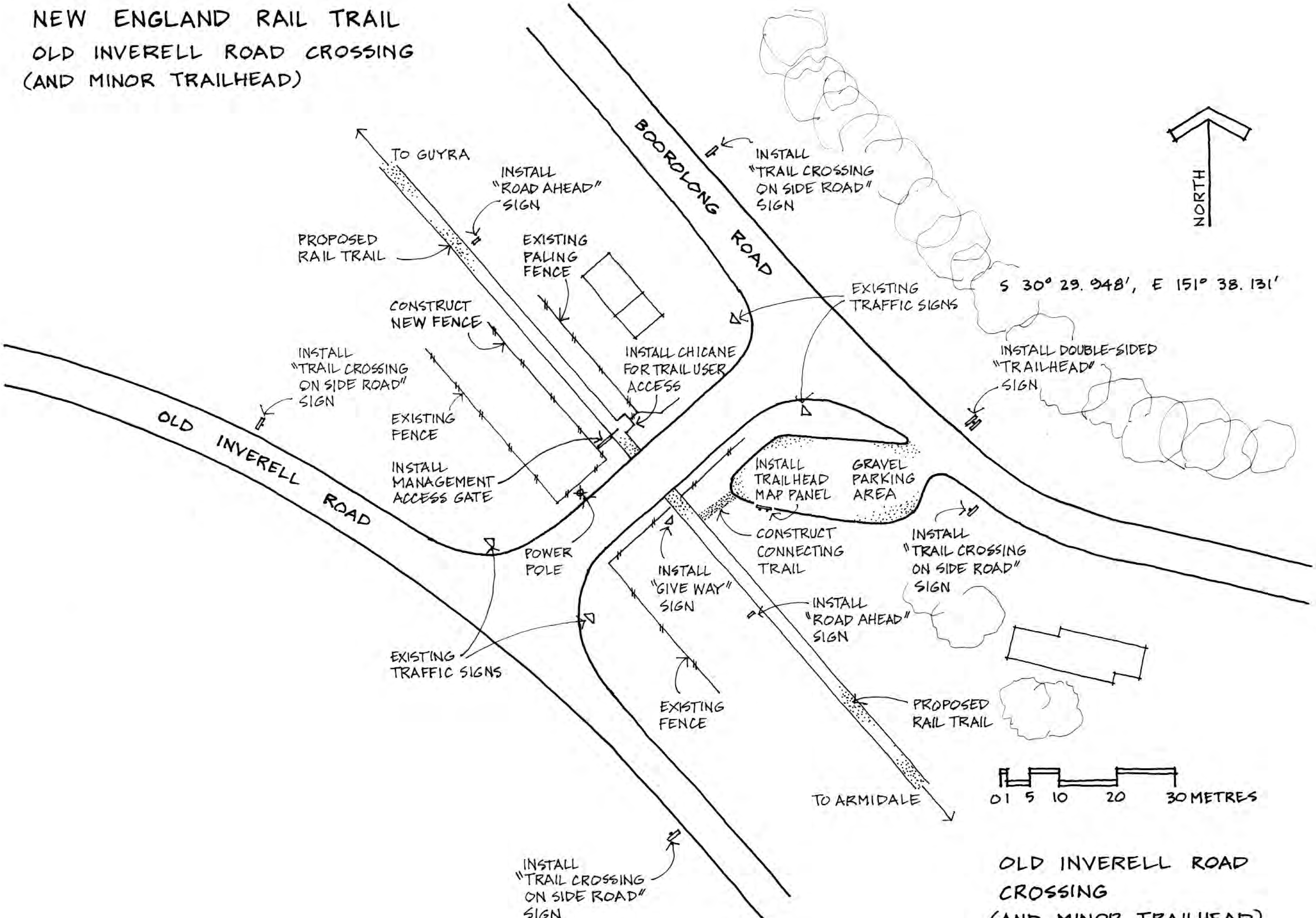
- Undertake a range of light maintenance tasks including pruning, clearing debris from the Track, replacing missing trail markers, installing water bars, removing litter and monitoring the campsite.

- Attends to their section at least 4 times per year (i.e. once every 3 months). In areas closer to Perth, or on sections that require a higher level of maintenance, more frequent visits are preferred.
- Submits a report to the Volunteer Coordinator after each maintenance visit. These reports are vital in assisting the Bibbulmun Track Foundation and DPAW in dealing with immediate problems and in planning for the future of the Track.

APPENDIX 1: ROAD CROSSING DRAWINGS

NEW ENGLAND RAIL TRAIL

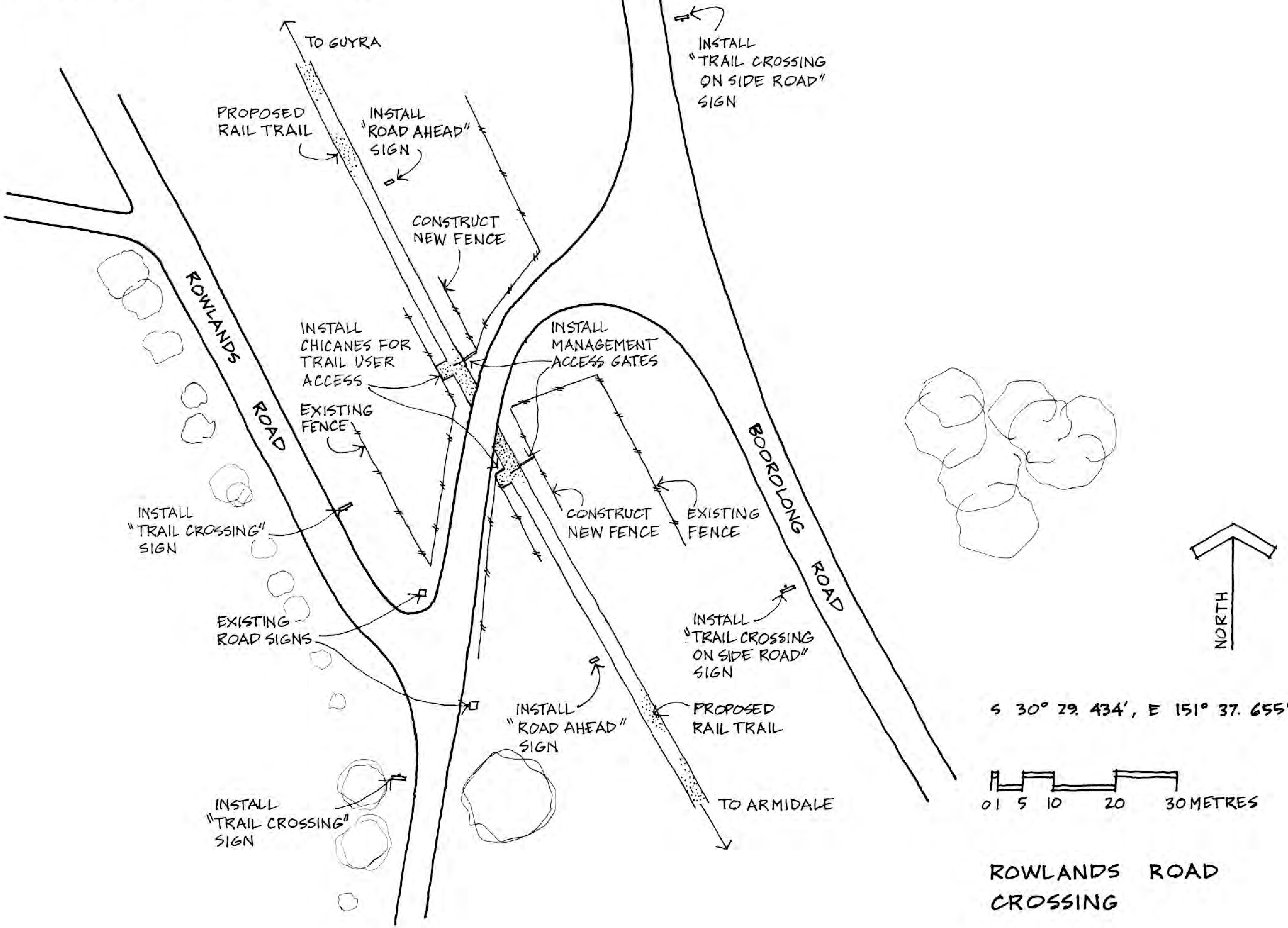
OLD INVERELL ROAD CROSSING (AND MINOR TRAILHEAD)



OLD INVERELL ROAD CROSSING (AND MINOR TRAILHEAD)

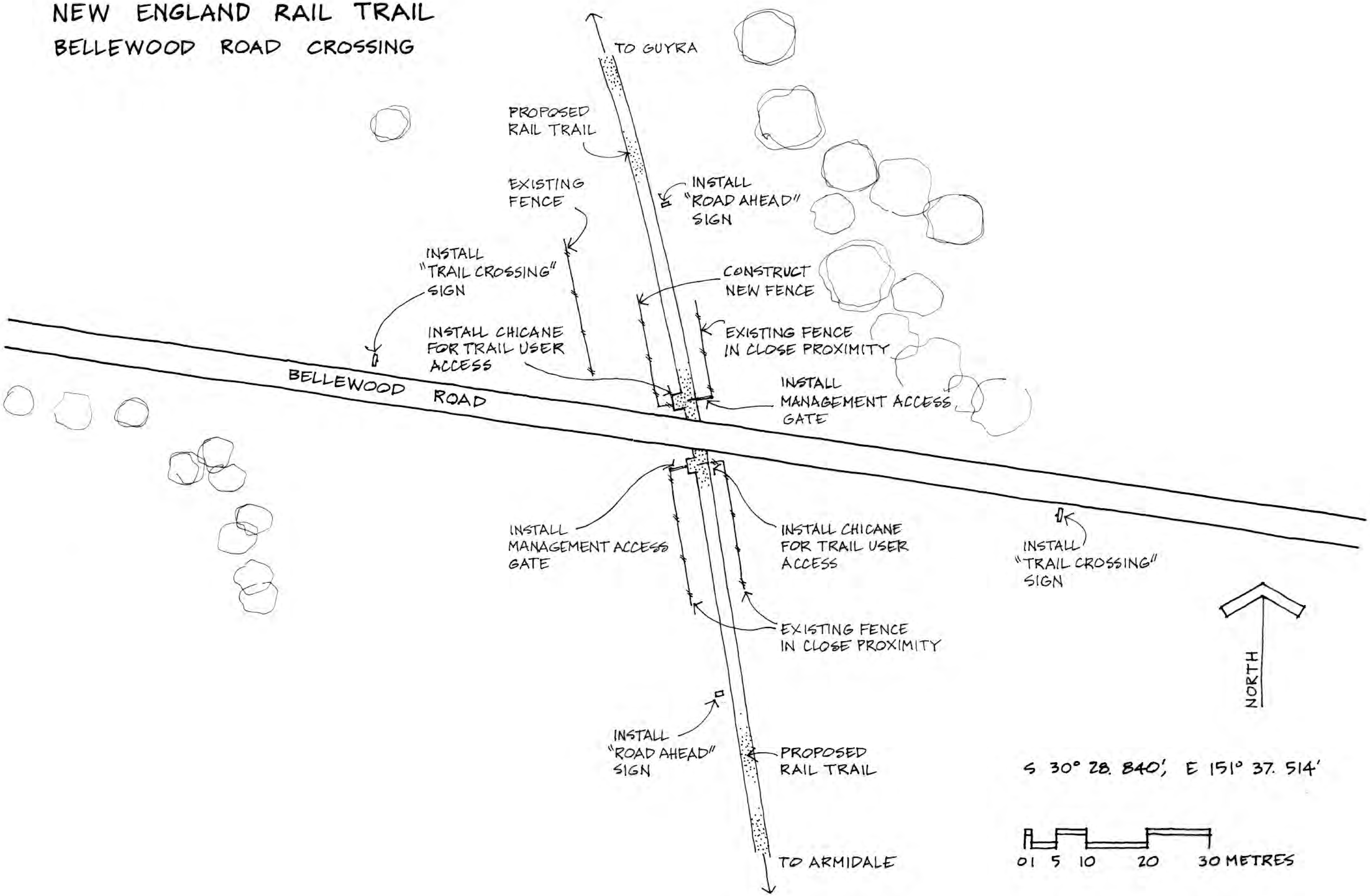
NEW ENGLAND RAIL TRAIL

ROWLANDS ROAD CROSSING



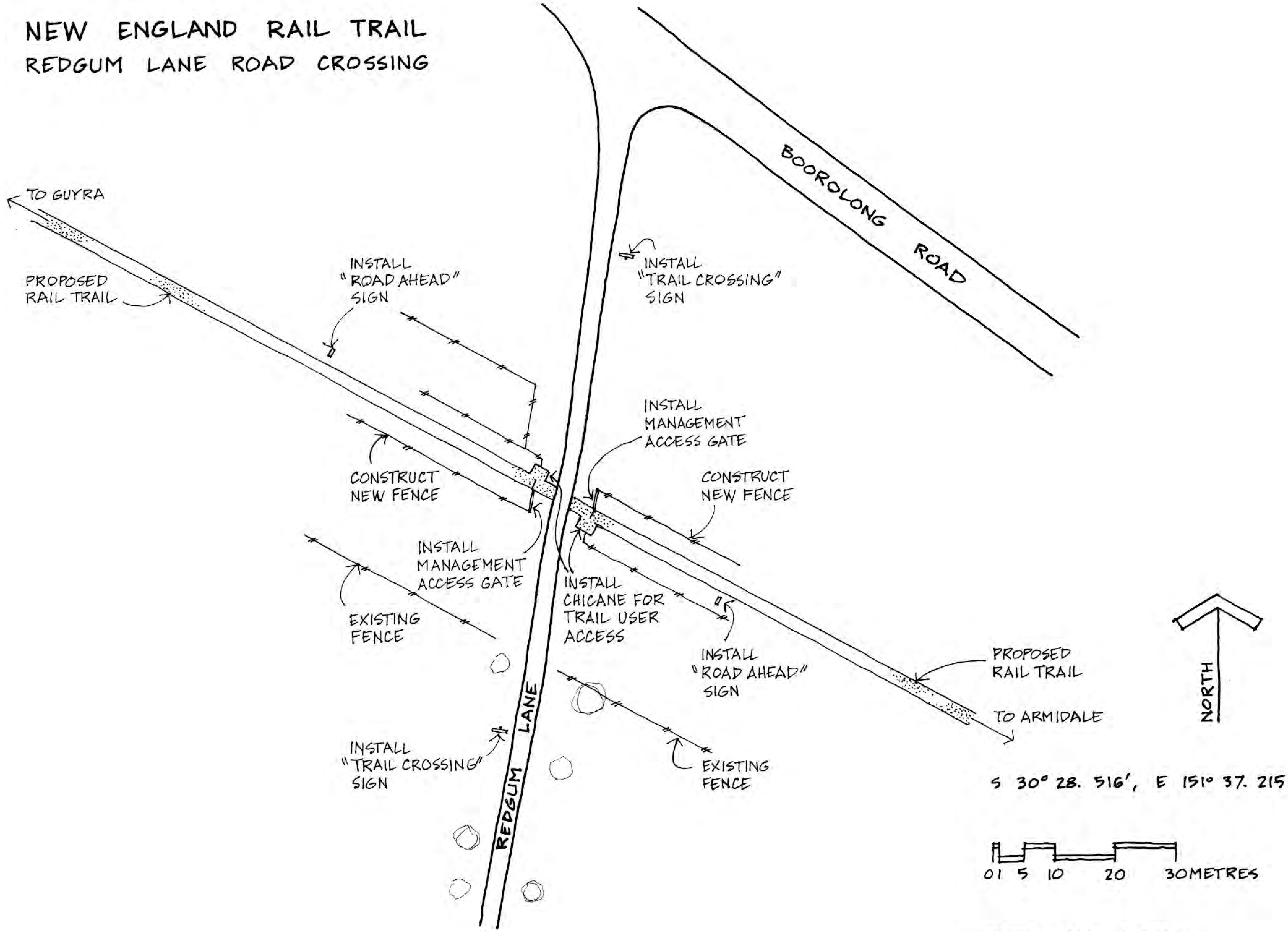
ROWLANDS ROAD CROSSING

NEW ENGLAND RAIL TRAIL
BELLEWOOD ROAD CROSSING



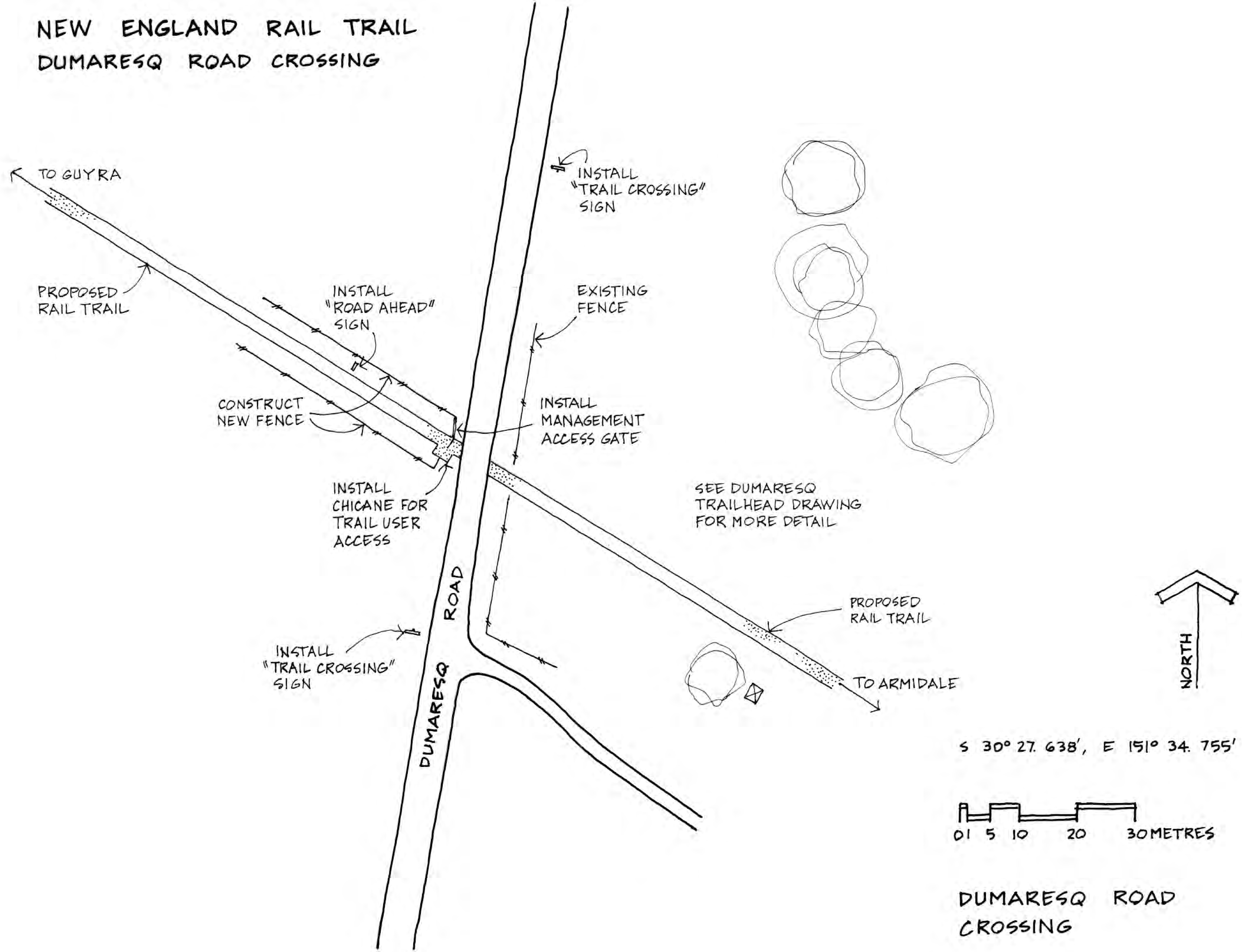
BELLEWOOD ROAD CROSSING

NEW ENGLAND RAIL TRAIL
REDGUM LANE ROAD CROSSING



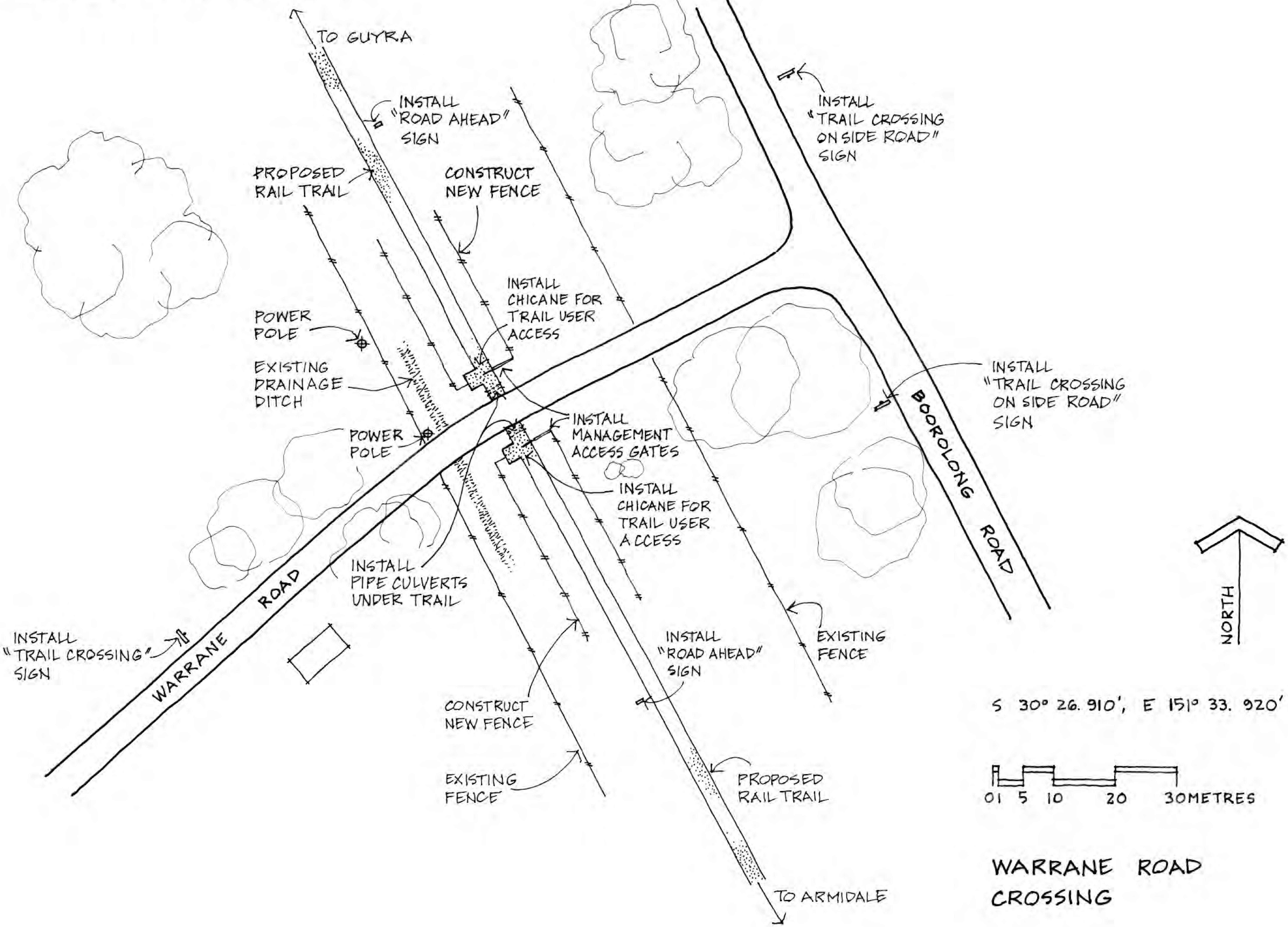
REDGUM LANE ROAD CROSSING

NEW ENGLAND RAIL TRAIL
DUMARESQ ROAD CROSSING



NEW ENGLAND RAIL TRAIL

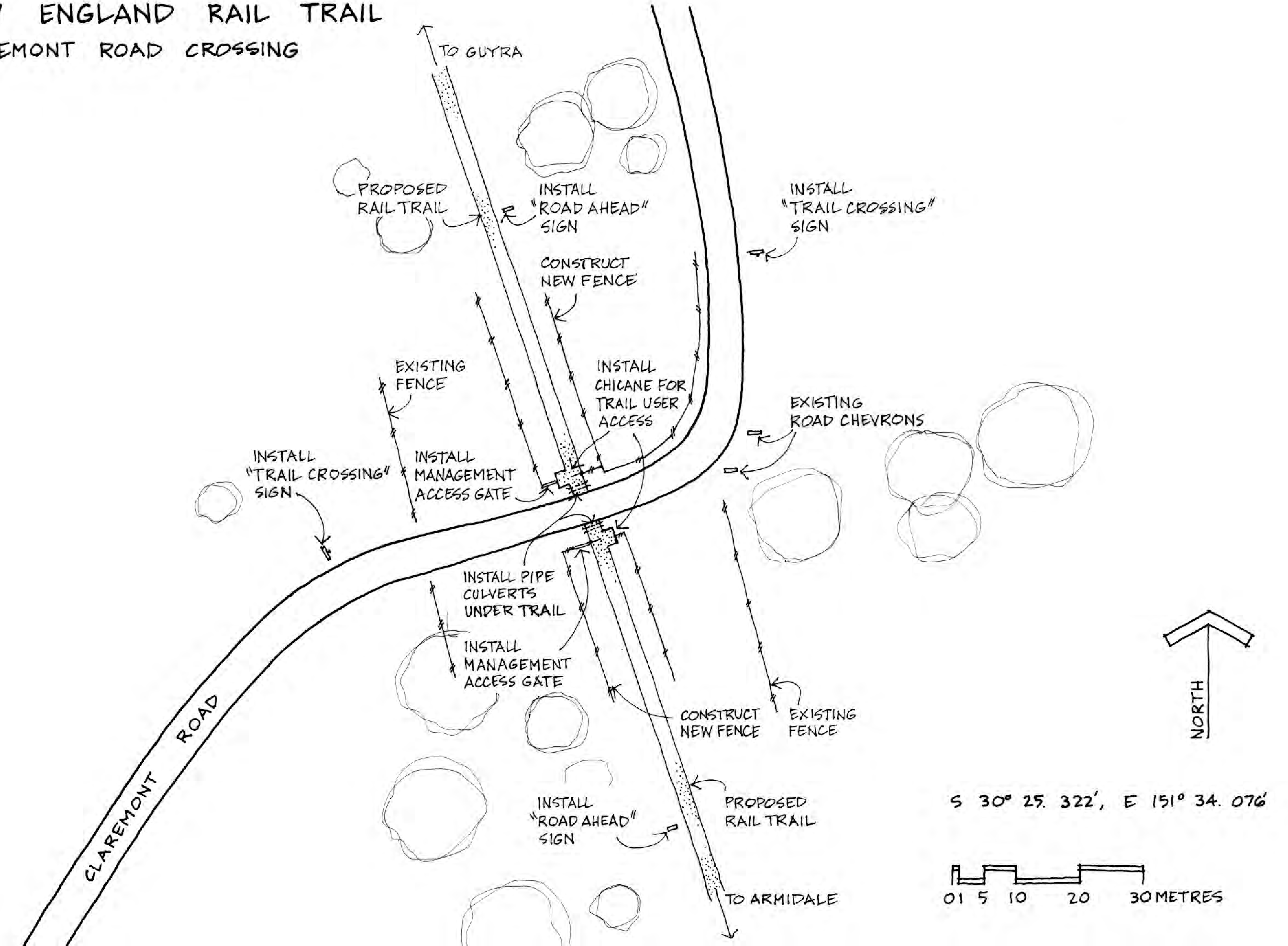
WARRANE ROAD CROSSING



WARRANE ROAD CROSSING

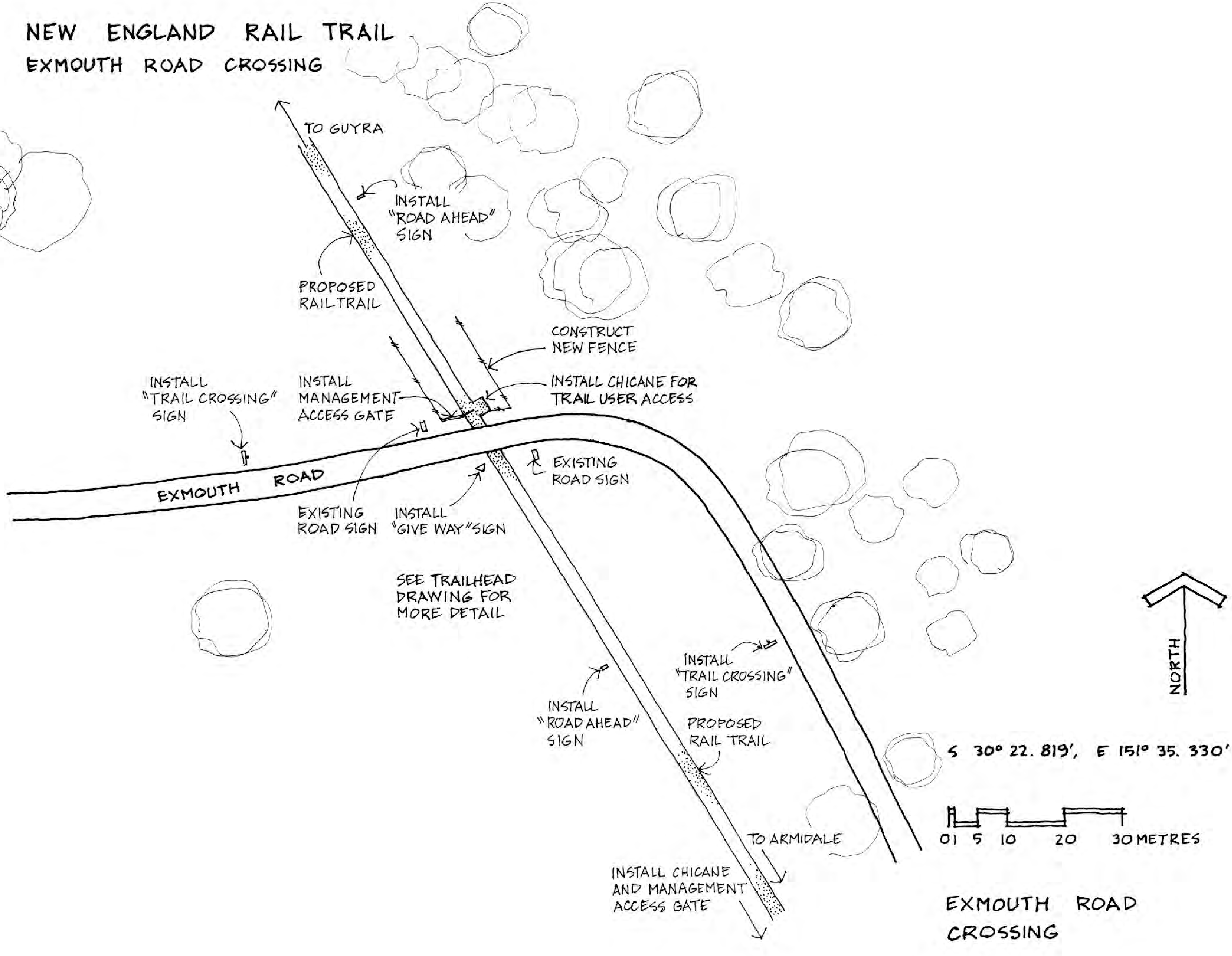
NEW ENGLAND RAIL TRAIL

CLAREMONT ROAD CROSSING

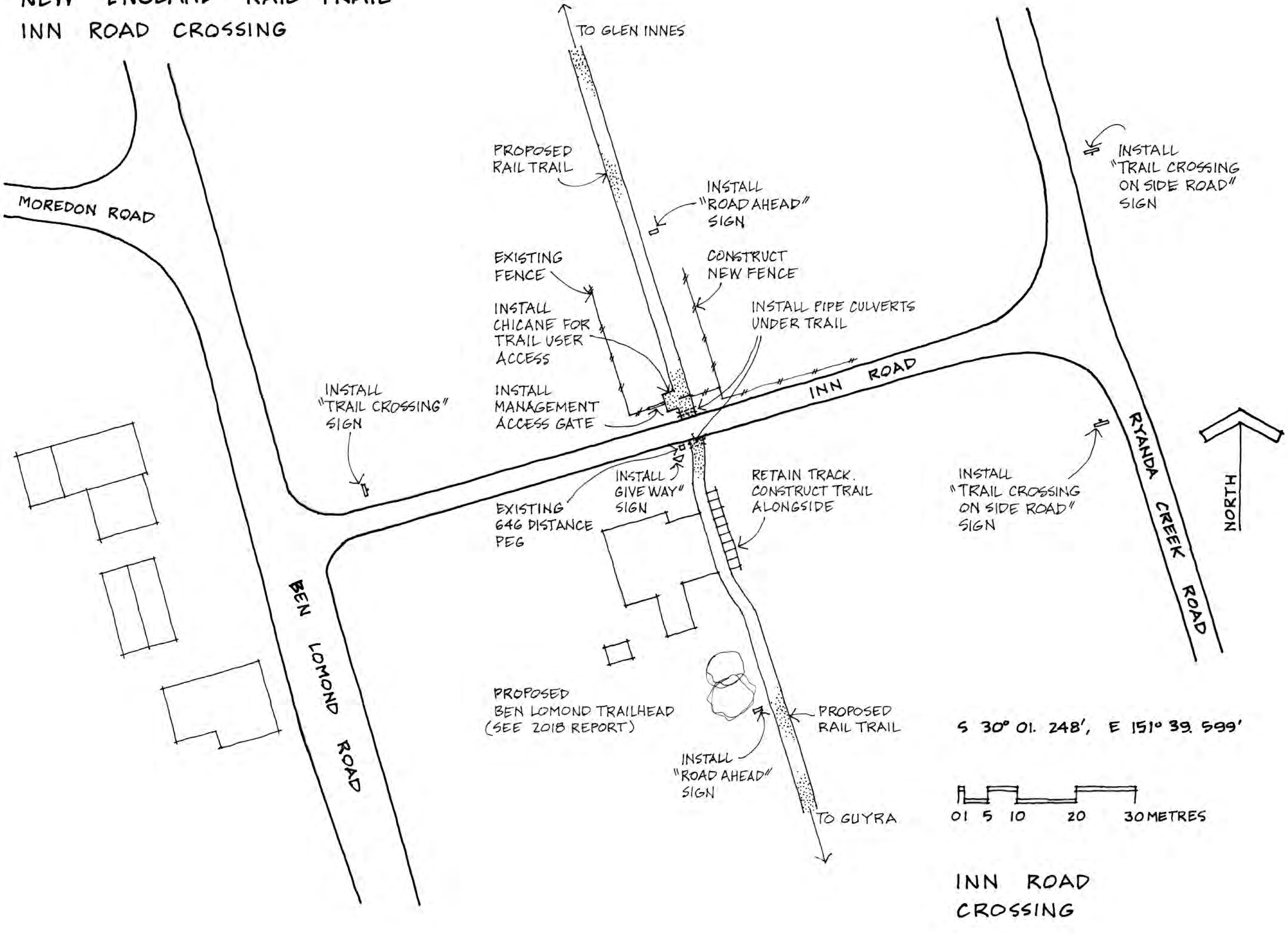


CLAREMONT ROAD CROSSING

NEW ENGLAND RAIL TRAIL
EXMOUTH ROAD CROSSING

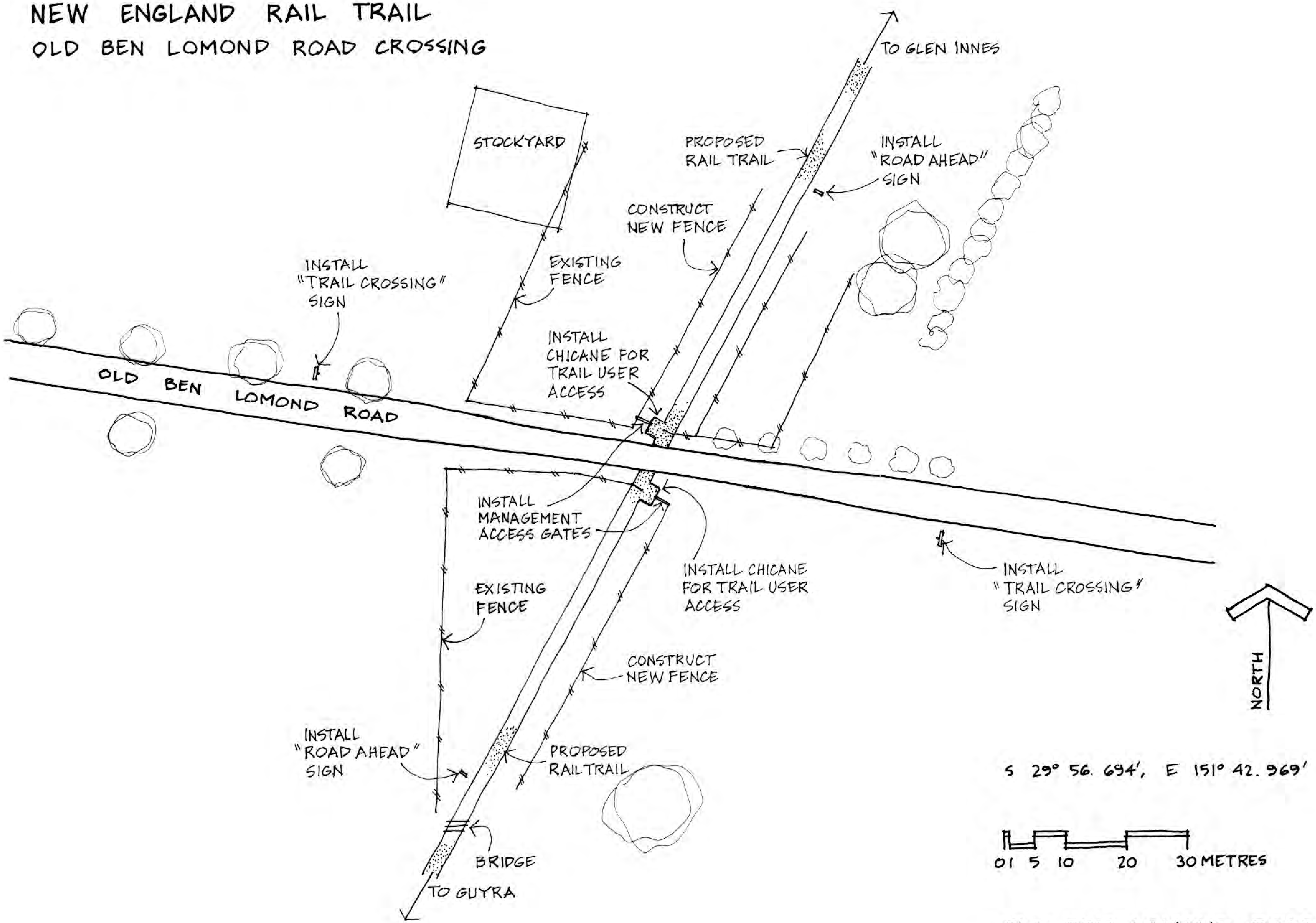


NEW ENGLAND RAIL TRAIL
INN ROAD CROSSING



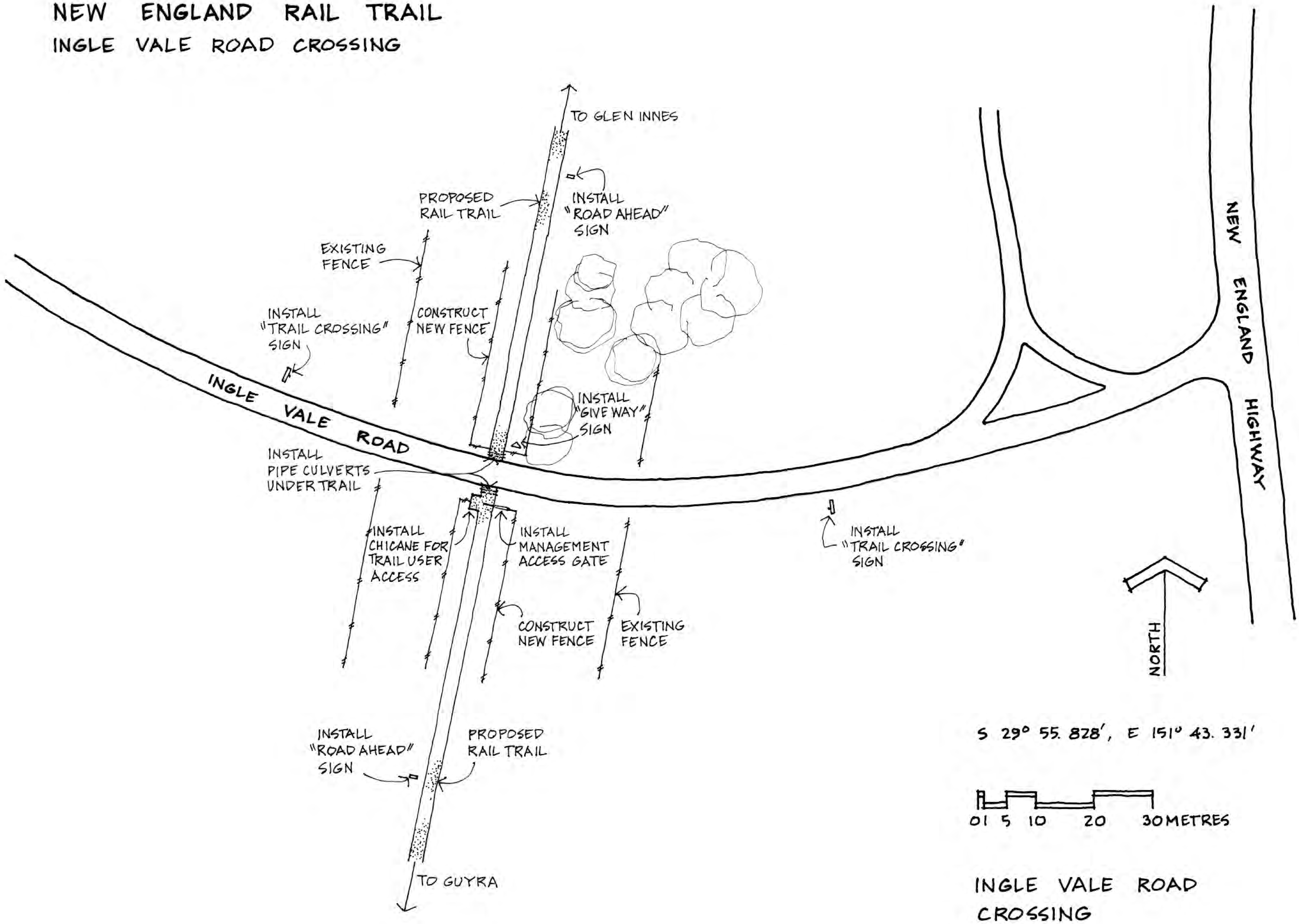
NEW ENGLAND RAIL TRAIL

OLD BEN LOMOND ROAD CROSSING



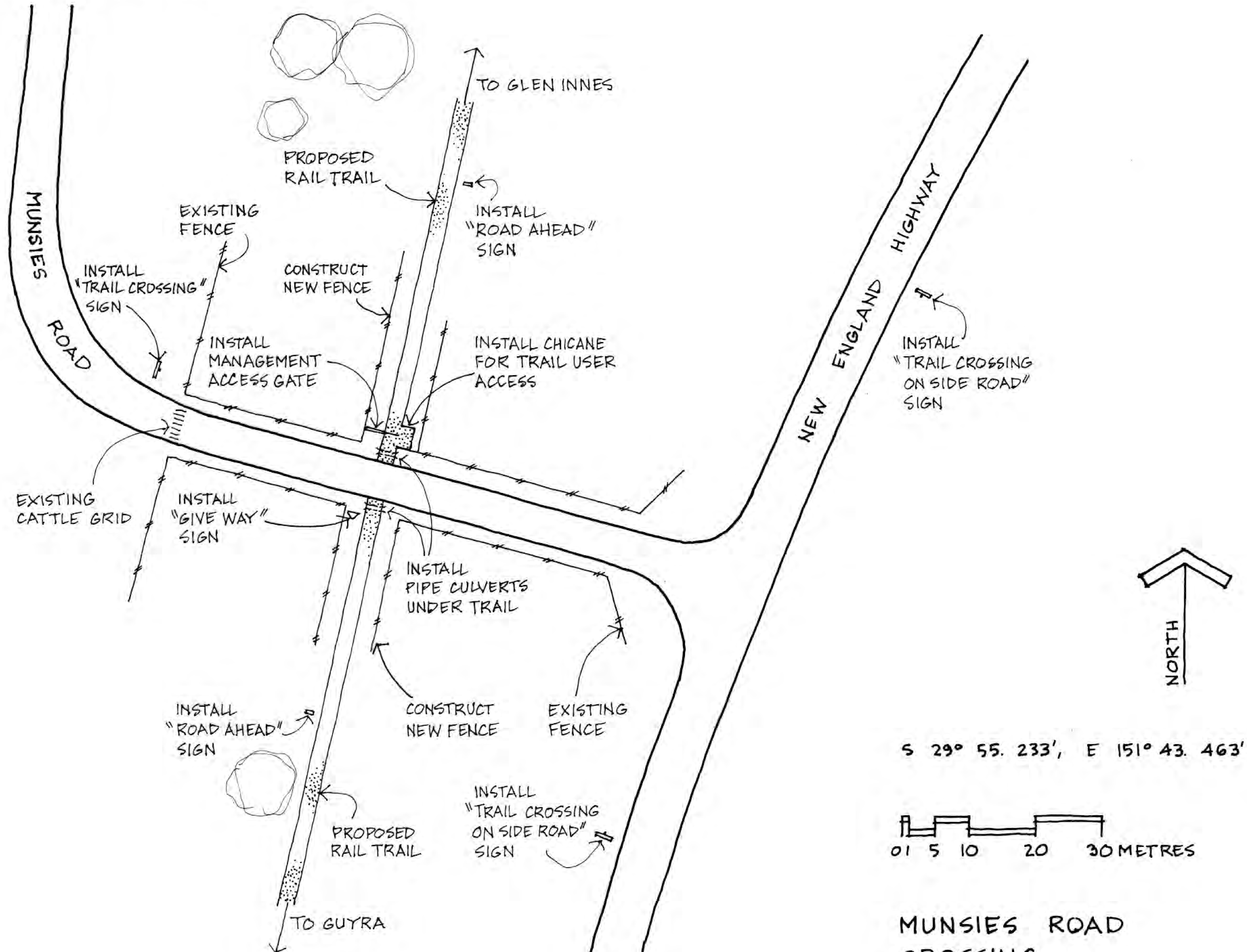
OLD BEN LOMOND ROAD CROSSING

NEW ENGLAND RAIL TRAIL
INGLE VALE ROAD CROSSING



INGLE VALE ROAD CROSSING

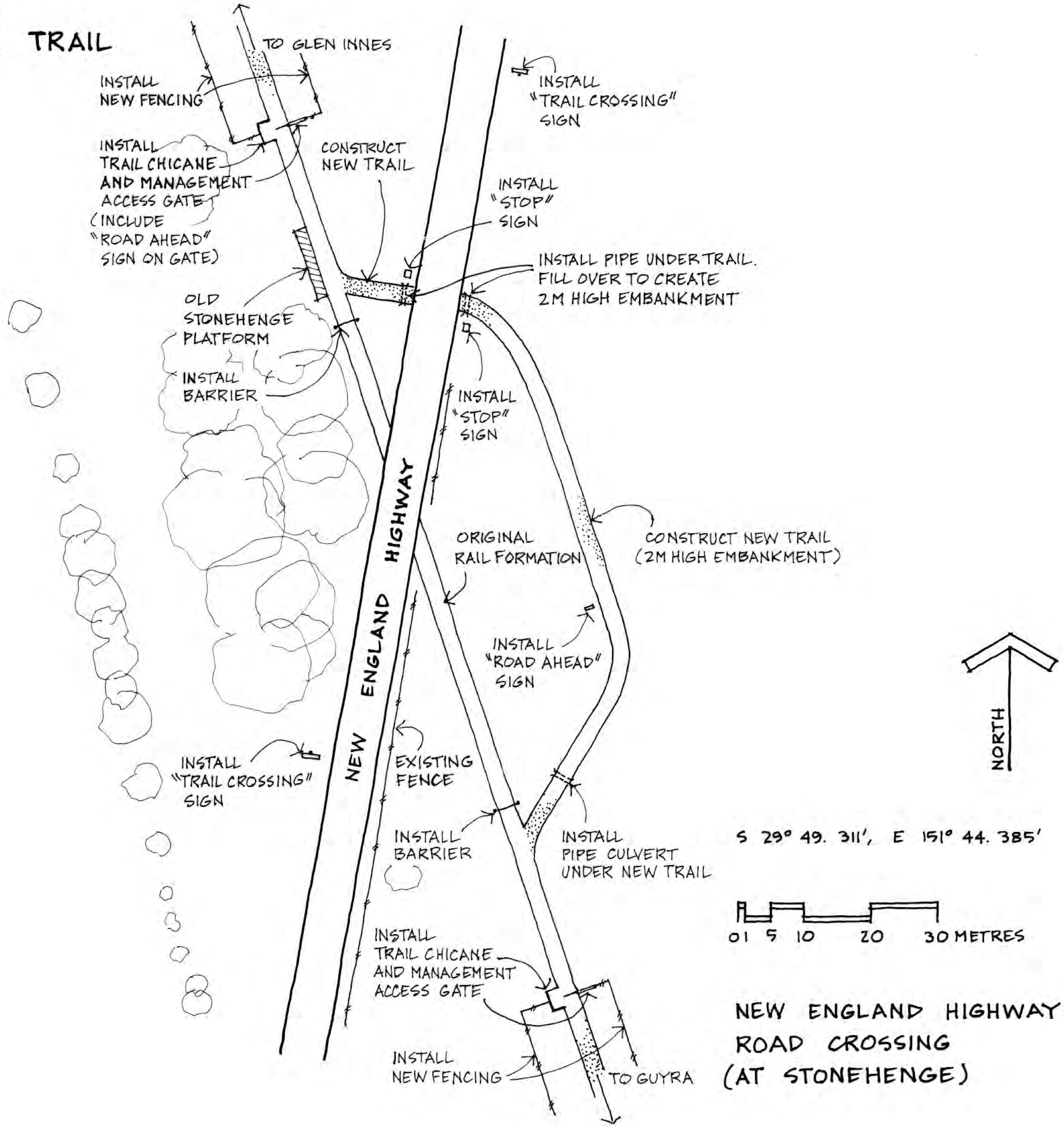
NEW ENGLAND RAIL TRAIL
MUNSIES ROAD CROSSING



MUNSIES ROAD CROSSING

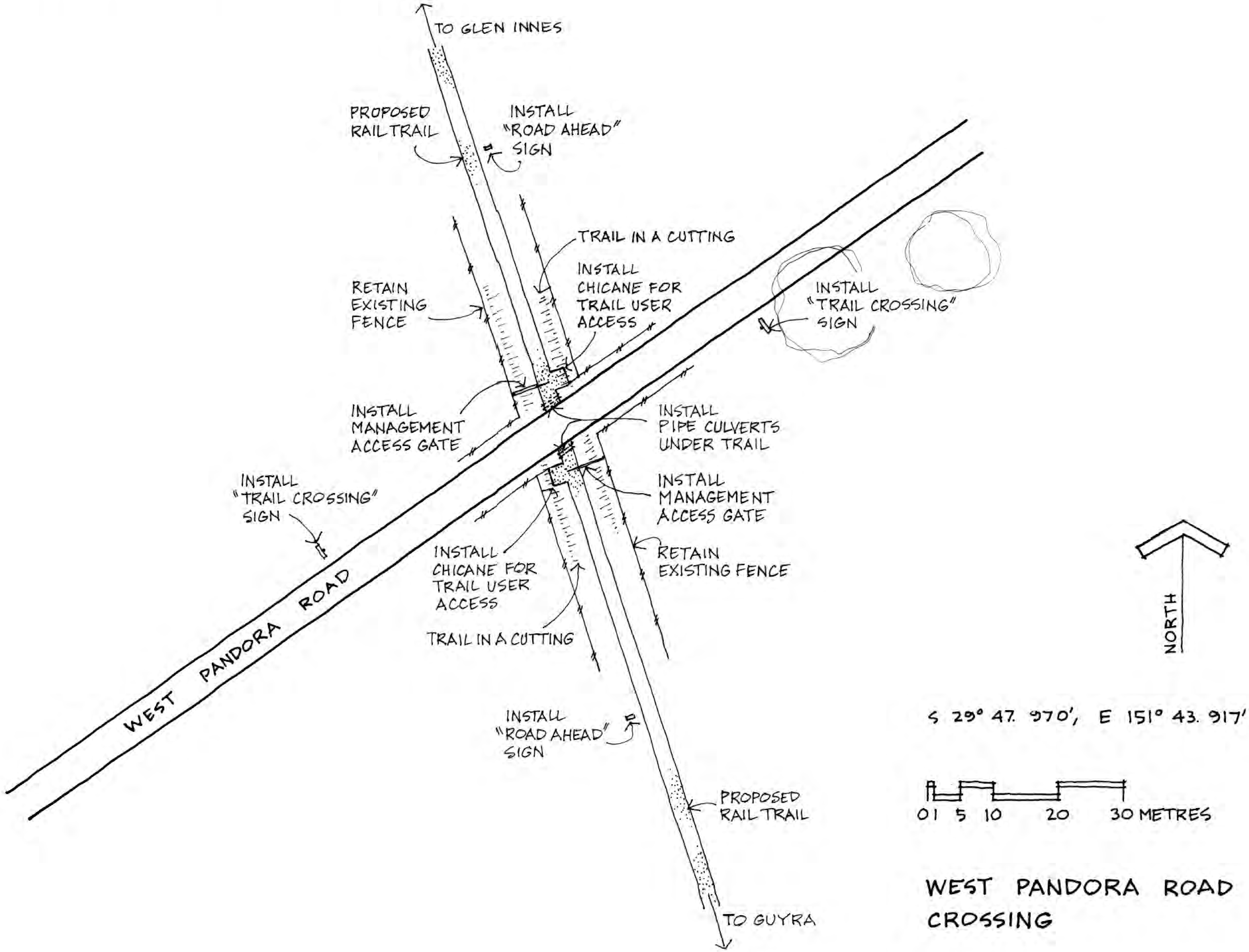
NEW ENGLAND RAIL TRAIL

NEW ENGLAND HIGHWAY ROAD CROSSING (AT STONEHENGE)



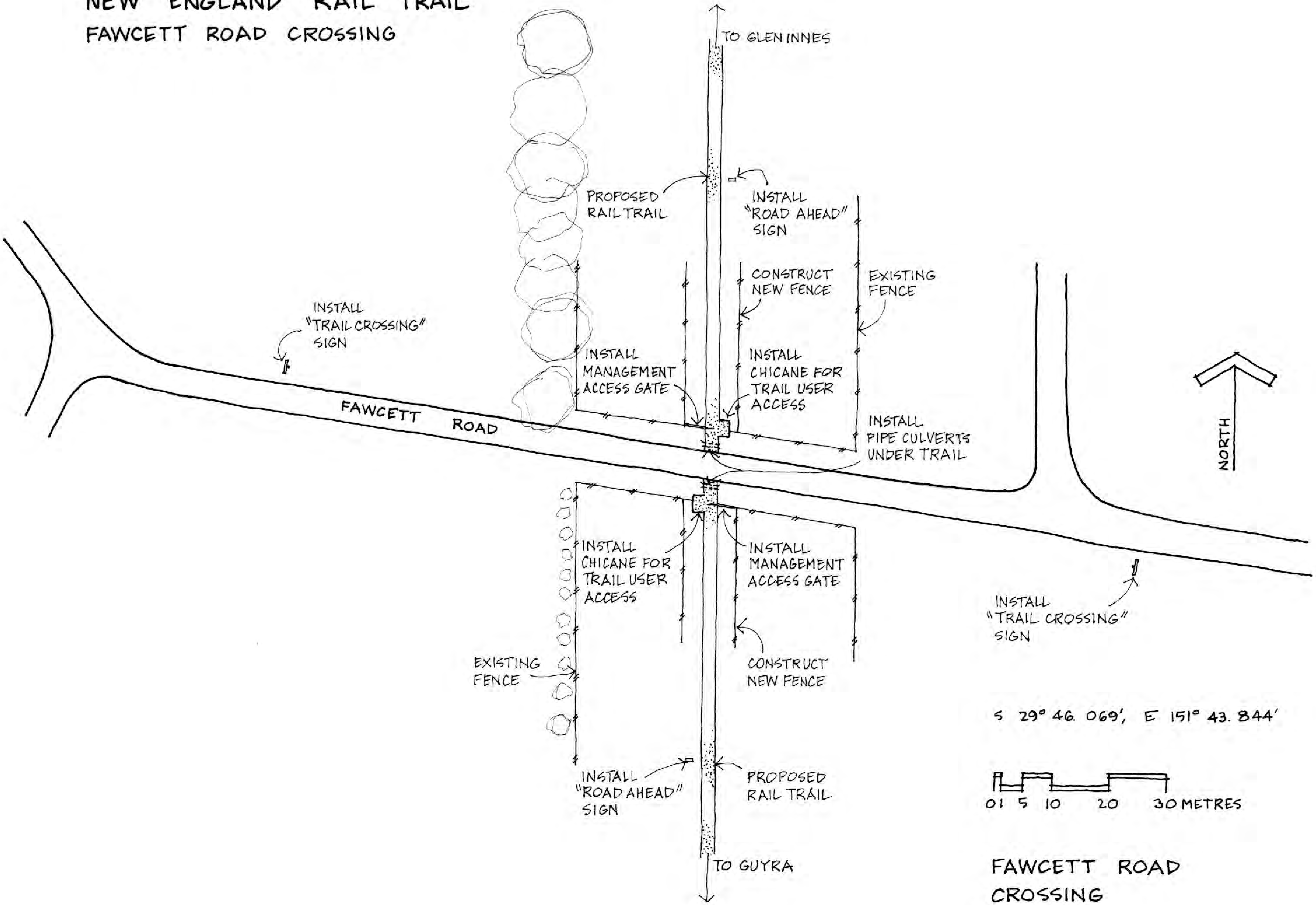
NEW ENGLAND HIGHWAY ROAD CROSSING (AT STONEHENGE)

NEW ENGLAND RAIL TRAIL
WEST PANDORA ROAD CROSSING



WEST PANDORA ROAD CROSSING

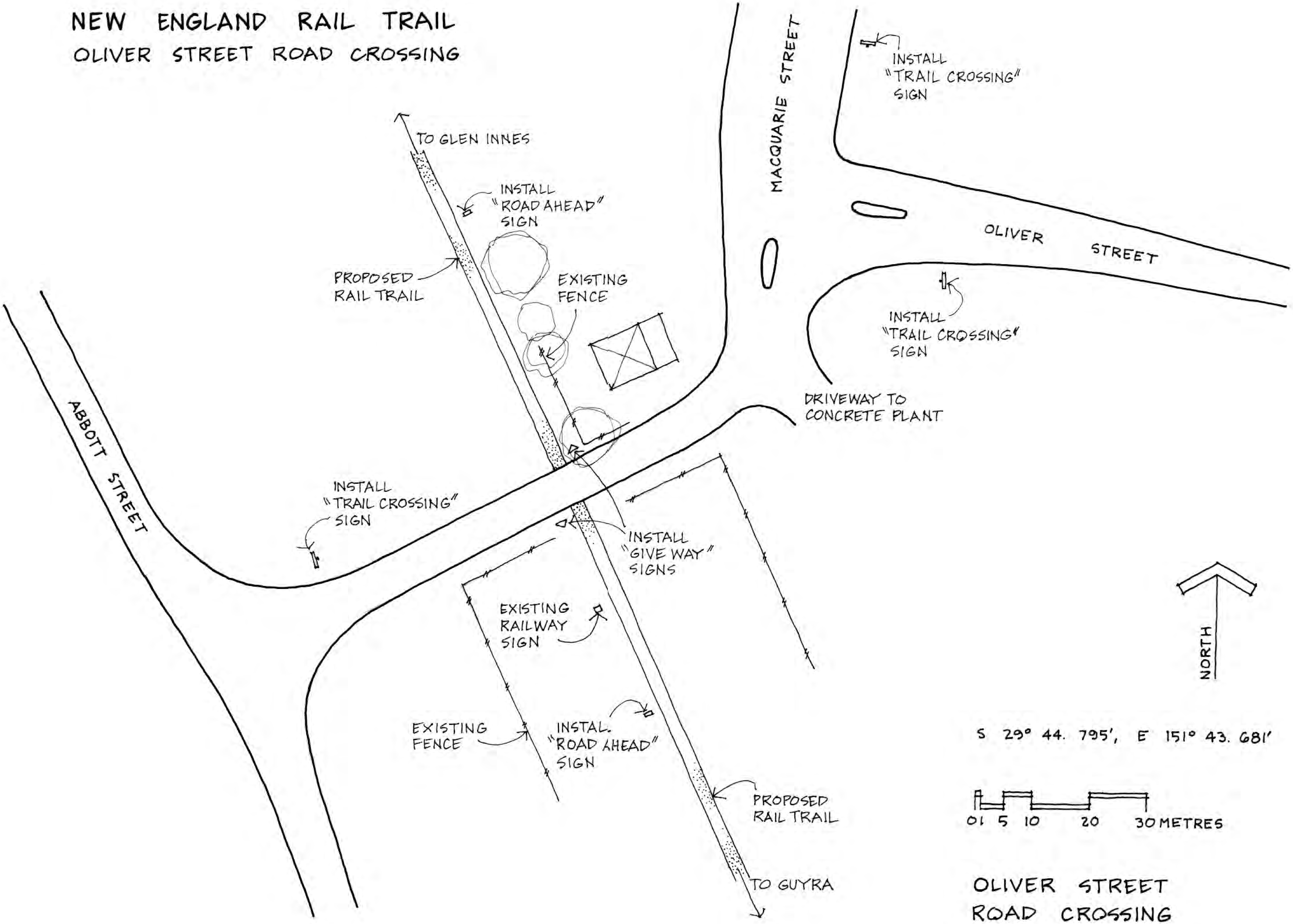
NEW ENGLAND RAIL TRAIL
FAWCETT ROAD CROSSING



FAWCETT ROAD CROSSING

NEW ENGLAND RAIL TRAIL

OLIVER STREET ROAD CROSSING



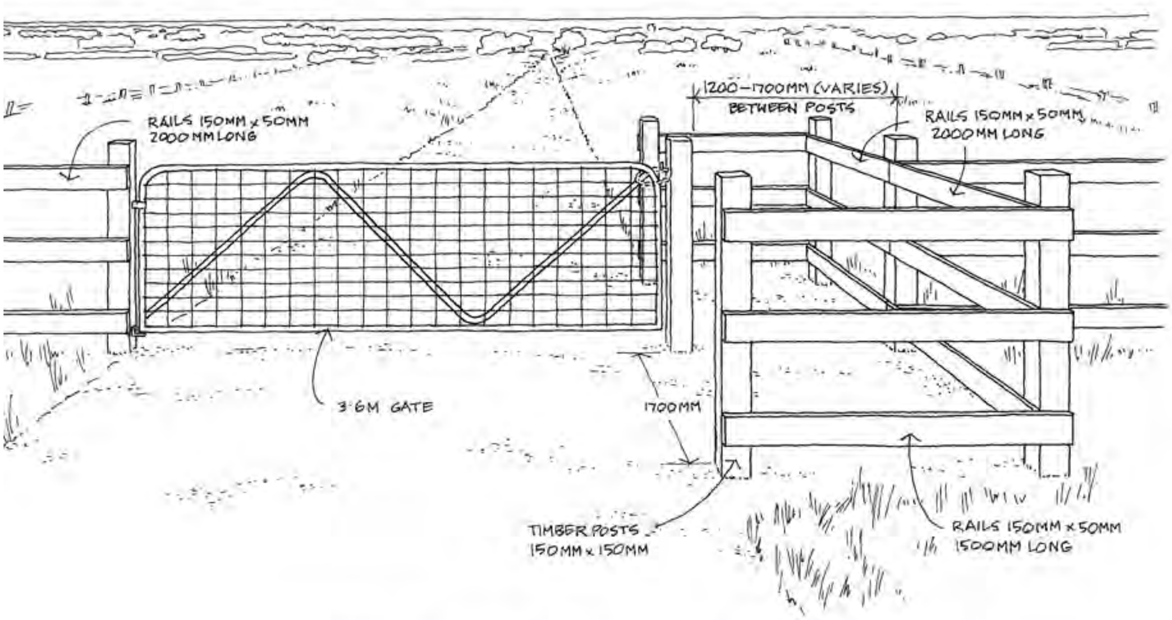
OLIVER STREET ROAD CROSSING

APPENDIX 2: ROAD CROSSING CHICANE DRAWINGS

The spring loaded 1200mm gate should only be installed where there is the likelihood of livestock on the trail (if the trail manager deems that appropriate and agreements and licences are in place). The gate should open “inwards” – to the trail rather than to the road (to prevent livestock pushing it open). The gate deliberately “stops” on the inside centre post (the gate is wider than the opening) to prevent livestock pushing it open.

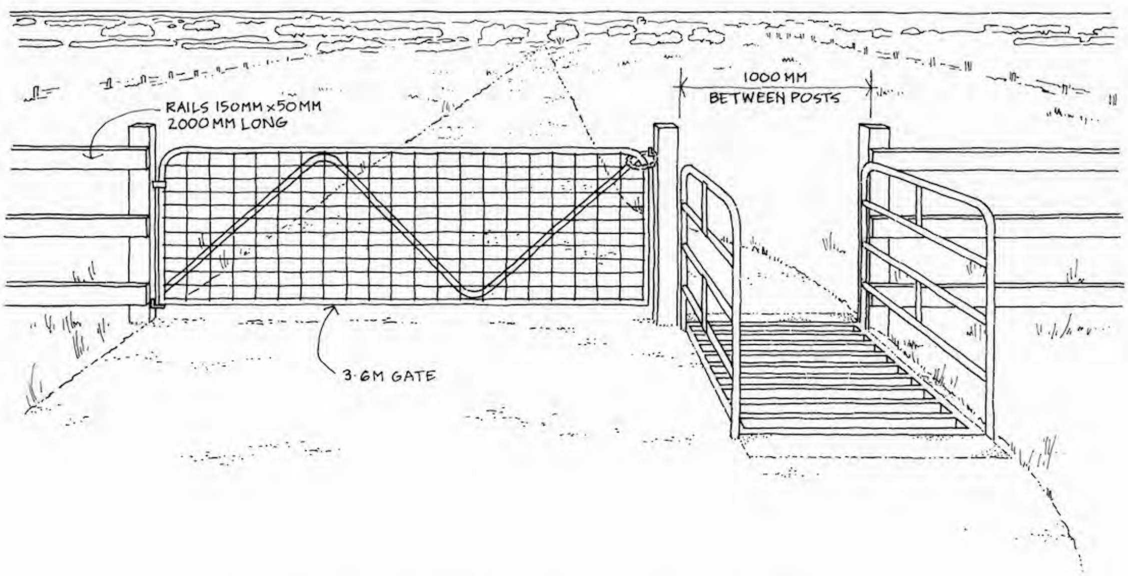
Where there is no likelihood of livestock, a gate should be installed only if the trail manager has a need to lock the gate on a regular basis (such as for events). In these cases, a standard gate (with no spring) could be used (the photo from the Lilydale Warburton Rail Trail shows such a gate).

Above: a management access gate and access chicane on the Lilydale to Warburton Rail Trail (Vic).

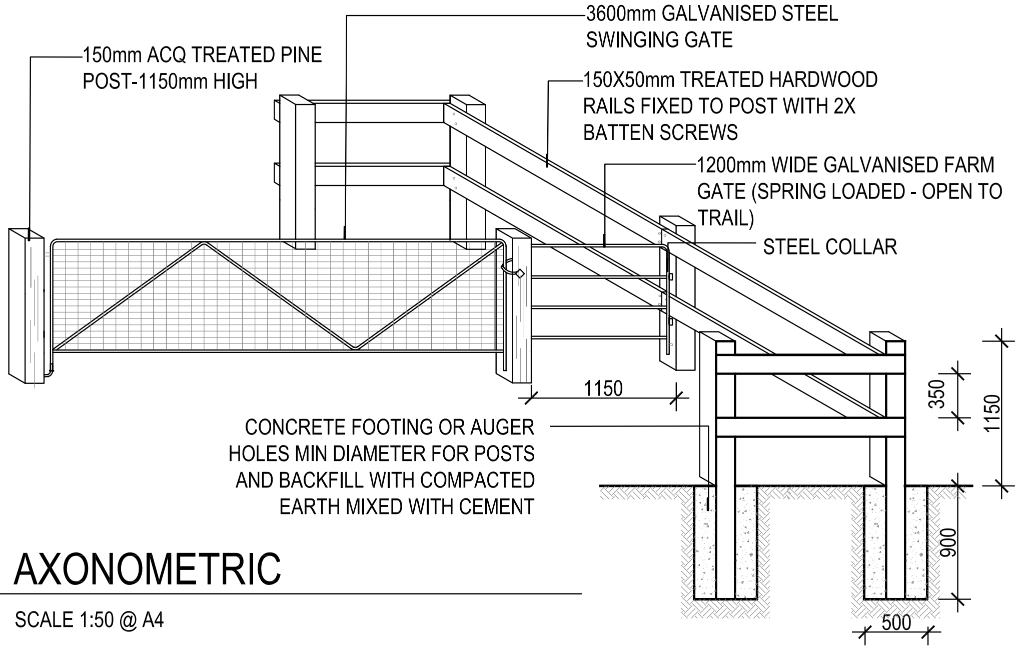


TYPICAL MANAGEMENT ACCESS GATE AND CHICANE

Above: a newly constructed management access gate and access grid on the Brisbane Valley Rail Trail (Qld).

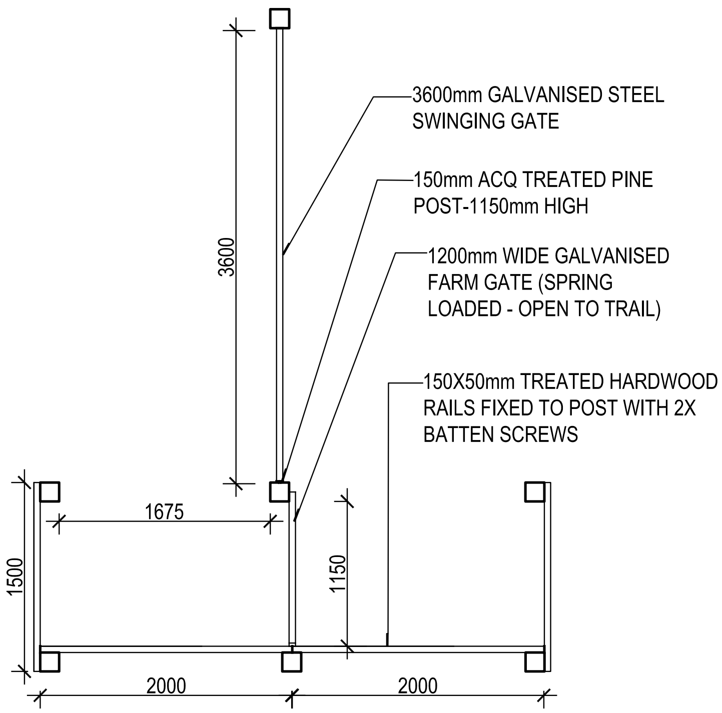


TYPICAL MANAGEMENT ACCESS GATE AND GRID



A1 AXONOMETRIC

SCALE 1:50 @ A4



P1 PLAN

SCALE 1:50 @ A4

APPENDIX 3: BRIDGE REPORT BY WRD

1st December, 2020

Condition Assessment Report and Repurposing Recommendations for a Rail Trail

Major Bridges – New England Rail Trail

Client: Mike Haliburton Associates

PREPARED AND PRESENTED BY:

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Wood Research and Development

ABSTRACT

Wood Research and Development was commissioned by Mike Haliburton Associates to complete a detailed visual inspection and refurbishment options report based on the current condition of the major bridges along the proposed New England Rail Trail (Ben Lomond to Glen Innes Section). The main objective of the investigation was to establish the general condition of the primary structural elements, and to assess what techniques could be utilized to safely repurpose the structure into a rail trail bridge for pedestrian and cyclist use.

The following is a summary of the Condition State Rating (CSR) for each bridge:

1. **Old Ben Lomond Rd Bridge (minor)**
    a. **Substructure CSR 4**
    b. **Superstructure CSR 4**
    c. **Deck CSR 5**
    d. **Overall CSR 4**

2. **Manrowan Creek Bridge (major)**
    a. **Substructure CSR 4**
    b. **Superstructure CSR 4**
    c. **Deck CSR 4**
    d. **Overall CSR 4**

3. **Upper Williams Creek Bridge (major)**
    a. **Substructure CSR 3**
    b. **Superstructure CSR 4**
    c. **Deck CSR 4**
    d. **Overall CSR 4**

4. **Williams Creek Bridge (major)**
    a. **Substructure CSR 4**
    b. **Superstructure CSR 4**
    c. **Deck CSR 4**
    d. **Overall CSR 4**

5. **Beardy Waters Bridge (major)**
    a. **Substructure CSR 4**
    b. **Superstructure CSR 4**
    c. **Deck CSR 4**
    d. **Overall CSR 4**

6. **Stonehenge Creek Bridge (minor)**
    a. **Substructure CSR 3**
    b. **Superstructure CSR 3**
    c. **Deck CSR 3**
    d. **Overall CSR 3**

The above Condition State Ratings (CSR) for each of the bridges was based upon a small sample size of NDT field data collected by the Wood Research and Development (WRD) Level II Certified Field staff. It is highly recommended that a detailed inspection of each bridge be conducted. See **Figure 11-1** and **Appendix A** for more detail about the WRD inspection Non Destructive Testing (NDT) technologies. These detailed inspections will allow the client to be provided with a higher level of accuracy for the recommended repair options listed and Level D restoration costs shown in **Sections 4.3, 5.3, 6.3, 7.3, 8.3 & 9.3.**

Each bridge differs in configuration and level of deterioration, thus, each bridge requires varying levels of restoration; however moderate to severe deterioration of the elements is noted in all structures. **Sections 4 to 9** outline the proposed replacement and repair strategies for each bridge. Based on the information compiled from both the visual inspection and brief SWT (NDT) testing conducted by the WRD technicians, the bridges will require several repairs/replacement to repurpose the railway bridges as rail trail bridges for pedestrian, equestrian and cycle use. Two (2) options have been developed to refurbish the structures into rail trail bridges.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating. A 5 kPa load rating also has the advantage over a 3 kPa loading in that it allows light duty service vehicles to cross the bridges for maintenance purposes on the trail.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

Another option was explored for repurposing these rail trail bridges that utilizes the entire existing structure (minus the ballast, transom and railway line) in its 'current' condition with the existing poor (missing) deck planks being replaced and a new code compliant handrail system installed to the exterior girders. Given the very poor condition of most of the elements in all the bridges this option is not viable due to it being structurally unsafe and have a very limited life span with major maintenance costs.

Examples of the recommended refurbishment options can be found in Figures 11-2 to 11-4. Option 2 offers the longest design life and improves the Overall Condition State Rating to 1 based on the following assumptions:

a) Overall Condition State Rating 1 – 100% Remaining Life (80 years)
b) Overall Condition State Rating 2 – 80% Remaining Life (64 years)
c) Overall Condition State Rating 3 – 30% Remaining Life (24 years)
d) Overall Condition State Rating 4 – 5% Remaining Life (4 years)
e) Overall Condition State Rating 5 – 1% Remaining Life (< 2 years)

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described below in **Appendix B.** Finally, it is highly recommended that all exposed bright wood be treated with Copper Naphthenate and seal end-grain with a paraffin wax sealant.

TABLE OF CONTENTS

1.0 INTRODUCTION & BACKGROUND

The detailed visual condition state inspection of the major timber bridges along the proposed New England Rail Trail was completed by a Wood Research and Development (WRD) Level II Certified Inspection Engineer on the 10th & 11th of November 2020. The objective of the investigation was to establish the general condition of the primary structural elements, and to assess what techniques could be utilized to safely repurpose the structures into rail trail bridges for pedestrian, equestrian and cyclist use. A detailed visual inspection was commissioned and used in this investigation along with a brief, low density cavity test of several elements using non-destructive tests, including: EPHOD® Stress Wave Technology. Refer to **Appendix B** for more information about this technology.

This inspection report has been prepared by Dan Tingley Ph.D., P.Eng. (Canada), MIEAust, CPEng, RPEQ, senior engineer and wood technologist for WRD and Andrew La Spina, Timber Structures Engineers for WRD.

There are many timber bridges situated along the decommissioned rail line (Main North Line – formerly known as the Great Northern Railway) connecting Armidale to Glenn Innes. There were 4 major and 2 minor (structures) identified for this investigation. The bridges that were inspected are situated on the railway line between the towns of Ben Lomond and Glen Innes which opened in 1884 and continued operation until 1993 when the line was closed due to the deteriorating condition of the line and the lack of demand for services. These 6 bridges encompass the inspection scope of this report with the location of each bridge depicted in **Figure 1-1**. An additional brick arch overbridge (Crotty Road) was also briefly investigated.

All the bridges (expect the steel plated girder bridge – Stonehenge Creek) have ballast top deck that consist of a full timber decking that supports the 300mm thick rock ballast that the timber transoms (sleepers/rail ties) bear on. The bridges are believed to be constructed from local hardwood species with no indication of maintenance works conducted since the line was closed in 1993. Refer to Table 1-1 for a full summary of the bridge configurations.

The nomenclature used in this report is consistent with that adopted by the respective bridge inspection manuals. The abutments and bents are numbered in increasing order as they progress further along the railway line away from Armidale, and the girders and corbels are numbered increasing from left to right.

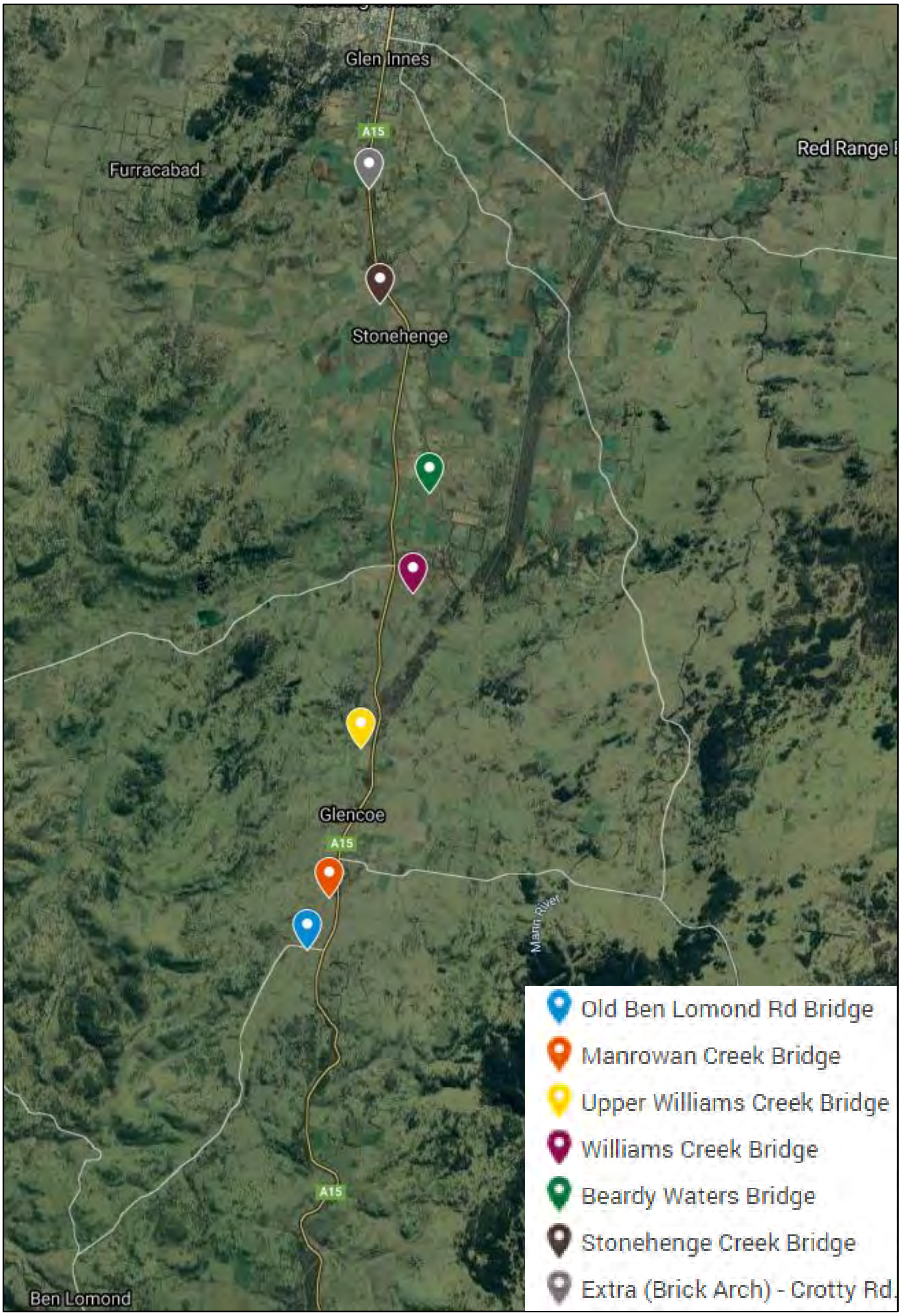


Figure 1-1: Location of each of the bridges with Armidale to the south.

Table 1-1: Summary of Configuration and Dimensions for Significant Bridges along the Proposed New England Rail Trail

Bridge Name	GPS Location	Type of Bridge/Span	Significance	Total Length	Number of Spans	Span Length	Type of Substructure (supports)	Water Spans/ depth
Old Ben Lomond Rd Bridge	-29.94544, 151.71578	Hardwood Girder Under	Minor	8m	2	4m	1m Timber Piles (4)	Both – approx. 500mm deep. Boggy 'Spring'
Manrowan Creek Bridge	-29.93403, 151.72131	Hardwood Girder Under	Major	56m	8	8m with 4m approach spans	2.5-4m Timber Posts (6 TYP) on concrete piers/footing	Spans 5 and ½ 6 and max. 1m deep
Upper Williams Creek Bridge	-29.90157, 151.72925	Hardwood Girder Under	Major	14m	2	7m	Brick Piers and square posts/piles at Abutments	Span 2 – no flow, 0.5-1m deep
Williams Creek Bridge	-29.86805, 151.74224	Hardwood Girder Under	Major	24m	3	8m	Timber Piles (4)	Spans 2 & 3 Water was not flowing Approximately 0.5-1m deep
Beardy Waters Bridge	-29.84623, 151.74623	Hardwood Girder Under	Major	112m	14	8m	2.5-4m Timber Posts (6 TYP) on concrete piers/footing - 30° skew	Span 5 – 1.5-2m deep
Stonehenge Creek Bridge	-29.80512, 151.73389	Steel Plated – Girder Under	Minor	18m	3	6m	Brick Piers	Span 2 – 0.5m deep

Note: The dimensions and descriptions were sourced from the original drawings and brief site inspections. A detail inspection and survey is required to be completed before any design and repair work is undertaken.

2.0 CONDITION STATE RATING DESCRIPTIONS

The Condition State Rating system in **Table 2-1** has been developed by Wood Research and Development, through timber inspection experience, to clearly describe the condition of the elements inspected. While similar rating systems are found in bridge inspection manuals, the ratings outlined in this report are not based on standard manual for evaluation procedures.

The definitions of the various Condition State Ratings used in this report are as follows:

Table 2-1: Condition State Rating Descriptions

Condition State	Subjective Rating	Estimated Remaining Life Span		Description
1	Good	100%	80 Years	Like new condition and free of defects.
2	Fair	80%	64 Years	Free of defects affecting structural performance, integrity and durability. Deterioration of a minor nature in the protective coating and/or parent material is evident.
3	Poor	30%	24 Years	Defects affecting the durability/serviceability which may require monitoring and/or remedial action or inspection by a structural engineer. Component or element shows marked and advancing deterioration including loss of protective coating and minor loss of section from the parent material is evident. Intervention is normally required.
4	Very Poor	5%	4 Years	Defects affecting the performance and structural integrity of the structure which require urgent action as determined by a detailed structural engineering inspection. Component or element shows advanced deterioration, loss of section from the parent material, signs of overstressing or evidence that it is acting differently to its intended design mode or function.
5	Unsafe	1%	Less Than 2 Years	Bridge should be closed. Structural integrity is severely compromised, and the structure must be taken out of service until a structural engineer has inspected the structure and recommended the required remedial action.

1. Typically a structure may be defined as defective when greater than 25% of principal components are rated as Condition State 4 in a single abutment, pier or span group.

3.0 MAJOR CAUSES OF WOOD DETERIORATION

Wood deteriorates for numerous reasons, and as deterioration implies this adversely affects woods properties. The two primary causes of deterioration in wood are: biotic (living) agents and physical (nonliving) agents. In many cases the agents that first alter the wood, provide the conditions for other agents to attack (e.g. insects bring woodpeckers). The effectiveness of an inspection of deteriorated wood depends upon the inspector's knowledge of the agents of deterioration. A well-trained inspector is essential for accurately assessing wood deterioration.

3.1 Wood Deterioration Due to Biotic Agents

Biotic, or living, organisms that attack wood include bacteria, fungi, insects, and marine borers. As living organisms, they require certain conditions for survival such as moisture, oxygen, temperature, and food, which is usually the wood. When the basic necessary living conditions are available biotic agents of wood deterioration are free to proliferate, but if any one of them is removed the wood is safe from further biotic attack. Geographical regions tend to have higher moisture content due to average temperature and relative humidity. See **Figure 3-1** below for the decay hazard zones for Australia.

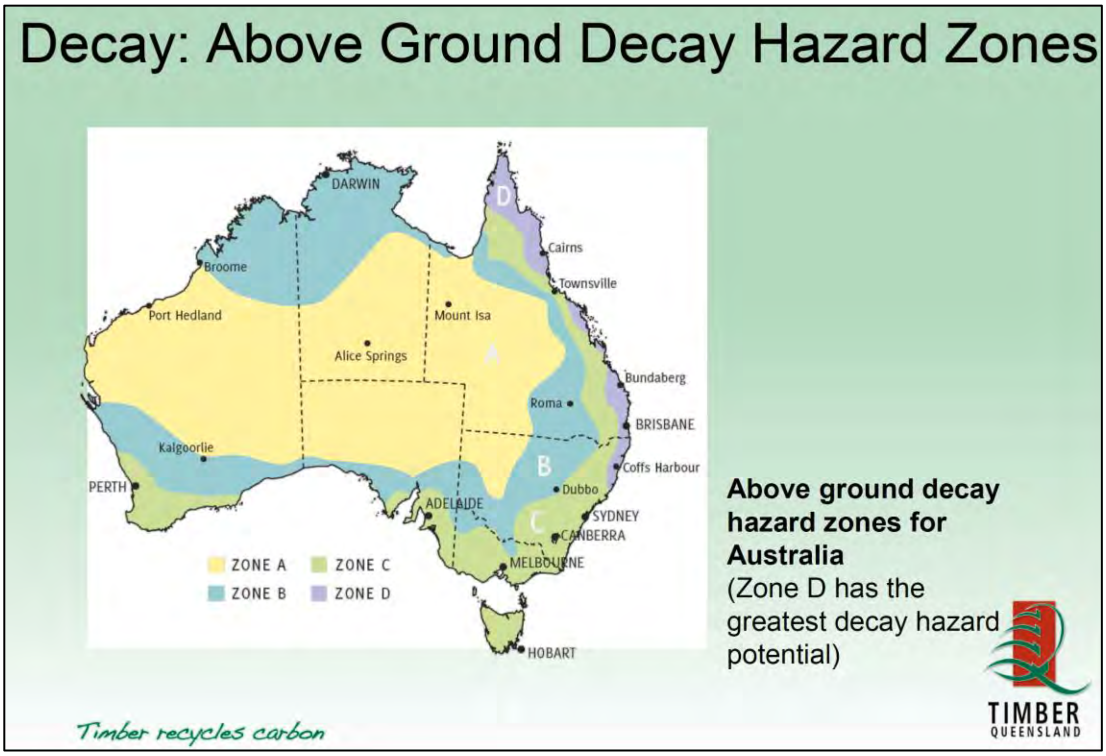


Figure 3-1: Decay Hazard Map for Australia showing that the proposed New England Rail Trail bridges are in Zone C of the decay hazard zones in Australia. The typical moisture contents in these timber bridges are 16.4% for open deck bridges and 14.2% for closed deck bridges. Decay doesn't begin in wood till the moisture content reaches 22%. The majority of decay in timber elements is due to vertical fasteners and design details that allow moisture to accumulate in and around timber elements.

3.1.2 Bacteria

In very wet environments bacteria can colonize untreated wood. Bacterial damage can include softening of the wood surface, increased permeability, and even degradation of chemical preservatives so that the wood becomes more susceptible to less chemically tolerant organisms. Usually the process bacterial attack is very slow, but under extensive exposure for long periods, damage can become significant.

3.1.3 Fungi

When exposed to favourable conditions, most types of wood become an attractive food source for a variety of decay-producing fungi. The fungi require moderate temperature, oxygen, and a moisture content of approximately 22% or greater (oven dry basis) to become active. Decay progresses most rapidly at temperatures between 10°C (50°F) and 35°C (95°F), outside this range decay growth slows considerably, and ceases when the temperature drops as low as 2°C (35°F) or rises as high as 38°C (100°F). Wood can be too wet for decay also. If the wood is water-soaked, the supply of oxygen may be inadequate to support development of typical decay fungi. Thus, wood will not decay, and decay already present from prior infestation will not progress if appropriate conditions are not met.

Examples of wood preservation by environmental conditions are common. Timber pagodas in China have survived hundreds of years, and in some cases over 1,000 years, because the wood was kept dry. Entrepreneurs in the United States are recovering old growth wood from sunken transport ships and selling the recovered wood. The sunken wood has been almost perfectly preserved by being kept saturated such that oxygen is not available for decay to proceed.

Decay fungi may be generally classified into two categories by the appearance on the wood surface.

1. **Brown Rot |** Appears darker and can crack across the grain. Brown rot fungi attack the cellulose in the wood fibres. The brown colour is due to the remaining lignin (the binder which holds the cellulose structure together), which is not consumed by the fungi. The decayed wood tends to form into small cubic shaped sections, which is a sign of advanced decay.

2. **White Rot |** Appears lighter in colour and does not crack across the grain until severely degraded. In contrast to brown rot, white rot consumes both the lignin and cellulose and leaves the surface appearing generally intact, but with little or no significant mechanical strength. The surface of the decayed wood tends to have a “white” appearance.

Dry rot is a common term utilized by building inspectors to describe wood that becomes brown and crumbly and in an apparent dry condition. However, dry rot is a misnomer, because the wood must have some moisture in it to decay, although it may become dry later. A few fungi have water-conducting strands (hyphae) which are capable of carrying water, usually from the soil, into buildings or wood piles where they moisten and rot wood that would otherwise be dry. The material they are calling dry rot is frass or the residual material left after the decay causing fungal colony has moved on.

Interior decay damage can occur even when some precaution has been taken. Surface treated wood material can form cracks, which extend beyond the treated surface into untreated core material. Water can also get into the core of “protected” wood by the fungi hyphae. In either case water enters the core material and provides the adequate conditions for decay fungi to live. Wood with as little as a 10% loss in Specific Gravity (SG) due to decay can have up to 75% loss in bending strength and 80% loss in compression perpendicular to grain strength.

3.2 Wood Deterioration Due to Vertical Fasteners

Figure 3-2 below shows the level of decay typically found due to vertical through bolts. A similar occurrence happens to the base of the pile when they are sitting directly on concrete. The timber soaks up the water from the concrete, which accelerates decay.

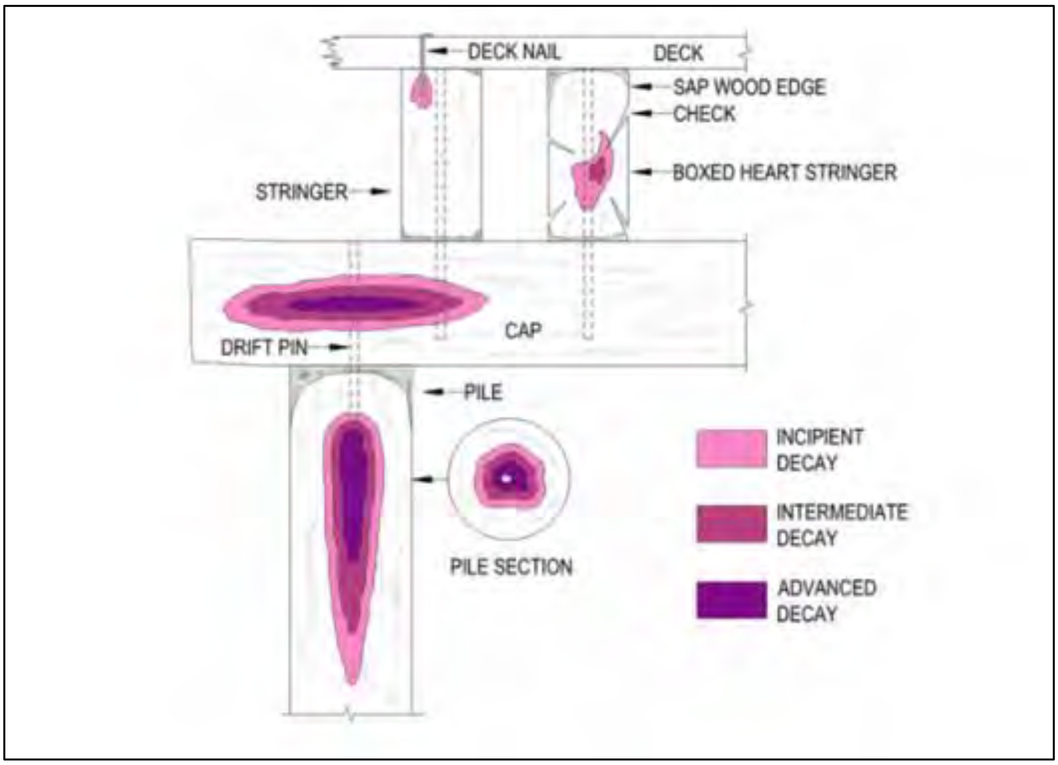


Figure 3-2: Shows the level of decay that occurs in timber due to the use of vertical fasteners. Vertical fasteners increase the rate of decay in timber as they allow moisture to travel down the fastener into the heartwood of the headstock (cap), girders (stringers), corbels and piles, therefore increasing the moisture content in the middle of these elements. The heartwood of a log element is less capable of breathing and expelling moisture than the sapwood that surrounds it, so vertical connectors funnel the moisture directly into the heartwood accelerating decay. Once the moisture content exceeds 22%, timber consuming fungi are activated and the decay process begins.

4.0 INSPECTION FINDINGS – OLD BEN LOMOND RD BRIDGE

4.1 Visual Inspection – Old Ben Lomond Rd Bridge

An essential step in evaluating the condition of a structure is undertaking a visual inspection. The visual aspect of the investigation is used to pick up missing or failed elements, cracks and splits, cavitation, connection details, abutment condition, undermining and debris build-up, among other important information. Gathering this information is essential for completing a comprehensive investigation, and taking into account the surroundings in addition to the main structural elements. See **Figure 4-1** through **Figure 4-5** below for a summary of findings as well as the description of each bridge.

Figure 4-1: View of Old Ben Lomond Rd Bridge from Abutment 1. The timber bridge is 2 spans long and approximately 8 metres long. At the time of inspection, the water was not flowing (boggy 'spring') and had a maximum depth of 0.5m. The wingwalls and backwalls have significantly deteriorated and no longer retain any of the approach fill material. Also note there is a fence located/attached on the left side of the bridge. Also note the horizontal crack on Girder 4 which is a key sign of internal decay and section loss causing the beam to fail under the deadweight of the bridge alone.

Figure 4-2: View of the timber abutments and pile. The bents comprise of 4 piles with significant deteriorated found and evident with timber packers placed under some piles (Pile 3 in the left-hand image above). Overall the timber bents were found to be in very poor condition with a complete re-build required. Breast walls were burst and pile to cap connection was lost.

Figure 4-3: Most elements have started to undergo significant decay with Bent 1 cap visibly decayed above. Large amounts of fungi growth (white spots) are evident on most elements and is seen in the left-hand image above. Once the moisture content in the timber elements reaches 22%, decay causing fungi are activated and the decay process begins.

Figure 4-4: More evidence of decay present as there is large fungi growth on most elements. Brief NDT testing was completed using non-destructive methods, such as EPHOD® Stress Wave Technology. Refer to Appendix A for more information of this type of testing method. Readings above 2000-3000µs was recorded for the time taken for the compression wave to travel across the section of the member tested. This was recorded on most elements. Deterioration of this magnitude means that the Modulus of Elasticity/Modulus of Rupture in various stress directions (wood is anisotropic with different strength properties in different directions) has deteriorated to an extent that the element can no longer support its own dead weight. Readings between 1000µs and 2200µs indicate that the member cannot carry its own dead weight in these regions. Readings in excess of 2200µs can signify a cavity while a reading above 3300µs indicates the element can no longer support its own dead load and is at risk of failing at any point. Refer to Section 4.3 below for a full list of recommended repair options for refurbishment to a pedestrian/cycle bridge.

Figure 4-5: The timber transoms (rail ties) were found to be in a poor condition with fouled ballast and lost ballast. If the bridge was to be repurposed for pedestrian and cycle use the timber transoms, railway line and rock ballast would be required to be removed. The existing timber edge rail that contains the ballast can left in place to act as a kerb/kick rail in the re-purposed bridge. To meet the current standards and Australian codes; vertical balustrade panels and a 1.4m high cycle rail will need to be installed. The current width of the bridge from inside of kerb to inside of kerb is approximately 3.0 metres which will result in a code compliant width for pedestrian bridges. As many of the deck planks are 'falling' out a new deck would be required for this bridge.

4.2 Bridge Configuration & Condition State Rating – Old Ben Lomond Rd Bridge

Overall Old Ben Lomond Rd Bridge is in very poor condition (CSR of 4) with significant works required to repurpose the bridge for pedestrian and cycle use. This rating does not speak to the load rating. A load rating of the structure was not part of the scope of works for this report. This condition rating was based from a small sample size of data collected and it is highly recommended to conduct a detailed Level 2/3 inspection of the entire bridge. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Section 4.3** below. See **Table 4-1** below for a breakdown of the condition state rating (CSR) per each of the element types. As previously mentioned, the accessible structural elements were tested using the SWT machine with the limited results displayed in **Table 4-2** below.

Table 4-1: Bridge Configuration & Condition State Rating Table– Old Ben Lomond Rd Bridge

	Element Details						Overall Visual Condition State Rating per Element Type %		
Element	**Size (Width x Depth)**	**Length (m)**	**Typ. Spacings (Centre to Centre)**	**QTY per Span/Bent**	**# Spans/Bents Applicable**	**Total QTY**	**Fair (2)**	**Poor (3)**	**Very Poor (4)**
Backwalls/Wingwalls	1000 x 1000	3	NA	Abutment 1 & 2	NA	1	0%	0%	100%
Pile	Ø350-400 or sq 300	1.5m	situated under girder lines. Batter piles is 1:5 grade	4	3	12	0%	10%	90%
Headstock/Cap	300 x 300	4.5m	NA	1	3	3	0%	0%	100%
Corbels	300 x 300	2-2.5m	same as Girders	4	2	8	0%	20%	80%
Girders	300 x 300	8m (continuous over bent)	1m for exterior & 1.5m for interior	4	1	4	0%	20%	80%
Deck planks	75 x 200	3.6m	Stacked tight	Approx. 20	2	40	0%	0%	100%
Kerb/Ballast Support Planks	100 x 300	Varies (8m)	Installed on top of exterior girders	NA	NA	16 lin. m	0%	20%	80%
Transom (Sleeper)	225 x 125	2.5	650-800mm	6	2	12	0%	40%	60%

Table 4-2: Scatted SWT Readings (adjusted values) - Breakdown Percentage %					
Element	400-700µS	700-1000 µS	1000-1500 µS	1500-2500 µS	2500+ µS
Girders	0%	0%	10%	20%	70%
Corbels	0%	0%	10%	20%	70%
Caps	0%	0%	10%	20%	70%
Piles	0%	0%	10%	20%	70%

4.3 Refurbishment Recommendations & Cost Estimates

Based on the information compiled from both the visual inspection and brief SWT testing, the bridge will require significant repairs/replacement to repurpose the railway bridge as a rail trail bridge for pedestrian and cycle use. Two (2) options have been developed to refurbish the structure into a rail trail bridge.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new single span treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix B.

See below for high level (level D) cost estimates for each of the options mentioned above.

4.3.1 Option 1 - Intermediate Term Refurbishment Cost Estimate (25-50 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Old Ben Lomond Rd Bridge
Option #1 - Like-For-Like Replacement of the Substructure and Superstructure and New Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$10,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$5,000
3	Crane / Excavator Hire including demolition	$10,000
4	Shipping material to job site	$2,500
	Sub Total:	**$27,500**

	Supply and Installation	
5	New Substructure Elements including abutment/pier repairs as required	$40,000
6	New Hardwood Superstructure Elements (girders)	$10,000
7	New Deck and Code Compliant Handrail (with cycle rail) System	$25,000
8	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$75,000**

Total:	**$102,500**
Contingency (15%)	**$15,375**
GST (10%):	**$11,788**
Grand Total:	**$129,663**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 2 weeks to perform retrofit tasks. This is an estimate only.

4.3.2 Option 2 - Long Term Refurbishment Cost Estimate (75-100 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Old Ben Lomond Rd Bridge
Option #2 - Repair/Replace Substructure and New Glulam Superstructure and Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$10,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$5,000
3	Bridge Access (scaffolding)	$0
4	Crane / Excavator Hire including demolition	$10,000
5	Shipping material to job site	$2,500
	Sub Total:	**$27,500**
	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs and cross bracing re-installation as required	$45,000
7	New Glulam Superstructure Elements (girders and lateral bracing)	$15,000
8	New Glulam Deck and Code Compliant Handrail (with cycle rail) System	$25,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$85,000**
	Total:	**$112,500**
	Contingency (15%)	**$16,875**
	GST (10%):	**$12,938**
	Grand Total:	**$142,313**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 1 weeks to perform retrofit tasks. This is an estimate only.

5.0 INSPECTION FINDINGS – MANROWAN CREEK BRIDGE

5.1 Visual Inspection – Manrowan Creek Bridge

An essential step in evaluating the condition of a structure is undertaking a visual inspection. The visual aspect of the investigation is used to pick up missing or failed elements, cracks and splits, cavitation, connection details, abutment condition, undermining and debris build-up, among other important information. Gathering this information is essential for completing a comprehensive investigation, and taking into account the surroundings in addition to the main structural elements. See **Figure 5-1** through **Figure 5-10** below for a summary of findings as well as the description of each bridge.

Figure 5-1: View of Manrowan Creek Bridge from the Abutment 1 end of the structure. The timber girder under bridge has 8 spans in total with an overall length of 56m. This type of design was quite common for the longer spans that transverse over the larger creeks along the New England Railway line. At the time of inspection there no water flowing in Manrowan Creek, only a pool of water approximately 1m deep at spans 5 & 6.

Figure 5-2: A view of the underneath section of the bridge. It can be seen that the deck has collapsed in sections along the bridge. These planks will require replacement before the bridge can be reopened for pedestrian and cycle use. The superstructure comprises of 4 solid sawn girder lines per span with the 2 girders per a girder line (8 girders per span in total). The double stacked girders are separated by traverse beams that contribute to the load sharing ability of the superstructure. Generally the transverse beams were in poor condition and the girders are in poor-very poor condition. One of the girders has undergone significant deterioration with large splits visible from the underneath as well as being covered fully in decay fungi growth. The girders and corbels are connected with large vertical through bolts. Vertical fasteners increase the rate of decay in timber as they allow moisture to travel down the fastener into the heartwood of the girders and corbels where evaporation is more difficult, therefore increasing the moisture content in the middle of these elements over longer periods of time. The heartwood of a large dimensional element is less capable of breathing and expelling moisture than the sapwood that surrounds it, so vertical connectors funnel the moisture directly into the heartwood accelerating decay. Once the moisture content exceeds 22%, timber consuming fungi are activated and the decay process begins. Refer to Figure 3-2 for a detailed description of how and where the decay occurs due to these vertical bolts.

Figure 5-3: View of the typical timber pile bent configuration. The bent comprises of 6 square (or round) dimensional post bearing directly on a timber bottom cap which is vertically connected to the concrete footing. The bent is also supported by cross bracing that provides adequate support for the 2.5-4m long posts. Overall the timber bents were found to be in a poor condition with the timber bottom caps being in the worst condition. This is as per expected due to the timber bearing directly on the concrete footing which typically has a high moisture content. Over time the timber post undergoes capillary action and draws up the moisture like a 'straw'. Once the moisture content in the timber elements reaches 22%, decay causing fungi are activated and the decay process begins. This timber bottom cap has partially 'protected' the timber posts which are in relatively poor condition, however the timber cap wales will cost a significant amount to be replaced or repaired in-situ.

Figure 5-4: View of Spans 5 & 6 where the creek mainly flows. A close-up view of the decayed bottom cap that is vertically connected to and directly bearing on the concrete footing. Also the 2 concrete footing on either side of the main stream flow (Span 5) have signs of deterioration and scour. Scour protection (rip rap) is recommended to be installed.

Figure 5-5: A view of a section of the deck that has collapsed. These planks will require replacement before the bridge can be reopened for pedestrian and cycle use. The ballast rock will also be required to be removed to accommodate pedestrian and cycle traffic. Large amounts of decay fungi growth evident which indicates large amount of deterioration present.

Figure 5-6: Close-up view of the approach span. The members are connected with a vertical through bolt. Vertical fasteners increase the rate of decay in timber as they allow moisture to travel down the fastener into the heartwood of the girders and corbels where evaporation is more difficult, therefore increasing the moisture content in the middle of these elements over longer periods of time. The heartwood of a large dimensional element is less capable of breathing and expelling moisture than the sapwood that surrounds it, so vertical connectors funnel the moisture directly into the heartwood accelerating decay. Once the moisture content exceeds 22%, timber consuming fungi are activated and the decay process begins.

Figure 5-7: View of the typical approach configuration. The formation of the line has been significantly raised to pass over the creek which has resulted in steep unstable slopes on each side/end. The approach retaining wall is in very poor condition and requires repair to achieve a safe and stable approach formation.

Figure 5-8: View of Abutment 1 which is the typical board-formed, poured place, concrete wing and breast wall configuration. The concrete mass block/seat is in fair condition with the wingwalls intentionally angled back towards the approaches to help overcome the large forces from the approach fill.

Figure 5-9: View of Side 2 (Right-hand side) of the bridge from Abutment 2. The bridge maintains a fairly straight alignment while the decay of the bents/girders are visible to the uneven 'drops' along the length of the bridge. The ballast tray remains intact with most of the ballast.

Figure 5-10: View of Manrowan Creek from Abutment 2 side of the creek. Note the fence attached to the bridge which can have a negative impact on the bridge due to the increased chance of debris getting trapped and thus the lateral loads on the bridge increase.

5.2 Bridge Configuration & Condition State Rating – Manrowan Creek Bridge

Overall Manrowan Creek Bridge is in very poor condition (CSR of 4) with significant works required to repurpose the bridge for pedestrian and cycle use. This rating does not speak to the load rating. A load rating of the structure was not completed for this report. This condition rating was based from a small sample size of data collected and it is highly recommended to conduct a detailed Level 2/3 inspection of the entire bridge. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Section 5.3** below. See **Table 5-1** below for a breakdown of the condition state rating (CSR) per each of the element types. The accessible structural elements were tested using the SWT machine with the limited results displayed in **Table 5-2** below.

Table 5-1: Bridge Configuration & Condition State Rating Table– Manrowan Creek Bridge

	Element Details						Overall Visual Condition State Rating per Element Type %		
Element	Size (Width x Depth)	Length (m)	Typ. Spacings (Centre to Centre)	QTY per Span/Bent	# Spans/Bents Applicable	Total QTY	Fair (2)	Poor (3)	Very Poor (4)
Pile	Ø350-400 or sq 300	2.5-4m	situated under girder lines. Batter pile is 1:5 grade	6	7	42	10%	20%	70%
Pile Bent Bracing	100 x 225	4.5-5m	NA	2	7	14	10%	20%	70%
Top & Bottom Cap	300 x 300	4.5-6m	NA	2	7	14	10%	20%	70%
Corbels	300 x 300	2.5m	same as Girders	4	6	24	10%	20%	70%
Girders	300 x 300	8m & 4m (approach spans)	1m for exterior & 1.5m for interior	8	8	64	10%	20%	70%
Transverse Support Beams	150 x 200	4.3m	1-1.1m	8	8	64	10%	20%	70%
Deck planks	75 x 200	3.6m	Stacked tight	8m spans - 40 4m spans - 20	8	280	10%	20%	70%
Kerb/Ballast Support Planks	100 x 300	Varies (8m)	Installed on top of exterior girders	NA	NA	112 lin. m	10%	20%	70%
Transom (Sleeper)	225 x 125	2.5m	650-800mm	10	8	80	10%	40%	50%

Table 5-2: Scatted SWT Readings (adjusted values) - Breakdown Percentage %					
Element	400-700µS	700-1000 µS	1000-1500 µS	1500-2500 µS	2500+ µS
Girders	No Access				
Corbels	No Access				
Bottom Caps	0%	0%	10%	20%	70%
Piles	0%	0%	10%	20%	70%

5.3 Refurbishment Recommendations & Cost Estimates

Based on the information compiled from both the visual inspection and brief SWT testing, the bridge will require significant repairs/replacement to repurpose the railway bridge as a rail trail bridge for pedestrian and cycle use. Two (2) options have been developed to refurbish the structure into a rail trail bridge.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix B.

See below for high level (level D) cost estimates for each of the options mentioned above.

5.3.1 Option 1 - Intermediate Term Refurbishment Cost Estimate (25-50 years)

New England Rail Trail - Manrowan Creek Bridge
Option #1 - Like-For-Like Replacement of the Substructure and Superstructure and New Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$40,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$10,000
3	Bridge access (scaffold, ladders)	$45,000
4	Crane / Excavator Hire including demolition	$70,000
5	Shipping material to job site	$10,000
	Sub Total:	**$175,000**

	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs as required	$85,000
7	New Hardwood Superstructure Elements (girders)	$65,000
8	New Deck and Code Compliant Handrail (with cycle rail) System	$115,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$265,000**

Total:	**$440,000**
Contingency (15%)	**$66,000**
GST (10%):	**$50,600**
Grand Total:	**$556,600**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 4 weeks to perform retrofit tasks. This is an estimate only.

5.3.2 Option 2 - Long Term Refurbishment Cost Estimate (75-100 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Manrowan Creek Bridge
Option #2 - Repair/Replace Substructure and New Glulam Superstructure and Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$40,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$10,000
3	Bridge Access (scaffolding)	$45,000
4	Crane / Excavator Hire including demolition	$70,000
5	Shipping material to job site	$10,000
	Sub Total:	**$175,000**

	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs and cross bracing re-installation as required	$75,000
7	New Glulam Superstructure Elements (girders and lateral bracing)	$55,000
8	New Glulam Deck and Code Compliant Handrail (with cycle rail) System	$150,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$280,000**

Total:	**$455,000**
Contingency (15%)	**$68,250**
GST (10%):	**$52,325**
Grand Total:	**$575,575**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 3 weeks to perform retrofit tasks. This is an estimate only.

6.0 INSPECTION FINDINGS – UPPER WILLIAMS CREEK BRIDGE

6.1 Visual Inspection – Upper Williams Creek Bridge

An essential step in evaluating the condition of a structure is undertaking a visual inspection. The visual aspect of the investigation is used to pick up missing or failed elements, cracks and splits, cavitation, connection details, abutment condition, undermining and debris build-up, among other important information. Gathering this information is essential for completing a comprehensive investigation, and taking into account the surroundings in addition to the main structural elements. See **Figure 6-1** through **Figure 6-5** below for a summary of findings as well as the description of each bridge.

Figure 6-1: View of Upper Williams Creek Bridge from Abutment 1 end of the bridge. Abutment 1 (Southern end) is to the right side of the image above. The natural flow of the creek is through span 2 with no water flow at the time of inspection. The configuration and current condition of the bridge is similar to Manrowan Creek Bridge with a beautiful brick pier (which can be saved to protect the construction of the era) instead of timber bents. The timber bridge is only 2 spans long and approximately 14 metres in length.

Figure 6-2: The deck planks that support the ballast rock are in very poor condition with many of the planks missing and large amounts of ballast have fallen out.

Figure 6-3: View of the brick pier that is approximately 3 metres in height. The timber girders are supported by corbels that rest on a timber cap that bears directly on the brick pier. On either side of the pier there are signs of deterioration and scour. Scour protection (rip rap) is recommended to be installed.

Figure 6-4: View of the typical abutment wingwall configuration and condition. The timber breastwall and wingwall planks have undergone significant deterioration and are now leaning 'outwards'. There is a loss of fines and larger aggregate from the approach through the breastwall.

Figure 6-5: A view of the underneath section of the bridge. It can be seen that the deck has collapsed in sections along the bridge. These planks will require replacement before the bridge can be reopened for pedestrian and cycle use. The superstructure comprises of 4 girder lines per span with the 2 girders per a girder line (8 girders per span in total). The double stacked sawn square girders are separated by traverse beams that contribute to the load sharing ability of the superstructure. Several of the girders has undergone significant deterioration with large splits visible from the underneath. The girders and corbels are connected with large vertical through bolts. Vertical fasteners increase the rate of decay in timber as they allow moisture to travel down the fastener into the heartwood of the girders and corbels where evaporation is more difficult, therefore increasing the moisture content in the middle of these elements over longer periods of time. The heartwood of a large dimensional element is less capable of breathing and expelling moisture than the sapwood that surrounds it, so vertical connectors funnel the moisture directly into the heartwood accelerating decay. Once the moisture content exceeds 22%, timber consuming fungi are activated and the decay process begins. Refer to Figure 3-2 for a detailed description of how and where the decay occurs due to these vertical bolts.

6.2 Bridge Configuration & Condition State Rating – Upper Williams Creek Bridge

Overall Upper Williams Creek Bridge is in very poor condition (CSR of 4) with significant works required to repurpose the bridge for pedestrian and cycle use. This rating does not speak to the load rating. A load rating of the structure was not completed for this report. This condition rating was based from a very small sample size of data collected and it is highly recommended to conduct a detailed Level 2/3 inspection of the entire bridge. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Section 6.3** below.

See **Table 6-1** below for a breakdown of the condition state rating (CSR) per each of the element types.

Table 6-1: Bridge Configuration & Condition State Rating Table– Upper Williams Creek Bridge

	Element Details						Overall Visual Condition State Rating per Element Type %		
Element	**Size (Width x Depth)**	**Length (m)**	**Typ. Spacings (Centre to Centre)**	**QTY per Span/Bent**	**# Spans/Bents Applicable**	**Total QTY**	**Fair (2)**	**Poor (3)**	**Very Poor (4)**
Pile (Abutments)	Ø350-400 or sq 300	1.5m	situated under girder lines. Batter pile is 1:5 grade	4	2	8	10%	20%	70%
Brick Pier	Approx. 3m high	4.5-5m	NA	1	1	1	0%	100%	0%
Headstock/Cap	300 x 300	5-5.5	NA	1	3	3	10%	20%	70%
Corbels	300 x 300	2.5	same as Girders	4	3	12	10%	20%	70%
Girders	300 x 300	8 & 5 (approach spans)	1m for exterior & 1.5m for interior	8	2	16	10%	20%	70%
Transverse Support Beams	150 x 200	4.3	1-1.1m	8	2	16	10%	20%	70%
Deck planks	75 x 200	3.6	Stacked tight	35	2	70	10%	20%	70%
Kerb/Ballast Support Planks	100 x 300	Varies (8m)	Installed on top of exterior girders	NA	NA	28 lin. m	10%	20%	70%
Transom (Sleeper)	225 x 125	2.5	650-800mm	7	2	14	10%	40%	50%

Table 6-2: Scatted SWT Readings (adjusted values) - Breakdown Percentage %					
Element	400-700µS	700-1000 µS	1000-1500 µS	1500-2500 µS	2500+ µS
Girders	0%	0%	10%	20%	70%
Corbels	0%	0%	10%	20%	70%
Caps	0%	0%	10%	20%	70%
Piles	0%	0%	10%	20%	70%

6.3 Refurbishment Recommendations & Cost Estimates

Based on the information compiled from both the visual inspection and brief SWT testing, the bridge will require significant repairs/replacement to repurpose the railway bridge as a rail trail bridge for pedestrian and cycle use. Two (2) options have been developed to refurbish the structure into a rail trail bridge.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix B.

See below for high level (level D) cost estimates for each of the options mentioned above.

6.3.1 Option 1 - Intermediate Term Refurbishment Cost Estimate (25-50 years)

New England Rail Trail - Upper Williams Creek Bridge
Option #1 - Like-For-Like Replacement of the Substructure and Superstructure and New Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$15,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$5,000
3	Bridge access (scaffold, ladders)	$5,000
4	Crane / Excavator Hire including demolition	$25,000
5	Shipping material to job site	$2,500
	Sub Total:	**$52,500**

	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs as required	$40,000
7	New Hardwood Superstructure Elements (girders)	$20,000
8	New Deck and Code Compliant Handrail (with cycle rail) System	$35,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$95,000**

Total:	**$147,500**
Contingency (15%)	**$22,125**
GST (10%):	**$16,963**
Grand Total:	**$186,588**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 2 weeks to perform retrofit tasks. This is an estimate only.

6.3.2 Option 2 - Long Term Refurbishment Cost Estimate (75-100 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Upper Williams Creek Bridge
Option #2 - Repair/Replace Substructure and New Glulam Superstructure and Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$15,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$5,000
3	Bridge Access (scaffolding)	$5,000
4	Crane / Excavator Hire including demolition	$25,000
5	Shipping material to job site	$2,500
	Sub Total:	**$52,500**
	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs and cross bracing re-installation as required	$50,000
7	New Glulam Superstructure Elements (girders and lateral bracing)	$20,000
8	New Glulam Deck and Code Compliant Handrail (with cycle rail) System	$40,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$110,000**
	Total:	**$162,500**
	Contingency (15%)	**$24,375**
	GST (10%):	**$18,688**
	Grand Total:	**$205,563**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 2 weeks to perform retrofit tasks. This is an estimate only.

7.0 INSPECTION FINDINGS – WILLIAMS CREEK BRIDGE

7.1 Visual Inspection – Williams Creek Bridge

An essential step in evaluating the condition of a structure is undertaking a visual inspection. The visual aspect of the investigation is used to pick up missing or failed elements, cracks and splits, cavitation, connection details, abutment condition, undermining and debris build-up, among other important information. Gathering this information is essential for completing a comprehensive investigation, and taking into account the surroundings in addition to the main structural elements. See **Figure 7-1** through **Figure 7-7** below for a summary of findings as well as the description of each bridge.

Figure 7-1: View of Williams Creek from Abutment 1 end of the structure. The 3 span, 24m long bridge has the same superstructure and deck configuration as Manrowan Creek Bridge with timber pile bents. There is a large amount of vegetation growth around the bridge which keeps the moisture content high in the timber. When the moisture level in the timber is above 22%, decay-causing fungi can start to grow; when the moisture content drops below this level, the fungi become dormant and decay will be arrested until the moisture content rises again.

Figure 7-2: The superstructure and deck are the same configuration and similar condition as Manrowan Creek Bridge. The girders are in very poor condition with Girder 4 in Span 1 having visible cavities and excessively deflecting under its own deadload which has result in full length cracking.

Figure 7-3: View of Pile Bent 2 (top) and Piles 3 & 4 of Pile Bent 1. The bottom of the piles in the 'splash' zone are significantly deteriorated with major repairs required. These piles will also require restoration for lateral stability of the bridge. When more than 50% of the piles in the bent require replacing then it is cost effective and beneficial for longevity that the pile bent is replaced with a new frame bent. That is, all piles are trimmed down to bright (solid) wood and a new bottom cap (sill) is placed on top of the pile stubs with the new posts connected to the sill to support the new cap and corbels/girders.

Figure 7-4: View of the typical abutment wingwall configuration and condition. The timber breastwall and wingwall planks have undergone significant deterioration and are now leaning 'outwards'. There is a loss of fines and larger aggregate from the approach through the breastwall. Also note the very poor condition of the Abutment 2 piles where the central pile is 'suspended'.


Figure 7-5: The deck planks that support the ballast rock are in very poor condition with many of the planks missing and large amounts of ballast have fallen out. To meet the current standards and Australian codes; vertical balustrade panels and a 1.4m high cycle rail will need to be installed along with a new deck system.

Figure 7-6: A view of the creek downstream. At the time of inspection the water was not flowing.

Figure 7-7: View from Abutment 2 end of the bridge. The vegetation overgrowth is again evident from this image as there is a large tree growing on the upstream side of the bridge.

7.2 Bridge Configuration & Condition State Rating – Williams Creek Bridge

Overall Williams Creek Bridge is in very poor condition (CSR of 4) with significant works required to repurpose the bridge for pedestrian and cycle use. This rating does not speak to the load rating. A load rating of the structure was not completed for this report. This condition rating was based from a small sample size of data collected and it is highly recommended to conduct a detailed Level 2/3 inspection of the entire bridge. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Section 7.3** below.

See **Table 7-1** below for a breakdown of the condition state rating (CSR) per each of the element types. As previously mentioned, the accessible structural elements were tested using the SWT machine with the limited results displayed in **Table 7-2** below.

Table 7-1: Bridge Configuration & Condition State Rating Table– Williams Creek Bridge

	Element Details						Overall Visual Condition State Rating per Element Type %		
Element	**Size (Width x Depth)**	**Length (m)**	**Typ. Spacings (Centre to Centre)**	**QTY per Span/Bent**	**# Spans/Bents Applicable**	**Total QTY**	**Fair (2)**	**Poor (3)**	**Very Poor (4)**
Piles	Ø350-400 or sq 300	1.5m	situated under girder lines. Batter pile is 1:5 grade	4	4	17	10%	20%	70%
Braces	100 x 225	5-5.5m	NA	2	2	4	0%	100%	0%
Headstock/Cap	300 x 300	5-5.5	NA	1	4	4	10%	20%	70%
Corbels	300 x 300	2.5	same as Girders	4	4	16	10%	20%	70%
Girders	300 x 300	8 & 5 (approach spans)	1m for exterior & 1.5m for interior	8	3	24	10%	20%	70%
Transverse Support Beams	150 x 200	4.3	1-1.1m	8	3	24	10%	20%	70%
Deck planks	75 x 200	3.6	Stacked tight	40	3	120	10%	20%	70%
Kerb/Ballast Support Planks	100 x 300	Varies (8m)	Installed on top of exterior girders	NA	NA	48 lin. m	10%	20%	70%
Transom (Sleeper)	225 x 125	2.5	650-800mm	10	3	30	10%	40%	50%

Table 7-2: Scatted SWT Readings (adjusted values) - Breakdown Percentage %					
Element	400-700µS	700-1000 µS	1000-1500 µS	1500-2500 µS	2500+ µS
Girders	0%	0%	10%	20%	70%
Corbels	0%	0%	10%	20%	70%
Caps	0%	0%	10%	20%	70%
Piles	0%	0%	10%	20%	70%

7.3 Refurbishment Recommendations & Cost Estimates

Based on the information compiled from both the visual inspection and brief SWT testing, the bridge will require significant repairs/replacement to repurpose the railway bridge as a rail trail bridge for pedestrian and cycle use. Two (2) options have been developed to refurbish the structure into a rail trail bridge.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix B.

See below for high level (level D) cost estimates for each of the options mentioned above.

7.3.1 Option 1 - Intermediate Term Refurbishment Cost Estimate (25-50 years)

Wood Research and Development

New England Rail Trail - Williams Creek Bridge
Option #1 - Like-For-Like Replacement of the Substructure and Superstructure and New Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$20,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$10,000
3	Bridge access (scaffold, ladders)	$5,000
4	Crane / Excavator Hire including demolition	$20,000
5	Shipping material to job site	$5,000
	Sub Total:	**$60,000**

	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs as required	$50,000
7	New Hardwood Superstructure Elements (girders)	$35,000
8	New Deck and Code Compliant Handrail (with cycle rail) System	$60,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$145,000**

Total:	**$205,000**
Contingency (15%)	**$30,750**
GST (10%):	**$23,575**
Grand Total:	**$259,325**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 3 weeks to perform retrofit tasks. This is an estimate only.

7.3.2 Option 2 - Long Term Refurbishment Cost Estimate (75-100 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Williams Creek Bridge
Option #2 - Repair/Replace Substructure and New Glulam Superstructure and Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$20,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$10,000
3	Bridge Access (scaffolding)	$5,000
4	Crane / Excavator Hire including demolition	$20,000
5	Shipping material to job site	$5,000
	Sub Total:	**$60,000**
	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs and cross bracing re-installation as required	$70,000
7	New Glulam Superstructure Elements (girders and lateral bracing)	$25,000
8	New Glulam Deck and Code Compliant Handrail (with cycle rail) System	$70,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$165,000**
	Total:	**$225,000**
	Contingency (15%)	**$33,750**
	GST (10%):	**$25,875**
	Grand Total:	**$284,625**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 2 weeks to perform retrofit tasks. This is an estimate only.

8.0 INSPECTION FINDINGS – BEARDY WATERS (NUMERALLA RIVER) BRIDGE

8.1 Visual Inspection – Beardy Waters Bridge

An essential step in evaluating the condition of a structure is undertaking a visual inspection. The visual aspect of the investigation is used to pick up missing or failed elements, cracks and splits, cavitation, connection details, abutment condition, undermining and debris build-up, among other important information. Gathering this information is essential for completing a comprehensive investigation, and taking into account the surroundings in addition to the main structural elements. See **Figure 8-1** through **Figure 8-9** below for a summary of findings as well as the description of each bridge.

Figure 8-1: Top image is the view of Beardy Waters Bridge from Abutment 1 and the bottom image is from Abutment 2. The timber bridge is 14 spans long and approximately 112 metres in length (8 metre long spans). Note several of the spans at Abutment 2 side of the river are in very poor (unsafe) condition and have partially collapsed and sunken.

Figure 8-2: View of the typical timber pile bent configuration. The bent comprises of 6 square (or round) dimensional post bearing directly on a timber bottom cap which is vertically connected to the concrete footing. The bent is also supported by cross bracing that provides adequately support for the 2.5-4m long posts. Overall the timber bents were found to be in a poor to very poor condition with the timber bottom caps being in the worst condition. This is as per expected due to the timber bearing directly on the concrete footing which typically has a high moisture content. Over time the timber post undergoes capillary action and draws up the moisture like a 'straw'. Once the moisture content in the timber elements reaches 22%, decay causing fungi are activated and the decay process begins. This timber bottom cap has partially 'protected' the timber posts which are in relatively poor condition, however the timber cap wales will cost a significant amount to be replaced or repaired in-situ. Also note the bents are heavily skewed (approximately 30 degrees) and are parallel with the stream.

Figure 8-3: It was noted that the bottom section of several posts and timber cap wales have started to undergo decay. This is as expected due to the timber posts bearing directly on the concrete footing which typically has a high moisture content. Over time the timber post undergoes capillary action and draws up the moisture like a ‘straw’. Once the moisture content in the timber elements reaches 22%, decay causing fungi are activated and the decay process begins. Overall the timber bents were found to be in poor condition. The bottom sections of the timber piles were determined to be a ‘hotspot’ for decay and determined to be an ideal area to test using non-destructive methods, such as EPHOD® Stress Wave Technology. Refer to Appendix B for more information of this type of testing method. A reading of above 1500µs was recorded for the time taken for the compression wave to travel across the section of the member tested. This was recorded at the bottom of one of the piles (left image above) and was found to be similar across most of the piles/posts. Deterioration of this magnitude means that the Modulus of Elasticity/Modulus of Rupture in various stress directions (wood is anisotropic with different strength properties in different directions) has deteriorated to an extent that the element can no longer support its own dead weight. Readings between 1000µs and 2200µs indicate that the member cannot carry its own dead weight in these regions. Readings in excess of 2200µs can signify a cavity while a reading above 3300µs indicates the element can no longer support its own dead load and is at risk of failing at any point.

Figure 8-4: A view of the underneath section of the bridge. The superstructure comprises of 4 girder lines per span with the 2 girders per a girder line (8 girders per span in total). The double stacked square cut solid sawn girders are separated by traverse beams that contribute to the load sharing ability of the superstructure. Generally the transverse beams were in poor condition and the girders are in poor-very poor condition. One of the girders has undergone significant deterioration with large splits visible from the underneath as well as being covered fully in decay fungi growth. The girders and corbels are connected with large vertical through bolts. Vertical fasteners increase the rate of decay in timber as they allow moisture to travel down the fastener into the heartwood of the girders and corbels where evaporation is more difficult, therefore increasing the moisture content in the middle of these elements over longer periods of time. The heartwood of a large dimensional element is less capable of breathing and expelling moisture than the sapwood that surrounds it, so vertical connectors funnel the moisture directly into the heartwood accelerating decay. Once the moisture content exceeds 22%, timber consuming fungi are activated and the decay process begins. Refer to Figure 3-2 for a detailed description of how and where the decay occurs due to these vertical bolts.


Figure 8-5: The timber transoms (rail ties) were found to be in a poor condition. If the bridge was to be repurposed for pedestrian and cycle use the timber transoms, railway line and rock ballast would be required to be removed. The existing timber edge rail that contains the ballast can left in place to act as a kerb/kick rail in the re-purposed bridge. To meet the current standards and Australian codes; vertical balustrade panels and a 1.4m high cycle rail will need to be installed. The current width of the bridge from inside of kerb to inside of kerb is approximately 3.0 metres which will result in a code compliant width for pedestrian bridges. As many of the deck planks are 'falling' out a new deck would be required for this bridge. The rock ballast can be reused to create the trail.


Figure 8-6: View of the stream upstream (left hand image) and downstream (right hand image).

Figure 8-7: A view of a section of the bridge that has collapsed/sunken at Span 11. These members will require replacement before the bridge can be reopened for pedestrian and cycle use. The superstructure comprises of 4 girder lines per span with the 2 girders per a girder line (8 girders per span in total). The double stacked girders are separated by traverse beams that contribute to the load sharing ability of the superstructure.

Figure 8-8: Another view of a section of the bridge that has collapsed/sunken due to the girder and corbel 'crushing' due to significant decay. The girders and corbels are connected down to the cap with a vertical through bolt. Vertical fasteners increase the rate of decay in timber as they allow moisture to travel down the fastener into the heartwood of the girders and corbels where evaporation is more difficult, therefore increasing the moisture content in the middle of these elements over longer periods of time. The heartwood of a large dimensional element is less capable of breathing and expelling moisture than the sapwood that surrounds it, so vertical connectors funnel the moisture directly into the heartwood accelerating decay. Once the moisture content exceeds 22%, timber consuming fungi are activated and the decay process begins. Refer to Figure 3-2 for a detailed description of how and where the decay occurs due to these vertical bolts.

Figure 8-9: View of the typical abutment wingwall configuration and condition. The timber breastwall and wingwall planks have undergone significant deterioration and are now leaning 'outwards'. There is a loss of fines and larger aggregate from the approach through the breastwall. The top image is Abutment 1 with the bottom image Abutment 2.

8.2 Bridge Configuration & Condition State Rating – Beardy Waters Bridge

Overall Beardy Waters Bridge is in very poor condition (CSR of 4) with significant works required to repurpose the bridge for pedestrian and cycle use. This rating does not speak to the load rating. A load rating of the structure was not completed for this report. This condition rating was based from a small sample size of data collected and it is highly recommended to conduct a detailed Level 2/3 inspection of the entire bridge. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Section 8.3** below.

See **Table 8-1** below for a breakdown of the condition state rating (CSR) per each of the element types. As previously mentioned, the accessible structural elements were tested using the SWT machine with the limited results displayed in **Table 8-2** below.

Table 8-1: Bridge Configuration & Condition State Rating Table – Beardy Waters Bridge

	Element Details						Overall Visual Condition State Rating per Element Type %		
Element	**Size (Width x Depth)**	**Length (m)**	**Typ. Spacings (Centre to Centre)**	**QTY per Span/Bent**	**# Spans/Bents Applicable**	**Total QTY**	**Fair (2)**	**Poor (3)**	**Very Poor (4)**
Pile	Ø350-400 or sq 300	2.5-4m	situated under girder lines. Batter pile is 1:5 grade	6	15	90	10%	20%	70%
Pile Bent Bracing	100 x 225	4.5-5m	NA	2	15	30	10%	40%	50%
Top & Bottom Cap	300 x 300	4.5-6m	NA	2	15	30	10%	20%	70%
Corbels	300 x 300	2.5m	same as Girders	4	15	60	10%	20%	70%
Girders	300 x 300	8m & 4m (approach spans)	1m for exterior & 1.5m for interior	8	14	112	10%	20%	70%
Transverse Support Beams	150 x 200	4.3m	1-1.1m	8	14	112	10%	20%	70%
Deck planks	75 x 200	3.6m	Stacked tight	40	14	560	10%	20%	70%
Kerb/Ballast Support Planks	100 x 300	Varies (8m)	Installed on top of exterior girders	NA	NA	224 lin. m	10%	20%	70%
Transom (Sleeper)	225 x 125	2.5m	650-800mm	10	14	140	10%	40%	50%

Table 8-2: Scatted SWT Readings (adjusted values) - Breakdown Percentage %					
Element	400-700µS	700-1000 µS	1000-1500 µS	1500-2500 µS	2500+ µS
Girders	No Access				
Corbels	No Access				
Bottom Caps	0%	0%	10%	20%	70%
Piles	0%	0%	10%	20%	70%

8.3 Refurbishment Recommendations

Based on the information compiled from both the visual inspection and brief SWT testing, the bridge will require several repairs/replacement to repurpose the railway bridge as a rail trail bridge for pedestrian and cycle use. Two (2) options have been developed to refurbish the structure into a rail trail bridge. This would be a grand old bridge to restore with either option 1 or 2.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix B.

See below for high level (level D) cost estimates for each of the options mentioned above.

Due to the long length of the bridge and the very poor condition of the structure, it is recommended that this bridge is considered for ‘by passing’ and the river to be crossed using a low cost, low level structure with a possibility of using the existing 2 concrete footing either side of the creek. The estimated cost of this low level crossing would be between $200k-$350k depending on the design specifications and overall length. This option would mean missing the opportunity to restore the old bridge representing the typical timber railway bridge design methods of the period.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix C.

8.3.1 Option 1 - Intermediate Term Refurbishment Cost Estimate (25-50 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Beardy Waters Bridge
Option #1 - Like-For-Like Replacement of the Substructure and Superstructure and New Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$50,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$15,000
3	Bridge access (scaffold, ladders)	$65,000
4	Crane / Excavator Hire including demolition	$105,000
5	Shipping material to job site	$15,000
	Sub Total:	**$250,000**

ITEM	DESCRIPTION	TOTAL
	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs as required	$180,000
7	New Hardwood Superstructure Elements (girders)	$135,000
8	New Deck and Code Compliant Handrail (with cycle rail) System	$220,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$535,000**

Total:	**$785,000**
Contingency (15%)	**$117,750**
GST (10%):	**$90,275**
Grand Total:	**$993,025**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 8 weeks to perform retrofit tasks. This is an estimate only.

8.3.2 Option 2 - Long Term Refurbishment Cost Estimate (75-100 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Beardy Waters Bridge
Option #2 - Repair/Replace Substructure and New Glulam Superstructure and Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$50,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$15,000
3	Bridge Access (scaffolding)	$65,000
4	Crane / Excavator Hire including demolition	$100,000
5	Shipping material to job site	$15,000
	Sub Total:	**$245,000**
	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs and cross bracing re-installation as required	$190,000
7	New Glulam Superstructure Elements (girders and lateral bracing)	$100,000
8	New Glulam Deck and Code Compliant Handrail (with cycle rail) System	$290,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$580,000**
	Total:	**$825,000**
	Contingency (15%)	**$123,750**
	GST (10%):	**$94,875**
	Grand Total:	**$1,043,625**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 6 weeks to perform retrofit tasks. This is an estimate only.

9.0 INSPECTION FINDINGS – STONEHENGE CREEK BRIDGE

9.1 Visual Inspection – Stonehenge Creek Bridge

An essential step in evaluating the condition of a structure is undertaking a visual inspection. The visual aspect of the investigation is used to pick up missing or failed elements, cracks and splits, cavitation, connection details, abutment condition, undermining and debris build-up, among other important information. Gathering this information is essential for completing a comprehensive investigation, and taking into account the surroundings in addition to the main structural elements. See **Figure 9-1** through **Figure 9-4** below for a summary of findings as well as the description of each bridge.

Figure 9-1: View of Stonehenge Creek Bridge from Abutment 2 end of the bridge. Abutment 1 (Southern end) is to the right side of the image above. The natural flow of the creek is through span 2 with no water flow at the time of inspection. The configuration and current condition of the bridge is similar to Upper Williams Creek Bridge with the brick pier(s) however the girders are steel plated which is very common for railway bridges. The steel girder bridge is only 3 spans long and approximately 18 metres in length. The bridge piers can be saved for aesthetics.

Figure 9-2: The top image is a view of the bridge looking back towards Armidale. The timber transoms are connected directly to the steel plated girders. There has been erosion/scour at Abutment 2 with many of the transoms missing and large amounts of approach fill missing. Notice the inner guard rail is still intact!!

Figure 9-3: View of the brick Abutment that is approximately 3 metres in height. The steel plated girders bear directly on the brick pier. The girders are lateral supported by transverse and diagonal bracing. The substructure can be preserved.

Figure 9-4: The steel is starting to show signs of corrosion with maintenance required for the steel plated beams. A lightweight deck system on-top of the girders will be the recommended repair solution for this bridge combined with steel repairs.

9.2 Bridge Configuration & Condition State Rating – Stonehenge Creek Bridge

Overall Stonehenge Creek Bridge is in poor condition (CSR of 3) with moderate works required to repurpose the bridge for pedestrian and cycle use. This rating does not speak to the load rating. A load rating of the structure was not completed for this report. This condition rating was based from a very small sample size of data collected and it is highly recommended to conduct a detailed Level 2/3 inspection of the entire bridge. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Section 9.3** below.

See **Table 9-1** below for a breakdown of the condition state rating (CSR) per each of the element types.

Table 9-1: Bridge Configuration & Condition State Rating Table– Stonehenge Creek Bridge

	Element Details						Overall Visual Condition State Rating per Element Type %		
Element	**Size (Width x Depth)**	**Length (m)**	**Typ. Spacings (Centre to Centre)**	**QTY per Span/Bent**	**# Spans/Bents Applicable**	**Total QTY**	**Fair (2)**	**Poor (3)**	**Very Poor (4)**
Brick Pier/Abutment	Approx. 3m high and 1.2m wide	4.5-5m	NA	1	4	4	0%	100%	0%
Girders	770 deep x 340 Flange x 16mm thick plate	6m	2m	2	3	6	0%	100%	0%
Transom (Sleeper)	225 x 125	2.5	650-800mm	12	3	36	10%	40%	50%

9.3 <u>Refurbishment Recommendations & Cost Estimates</u>

Based on the information compiled from the visual inspection, the bridge will require moderate repairs/replacement to repurpose the railway bridge as a rail trail bridge for pedestrian and cycle use. Two (2) options have been developed to refurbish the structure into a rail trail bridge.

Option 1 involves removing the existing railway line and transoms whilst repairing substructure and superstructure elements where required in-situ. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the steel girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam deck with handrail system on top of the repaired piers and girders. Refer to Appendix C for more information on treated glulam products.

All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described in Appendix B.

See below for high level (level D) cost estimates for each of the options mentioned above.

9.3.1 Option 1 - Intermediate Term Refurbishment Cost Estimate (25-50 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Stonehenge Creek Bridge
Option #1 - New Hardwood Deck for 5kPa Loading & 2.5m clear width - Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$15,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$5,000
3	Bridge access (scaffold, ladders)	$5,000
4	Crane / Excavator Hire including demolition	$10,000
5	Shipping material to job site	$2,500
	Sub Total:	**$37,500**
	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs as required	$0
7	Steel Maintenance (girders and lateral bracing)	$20,000
8	New Deck and Code Compliant Handrail (with cycle rail) System	$50,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$70,000**
	Total:	**$107,500**
	Contingency (15%)	**$16,125**
	GST (10%):	**$12,363**
	Grand Total:	**$135,988**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 1 weeks to perform retrofit tasks. This is an estimate only.

9.3.2 Option 2 - Long Term Refurbishment Cost Estimate (75-100 years)

WOOD RESEARCH AND DEVELOPMENT

New England Rail Trail - Stonehenge Creek Bridge
Option #2 - Repair/Replace Substructure and New Glulam Superstructure and Deck for 5kPa Loading & 2.5m clear width
Cost Estimate (Level D)

ITEM	DESCRIPTION	TOTAL
	Engineering & Project Management, Site Set-up & Running Costs & Machinery Hire	
1	Engineering, report writing, CAD drawings, Project Management and Supervision	$15,000
2	Crew Mobilisation, Site establishment, running costs and disestablishment	$5,000
3	Bridge Access (scaffolding)	$5,000
4	Crane / Excavator Hire including demolition	$10,000
5	Shipping material to job site	$2,500
	Sub Total:	**$37,500**

	Supply and Installation	
6	New Substructure Elements including abutment/pier repairs as required	$0
7	Steel Maintenance (girders and lateral bracing)	$20,000
8	New Glulam Deck and Code Compliant Handrail (with cycle rail) System	$50,000
9	Approach Works to be completed by trail contractor	$0
	Sub Total:	**$70,000**

Total:	**$107,500**
Contingency (15%)	**$16,125**
GST (10%):	**$12,363**
Grand Total:	**$135,988**

Additional Notes:
ASSUMES PILES BELOW GROUND AND CONCRETE FOUNDATION ARE GOOD FOR SUPPORTING A 5KPA PEDESTRIAN LOAD.
Estimate includes engineering analysis and sign-off by P.Eng as per the recommendations in the report.
It is anticipated that it will take 1 weeks to perform retrofit tasks. This is an estimate only.

10.0 INSPECTION FINDINGS – CROTTY ROAD – BRICK ARCH OVER BRIDGE

Figure 10-1: View of Crotty Road brick arch overpass bridge. This bridge is located just off the New England Highway and can be a major attraction to the trail given its historic features. The archway under the bridge is in fair to poor condition and with minor maintenance can be restored to accommodate pedestrians walking through.

11.0 CONCLUSION

Wood Research and Development was commissioned by Mike Haliburton Associates to complete a detailed visual inspection and refurbishment options report based on the current condition of the major bridges along the proposed New England Rail Trail (Ben Lomond to Glen Innes Section). The main objective of the investigation was to establish the general condition of the primary structural elements, and to assess what techniques could be utilized to safely repurpose the structure into a rail trail bridge for pedestrian and cyclist use.

The following is a summary of the Condition State Rating (CSR) for each bridge:

1. **Old Ben Lomond Rd Bridge (minor)**
   a. **Substructure CSR 4**
   b. **Superstructure CSR 4**
   c. **Deck CSR 5**
   d. **Overall CSR 4**

2. **Manrowan Creek Bridge (major)**
   a. **Substructure CSR 4**
   b. **Superstructure CSR 4**
   c. **Deck CSR 4**
   d. **Overall CSR 4**

3. **Upper Williams Creek Bridge (major)**
   a. **Substructure CSR 3**
   b. **Superstructure CSR 4**
   c. **Deck CSR 4**
   d. **Overall CSR 4**

4. **Williams Creek Bridge (major)**
   a. **Substructure CSR 4**
   b. **Superstructure CSR 4**
   c. **Deck CSR 4**
   d. **Overall CSR 4**

5. **Beardy Waters Bridge (major)**
   a. **Substructure CSR 4**
   b. **Superstructure CSR 4**
   c. **Deck CSR 4**
   d. **Overall CSR 4**

6. **Stonehenge Creek Bridge (minor)**
   a. **Substructure CSR 3**
   b. **Superstructure CSR 3**
   c. **Deck CSR 3**
   d. **Overall CSR 3**

This rating was based from a small sample size of NDT field data collected and it is highly recommended to conduct a detailed inspection of the entire bridge. See **Figure 11-1** and **Appendix A** for more detail about this technology. This will gain a higher level of accuracy for the recommended repair options listed and costed in **Sections 4.3, 5.3, 6.3, 7.3, 8.3 & 9.3.**

Each bridge differs in configuration and levels of deterioration, requiring varying levels of restoration; however moderate to severe deterioration of the elements is noted in all structures. **Sections 4 to 9** outline the proposed replacement and repair strategies for each bridge. Based on the information compiled from both the visual inspection and brief SWT testing, the bridges will require several repairs/replacement to repurpose the railway bridges as rail trail bridges for pedestrian and cycle use. Two (2) options have been developed to refurbish the structures into a rail trail bridges.

Option 1 involves removing the existing railway line, transoms and deck whilst repairing/replacing substructure and superstructure elements where required with kind for kind elements. A new hardwood deck system with a code compliant handrail and cycle rail system will be fitted on top of the girders utilizing a horizontal connection system that achieves a 25-50 year design life for this option along with a 5kPa load rating.

Option 2 will result in the longest design life (75-100 years) as this option involves installing a new treated glulam superstructure and deck with handrail system on top of the restored existing substructure. Refer to Appendix C for more information on treated glulam products.

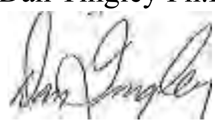
Another option was explored for repurposing these rail trail bridges that utilizes the entire existing structure (minus the ballast, transom and railway line) in its ‘current’ condition with the existing poor (missing) deck planks being replaced and a new code compliant handrail system installed to the exterior girders. Given the very poor condition of most of the elements in all the bridges this option is not viable due to it being structurally unsafe and have a very limited life span with major maintenance costs.

Examples of the recommended refurbishment options can be found in Figures 11-2 to 11-4. Option 2 offers the longest design life and improves the Overall Condition State Rating to 1 based on the following assumptions:

f) Overall Condition State Rating 1 – 100% Remaining Life (80 years)
g) Overall Condition State Rating 2 – 80% Remaining Life (64 years)
h) Overall Condition State Rating 3 – 30% Remaining Life (24 years)
i) Overall Condition State Rating 4 – 5% Remaining Life (4 years)
j) Overall Condition State Rating 5 – 1% Remaining Life (< 2 years)

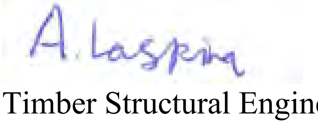
All options include the remaining hardwood elements to be diffused with Borate salt rods to increase the life of the structure by preventing decay as described below in **Appendix B.** Finally, it is highly recommended that all exposed bright wood be treated with Copper Naphthenate and seal end-grain with a paraffin wax sealant.

Dan Tingley Ph.D., P. Eng. (Canada), MIEAust, CPEng, RPEQ



Senior Wood Technology/ Structural Engineer
Wood Research and Development

Andrew La Spina



Timber Structural Engineer
Wood Research and Development

(a)

(b)

Figure 11-1: Photos showing global failure of a timber log girders. Both failures were caused by advanced decay in the ends of the girders and transverse shear failures. The primary cause of this decay was due to vertical fasteners. These failures were found in elements with SWT values in the 3k µs (photos a. above) to 6k µs range (photos b. below). Typically similar bending extreme tensile fibre failures in log girders occur in zones of decay where there are over 2k µs SWT values. Similarly if vast portions of the log girder have SWT values over 3k µs the failures may occur.

Figure 11-2: The above photo series demonstrates a similar repair to the option explored but deemed not viable for this rail trail. The existing railway bridge was left un-touched and a new hardwood deck system with handrails was installed. Six 100mm x 250mm timber joists were placed on top of the existing transoms (rail ties) with a 38-50mm thick hardwood deck installed on top. This option will likely be the lowest cost but also carries the shortest expected lifespan. As seen in the bottom left photo above, one of the girders has failed and fallen out creating a 'weak' point along the bridge. Due to a high residual capacity of timber and the continuous joists, a complete failure of the bridge (span) hasn't occurred yet but is only a matter of time unless extensive maintenance is undertaken.

(a)

(b)

(c)

Figure 11-3: The above photo series demonstrates Option 1 type of fix (hardwood) used for the construction of two Mary to Bay Rail Trail Bridges. Seen above in photo (a) is the construction of a frame bent using an intermediate cap which was installed on top of the existing pile stubs. This allowed the hardwood posts, cross bracing and cap to be installed at the correct reference height. Also note the yellow plugs that indicate that Decaystop® rods have been installed. Photo (b) shows the girders being installed using a horizontal connection system and a rubber liner between the timber girder and concrete pier. In photo (c) the pre-panelised deck is installed along with the modulus handrail and cycle rail system.

Figure 11-4: The photo series above demonstrates Option 2 type of fix that was done for Jimmy Gully Bridge along the BVRT. The existing poor condition superstructure was removed and the piles were repaired with high strength fibre or posted with new section. New glulam back wall, caps, girders and deck system was installed utilising a horizontal connection detail.

Figure 11-5: The repair of Meachams Bridge in Cassowary Coast. The bridge was retrofitted with fibre reinforcement on the bottom of the girders, some corbels and girders were injected with a high strength epoxy. Some piles were also wrapped with high strength fibre and injected with epoxy, then the entire bridge was diffused with borate salt rods to neutralize decay growth.

Figure 11-6: The brick abutments and the hardwood deck and girders at Shannon Road Bridge were in very poor condition with major refurbishments required. The abutment wall was repaired where the mortar was missing due to weathering and scour. The abutment wall was levelled off in preparation for a loadbearing sill pad for the girders. Once the abutments were repaired a new hardwood girder and deck system was lifted into position and the bridge now has a load rating of 15 Tonne.

APPENDIX

Appendix A - Additional Information about Stress Wave Timer Technology

Appendix B – Additional Information about Borate Salt Rod Diffusers

Appendix C – Additional Information about Penta Treated Glulam Timber

Appendix A – Additional Information about Stress Wave Timer Technology

A typical inspection by Wood Research and Development (WRD) includes the use of non-destructive test equipment identified as EPHOD® (Electronic Pulse Highlight and Outline Diagnostic) compression wave technology. The EPHOD® equipment was utilized to complete stress wave measurements along with other WRD techniques to locate internal decay in a non-destructive nature. Stress wave times are recorded on the accessible timber structural elements within the scope of the inspection.

The 'raw' SWT data is the number recorded in the field for each member tested across a measured distance i.e. diameter or width. The 'adjusted' SWT data is calculated using a calibrated 300mm gauge length to standardize the data into categories where it can be analysed based on its magnitude. When the through wave time values (adjusted for a 300mm gauge length, treatment, temperature, submersion or other factors that affect the SWT results such as species) exceed 700 microseconds (µs) but are below 1000µs (shown in yellow) the area measured is capable of carrying its own dead weight and an unknown live load at the localized area where the reading is recovered. When the times exceed 1000µs (shown in red) the element is not capable of carrying its own dead weight at that localized area. Readings in excess of 2200µs are indicative of cavities within the member. When the values reach numbers over 3300µs, the element can no longer support its own dead load and is at risk of failing at any point. The element can often be red with high SWT values and still be in place in the bridge. This doesn't mean the element is sound and the SWT data is wrong. It means that other criteria are impacting the situation such as fasteners which might be holding the element in place even though it is red throughout. **Figure 11-7** shows the colour scheme correlating to the SWT readings utilized in this report.

Readings are recovered in a clock-like format to ensure no cavity or deteriorated timber was missed. These directions typically include a 2/8, 3/9 and 4/10 reading. **Figure 11-6** below depicts the typical SWT configuration for round and rectangular timber cross sections.

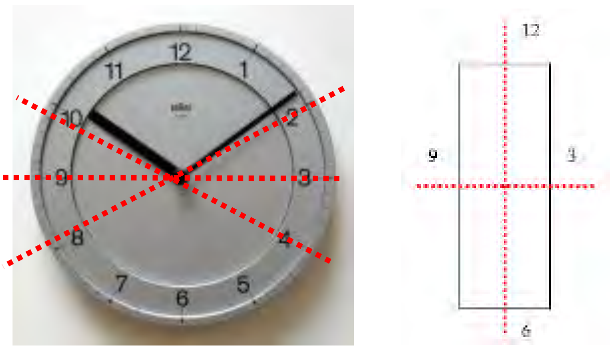


Figure 11-7: SWT configurations for round and rectangular timber

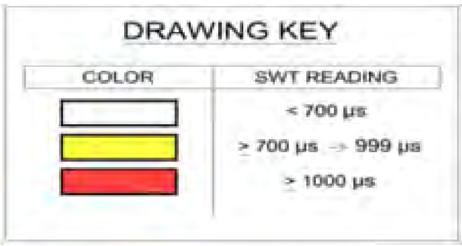


Figure 11-8: Stress Wave Timer Results Drawing Key

Appendix B – Additional Information about Borate Salt Rod Diffusers

Borate Salt Rod Diffusers:

Another complimentary method of controlling decay, should it commence due to the less frequent occurrence of ideal decay progression conditions, is to install Borate salt rod diffusers. These are included as an additional option at this stage due to budget constraints and can be installed at a later date during maintenance works to increase the longevity of the structures. The vitrified glass borate salt rod upon reaching a moisture content of approximately 22%, emits an alkaline brine throughout the wood cellular structure up to a radius of 150 mm from the rod. This brine neutralises the acidic enzyme that is secreted by a growing decay colony. Without the enzyme chemically attacking the cellular structure of the wood, decay cannot proceed. If diffusers are installed into the timber structure as insurance against the occurrence of ideal decay producing conditions and these diffusers are maintained throughout the life of the structure, then the achievement of the design life requirements for the structures proposed, is Guaranteed. Australian hardwoods, particularly the class 1 and 2 durability timbers can have a significantly longer life expectancy than previously thought based on the former statistical average element lifetimes.

Figure 11-9: Diffuser (Borate Salt) rods are installed in the remaining hardwood elements in order to resist further deterioration of the timber caused by fungi growth. Note the red bungs are the decay 'hotspots' where the timber is prone to have a higher moisture content. These holes are required to be checked for rod depletion as per the issued maintenance manual (typically every 2-5 years depending on environmental conditions).

Appendix C – Additional Information about Penta Treated Glulam Timber

Glulam timber manufactured from a wide range of timber species that is treated with Pentachlorophenol (Penta), a synthetic preservative treatment that is used only for heavy construction timbers such as railway ties, utility poles and bridge timbers. Penta, being an oil-based preservative treatment, has low solubility and is water repellent therefore has a very low leach rate.

Over 60 years ago, Pentachlorophenol was formulated to contain high levels of toxicity to act as a mass defoliant. Produced as polychlorinated dioxins 2,3,7,8-T or 2,4,5-T, Pentachlorophenol was highly toxic and ultimately dangerous to humans. These formulations are now banned or heavily restricted and the Pentachlorophenol formulation used to preservative-treat timber has a completely different dioxin with a much lower toxicity but still must be handled with care – same as for any treated timber. By minimising direct contact with immediate water environment, this significantly reduces impact on the environment. All glulam members are pre-fabricated in the factory where it is cut to length and all holes drilled before treatment. Where possible; avoid any cutting, drilling of treated timber whether in the factory or on site however, when it is required, appropriate PPE must be worn. Heavy duty wood preservatives, such as Penta, are applied to wood in specialised high pressure treatment cylinders at wood treatment facilities. With oil-borne preservatives such as Penta, bleeding after application can occur. To reduce this, timbers are vacuum-treated, extracting excess treatment solution that has not been fixed in the wood. Performing a double vacuum treatment is a standard practice for penta-treated wood intended for use in sensitive environments, such as open water locations. These vacuuming procedures reduce the chance that the Penta and carrier solution will migrate into the environment through water runoff. With the majority of penta-treated glulam being used in the superstructure of bridges, this minimising the contact of penta-treated glulam to the environment.

Over the last 30 years, there have been multiple examinations by US, Canadian and private agencies of treated timber's environmental effects on organisms and surrounds. Through due diligence, Penta is the right product to treat its glulam beams and will not adversely impact the environment. Penta readily degrades in the environment by chemical, microbiological, photolysis and photochemical processes. Photolysis appears to be a significant process for degradation since a measured photolysis half-life has been reported to be 52 minutes in running water under sunlight.

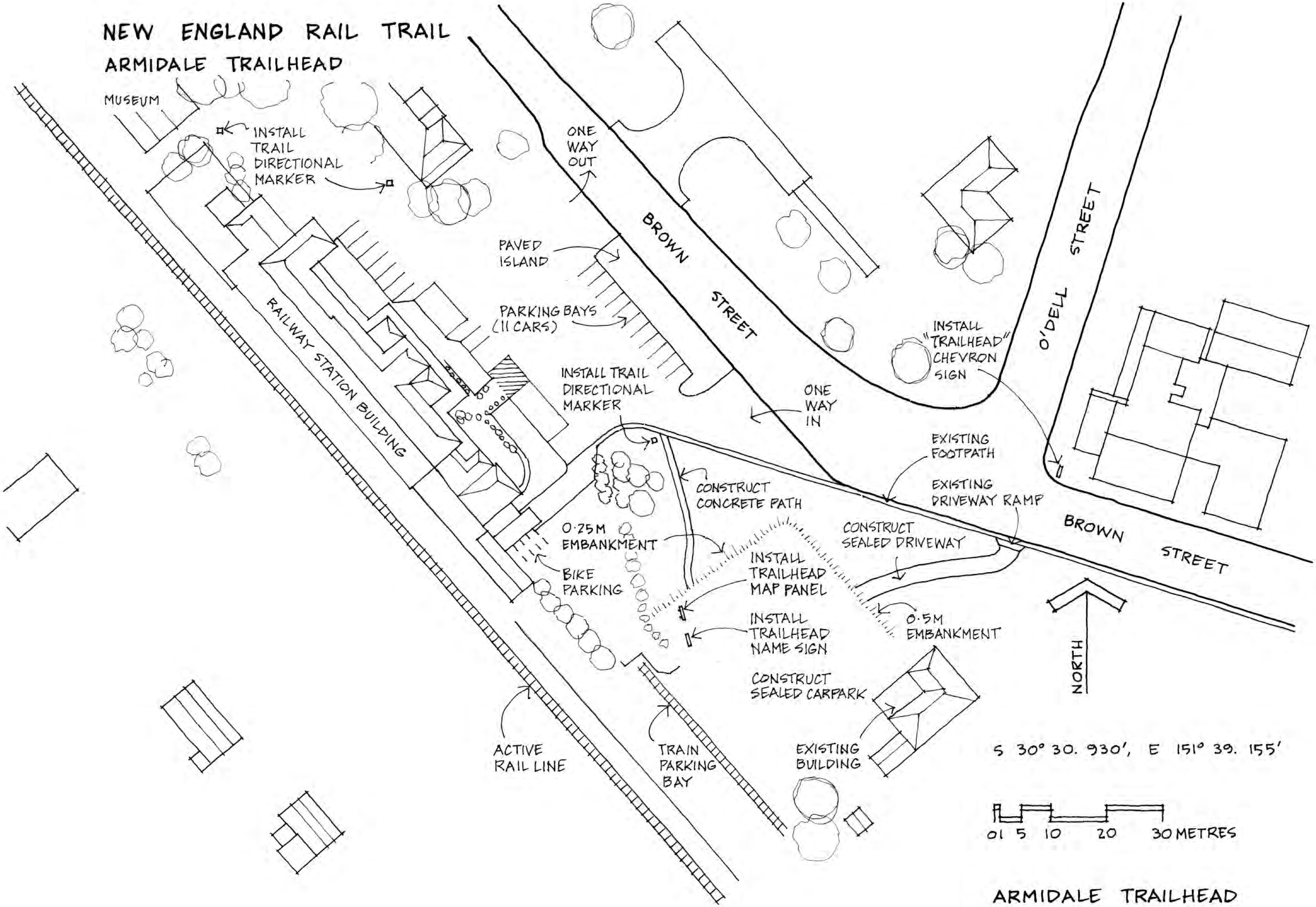
Glulam Elements – Material Specification Summary	
Material	Engineered Timber - Glulam
Typical Timber Species	Slash Pine, Douglas Fir, Southern Yellow Pine, Radiata Pine
Treatment	Pentachlorophenol (member incised, holes pre-drilled and pressure treated)
Treatment Concentration	9 kg/m^3
Weight of Timber (Density)	550-700 kg/m^3 (depending on timber species and strength grade)
Design Life	75-100 years (with minimal to no maintenance required)
Typically Panel Size	0.65m long x 2.5m wide x 80mm thick (can vary pending on design specifications)
Load Capacity	From 1kPa to 5kPa to SM1600 loading

Figure 11-10: The photo series above demonstrates an Option 2 type of fix that was done for Jimmy Gully Bridge along the BVRT. The existing poor condition superstructure was removed and the piles were repaired or posted with new section. New glulam back wall, caps, girders and deck system was installed utilising a horizontal connection detail.

APPENDIX 4: TRAILHEAD DRAWINGS

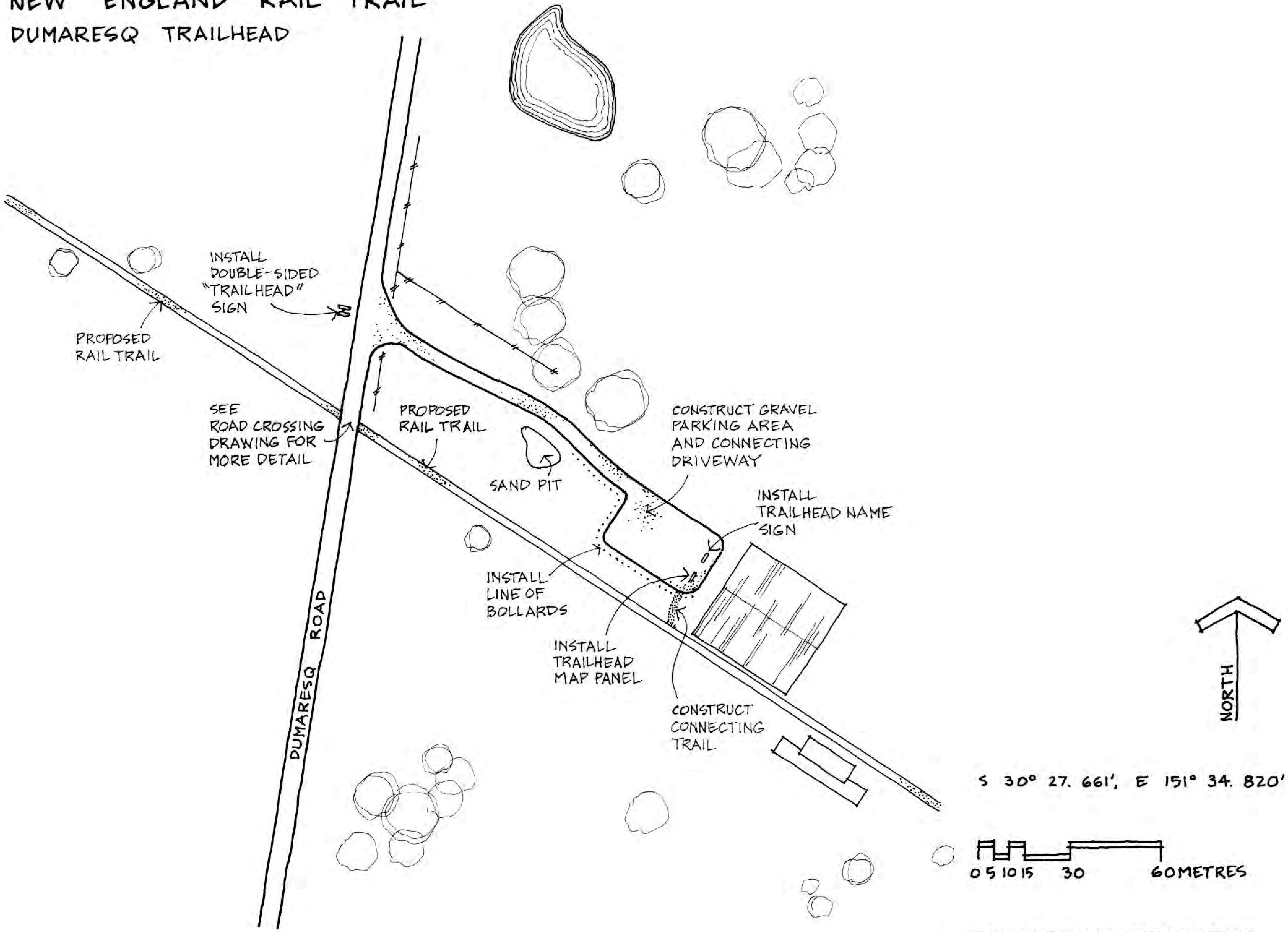
NEW ENGLAND RAIL TRAIL

ARMIDALE TRAILHEAD



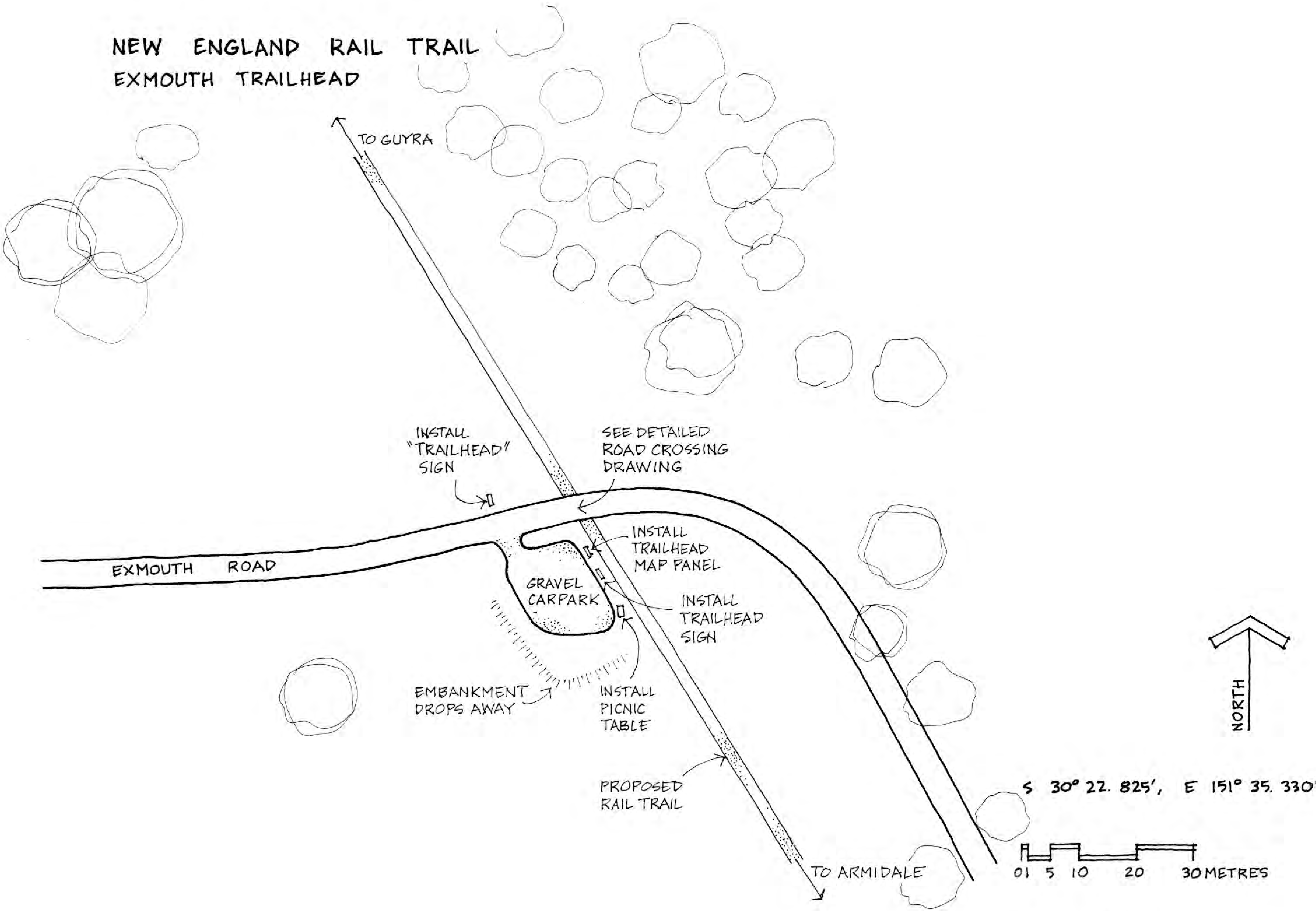
ARMIDALE TRAILHEAD

NEW ENGLAND RAIL TRAIL
DUMARESQ TRAILHEAD



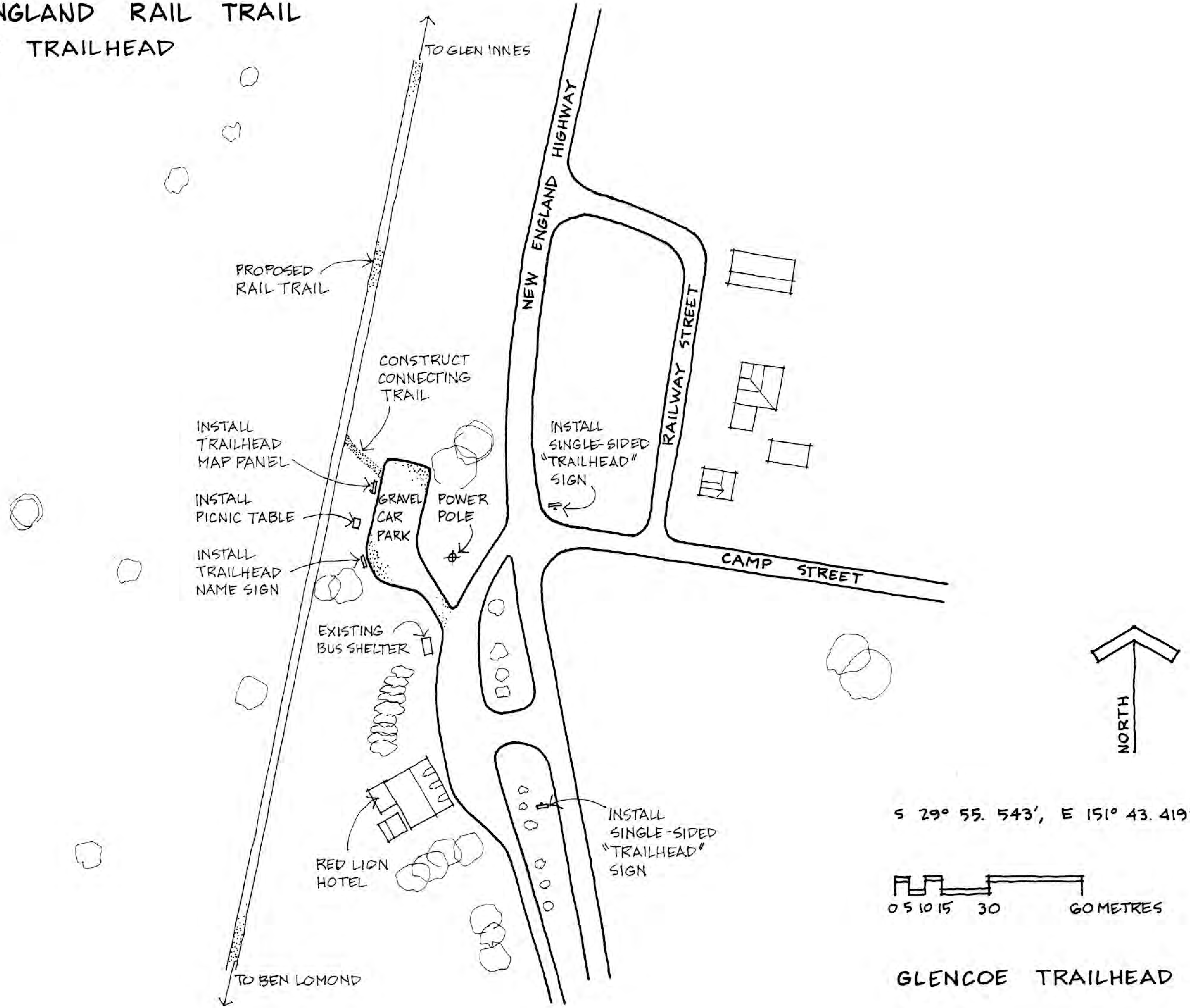
DUMARESQ TRAILHEAD

NEW ENGLAND RAIL TRAIL
EXMOUTH TRAILHEAD



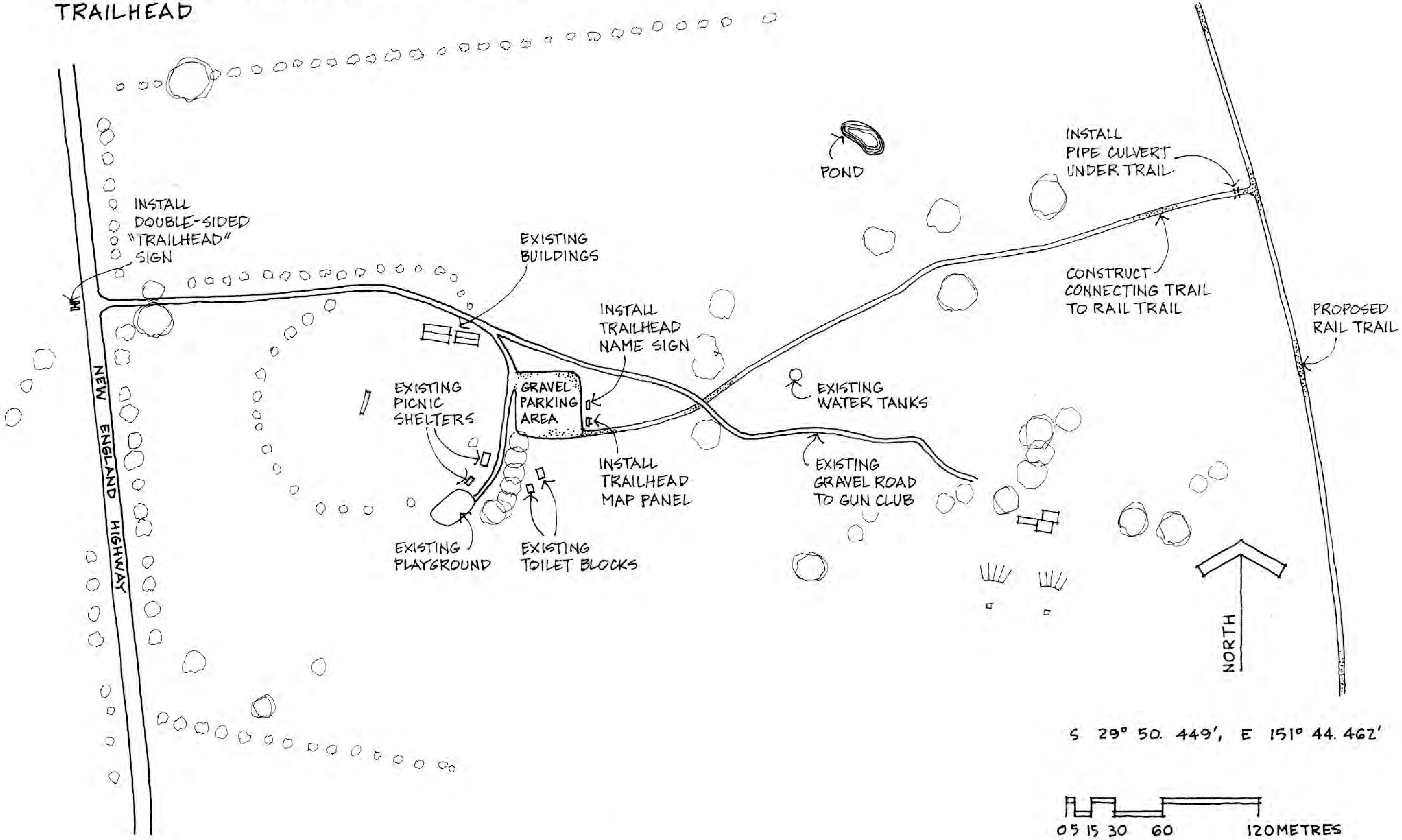
EXMOUTH TRAILHEAD

NEW ENGLAND RAIL TRAIL
GLENCOE TRAILHEAD



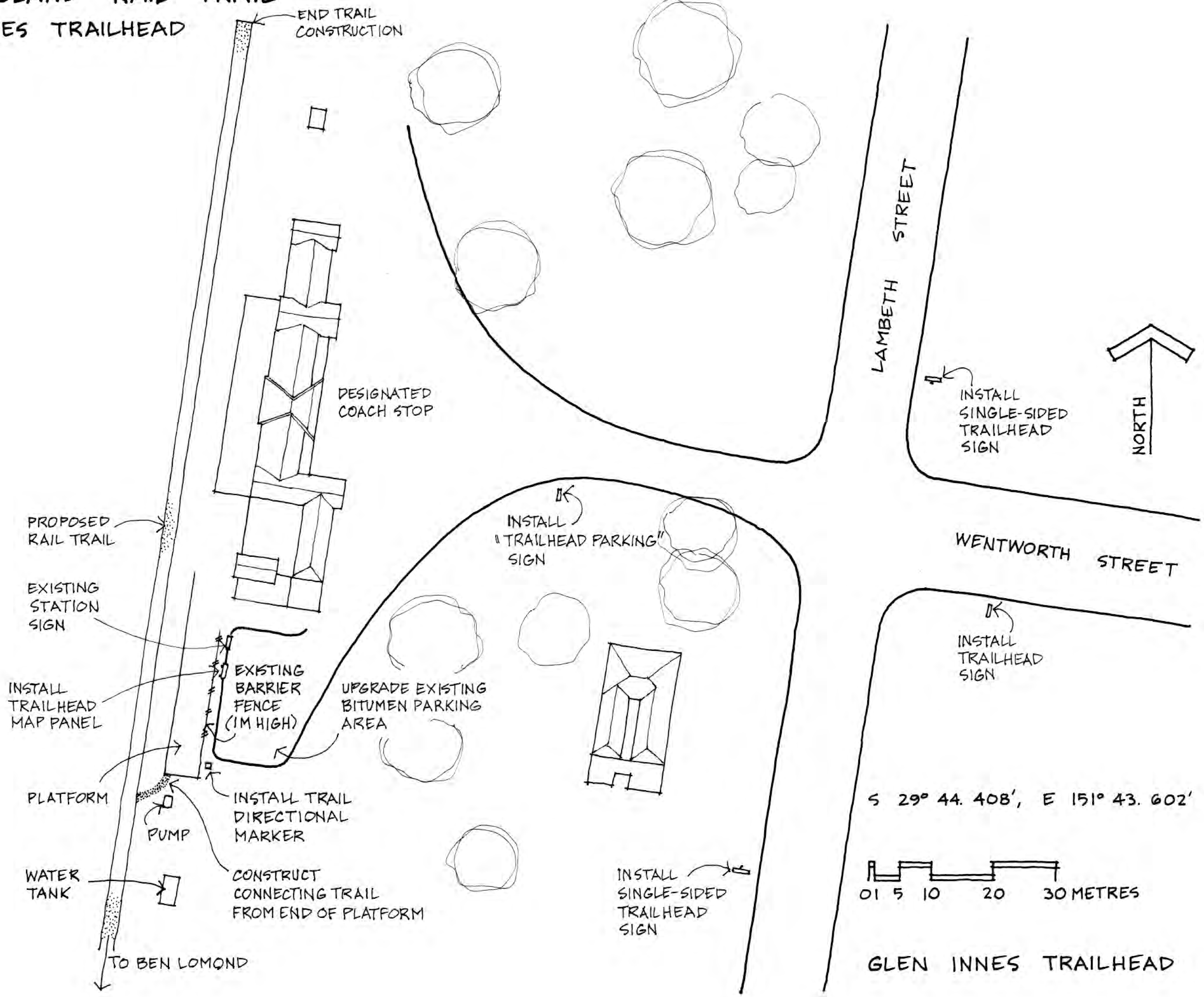
GLENCOE TRAILHEAD

NEW ENGLAND RAIL TRAIL
STONEHENGE RECREATION RESERVE
TRAILHEAD



STONEHENGE RECREATION RESERVE TRAILHEAD

NEW ENGLAND RAIL TRAIL
GLEN INNES TRAILHEAD



GLEN INNES TRAILHEAD

APPENDIX 5: TRAIL MAINTENANCE CHECKLIST: AN EXAMPLE

KEP TRACK MAINTENANCE CHECKLIST

The checklist that follows has been designed to be copied before each regular inspection, filled out and filed for future reference. It assumes the inspection will commence at Mt Helena and proceed in an easterly direction towards Wooroloo. This is an essential component of the maintenance program.

KEP TRACK (Mt Helena to Wooroloo) - MAINTENANCE CHECKLIST

Inspection Date (circle a year and tick one box):

☐ Jan 2005/6/7	☐ Feb 2005/6/7	☐ Mar. 2005/6/7	☐ Apr 2005/6/7
☐ May 2005/6/7	☐ Jun 2005/6/7	☐ Jul 2005/6/7	☐ Aug 2004/5/6
☐ Sep 2004/5/6	☐ Oct 2004/5/6	☐ Nov. 2004/5/6	☐ Dec 2004/5/6

Actual Date: ______________________

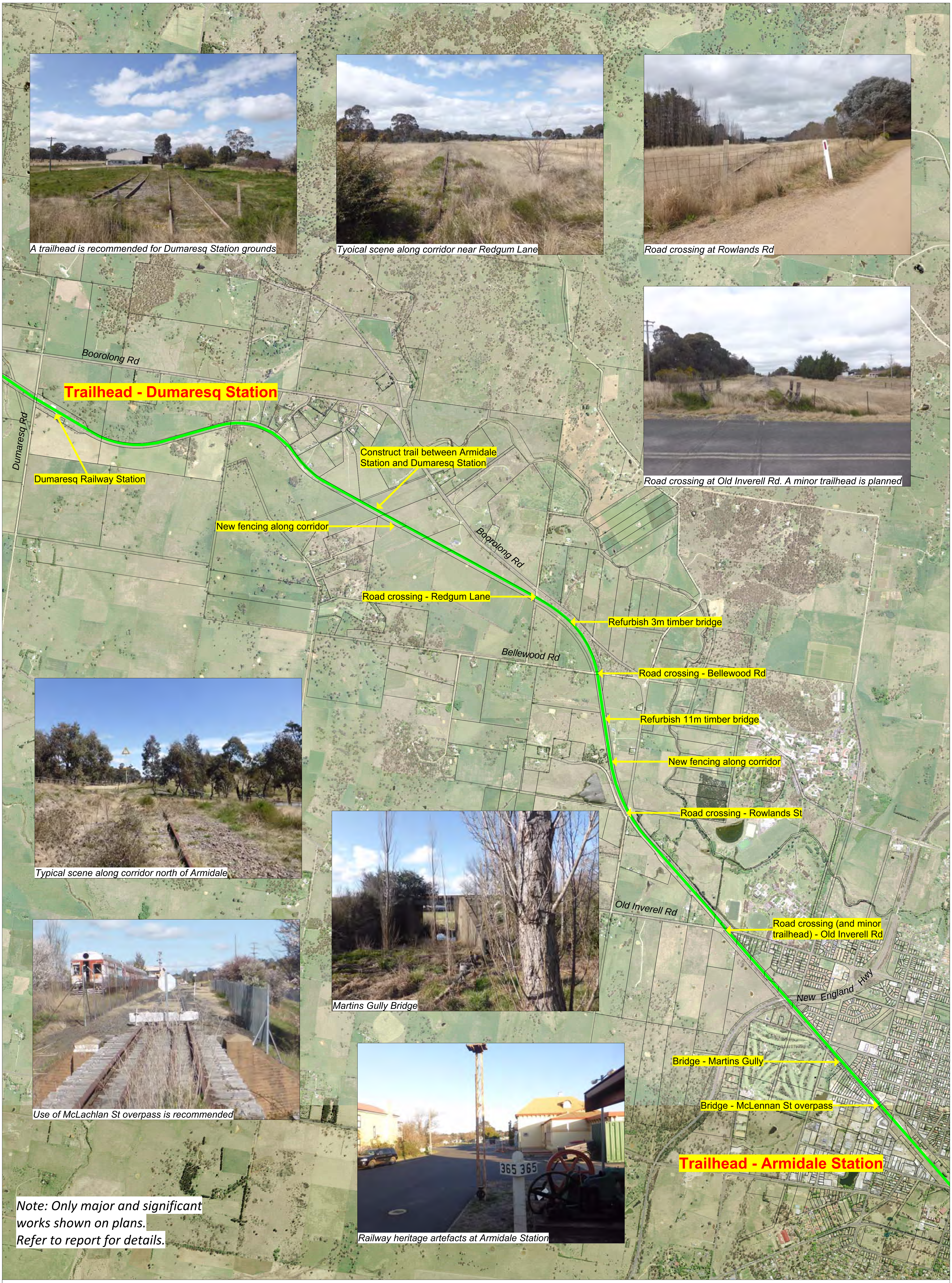
Person undertaking inspection: ______________________________ Signature:

LOCATION	ACTION REQUIRED	TICK IF OKAY	ACTION TAKEN (IF ANY)
Sawyers Road Crossing in Mt Helena	• Check gate west side • Check directional markers • Check totems and signage • Check promotional signage		
Johnston Street (Mt Helena)	• Check gate west side • Check directional markers • Check totems and signage		
Lion St crossing	• Check gates both sides • Check interpretive sign (north west corner) • Check directional markers • Check totems and signage • Check promotional signage		
Exit from Eastern Hills High School (crossing)	• Check gate east side • Check directional markers • Check totems and signage • Check interpretive sign (opposite Sime Rd)		
Thomas / Elliot road crossing	• Check gates both sides • Check directional markers • Check totems and signage • Check promotional signage • Check interpretive sign (opposite booster station)		
Chidlow Reserve	• Check interpretive signs (at turnoff to Lake Leschenaultia;opposite standpipe; opposite stone building; at old interpretive shelter) • Check condition of new trail through reserve		

KEP TRACK (Mt Helena to Wooroloo) - MAINTENANCE CHECKLIST

LOCATION	ACTION REQUIRED	TICK IF OKAY	ACTION TAKEN (IF ANY)
Old Northam Rd (Chidlow)	• Check gate east side • Check directional markers • Check totems and signage • Check promotional signage • Check culvert west side • Check ramps • Check interpretive sign (mid point between Old Northam Rd & Ash Rd)		
Ash Rd crossing	• Check gates both sides • Check directional markers • Check totems and signage • Check promotional signage		
Doconing Rd crossing	• Check gates both sides • Check directional markers • Check totems and signage • Check promotional signage • Check interpretive sign (150 metres east of crossing)		
Old Northam Rd crossing	• Check gates both sides • Check directional markers • Check totems and signage • Check promotional signage • Check culverts (both sides) • Check interpretive sign (SW corner)		
Entrance to horse trials paddocks	• Check gates • Check directional markers • Check totems and signage • Check road warning signs		
Government Rd crossing	• Check gates both sides • Check directional markers • Check totems and signage • Check new 40 metre section of trail at road crossing		
Government Road to Green St	• Check interpretive sign (where pipeline crosses trail) • Check interpretive sign (opposite Jason St)		
Green Street	• Check gates both sides • Check directional markers • Check totems and signage		
Any additional work required?			
Hazard Inspection	Whole trail - annually		
Annual budget allocation	Discuss with staff		

APPENDIX 6: RAIL TRAIL PLANS 1 – 6



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Mike Halliburton Associates

October 2020

New England Rail Trail

Armidale to Dumaresq

ARMIDALE Regional Council

GLEN INNES SEVERN COUNCIL

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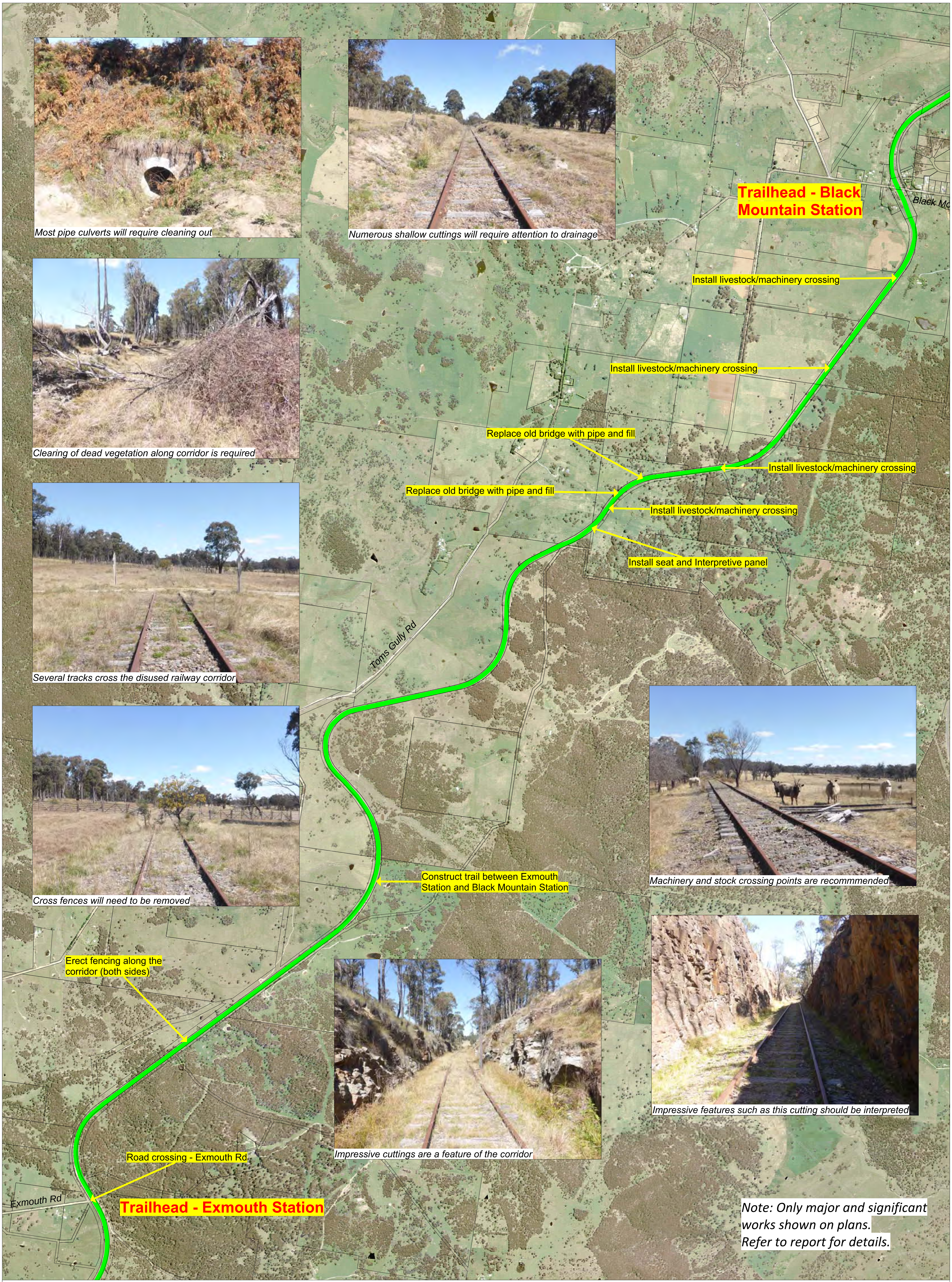
October 2020

New England Rail Trail

Dumaresq to Exmouth

ARMIDALE Regional Council

GLEN INNES SEVERN COUNCIL



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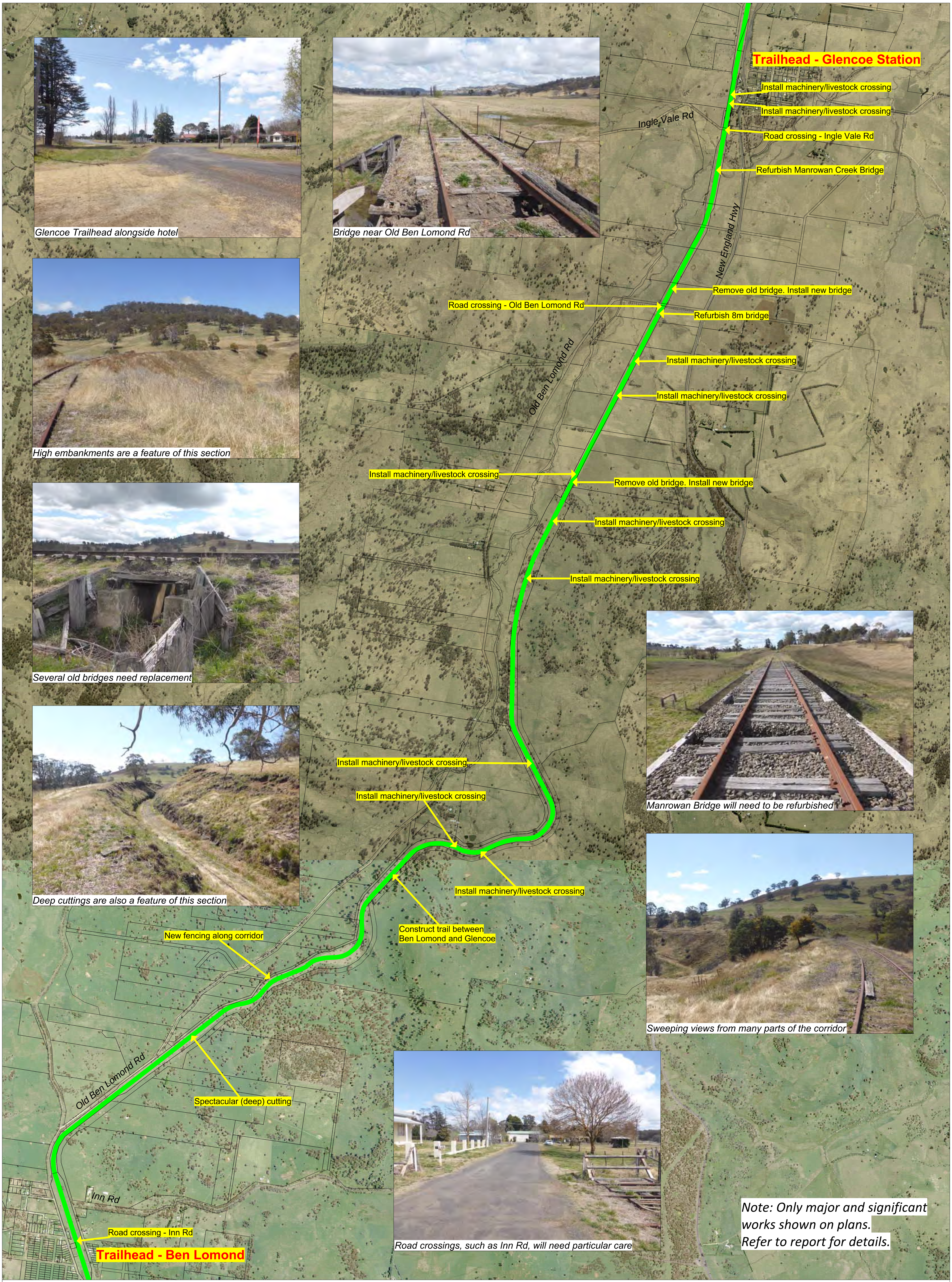
New England Rail Trail

Exmouth to Black Mountain

ARMIDALE Regional Council

GLEN INNES SEVERN COUNCIL



Glencoe Trailhead alongside hotel

Bridge near Old Ben Lomond Rd

High embankments are a feature of this section

Several old bridges need replacement

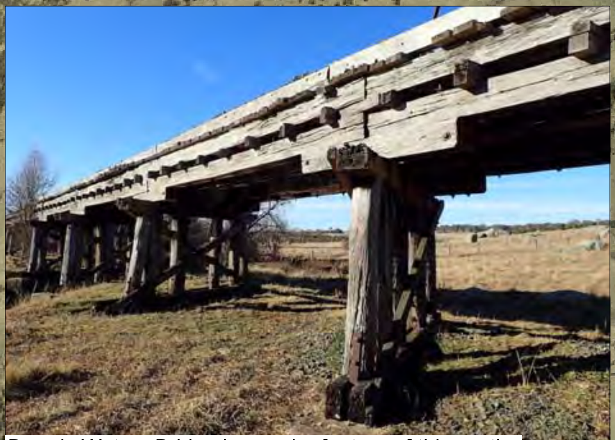
Deep cuttings are also a feature of this section

Manrowan Bridge will need to be refurbished

Sweeping views from many parts of the corridor

Road crossings, such as Inn Rd, will need particular care

Existing facilities at Stonehenge Recreation Reserve



Beardy Waters Bridge is a major feature of this section

Several significant bridges will need refurbishment

Several small timber culverts will need repair

Disused railway corridor near Munsies Road

The two underpasses under the New England Highway

One of many old timber bridges along the corridor

Typical scene along parts of the disused corridor

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Glencoe to Stonehenge

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Proposed trailhead site adjacent to Glen Innes Station

Oliver Road crossing just south of Glen Innes

Interesting arch road bridge over corridor at Crotty Road

Sections of the corridor pass through rocky outcrops

The old timber bridge across Red Bank Creek

Stonehenge Bridge is solidly constructed

The remains of Stonehenge Station platform

Crossing of New England Highway must be treated carefully

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Stonehenge to Glen Innes

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