Queensbury Tunnel Greenway

Feasibility Study

25 January 2024

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29/10/2021	-	1	Updates to Tables in sections 7,8, Appendix H.	KA/AB
04/10/2022	1	2	Edits to include stakeholder feedback, cost risk and uncertainty treatment, and updated economic analysis. Additional appendices inserted: C-General Arrangement Drawings and H- Stakeholder Feedback	KA/AB/GG
04/10/2023	2	3	Additional caveats provided within economic commentary, as requested by DfT & CBMDC. Minor formatting alterations	KA/GG/MB
25/01/2024	3	4	Approved executive summary added	KA/MB

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Executive Summary

This study was commissioned by City of Bradford Metropolitan District Council to investigate the viability of bringing Queensbury Tunnel (the Tunnel) into use for walking, wheeling and cycling as part of a network of active travel routes.

The study presents three possible routes between Keighley, Halifax, and Bradford, each developed to concept design level. For each route, options incorporating and excluding the Tunnel have been compared. Routes excluding the tunnel are termed the 'Alpine Option'.

There are therefore six routes in total:

- Most Advantageous and Attractive: Tunnel Option
- Most Advantageous and Attractive: Alpine Option
- Next Preferred: Tunnel Option
- Next Preferred: Alpine Option
- Low Cost Alternative: Tunnel Option
- Low Cost Alternative: Alpine Option

The study presents the development of the routes from the initial route option appraisal process through to concept design and costs for the final alignments. A Highways-England-commissioned report (Queensbury Tunnel Study, Jacobs, 13 April 2021), which presents a technical assessment of the works required to stabilise the Tunnel, was used to inform cost estimates for its restoration. Interim development reports, general arrangements and full estimated costs for the concept level designs are included in the appendices, along with a designer's risk register and ecological desk study.

The six routes are compared over five non-economic criteria: user experience, strategic success, risks to delivery, reliance of third-party schemes, and stakeholder satisfaction. An accompanying economic appraisal assesses the Benefit Cost Ratio (BCR), Tourism and Heritage benefits, and Carbon Impact of each route.

Usage figures for input into the economic appraisal are estimated using both the Department for Transport (DfT) Capital Fund Uplift Tool (CFUT) and past evidence from case studies of similar greenway and tunnel schemes. Comparative results for each approach are presented throughout. BCRs are calculated using the DfT Active Mode Appraisal Toolkit (AMAT). Tourism benefits are calculated using the Leisure Cycling and Leisure Walking Expenditure models1. Heritage benefits are calculated by switching analysis. Carbon impacts are estimated using the greenhouse gas emissions output from the AMAT. Sensitivity testing is carried out for all Tunnel options, by varying the estimated costs of works to bring Queensbury Tunnel back into use. A full explanation of the novel economic appraisal methodology is provided in the appendices.

Results of the economic appraisal show that BCRs for the six routes vary from 2.82 (High) to 1.50 (Low). Comparison of the CFUT and case study inputs do not reveal a consistent difference in outcomes between them. Tourism benefits are assessed to be between £5.98 million and £9.95 million. Tourism benefits are consistently higher when assessed using CFUT inputs. Per-trip heritage value calculated for the Tunnel options range from £13 to £33. The summarised and full results of the economic appraisal are presented in Chapter 7 and the appendices respectively.

Sensitivity testing is performed to assess how BCR would change under various circumstances. For the purposes of the sensitivity testing, the Most Advantageous and Attractive: Tunnel Option with case study uplifts is used as the benchmark case. Sensitivity testing shows that for the BCR to reduce to 1, present value costs for the route would need to increase by 182%. Sensitivity to baseline usage was also examined and is reported below.

The economic appraisal demonstrates that while the Most Advantageous and Attractive: Tunnel Option is the most expensive to deliver, it ranks highest in terms of value for money, using case study uplifts, and Tourism benefits. It also ranks highest when assessed against the five non-economic criteria. However, the Next Preferred Alpine Option and Low Cost and Quickest to Deliver Alpine Option have the highest value for money using the CFUT inputs and these options are also the cheapest to deliver. It is Sustrans' assessment that the Alpine Option for each route is valuable for the purposes of comparison but would in practice be a highly compromised solution in terms of level of service for users and would not deliver the heritage benefits of the tunnel.

A study of this complexity inevitably has limitations. The following limitations are identified across the analysis:

- There are no case studies to use as a direct comparator for tunnels of significant length used as walking and cycling routes in the UK. There is therefore a high level of uncertainty when using case study uplifts.
- Cost uncertainties are present due to expected unforeseen construction costs and known exclusions. Known exclusions include geotechnical and drainage works at Tunnel portals, and excavation and removal of material from the submerged Tunnel section. Cost uncertainties, and effects of inflation on costs were managed through sensitivity testing (described in Chapter 6) in agreement with CBMDC and DfT.
- Any baseline usage estimates have a level of uncertainty inherent, particularly as the tunnel alignment does not currently exist. The baseline estimates are based on population data, data from the National Travel Survey, and other assumptions.
- There is uncertainty around the assumption that between 20-50% of cycling and walking trips for people within 3.6 miles of the scheme would take place along the proposed routes. The assumptions used to generate the percentage of leisure journeys that would use the alignment are unevidenced estimates. These percentages were based on the lack of suitable infrastructure or other options for recreational walking and cycling along most of the proposed routes, especially in the more rural areas.
- The BCRs are dependent on the overall change in usage from baseline. For the BCR for the Most Advantageous and Attractive: Tunnel Option scenario to fall below 1, baseline usage would have to decrease by a factor of 2.8 (with the associated reduction in uplift).

In conclusion to the study, Sustrans summarises this complex and unique technical exercise and makes a recommendation from its position as a UK-wide charity. It must be acknowledged that DfT and CBMDC in particular have much greater weight of responsibility in assessing the significant risks and uncertainties that remain with this aspirational project such as:

- Concerns of securing access to the Tunnel, particularly from the south side
- The significant revenue cost exposure to the future owner of the Tunnel
- The delivery costs of the project will likely continue to rise due to inflation in the years it may take to prioritise the necessary funding.

1. Introduction

Queensbury Tunnel is a 1.4 mile long masonry and brick arch tunnel, passing under the village of Queensbury, Bradford. The southern portal of the tunnel is located in Holmfield, northern Halifax. The northern portal is located just off the Great Northern Railway Trail, near the foot of Station Road. The viability of Queensbury Tunnel as a possible cycling and walking route has been a point of focus for campaign groups, Highways England's (now National Highways) Historical Railways Estate and national and local government for a number of years.

In July 2020 the Secretary of State for Transport announced funding towards a package of studies to be undertaken into the potential for retaining Queensbury Tunnel for use within a network of cycling and walking routes. City of Bradford Metropolitan District Council (CBMDC) commissioned Jacobs to produce a technical study to assess the remediation works required to secure Queensbury Tunnel to support a walking and cycling route. Sustrans were commissioned to establish a maximum of three viable sustainable transport routes both incorporating and excluding Queensbury Tunnel, that provide sustainable connectivity between Bradford, Keighley and Halifax. This study is the outcome of the Sustrans commission and should be considered alongside the Jacobs technical remediation study.

1.1. Study Purpose

Sustrans' 2021 commission builds upon the previous report 'Queensbury Tunnel: Estimating the economic impact of reopening walking and cycling routes around Queensbury Tunnel' (June 2017).

This study presents three viable sustainable transport routes between Keighley, Halifax and Bradford, representing a Most Advantageous and Attractive option, a Next Preferred option, and a Low Cost alternative. For each of these routes, options incorporating and excluding Queensbury Tunnel have been developed to concept design level. The study provides information about the context against which the routes have been developed, the design methodology used to develop the routes, and details of the proposed interventions along each of the routes. Costs from the options are used to inform comparison of the routes using the Active Mode Appraisal Toolkit (AMAT).

AMAT provides a measure of the 'Value for Money' of a proposed intervention, in the form of a benefit - cost ratio (BCR). AMAT is a spreadsheet-based tool published by the Department for Transport (DfT) that enables the assessment and monetisation of the overall benefits and costs of proposed walking and cycling interventions. By quantifying the key impacts of a proposed intervention, AMAT provides as full a view as possible about impacts on transport users, the environment, society and the economy.

Using AMAT, this study calculates the Present Value Benefits (PVB) and Present Value Costs (PVC) of the proposed walking or cycling infrastructure for each route option, using a number of inputs about walking and cycling usage. The ratio of the Present Value Benefits (PVB) and Present Value Costs

(PVC) gives the Benefit-Cost Ratio (BCR) of the intervention. BCRs for each route are presented. Other potential economic impacts of the routes that are not included in the AMAT are also presented.

The outcome of the economic appraisal and consideration of the wider impacts of each route are discussed. A recommendation is put forward for consideration by the Client and Project Board, based on the findings of the study.

1.2. Study Structure

This study has been structured into the following sections:

- Chapter 1: Introduction
- Chapter 2: Strategic Context
- Chapter 3: Popular Context
- Chapter 4: Initial Option Appraisal
- Chapter 5: Final alignments
- Chapter 6: Route Options
- Chapter 7: Economic Appraisal Summary
- Chapter 8: Summary and recommendation

The following Appendices are also provided:

- Appendix A: Corridor & Alignment Appraisal
- Appendix B: Preferred Alignments Report
- Appendix C: General Arrangement Drawings
- Appendix D: Designers Risk Register
- Appendix E: Cost Estimates & Design Schedule
- Appendix F: Project Risk Register
- Appendix G: Ecological Desk Study
- Appendix H: Stakeholder Feedback
- Appendix I: Design Decision Log
- Appendix J: Economic Appraisal Methodology

2. Strategic Context

Provision of a cycling and walking route connecting Bradford, Halifax and Keighley has the potential to contribute to numerous strategic objectives at national, regional and local levels. This chapter reviews relevant policy to identify how such a route would contribute to stated strategic objectives. It then sets out the study objectives as based on the review and introduces the study area. Finally, a series of previous studies examining the technical and economic potential to use Queensbury Tunnel to house a cycling and walking route are reviewed.

2.1. Strategy & Policy Review

Table 1 and Table 2 set out a summary of the policies and strategies considered in the review. A discussion of how the scheme contributes to objectives and aspirations outlined in the documents follows.

Table 1: Summary of national policies and strategies relevant to the current study

National Level		
Ref:	**Policy and Strategy Document**	**Details of Policy and Strategy**
N1	Creating Growth, Cutting Carbon – Making Sustainable Local Transport Happen, (January 2011)[i]	This White Paper sets out the government's vision for a: "Transport system that is an engine for economic growth, but one that is also greener and safer and improves quality of life in our communities." The paper highlights the need to make transport choices that support society as a whole, as well as needing to reduce our carbon emissions to meet national commitments.
N2	Cycling and Walking Investment Strategy, (April 2017)[ii]	The vision of the strategy is to make cycling and walking the natural choices for shorter journeys, or as part of a longer journey. The strategy aims to support building a society that works for all and enables more people to have access to safe, attractive routes for cycling and walking by 2040. These routes should be reliable for travel for short journeys, or to form part of a longer journey.
N3	Transport Investment Strategy, (July 2017)[iii]	The strategy focuses on the need to develop an integrated transport network that underpins our economy. The document identifies that at a local level, people need to access employment centres and vital services. On a national scale, people need to travel between cities and international gateways as part of a cohesive, well-integrated national network.
N4	Gear Change: A bold vision for cycling and walking, (July 2020)[iv]	This plan describes the vision to make England a great walking and cycling nation. It sets out the actions required at all levels of government to make this a reality, grouped under four themes: better streets for cycling and people; cycling and walking at the heart of decision-making; empowering and encouraging local authorities; and enabling people to cycle and protecting them when they do. It includes a commitment to improve the National Cycle Network (NCN).
N5	Decarbonising transport: a better, greener Britain, (July 2021)[v]	The plan sets out the government's commitments and actions needed to decarbonise the entire transport system in the UK by 2050. It seeks to make public transport, cycling and walking the natural first choice for all who can take it. Measures used for decarbonisation should also deliver wider benefits such as improving air quality, noise, health, reducing congestion and delivering high-quality jobs and growth for everyone across the UK.

Table 2: Summary of regional and local policies and strategies relevant to the current study

Regional Level		
Ref:	**Policy and Strategy Document**	**Details of Policy and Strategy**
R1	Transport Strategy 2040, (August 2017)[vi]	The vision of the strategy is to enhance business success and people's lives by providing modern, world-class, well-connected transport that makes travel around West Yorkshire easy and reliable. Key objectives to be achieved are to create a more reliable, less congested, better connected transport network; have a positive impact on our built and natural environment; and put people first to create a strong sense of place. The Transport Strategy replaced the West Yorkshire Local Transport Plan (2011-2026), published in 2011.
R2	West Yorkshire Strategic Economic Framework, (September 2020)[vii]	The vision set out in the Framework is for West Yorkshire to be recognised globally as a place with a strong, successful economy where everyone can build great businesses, careers and lives supported by a superb environment and world-class infrastructure. In order to achieve this, it establishes the following investment and decision-making priorities: boosting productivity, enabling inclusive growth, tackling the climate emergency, delivering 21st century transport, and securing money and powers.
R3	West Yorkshire Connectivity Infrastructure Plan, (January 2021, draft for engagement)[viii]	As an extension of West Yorkshire's Transport Strategy 2040, the Plan sets out the proposed delivery pipeline of infrastructure improvements. The aim is to better connect all places, communities and economic assets, within the region and beyond. It focuses on a sustainable future, putting walking, cycling and green public transport infrastructure, including bus, rail and Mass Transit, at the top of the investment priorities.
R4	West Yorkshire Mass Transit Vision 2040, (January 2021, draft for engagement)[ix]	Sets out a vision for Mass Transit as part of an integrated transport system for West Yorkshire. The vision describes Mass Transit contributing to a low-carbon transport system, rebalanced economy, improved quality of life, and inclusive and sustainable development and growth in West Yorkshire. Various options for Mass Transit vehicles are presented. Identifies an opportunity for Mass Transit between Bradford and Halifax. States that options to use Queensbury Tunnel for Mass Transit will be considered.
Local Level		
Ref:	**Policy and Strategy Document**	**Details of Policy and Strategy**
L1	Bradford District Cycle Strategy 2016-2026, (2016)[x]	Its vision is to make Bradford District a place where cycling is naturally part of everyone's daily life. The strategy aims to continue to improve the environment for cycling, provide greater encouragement for people to cycle, and to improve engagement between partners involved in cycling to ensure people are aware of their cycling opportunities. The headline targets for 2026 include cycling investment, delivery of innovative cycle projects, increasing the share of commuting by bike, making the cycle network attractive and accessible for all, and increasing people's confidence and safety in cycling.
L2	Calderdale Transport Strategy 2016-2031, (2016)[xi]	The strategy envisions that by 2031 Calderdale's transport system underpins economic prosperity, high rates of productivity, a dynamic labour market, social cohesion and a healthy environment. The three central drivers of achieving this vision are enabling growth, improving connectivity, and enhancing the environment and people's quality of life. It aims for zero net growth in car trips by 2026 and sets the targets for trip increases by bus (+25%), rail (+50%), walking (+50%) and cycling (+100%).
L3	Connecting people and place for better health and wellbeing: A joint Health and Wellbeing Strategy for Bradford and Airedale 2018-2023, (2018)[xii]	The health and wellbeing strategy recognises that where people live influences their health and wellbeing. It aspires to improve health and wellbeing in the Bradford and Airedale District. Four outcomes underpin this aspiration: children having a great start in life, people in the District having good mental wellbeing, people living well and ageing well, and the District being a healthy place to live. An improved environment for cycling and walking is identified as a means of achieving a healthy place to live. The strategy recognises success in this area as people living "in places where it is safe to walk and cycle".

L4	Wellbeing Strategy for Calderdale 2018 – 2024 (2018) [xiii]	The wellbeing strategy sets out priorities for health and wellbeing over four stages of life: starting (0-5), developing (6-25), living and working, and ageing. The strategy sets out a commitment to health and wellbeing and the climate emergency in all council policies. Obesity and levels of physical activity are identified as two of many indicators by which to measure progress towards improving the health and wellbeing of Calderdale citizens.
L5	Bradford Council's Sustainability Agenda: Sustainable Development Action Plan 2020-2021, (2020)[xiv]	Published as a follow-up to declaring a climate emergency in 2019, the Action Plan sets out activities and actions that the Council, in partnership with the Government and other stakeholders, will take to reduce the extent of climate change, adapt to its impact, promote and improve environmental stewardship and seize the opportunities it offers for sustainable and inclusive development. Relevant activities set out in the plan include improving air quality, health and well-being, and promoting reductions in the use of cars and facilitating greater street safety.
L6	CBMDC Local Infrastructure Plan, (February 2021)[xv]	The plan establishes the extent of current infrastructure provisions and identifies the costs, delivery agents and means of funding for the infrastructure required to support the future growth proposed in the Bradford Local Plan. Looking at areas for improvement in physical, social and environmental infrastructure, it outlines projects relating to the highways and road network, rail network and capacity, station improvements including Park & Ride, public transport (bus & Mass Transit) and walking and cycling.
L7	Culture is our plan: A cultural strategy for Bradford District, 2021 – 2031, (2021)[xvi]	The plan was commissioned by the Bradford Cultural Place Partnership with funds from CBMDC and Arts Council England. It identifies the historic underperformance of the Bradford District in attracting national investment in arts, culture and heritage. Ten targets are set out to improve Bradford's position within the art, culture and heritage sector. These include an increase in the "number, range and scale and ambition" of arts, culture and heritage activities in the District, and realisation of capital projects to "rehouse, reimagine and repurpose the District's cultural and heritage assets".
L8	LTP3 Bradford Implementation Plan, 2011-2026[xvii]	The local implementation plan provides a local context to the West Yorkshire Local Transport Plan Strategy 2011-2026, and sets out the transport aspirations of the Bradford District. The plan identifies active travel as a key approach to reducing congestion, carbon and pollutant emissions. The plan identifies the provision of cycling and walking schemes as part of the suite of solutions that are required to improve travel choice, connectivity and enhancement to the travel network.

Inclusive Growth

The 2011 White Paper: Creating Growth, Cutting Carbon sets out how investment in cycling and walking routes can improve local accessibility, with "positive benefits for growth and the local economy" (N1, p42). Using the 22.5 mile Exe Estuary Trail as an example, co-benefits such as new business opportunities, increased use of connecting travel infrastructure and increased visitor numbers to the area are described in addition to the direct benefits of use of the path itself. Providing sustainable connectivity between Bradford, Keighley and Halifax has the potential to realise similar co-benefits at the same time as contributing to the health, transport and inclusive growth ambitions set out in local and regional strategies. Inclusion of Queensbury Tunnel within a sustainable travel route has the potential to be a flagship capital project that contributes to the reimagining and repurposing of the District's cultural and heritage assets, a key target in Bradford's Cultural Plan (L7, p11).

A sustainable network between Bradford, Keighley and Halifax would close current gaps in the region's transport network and contribute to the creation of an integrated and accessible transport network across the region. The study area includes many communities experiencing deprivation that are a focus for inclusive growth (R3, p24-27). Provision of routes between these communities can help to mitigate the impact of non-vehicle ownership. This is especially important as areas of persistent deprivation have not improved between 2004 and 2019, and a lack of car ownership can serve as a barrier to work. Nationally, 58% of journeys below five miles are made in private cars (N5, p56). As well as mitigating the impacts of non-car ownership, providing safe, attractive infrastructure for cycling and walking in growth areas has the potential to reduce the number of additional short vehicle journeys that may otherwise be introduced as a result of future development.

Connecting deprived communities contributes to national objectives for a more balanced economy set out in the national Transport Investment Strategy (N3). Investment in any of the routes presented in this study would also align with the regional Strategic Economic Framework (R2) focus on inclusive growth, by providing connectivity between rural towns beyond the region's city centres.

Active Travel Choice

England's Cycling and Walking Investment Strategy (N2) ambition is clear: cycling and walking should be a natural choice for a shorter journey or as part of a longer journey. However it is also the case that realising this ambition requires investment in cycling and walking infrastructure. Lack of walking and cycling infrastructure is identified as a barrier to sustainable connectivity in the Calderdale Transport Strategy (L2, p13). While Bradford's Local Infrastructure plan states that there is already a comprehensive network to support active travel, it also identifies an aim to "create appealing places to walk and cycle, supported by better connectivity between all sustainable travel modes" (L6, p37).

The routes in this study have the potential to support connectivity by complementing initiatives for high-speed rail links at Bradford and the Mass Transit system across the region, as set out in the West Yorkshire Mass Transit Vision (R4). In the absence of any direct rail connectivity between Halifax and Keighley, the routes put forward in this feasibility study would also help to mitigate a current lack of mobility choice between these towns. Furthermore, with connections to local railway stations and existing cycling networks in Bradford, Halifax and Keighley, the routes explored can provide connectivity across longer distances. In doing so, they contribute to the aims of CBMDC's Local Infrastructure Plan and the regional Connectivity Infrastructure Plan for "seamless, door to door journeys" (R3, p43).

At a local level, all the routes evaluated in this study would meet Aim 1 in the Bradford District Cycle Strategy (L1, p13) of improving the environment for cycling. All the routes assessed in this feasibility study have the potential to cater for longer distance touring, providing an alternative to routes funnelled into valleys alongside all other forms of transport; and meeting objective 1A to develop strategic routes that connect local neighbourhoods and provide for long distance journeys. Additionally, routes that include the restoration and use of Queensbury Tunnel provide an opportunity for provision of a world-renowned facility that "pull[s] cycling to the forefront of [the] local economy" (L1, p13).

Health & Wellbeing

The link between a lack of physical activity and poor health and wellbeing is well documented. Published in July 2020, the national vision for cycling and walking (Gear Change N4) estimates that "physical inactivity costs the NHS up to £1bn per annum, with further indirect costs calculated at £8.2bn". Increasing daily physical activity has a direct and positive impact on an individual's health.

But health and wellbeing benefits from everyday cycling are not limited to those taking part in the physical activity. When more people walk and cycle short journeys, streets are safer, and air and noise pollution are reduced. All these effects contribute to improved health and wellbeing across a community (N4).

The potential for cycling and walking to improve health outcomes is also recognised locally, with Bradford and Airedale's health and wellbeing plan (L3) identifying the presence of safe spaces to walk and cycle as a means of ensuring the region is a healthy place to live and work. Similarly the Calderdale Wellbeing Strategy (L5) recognises that avoidable disability and premature death can be reduced by designing an environment that facilitates a healthy lifestyle. Regionally, these aspirations are backed up by the Transport Strategy for West Yorkshire (R1) that includes "encouraging walking and cycling for health and other benefits" (p16) as part of a key objective for people and place[s] in the region.

The routes put forward in this feasibility study provide options for leisure and utility cycling across the study area. This supports both a vision for everyday cycling, but also facilitates cycling and walking as a leisure activity. The existing traffic-free Great Northern Railway Trail (GNRT) is integrated into the wider route suggestions, connecting two isolated stretches to urban hubs and each other. Being able to access these well-used stretches safety without a vehicle increases the proportion of the population able to take advantage of the facilities, and has the potential to reduce congestion at existing access points. Both of these possible outcomes support the objectives of the health and wellbeing strategies outlined above.

Climate and Sustainability

Connecting strategic towns in the region with cycling and walking infrastructure supports the visions for sustainability and minimising the impact of climate change as set out in the Strategic Economic Framework (R2), Infrastructure Connectivity Plan (R3) and Bradford's Sustainable Development Action Plan (L5). By extending the regional transport network to enable choice of mobility, each of the routes presented can help to reduce car use, congestion and transport emissions. With the region seeking to make walking and cycling the first choice and making sustainable travel a top investment priority, the scheme contributes to achieving this vision.

Establishing active travel connections across the study area contributes towards the regional target of becoming a net zero carbon economy by 2038. With the Connectivity Infrastructure Plan (R3) identifying Halifax and Bradford as areas of focus for planned growth, providing a link between the two could help to meet inclusive growth without compromising climate goals.

Summary

Provision of a walking and cycling route between the major settlements of Bradford, Keighley and Halifax, and the minor strategic settlements between them demonstrably contributes to numerous national, regional and local strategies. Many of these strategies include time-limited outcomes including significant progress towards net-zero carbon by 2030 (R3), a 300% increase in bicycle trips in West Yorkshire by 2027 (R1, L5), and no net growth in car trips in Calderdale by 2026, after accommodation of trips generated by new development (L2). Delivery of any of the routes described in this feasibility study has the potential to contribute to these time-limited objectives.

If strategic objectives beyond connectivity and growth are considered, inclusion of Queensbury Tunnel within active travel routes opens up opportunities to support development of heritage and cultural facilities in the Bradford District. Hosting the Grand Depart of the Tour de France in 2014 brought West Yorkshire to international attention, and provided a £12m boost to the local economy (L1). Using Queensbury Tunnel within a route that connects the region's heritage towns and cities has the potential to create a flagship attraction that people travel to the region to experience. This could build cycle tourism into the local economic model for the long term.

2.2. Study Objectives

This study examines the feasibility of providing a sustainable route to link the towns of Bradford, Halifax and Keighley using the heritage infrastructure of Queensbury Tunnel. For comparison, the feasibility of routes excluding the tunnel are also considered. Building on the strategic objectives of the West Yorkshire Local Transport Plan, the study incorporates utility-focused options alongside greenway options. This also enables the value of Queensbury Tunnel as part of a leisure-focused route to be compared with its value as a link in a more utility focused network.

Through consideration of relevant policy and strategy, the following study objectives have been developed. The study objectives will underpin the vision for the proposed cycling and walking routes.

The proposed routes should:

1. Enable and encourage people to undertake short journeys actively
2. Be safe, comfortable and attractive to all users
3. Form part of a cohesive transportation network
4. Improve the convenience of walking and cycling
5. Contribute to a reduction in carbon emissions by reducing congestion on the transportation network

2.3. Study Area

Queensbury Tunnel runs beneath the village of Queensbury, West Yorkshire. Constructed between 1874 and 1878, the tunnel linked Queensbury and Holmfield stations. Queensbury Station sat at the intersection of three branches of the Great Northern Railway that extended to Keighley in the north, Bradford in the east and Halifax in the south (Figure 1). The former Queensbury station is located approximately at the centre of the current study area, which also encompasses the former railway corridors to the three towns. Broadly following the alignment of the former railway, the study area can be considered as three branches that meet at Queensbury town, each named for the town at their furthest extent. Within each branch, corridors link strategic towns as defined in the strategies and policies summarised in this study. Each of the branches also connects with existing routes on the National Cycle Network (NCN).

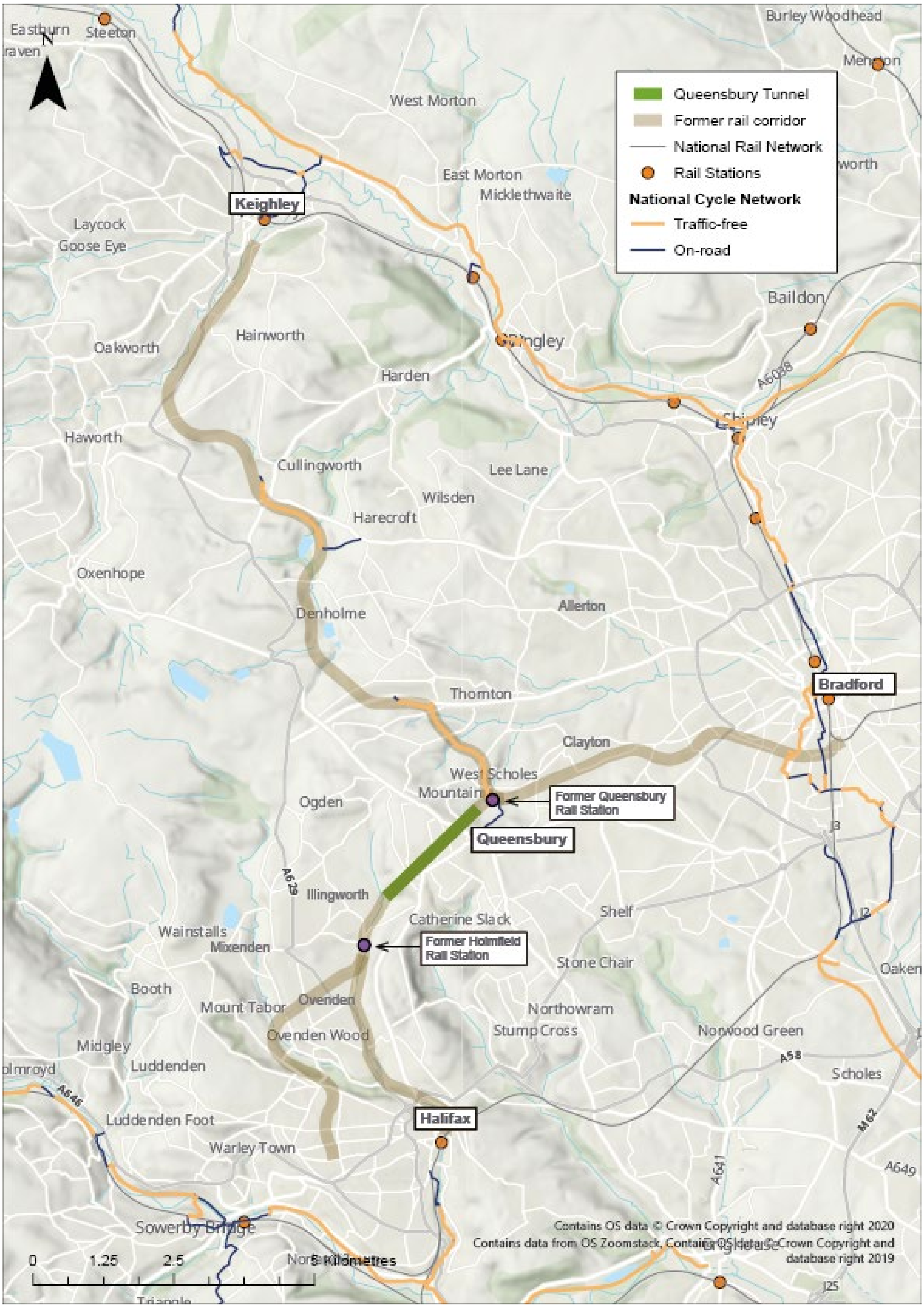

Figure 1: Study area, showing former railway corridors connecting Bradford, Halifax, Keighley and Queensbury

Keighley, Cullingworth, Denholme, and Thornton are strategic towns situated within the northern branch to Keighley (Figure 2), which also includes the Great Northern Railway Trail (GNRT) and Station Road, both part of the existing but discontinuous NCN 69. At the northern end of this branch, on-road cycle routes link to further sections of NCN 69, and NCN 696, along the towpath of the Leeds and Liverpool Canal.

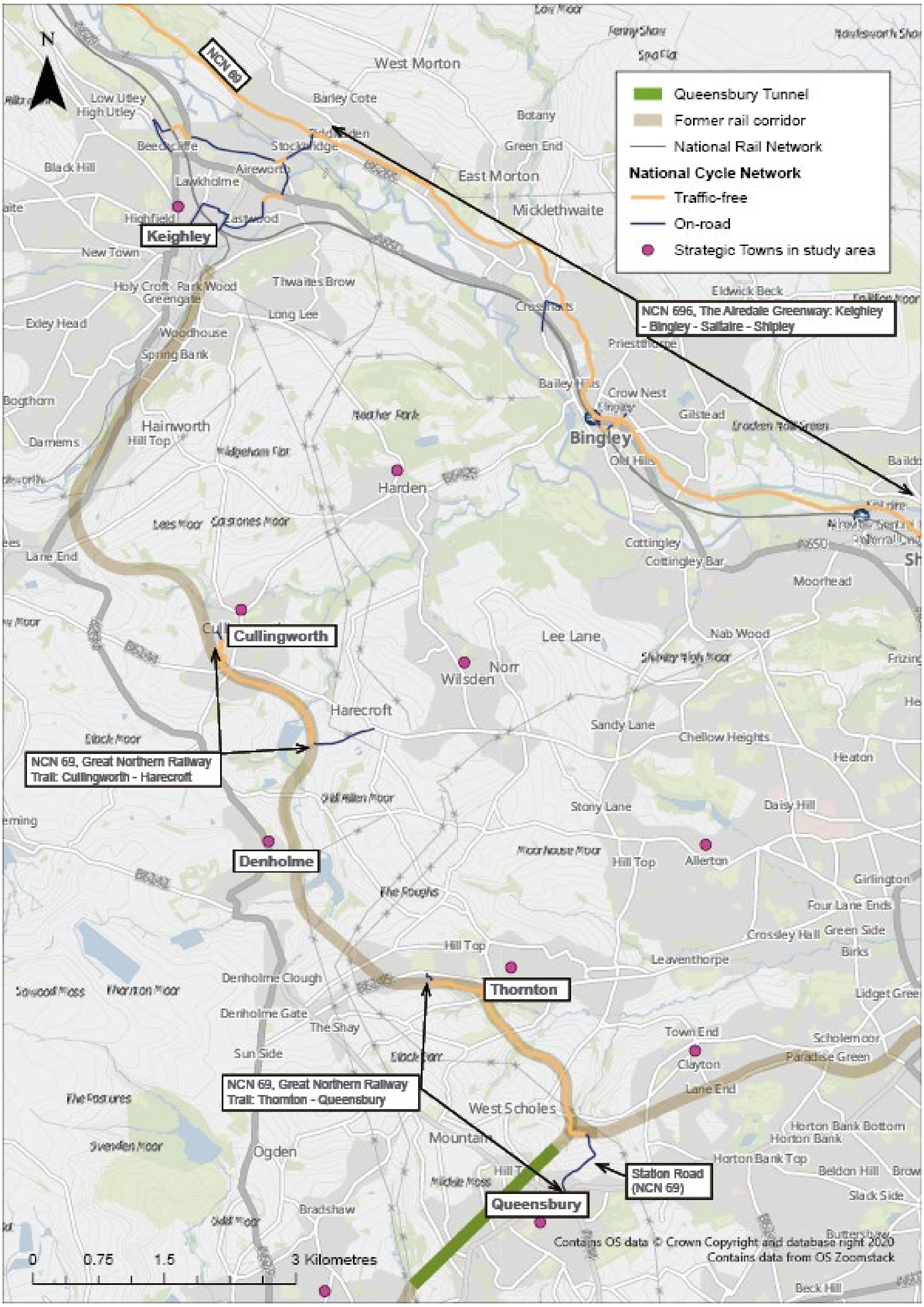

Figure 2: NCN links in and around the Keighley branch of the former railway line.

The Bradford branch to the east of Queensbury (Figure 3) includes the strategic towns of Bradford, Thornton and Clayton. With the development of the proposed Thornton Road Cycle Superhighway, this branch will connect the GNRT to the north-south traffic-free Bradford Red Bridge Route (NCN 66) at its eastern end.

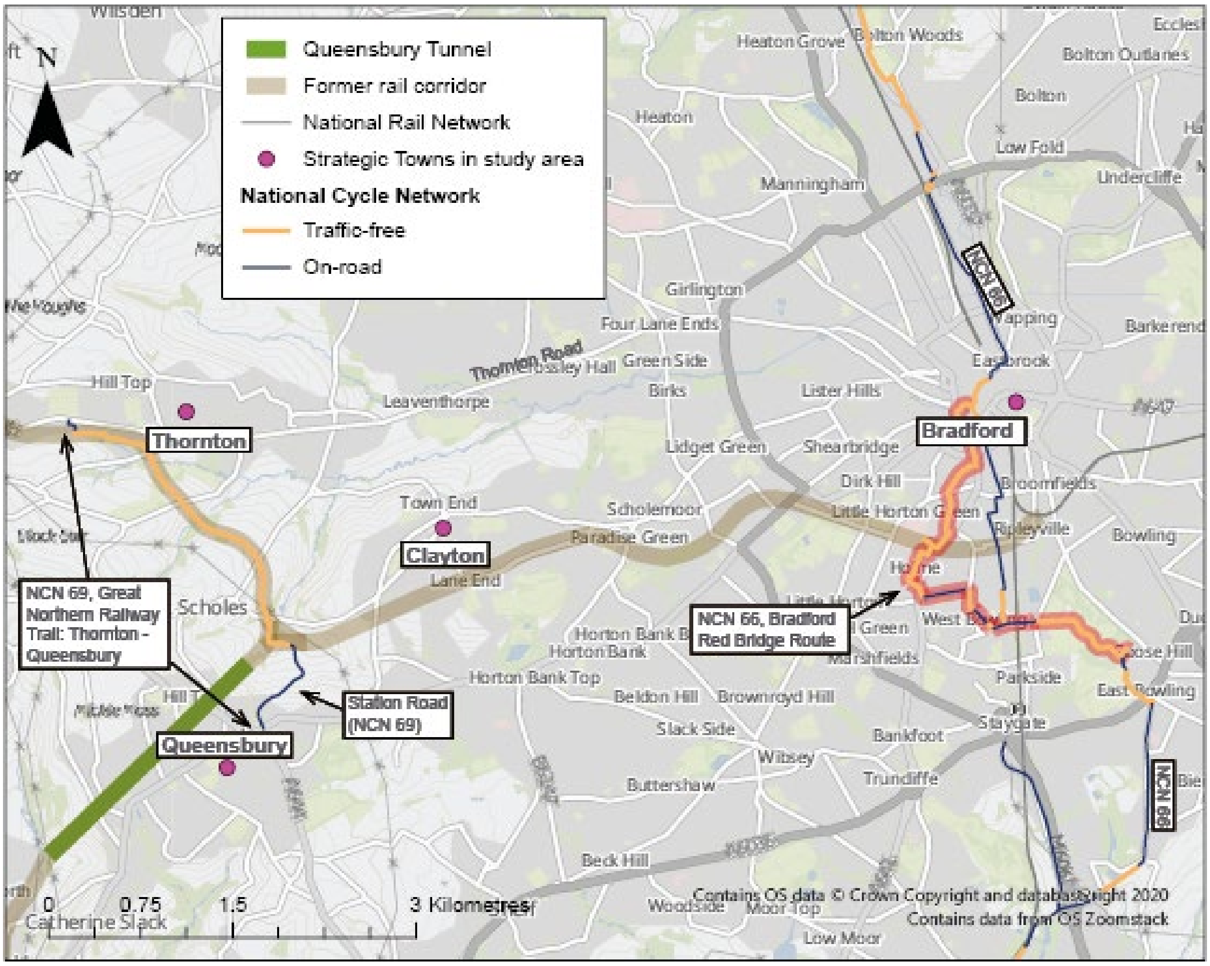

Figure 3: NCN links around the Bradford branch of the former railway line.

Finally, the southern Halifax branch (Figure 4) contains Halifax, Holmfield, Ovenden and Queensbury Tunnel. At the furthest southern extent, there is potential to connect to the existing Hebble Trail (NCN 69) and onward routes to Elland, Brighouse, Sowerby Bridge, Hebden Bridge, and Todmorden, along with access to the Pennine Cycleway and Trans Pennine Trail. Illingworth and Mixenden lie just to the west of the southern study area.

This study is intended to provide an assessment of the potential to provide viable sustainable transport routes between Keighley, Halifax and Bradford, with a focus on the value of Queensbury Tunnel as a potential link in the network. To ensure the best possible comparison between different options, all options assessed for their economic performance include three major settlements of Keighley, Halifax and Bradford, and the minor settlement of Queensbury.

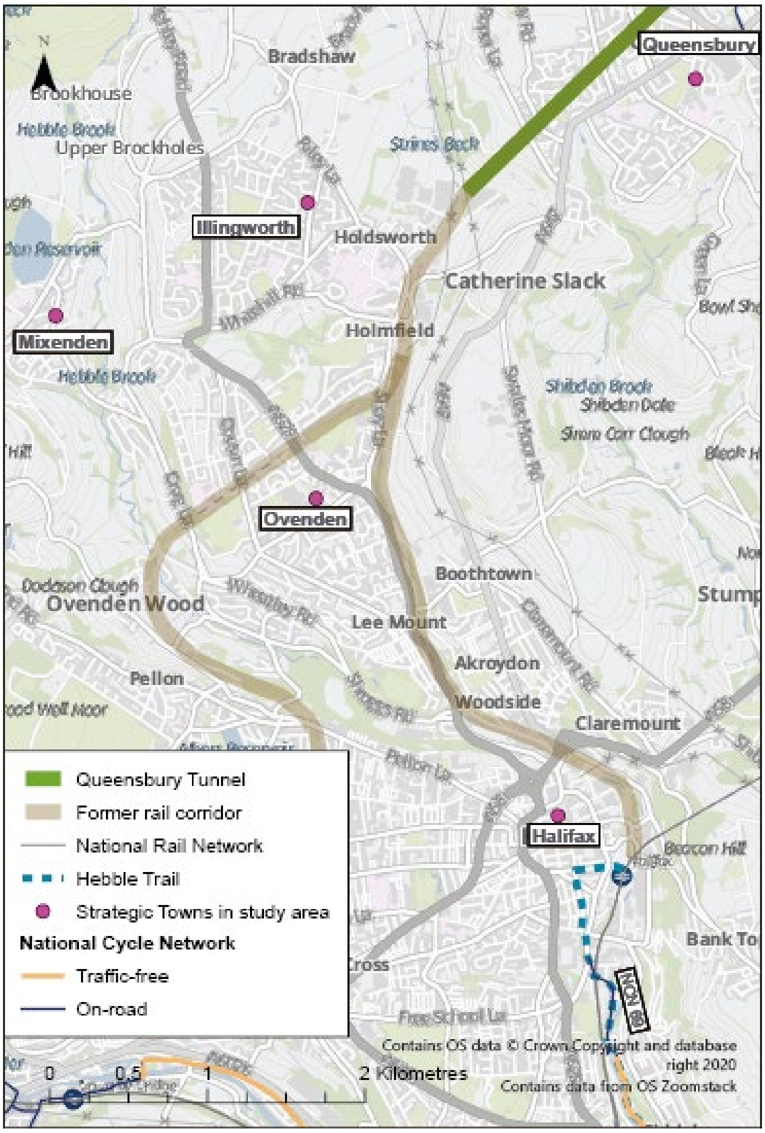

Figure 4: NCN links around the Halifax branches of the former railway line.

2.4. Previous Work

Numerous previous studies by Jacobs, AECOM, Sustrans and the Queensbury Tunnel Society (QTS) have examined the potential to retain Queensbury Tunnel. These studies either take a technical remediation perspective or focus on the potential value of the tunnel as a cycling and walking route. A chronological record and brief summaries of the most relevant studies are presented below:

- Jacobs (2009). HQU3D Queensbury Tunnel Feasibility Study of Future Asset Management
- Jacobs (2016). HQU3D Queensbury Tunnel Options Report
- Queensbury Tunnel Society (2016). Queensbury Tunnel: Asset or Liability?
- Sustrans (2017). Queensbury Tunnel: Estimating the economic impact of reopening walking and cycling routes around Queensbury Tunnel
- Queensbury Tunnel Society (2017). Queensbury Tunnel: Cost Comparison
- AECOM (2018a). Queensbury Tunnel Phase 1: Literature Review – Summary Technical Note Review
- AECOM (2018b). Queensbury Tunnel Phase 2: Technical Summary

HQU3D Queensbury Tunnel Feasibility of Future Asset Management (Jacobs, 2009)

It has not been possible to obtain sight of the original of this report. Referenced in later reports, this study included details of the conditions of the tunnel shaft linings, and the potential risks and consequences of their collapse.

HQU3D Queensbury Tunnel Options Report (Jacobs, 2016)

In 2016, Highways England Historical Railway Estates commissioned Jacobs to conduct a desk-study exercise to develop estimates for the costs and risks of four options for the closure or repair of Queensbury Tunnel:

- Do nothing
- Tunnel abandonment (risk reduction)
- Shaft abandonment
- Tunnel and shaft restoration and upgrading (for public use)

The cost to restore the tunnel for public use was estimated at £35 million, of which £21.5 million was civil engineering works, and £13.5 million were other costs, primarily design fees and design, construction and employer risk. Risk and optimism bias, and inflation were excluded from the cost estimates, which were quoted as having an accuracy level of +/- 40%. The estimated time for construction was 108 weeks. Improved access to the southern portal, new drainage and water management systems, and the installation of a roadway, lighting and emergency communication system within the tunnel are all listed in the anticipated works for restoration of the tunnel. Optimism bias, inflation and VAT were excluded.

Queensbury Tunnel: Asset or Liability? (Queensbury Tunnel Society, 2016)

In response to Jacobs' options report, QTS also developed a cost estimate for restoration of Queensbury Tunnel using an alternative method of remediation, and an estimated duration of just 44 weeks. This report put forward a figure of £1.83 million for core civil engineering works and shaft repairs. Security, condition surveys, design and other project costs brought the estimated total for remediation works to £2.81 million, excluding inflation and VAT. A contingency of 20% was included. The "costs relating to the proposed cycle path (surfacing, lighting, rebuilding north portal etc.)" are excluded from the QTS estimate.

Estimating the economic impact of reopening walking and cycling routes around Queensbury Tunnel (Sustrans, 2017)

Subsequent to the publication of Jacobs' and QTS' reports, in 2017 Sustrans were commissioned by the Queensbury Community Heritage and Action Partnership to identify a number of route options and delivery scenarios between the settlements of Keighley, Cullingworth, Denholme, Thornton, Bradford City Centre, Queensbury, Ovenden and Halifax. The study formed an extension to a wider West Bradford Study, with agreement of CBMDC. Benefit Cost Ratios (BCR) were calculated and compared for each of the identified scenarios. The report noted the variation between estimates for refurbishing Queensbury Tunnel put forward by Jacobs and QTS. To account for this, where scenarios included the tunnel, BCRs were calculated for a maximum, minimum and mean estimate of refurbishment costs. This resulted in significant variations in BCRs between and within individual scenarios.

The report identified BCRs ranging from 0.2 to 2.3 for scenarios including the tunnel, and BCRs ranging from 0.2 to 3.8 across the non-tunnel scenarios. Table 3 provides the summary details for these maximum and minimum BCR values. Scenario letters correspond to scenarios options presented in the 2017 report.

Table 3: Summary of estimated benefits and costs for best- and worst-case scenarios by BCR as calculated in Sustrans' 2017 report

Scenario	BCR	Description	Total Benefits (£ rounded)	Cost (over 30 years)
E max[1]	0.2:1	Tunnel included with assumed maximum restoration cost. Bradford to Halifax, via Thornton Road option.	7,445,000	31,888,000
A min[1]	2.3:1	Tunnel included with assumed minimum restoration cost. Keighley to Halifax via Cullingworth, and Halifax to Bradford via valley bottom.	26,768,000	11,588,000
H	0.2:1	Tunnel excluded. Bradford to Queensbury via Thornton Road.	1,889,000	10,548,000
G	3.8:1	Tunnel excluded. Bradford to Queensbury via valley bottom and Queensbury to Thornton.	10,082,000	2,643,000
I	3.8:1	Tunnel excluded. Bradford to Queensbury via valley bottom and Queensbury to Keighley via Thornton and Cullingworth.	19,307,000	5,147,000

[1]Max and min refer to scenarios using maximum and minimum tunnel remediation estimates respectively. The maximum was £35 million, based on Jacobs' remediation estimate (including provision of a cycle path). The minimum was £4.3 million, based on the QTS remediation estimate, plus the additional estimated cost of providing a cycle path through the tunnel.

Queensbury Tunnel Phase 1: Literature Review – Summary Technical Note Review (AECOM, 2018a)

As noted above, significant discrepancies in the estimated costs of retaining Queensbury Tunnel are present in the pre-2018 reports by Jacobs and QTS, due to differing assumptions regarding remediation method and duration of works. As a result of the discrepancies, AECOM were commissioned by CBMDC to review the reports by Jacobs and QTS. The review concluded that the remediation costs suggested by Jacobs were high, while those put forward by QTS were low. The variation in cost estimates, and AECOM's own desk top study estimates for full remediation of the tunnel are shown in Table 4. Values and comments shown are direct extracts from Table 1 of the Phase 1 AECOM report.

Table 4: Summary of Cost Limits for Option 4a: remediation. Extract from Table 1, AECOM (2018a).

Item	AECOM Cost Limit (2018)	JACOBS Cost Limit (2016)	QTS Estimate (2017)	Comment
Option 4a: Remediation	£6,012,419	£35,3881,398	£2,810,000	Differing repair methodologies for AECOM (QTS) /JE. Costs vary.

The AECOM £6,012,419 value includes a 40% allowance for risk (£1,717,834) applied to the total cost for engineering works, project / design team fees, and development / project costs (£4,294,584).

Queensbury Tunnel Phase 2: Technical Summary (AECOM 2018b)

Building on Phase 1, CBMDC commissioned AECOM to undertake a Phase 2 technical study. Further tunnel examinations to determine the condition of Queensbury Tunnel and the likely extent of required repairs were carried out in 2018. The examinations included a combination of visual, radar and intrusive surveys along the tunnel length. A 305m length mid-way through the tunnel was omitted from further survey due to the presence of an 'exclusion zone'. Based on the further investigations AECOM raised their estimate for remedial works to the tunnel from £6,012,419 to £6,912,050. The increased figure includes a 35% allowance for risk (reduced from 40% as a result of additional information obtained) applied to a total of £5,116,045 for engineering works, project / design team fees, and development / project costs.

The Phase 2 report emphasises the nature of the cost estimates as high-level desk top estimates. Both Phase 1 and Phase 2 estimates exclude costs for operation and maintenance, optimism bias, inflation and VAT.

No reference is made to provision of a cycle path within the tunnel, and the associated need for lighting, suitable drainage and surfacing. It is therefore assumed that costs to provide a cycle path through the tunnel have been excluded from the estimate. This is in line with the approach taken in the Phase 1 report, which uses the QTS remediation approach as the basis for an updated cost estimate. The QTS remediation proposal also excluded works to provide a cycle path through the tunnel.

2.4.1. Summary and implications for the current commission

The bulk of previous work undertaken with respect to Queensbury Tunnel has focused on the viability of securing the structure to be safe for public use. The multiple cost estimates reflect a variety of possible approaches to achieving remediation, with the cost of providing a cycling route through the tunnel included in some estimates and not in others.

The Sustrans' study in 2017 stands alone in trying to quantify the wider benefit of retaining the tunnel as part of a walking and cycling network. However, two important limitations in the 2017 Sustrans report are relevant for the current commission:

- The necessary inclusion of a range of estimated costs from third parties for the refurbishment of Queensbury Tunnel, from £4.3 million to £35.4 million. This led to significant variation between the maximum and minimum BCR calculations for any scenarios that included the tunnel.
- All scenarios that exclude the tunnel exclude connection to Halifax by proxy. There is no BCR estimate that includes a connection to Halifax via an alternative, non-tunnel route.

Both of these limitations are addressed in this study.

HQU3D Queensbury Tunnel Study: Draft 2 (Jacobs 2021)

A technical study undertaken as part of the current commission was produced by Jacobs in April 2021 (hereafter referred to as the 'Jacobs 2021 Study'). This provides an updated cost for the Queensbury Tunnel remediation works, estimated to be **£26,382,087 with a cost tolerance of +/- 30%.** The cost estimate has been developed by Amco-Giffen, based on a description of the required repairs described in the Jacobs report. The estimate includes a risk cost of £4,123,000 in addition to the total of £22,259,087 for engineering works, ventilation, and design, development and supervision. The estimate provided is for remediation only and excludes optimism bias and inflation. It does not include provision of a cycling path and associated infrastructure through the tunnel, unlike that provided by Jacobs in 2016. An additional **£24,909/year** is estimated for ongoing inspection and maintenance costs for the tunnel. It is not stated whether VAT is included or excluded in the estimates.

The updated cost estimates for the tunnel remediation are used in the BCR calculations for this study. Treatment of risk is discussed in section 6.2.

3. Popular Context

Within the study area, there are several public campaign groups operating to retain, enhance or create sections of traffic-free infrastructure. Sections of interest include Queensbury Tunnel, Clayton Deep Lane, and the Great Northern Railway Trail. This chapter outlines public activity related to these areas and describes some examples of similar infrastructure in other areas of the UK.

3.1. Public campaigns

3.1.1. Queensbury Tunnel

Retention and restoration of Queensbury Tunnel for future use has been the focus of a sustained and lengthy public campaign. Queensbury Tunnel Society (QTS) was formed in 2016 to focus on and gain support for the preservation of Queensbury Tunnel for use as a public route for walking and cycling and for recognition of its heritage value. The constitution of QTS continued activity that had first been initiated by Queensbury Community Heritage & Action Partnership (Q-CHAP), who had garnered significant political interest in the predicament of the tunnel and the critical decisions that needed to be made about the tunnel's future.

QTS has undertaken a significant amount of campaign activity to save Queensbury Tunnel, including media activity, collating a petition[xviii] of over 14,000 individuals, holding events and communicating with local councillors and government ministers. QTS maintain a website[xix] where full details of their activity, aspirations and substantial supporting information can be found.

3.1.2. Clayton Deep Lane

Deep Lane in Clayton was the focus of a recent campaign by Clayton Footpath Group (CFG) to repair underground pipework at the top of the lane. The lane, believed to have existed since medieval times, had become flooded due to water flowing from the broken pipework[xx]. The footpath group have expressed a desire for the lane to be adopted by Sustrans and form part of a new cycle way from Bradford to Halifax.

Proposals for the Lane as part of a cycle route include creation of a linear park, and use as a link for school travel between Clayton and primary and secondary schools located in the valley.

3.1.3. The Great Northern Railway Trail

The aspiration for development of a walking and cycling route along the Great Northern disused railway was initiated by two local railway historians in 2000. The plan was to form a route on the former railway line that linked Bradford with Halifax and Keighley by using as much as possible of the old railway formation. With the subsequent formation of the Great Northern Railway Trail Forum and with the support of Bradford Council, Sustrans and other organisations, two disconnected sections of the route between Cullingworth and Queensbury are now open for public use.

In 2018, the original members of the Great Northern Railway Trail Forum formed a Development Group whose purpose is to work with various organisations and official bodies to expand this amenity for the public benefit by actively promoting extensions to provide a connected route between the towns and other places served by the old railway. The Great Northern Railway Trail Development Group (GNRTDG) maintain a website[xxi] that contains information, news and contact information.

3.2. Active travel tourism in the UK

Cycle tourism represents a growth market in the UK, particularly in rural areas[xxii]. Long distance cycle routes in particular contribute significantly to local economies within a route corridor, but evidence from projects in recent years demonstrates that there are also significant benefits to be realised from new infrastructure provision on shorter routes. The following are examples of projects that have a focus on reopening disused railway infrastructure to the public for walking and cycling use.

Bath Two Tunnels Greenway (NCN 244)

As one of Sustrans BIG lottery funded Connect2 schemes, a four mile stretch of the former Somerset and Dorset railway line was transformed for cycling and walking. The route includes two disused railway tunnels and a viaduct: the Devonshire Tunnel (0.25 miles), the Combe Down Tunnel (which at approximately 1 mile in length is currently the longest cycling tunnel in the UK), and the Tucking Mill Viaduct. The route connects North East Somerset to the centre of Bath.

Since its opening in 2013, the Two Tunnels Greenway has become a well-used route and a tourist attraction in its own right, with people travelling to Bath to visit and experience the longest cycling tunnel in the UK. The project has realised the following benefits:

- Scheme cost: £5,158,000
- 131% increase in total route usage after the opening of the route – 366% increase in cycling, and 50% increase in walking
- Estimated BCR over 30 years - **3.4 to 1**

The route has also prompted the development of events such as the Two Tunnels Races, in which runners can race a variety of distances all of which include a passage through Combe Down Tunnel.

Monsal Trail, Peak District

The Monsal Trail is in the centre of the Peak District National Park. There are hundreds of interesting things to see along the Monsal Trail including wildlife, geology, industrial and rail heritage. The trail is a way-marked route with coordinated interpretation panels and listening posts to help people enjoy all it has to offer. The 8.5 mile traffic-free route passes through four railway tunnels, each about 400 metres long and lit during normal daylight hours. In 2015, the route was voted the nation's favourite cycle route under 30 miles[xxiii].

Automatic cycle and pedestrian counter data from the Hassop Station on the Monsal Trail shows a steady level of usage by both cyclists and walkers since 2012. Since 2018, the pedestrian Annual Mean Daily Totals (AMDT) have been 420 users per day or above, and the AMDT for cycles has been

150 or above (reaching 191 in 2018 and 2019, pre-COVID-19 pandemic). During the summer of 2020, peak use reached almost 2,000 visits per day[xxiv].

Table 5: Monsal Trail (Hassop Station) Automatic Cycle Counter Data (Annual Mean Daily Totals)

Monsal Trail - Hassop Station	Annual Mean Daily Totals (AMDT)								
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pedestrians	365	341	352	439	412	588	420	421	480
Cycles	173	200	232	206	223	255	191	191	155

Bennerley Viaduct

In 2015 the Heritage Lottery funded "Rediscovering Bennerley Viaduct" project was commissioned, with the aim of raising awareness about the viaduct and getting local people engaged with caring for the structure and the heritage of the site. Through this project, the Friends of Bennerley Viaduct group was formed and has been working closely with the viaduct's owner, Railway Paths Limited. Ultimately, an aspiration was activated to restore the Bennerley viaduct and bring it into use for the public as a walking and cycling crossing. Built by the Great Northern Railway Company, the viaduct is over a quarter of a mile long and a Grade II* listed structure that straddles the River Erewash. It connects Ilkeston in Derbyshire with Awsworth in Nottinghamshire.

The activities of the 2015-2017 project included self-guided walks, tours, exhibitions, engagement with schools, working with volunteers, and improving habitat management and ecological heritage. In addition to the impact of the Bennerley Viaduct project in terms of raising awareness and getting the local community involved, there is clear support for the future aspiration for Bennerley Viaduct and an appreciation of its heritage value and its value to the community. Specifically, the project successfully demonstrated there was support for restoring the Bennerley Viaduct and its planned use as a walking and cycling route as follows:

- 98.1% of respondents were in agreement with efforts to restore the viaduct (87.5% strongly agree with this).
- 98.2% of respondents agree (with 91.4% strongly agreeing) that they would like to see the viaduct used as a walking and cycling path.

In July 2019, planning consent was granted to bring the viaduct back into use as a walking and cycling route. Works to restore the viaduct are nearly complete. In September 2021, a new long-distance heritage cycling route linking Bennerley viaduct to Meldon Viaduct in Devon was launched[xxv].

4. Initial Option Appraisal

Definitions

This chapter and following chapters include the use of the terms ‘corridor’, ‘alignment’ and ‘route’. For the avoidance of any doubt:

- **Corridor**: regions between named locations. Corridors contain alignments.
- **Alignment**: intended path along which provision will be provided. Multiple alignments may be present in a single corridor.
- **Route**: a set of alignments, including at least one from each corridor, combine to create a route.

The area under investigation in this study is extensive, presenting possibilities for a wide range of approaches to be taken to connect the three settlements of Keighley, Bradford and Halifax.

The final route options have been determined using a four-stage process, in consultation with relevant stakeholders:

- **Stage 1 -** Initial corridor development and assessment
- **Stage 2 -** Options appraisal of potential alignments within suitable corridors
- **Stage 3 -** Preferred alignments and overall route proposals issued for discussion
- **Stage 4 -** Final alignments and agreed routes developed and costed for feasibility and input into economic assessment.

This chapter introduces the corridors and individual route alignments and describes how corridors and alignment options were narrowed down to the final proposals. Chapter 5 describes the final corridors and alignments and should be read in conjunction with the accompanying general arrangement drawings. Chapter 6 describes how the alignments combine to create the overall routes for economic assessment. Routes and alignments were developed with a focus on both utility and leisure cycling.

4.1. Stage 1: Corridor development and assessment

Section 2.4 described Sustrans’ 2017 assessment of the economic impact of reopening walking and cycling routes around Queensbury Tunnel. In that report, seven corridors between strategic towns were identified. These were used as the starting point in the current study. As identified in section 2.4.1, one of the limitations to the 2017 study was the lack of examination of non-tunnel links to Halifax. In order to address this limitation, three corridors were added to the original seven, as shown in Figure 5.

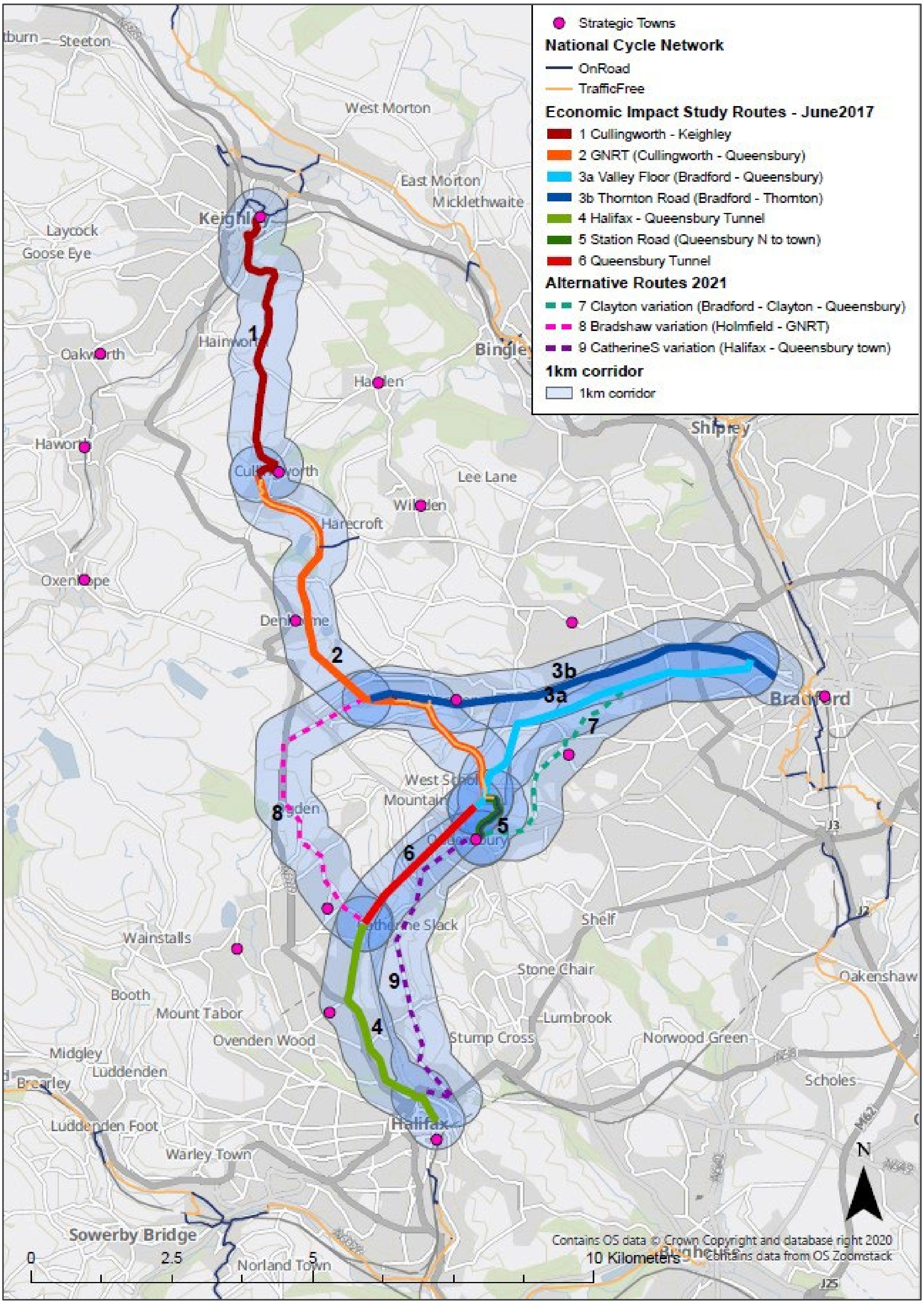

Figure 5: Initial corridor considerations

The purpose of the initial corridor assessment was to assign each corridor a score that can be used as a basis for ranking their potential to host possible alignments. Prior to the development of alignments, the 10 possible corridors were assessed for their overall potential to connect the settlements of Bradford, Halifax and Keighley.

4.1.1. Assessment criteria

Each of the 10 original corridors was assessed against a set of high-level criteria, to determine its potential to host routes that meet both technical and strategic needs. Based on the assigned scores, potential corridors were ranked according to their likely suitability to host alignments.

Technical criteria

Corridors were assessed according to their potential to host routes that meet the core design principles of LTN1/20. The five core design principles require routes to be:

- **Coherent**. Assess whether potential corridors provide opportunities to link in with existing and proposed active travel networks, whether they link day to day destinations, and whether they are likely to support routes that can be provided to a consistent standard along their lengths.
- **Direct.** Assess whether potential corridors can support routes that link destinations by the shortest and/or least stop-start routes. For longer touring-focused routes, an assessment of directness may be weighted towards ease of progress rather than distance.
- **Safe.** Assess the degree to which routes within a potential corridor are likely to support safe cycling, and an associated perception of safety and personal security.
- **Comfortable.** Evaluate corridors for their potential to support comfortable conditions along routes within them. Comfort is assessed in terms of gradients, potential to provide routes of the required width and the need to interact with high speed or high-volume traffic.
- **Attractive.** Determine whether potential corridors are likely to give rise to routes that users are keen to experience.

How well each corridor meets the above design criteria was assessed using the following scoring.

1	2	3	4	5
Very limited	Limited	Average	High	Very high

Non-technical criteria

The following non-technical criteria were also used to rank the corridor options.

- **Strategic context**: assesses the potential of the proposed corridors to meet strategic objectives set out in WYCA and CBMDC policy and strategy documents.
- **Ecological potential:** assesses whether there are likely ecological constraints within a proposed corridor, and the potential within a corridor for biodiversity net gain.

Scoring for the potential for each corridor to meet the above non-technical criteria was based on the following scale.

1	2	3	4	5
Very poor	Poor	Average	Good	Very good

Constructability was not considered during the initial assessment, as individual alignments were not defined. Consideration of the feasibility of potential alignments was assessed through desk study and site visits in Stage 2.

Table 6 summarises the scores and rankings from the initial corridor appraisal. The results of the assessment were shared for discussion with CBMDC, and used to inform the options appraisal process. The initial corridor appraisal is included in full in Appendix A.

Table 6: Summary scores and ranking from initial corridor assessment exercise

Corridor	Technical criteria							Non-technical criteria				Overall	
	Coherence	Directness	Safety	Comfort	Attractiveness	Score	Rank	Strategic context	Ecological context	Score	Rank	Score	Rank
1. Cullingworth – Keighley	3	5	3	2	4	17	**4**	3	3	6	**7**	23	**6**
2. GNRT (Cullingworth – Queensbury)	4	5	5	5	5	24	**1**	5	2	7	**=4**	31	**1**
3a. Valley Floor (Bradford – Queensbury)	4	3	4	4	4	19	**3**	2	3	5	**=8**	24	**5**
3b. Thornton Road (Bradford – Thornton)	5	2	4	3	2	16	**=5**	5	4	9	**=1**	25	**=3**
4. Halifax – Queensbury Tunnel	4	3	2	3	3.5	15.5	**7**	4	3	7	**=4**	22.5	**7**
5. Station Road (Queensbury N to town)	2	4	5	1	2	14	**9**	3	5	8	**3**	22	**8**
6. Queensbury Tunnel	4	5	4	5	5	23	**2**	5	2	7	**=4**	30	**2**
7. Clayton Variation (Bradford – Clayton – Queensbury)	4	3	3	3	3	16	**=5**	5	4	9	**=1**	25	**=3**
8. Bradshaw Variation (Holmfield - GNRT)	4	2	3.5	2	3	14.5	**8**	3	1	4	**10**	18.5	**9**
9. CatherineS Variation (Halifax - Queensbury Town)	2	3	2	2	2	11	**10**	2	3	5	**=8**	16	**10**

4.2. Stage 2: Options appraisal of potential alignments

As a result of feedback from CBMDC in Stage 1, twelve corridors (shown in Figure 6) were taken forward for options appraisal. Potential alignments were developed using desk study analysis, for evaluation on site. Corridor 9 was divided into two sections (9 and 9s), and a link connecting these corridors to Holmfield was added (10). The desk study considered desirable alignments, potential areas of interest and potential problematic areas. The study used ArcGIS - a geographical information system and mapping tool - for the collation, study and analysis of data across the study area. Geographical information collated from the ArcGIS Living Atlas and Sustrans' internal GIS team included:

- Satellite imagery
- School locations
- Historic England Heritage at Risk Register 2019
- Listed Buildings
- National Rail Network and stations
- Environment Agency Flood Alert areas
- Potential sites of ecological interest
- Public Rights of Way (PRoW)
- Water courses
- Parish, District and Council boundaries
- Other local walking/cycling routes in the study area

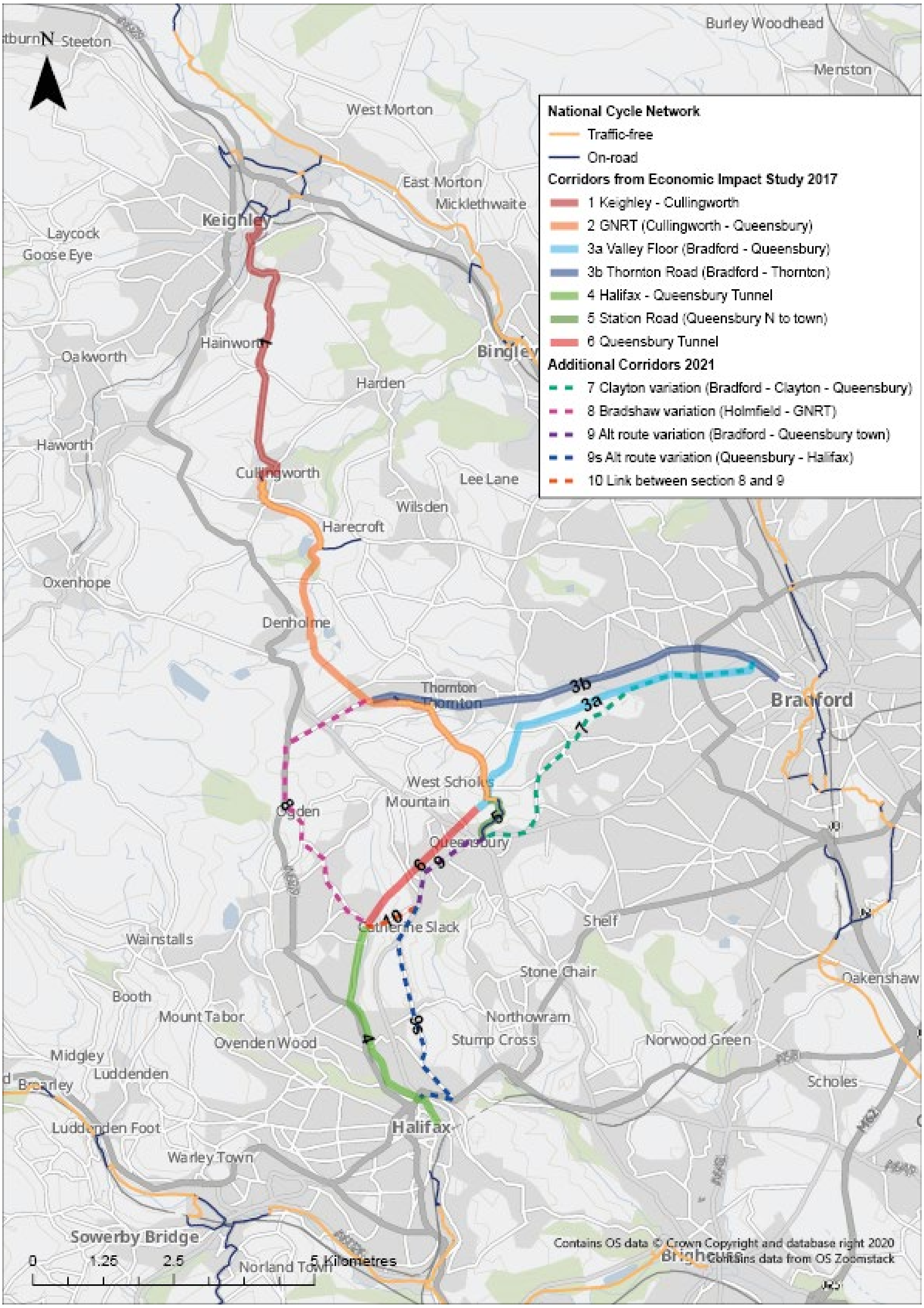

Figure 6: Corridors considered during options appraisal

In addition to GIS-based data, information was collected from CBMDC and Calderdale Council to inform the identification of potential alignments. This included:

- RUDP Proposals Map 2005
- Bradford Draft Local Plan Policies Map 2020-2038
- Calderdale Local Plan and local plan development sites information
- Strategic Towns (identified from the documents summarised in section 2.1)
- Planning Application sites within the corridors (Bradford and Calderdale planning portal websites)
- Public Rights of Way information supplied by CBMDC
- OS MasterMap base (CBMDC Ordnance Survey PSGA agreement)
- TCF schemes in development (Bradford and Calderdale)

Three additional Sustrans' studies were examined for candidate alignments:

- Queensbury Walking and Cycling Study, Feb 2016
- West Bradford Greenway Feasibility Study, Feb 2016
- Thornton Road Feasibility Study, Feb 2017

Information was also gathered from a range of other publicly available sources:

- Lines of disused railway and tunnels (forgottenrelics.co.uk and railmaponline.com)
- MagicMaps (magic.defra.gov.uk) for identification of sites of historic, conservation and ecological interest
- Land ownership data (Land Registry Government website and INSPIRE Index Polygons)
- Ordnance Survey contour data (OS Terrain 5)
- The National Cycle Network (Sustrans)
- Vehicle Flow Counts (DfT)

Using the collated information, possible alignments throughout the 12 corridors were identified for appraisal on site. Site visits were conducted over three days by four Sustrans staff, accompanied by a representative from CBMDC. Two further visits were undertaken by Sustrans staff later in the development process. Prior to visiting the corridors surrounding Halifax, candidate alignments were discussed with an officer at Calderdale Council.

During the site visits, alignments were primarily evaluated for their potential to be safe, comfortable and attractive. The practicality of construction along alignments was also considered. Alternative alignments identified during site visits were also recorded and assessed.

Over 150 possible short sections of alignment were evaluated and rationalized. A summary of the alignments and accompanying evaluation is included in Appendix A.

Table 7 shows four corridors that were also discounted during the options appraisal process, with a brief reason for their exclusion from further consideration. Based on the combined findings of the desk analysis and site visits, a reduced number of preferred longer alignments were developed within eight corridors. The preferred alignments at the end of Stage 2 are shown in Figure 7.

Following the initial options appraisal, a draft preferred alignment report was issued for discussion with CBMDC and Calderdale Council. The report is included in Appendix B.

Table 7: Corridors discounted during options appraisal

Corridor[1]	No.	Reason for discard
Holmfield to GNRT	8	This alignment, while technically feasible, would result in a highly indirect link between Halifax and Bradford, and Halifax and Queensbury. Wholly highway based, it is also not in keeping with the aspiration for a greenway network between the towns.
Windy Bank (top) to Queensbury	9	This alignment was initially partially incorporated into the overland option between Holmfield and Station Road. The northern section of this alignment is unfeasible without significant changes to the highway layout and character in Queensbury.
Halifax to Windy Bank (top)	9s	This alignment travels through areas previously investigated and discounted for provision by Calderdale Council. It faces the same topographical challenges as other corridors but misses any opportunity to connect strategic towns into the network.
Windy Bank	10	Windy Bank is a steep road bounded by stone walls. This alignment starts and ends in similar locations to alternative options and provides no benefit over these options.

For corridor locations, refer to Figure 6.

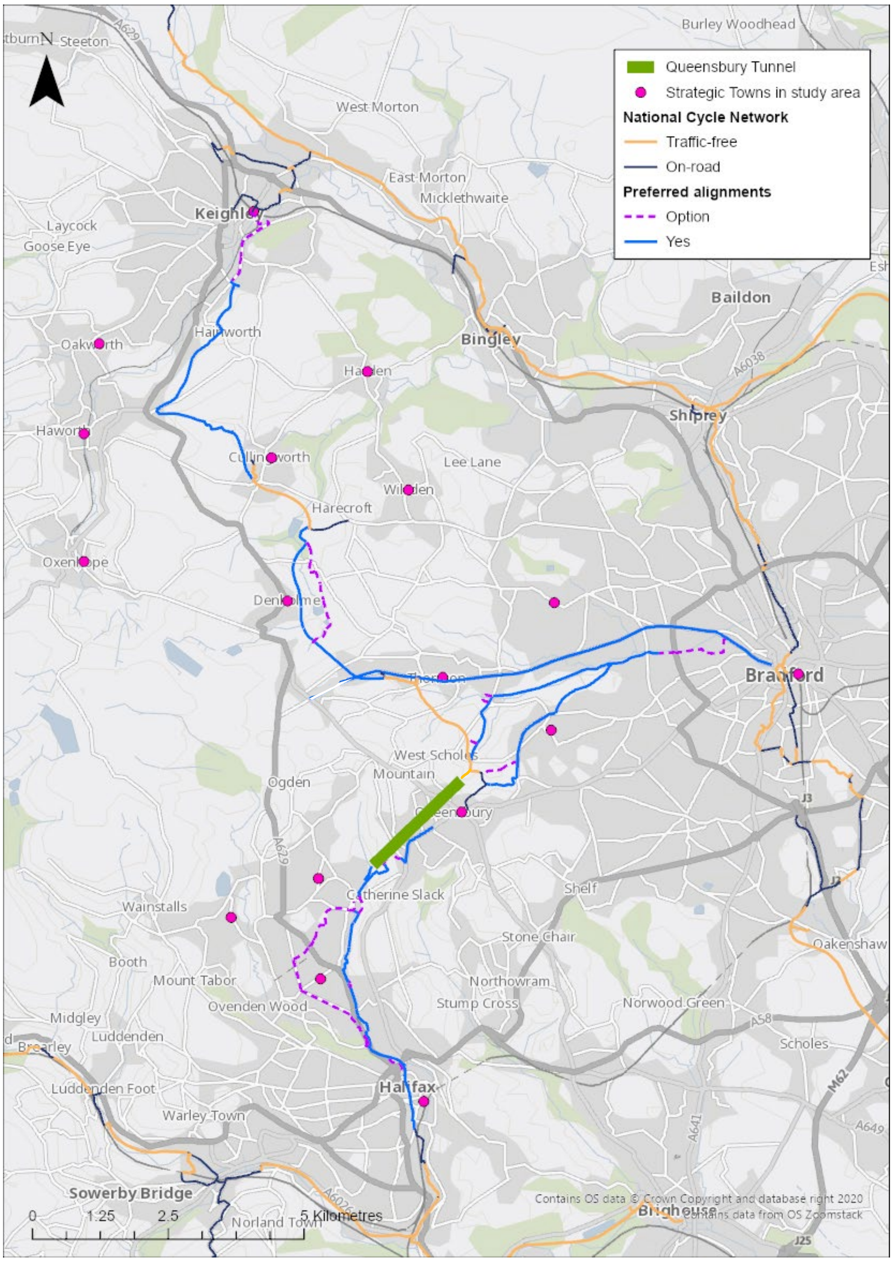

Figure 7: Preferred alignments at Stage 2. No preferred alignment was identified through Queensbury during Stage 2.

4.3. Stage 3: Preferred alignments and route proposals

The preferred alignments report and associated maps were used to engage in further discussion with key stakeholders as to the suitability of the proposals. Representatives within CBMDC and Calderdale Council were requested to share the report amongst relevant officers within their organisations, in order that any relevant issues associated with the alignments be identified. Additional feedback was received from CBMDC Rights of Way Officers, and Calderdale Transport officers.

Feedback was also sought from the following non-local authority stakeholder groups:

- Queensbury Tunnel Society
- Great Northern Railway Trail representatives
- Friends of Bradford Becks
- Clayton Deep Lane group

After the rationalisation of initial corridor options, a strategic decision was made to include access to the settlement of Queensbury as a feature of all route options appraised. The inclusion of Queensbury as a connected settlement provides a consistent baseline for the comparison between the value of route options including or excluding Queensbury Tunnel. Queensbury is also identified as a strategic location in regional and district transport policy. The final alignments to be developed for costing, and associated route options to be taken forward were presented to and agreed with CBMDC on 5th August 2021.

The final alignments described in Chapter 5 vary slightly from the preferred alignments developed during Stage 2. The final alignments take account of design feasibility issues identified during the development of the concept design, and stakeholder feedback received during Stage 3.

5. Final alignments

Definitions

This chapter includes the use of the terms ‘corridor’, ‘alignment’ and ‘route’. For the avoidance of any doubt:

- **Corridor**: regions between named locations. Corridors contain alignments.
- **Alignment**: intended path along which provision will be provided. Multiple alignments may be present in a single corridor.
- **Route**: a set of alignments, including at least one from each corridor, combine to create a route.

This chapter describes the final proposed alignments, describing the character of each and the types of provision that would be suited to the varying environments found along their lengths. Chapter 6 describes how the alignments are combined to create the route options.

Twenty General Arrangement (GA) drawings are provided with a Key Plan in Appendix C. Summaries of proposed provision presented in sections 5.3 to 5.7 should be read alongside the General Arrangement (GA) drawings. Tables summarising the proposed provision include the corresponding GA sheet numbers in their headings.

Where further details for particular section(s) within an alignment are provided, the section(s) are identified using an alphanumeric system. Corridors in the study area converge on GA sheet 11, which is considered the centre of the study area. The alphanumeric system starts at the furthest extent of each corridor. The system can be summarized as follows:

- K101 to K148: Keighley to Station Road, Queensbury, travelling south
- B101 to B123: Bradford West Clayton option, travelling west
- B201 to B205: Bradford West Thornton Road option, travelling west
- H101 to H128: Halifax to Holmfield Greenway and Alpine options, travelling north
- H201 to H217: Halifax to Holmfield Highway and Tunnel options, travelling north

Final alignments were developed taking account of design feasibility and stakeholder feedback. In some areas, alignments represent the most likely short-to-medium deliverability, but an aspirational long-term option remains. Where there is potential for improved provision in the future this is described in the study narrative.

The following recommendations are considered to be sufficient for the feasibility assessment this study represents. As such, they would be subject to further investigation at subsequent design stages.

For the purposes of the Construction (Design and Management) Regulations 2015 (CDM 2015), the recommendations provided for each alignment are considered to be design advice. A Designers Risk Register is included in Appendix D.

5.1. Development process for leisure-focused alignments

Where possible, route alignments are suggested as traffic-free infrastructure on the assumption this would be the preference of any user. If traffic-free provision is not possible, we have opted for routes within the highway, but with separation from traffic where volume and speed dictates this.

Where neither traffic-free nor separated options are possible or viable, roads with low traffic volume and speeds have been chosen to complete the alignments. If a road is not currently suitable but has the potential to be so, modifications to existing road layouts and access are suggested, to ensure traffic volumes and speeds remain at a level that will attract walking and cycling.

Across the study area, traffic-free provision is provided at either 3m or 4.5 m widths. The choice of width for any individual section was determined by considering the likely demand it may experience, its buildability and likely visual impact of the completed path. Where alignments cross steep slopes, or pass through greenfield rural landscapes, 3m widths have usually been specified to minimise impact during and after construction. Sections of alignment where anticipated use is likely to be high, and/or risk of user conflict is increased (e.g. nearer urban centres and through tunnels) are specified to 4.5m width where possible. In taking this approach, we anticipate that the specified widths will match a likely uneven distribution of user demand across any individual route.

5.2. Development process for utility-focused alignments

Provision of utility-focused active travel routes is an ongoing focus for both CDMBC and Calderdale Council. As a result, in Bradford and Halifax it has been possible to use existing proposals that are supported by the Transforming Cities Fund (TCF) and West Yorkshire Transport Plus (WY+TF) fund as the foundation of the highway-based alignments.

Where existing proposals do not provide a complete route as required by this study, additional links are suggested. Utility-focused alignments prioritise access to and from surrounding settlements over traffic-free provision. Therefore, utility-focused alignments are primarily highway based. Alignments along existing roads are a combination of mixed-traffic or separated provision as appropriate. Unlike the leisure-focused approach, equal hierarchy is assigned to the use of low-traffic routes and suitable separated provision on busier links.

Relevant Infrastructure Design Guidance

The design recommendations in this study and accompanying documents have been developed with reference to current walking and cycling infrastructure design guidance. Relevant guidance used to inform the design recommendations is listed in Table 8.

Table 8: Walking and cycling infrastructure design guidance documents

Title	Author	Version
Cycle Infrastructure Design: LTN1/20	Department for Transport	2020
Traffic-Free Routes and Greenways Design Guide	Sustrans	2020
Traffic Management and Streetscape: Local Transport Note 1/08	Department for Transport	2008
Traffic Calming: Local Transport Note 1/07	Department for Transport	2007
Manual for Streets	Department for Transport	2007

5.3. Keighley to Station Road, Queensbury

Location

The Keighley to Station Road corridor is situated entirely within the jurisdiction of CBMDC. The corridor starts at Keighley Railway Station and includes Hainworth, Cross Roads, Cullingworth, Denholme and Thornton (Figure 2). Much of the proposed alignment makes use of existing traffic-free bridleways or permissive routes. Short sections of on-road provision connect longer traffic-free links.

Existing walking and cycling infrastructure includes a footpath linking Hainworth and Cross Roads, a bridleway linking Cross Roads with Cullingworth, and the Great Northern Railway Trail and Station Road (NCN 69). The GNRT currently provides two high quality well-used leisure links between Cullingworth and Haworth Road via the Hewenden Viaduct, and between Thornton and Station Road via the Thornton Viaduct. The proposed alignment within the Keighley to Station Road corridor connects and extends these two existing sections of GNRT to provide an extensive, largely traffic-free route. At the southern-most end, Station Road is a no-through road linking the GNRT with Queensbury itself. An equestrian centre and shop, and a small number of residential and farm properties are located on Station Road. The majority of properties accessed from Station Road are clustered at its southern end. Station Road is also used as an access route to the northern portal of Queensbury Tunnel for maintenance contractors.

Topography

The topography between Keighley and Station Road is characterised by a series of ridges and valleys of varying steepness. Within the northern GNRT section, two disused railway viaducts serve to minimise elevation changes between Cullingworth and Denholme. A third viaduct south of Thornton enables a gentle gradient to be achieved in the southern section of the GNRT. Along the new alignment to Keighley, and between the two sections of the existing GNRT, it is ridges that present the most significant obstacles. Between Keighley and Cullingworth, unnecessary elevation gain has been minimised by the use of an indirect alignment. Between Cullingworth and Station Road, it is proposed that a series of disused tunnels are brought back into use to pass under high ground. Travelling north to south along the corridor the route is broadly in ascent, with the steepest gradients between Keighley and Cullingworth, and on Station Road, Queensbury. Gentle gradients from Cullingworth to Station Road reflect the fact that the alignment follows the route of the disused railway.

Flooding and Drainage

Along Low Mill Lane, Keighley, approximately 100 m of the route lies within flood zone 2, assessed as having medium flooding risk. At Denholme, the route crosses Carperley Beck, listed as flood zone 3, within the new housing development (Ref: 19/05214/MAF). No further river flood risk zones are present within the corridor. A drainage assessment has not been undertaken.

Structures

There are a number of existing structures situated within the Keighley to Station Road corridor. These are detailed Table 9. The scope of this study excludes assessment of the condition of structures in the study area. An estimate of the current condition of structures has been derived from third-party information where available.

Table 9: Relevant structures between Keighley and Station Road, Queensbury

Structure name and approximate location	Description	Ownership	Current condition/use if known
Bridge/Culvert (K107a)	Masonry.	Unknown	Unknown, though no evidence of subsidence in road above.
Bridge (K116 – K117)	Masonry overbridge on private land.	Unknown	Unknown. No visible issues from beneath bridge. In use as private vehicular access to property.
Cullingworth Viaduct (K120 – K121)	9-span masonry arch viaduct.	DfT[1], Sustrans lease.	Good. In use as part of GNRT traffic-free path.
Moat Hill Farm Bridge (121a)	Masonry arch overbridge.	Sustrans	Good. In use as part of GNRT traffic-free path.
Hewenden Viaduct (K122 – K123)	17-span masonry brick arch. Grade II listed.	DfT[1], Sustrans lease.	Good. In use as part of GNRT traffic-free path.
Whalley Lane Bridge (K129a)	Masonry arch underbridge.	RPL owned.	Unknown. Presumed fair from most recent records. Inspection recommended prior to detailed design.
Inverted Arch A (K131 – K132)	102m masonry inverted arch.	Private 3rd Party	Unknown. Localised spalling evident >10 years ago. Inspection recommended prior to detailed design[1].
Inverted Arch B (K133 – K134)	30m masonry inverted arch.	Private 3rd Party	Unknown. Condition assessed as good >10 years ago. Inspection recommended prior to detailed design[1].
Doe Park Tunnel (K135 – K136)	128m stone/brick tunnel.	Private 3rd Party	Unknown. Areas of spalling brickwork evident >10 years ago. Vegetation encroaching on sealed portals. Base of cutting very wet. Inspection recommended prior to detailed design[2].
Hamers Tunnel (K139 – K140)	140m stone/brick tunnel.	Private 3rd Party	Unknown. Localised spalling identified >10 years ago. Inspection recommended prior to detailed design[1].
Well Heads Tunnel (K141 – K142)	605m stone/brick tunnel.	Private 3rd Party/DfT[1]	Unknown. 2017 report suggests tunnel in reasonable condition[3]. Northern portal is currently infilled. Inspection recommended prior to detailed design.
Thornton Road Bridge (K142a)	Bridge supporting Thornton Road.	Unknown	Unknown. Records have not been identified. Structural inspection and repairs required to enable route to pass beneath Thornton Road.
Thornton Viaduct (K144 – K145)	20-span masonry brick arch viaduct. Grade II listed.	DfT[1], Sustrans lease.	Good. In use as part of GNRT traffic-free path.

1: Owned by the Secretary of State for Transport, managed by HRE, 2: Stakeholder information, 3: Examination reports for Well Heads Tunnel, Carillion (2017)

5.3.1. Proposed provision: Keighley to Station Road, Queensbury

Table 10 and Table 11 describe the general nature of different interventions proposed in the Keighley to Station Road corridor, a description of where they are located, the design challenges and any areas where achieving the recommendations of current guidance is not possible. The suggested solutions are considered to be feasible following a number of site visits, collation of information from desk study research, and consultation with a small number of key stakeholders. Each recommendation will require further stages of investigation, design and development prior to implementation.

It is intended that the tables are read in conjunction with the general arrangement drawings. A full breakdown of each section identified in the general arrangement drawings is available in the design schedule in Appendix E. Within the tables, provision is grouped by infrastructure type to provide a summary of the key information available in the schedule. For each provision type, the relevant key symbol from the GAs is shown, to assist with cross referencing.

In some sections, assumptions as to the feasibility of future delivery have necessarily been made, e.g. the viability of the future use of tunnels to provide continuity to the alignment. Risks to delivery of routes are captured in the project risk register, included in Appendix F.

Table 10: Proposed provision – Keighley to Station Road, Queensbury

Keighley to Station Road, Queensbury (To be read in conjunction with GA Sheets 1 - 11)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations from Guidance*
Cycling in mixed traffic environment		Keighley Station to Park Lane (KSPL), Hainworth Wood Road North, Hainworth, Cross Roads	Alterations to street environment to provide safe conditions for cycling in mixed traffic. Alterations may include the addition of modal filters/bus gates, formalisation of parking provision, speed limit reductions and traffic calming features.	Provision in place on public highway. Removal/formalisation of parking and implementation of traffic restrictions may face public opposition.	Cobbles at Low Mill Lane (KSPL) and Hainworth Lane (Hainworth) are not a smooth surface. Vehicle movements in and out of Pitt Street (KSPL) are assumed to be infrequent, however additional measures may be required if volumes are higher than anticipated. Gradient at Hainworth (~10%) exceeds recommended maximum.
Shared use path		Park Lane	Eastern footway built out to provide 3m shared use space.	Insufficient highway width to provide separated infrastructure.	Shared use provision within the urban environment is not generally recommended by LTN1/20. However, in the absence of workable alternatives this is suggested to provide continuity of the wider cycle route.
3m wide traffic free route		Hainworth Road, Hainworth to Cross Roads, Sugden House Farm to Lakeside Farm, Hewenden reservoir to Denholme	Asphalt surfaced path with sub base extended beyond path width.	Hainworth Road currently unadopted highway. TRO required to close through road/reclassify as bridleway. Footpath upgrades/bridleway creation orders will be required (short section already subject to upgrade request). Land ownership. Ecological constraints present in most stretches with mitigation and/or compensation likely to be required.	Hainworth Road gradient (average 10%) exceeds recommended maximum.
Trotting strip		Hainworth Road, Hewenden Reservoir to Denholme	Compacted sub-base with seeded topsoil layer.	Vegetation removal may be necessary to provide sufficient overhead clearance. Lack of available space to provide continuous trotting strip beyond areas indicated.	Trotting provision will not be continuous along route. Surfacing in some places will therefore not meet BHS preferred standard.

Keighley to Station Road, Queensbury (To be read in conjunction with GA Sheets 1 - 11)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations from Guidance*
Resurfacing		Hainworth Road (part), Hainworth, Cross Roads to Sugden House Farm, Lakeside Farm to GNRT, Glen House driveway.	Existing surfacing renewed.	Land ownership. Mix of highway status: part-adopted, private access track, footway, bridleway. Upgrade/provision orders as appropriate. May require land purchase. Potential for stakeholder objection.	Gradient exceeds recommended maximum in some areas. See schedule for full details.
Route access ramp		Hewenden Reservoir	Earthworks ramp ascending to railway embankment level.	Vegetation clearance required. Challenging construction environment – steep slopes.	
4.5m wide traffic free route		Denholme to Thornton	Asphalt surfaced path with sub base extended beyond path width.	Land ownership. Bridleway creation order will be required.	
Tunnels		Denholme to Thornton	Structural checks and repairs, lighting. Motion sensitive CCTV and secure gates at tunnel portals.	Constrained construction environment. High ecological (bat) risk will require full surveys to be completed and likely mitigation. Restoration assumed feasible. Risk to route delivery if surveyed condition precludes use.	
Improved existing traffic free route		Existing GNRT between Cullingworth and Hewenden Reservoir, and Thornton and Station Road.	Improvements to existing traffic-free provision. Current asphalt path, 2-3m along most of length. Where possible, path to be widened to 3m min and resurfaced. Surfacing will remain asphalt.	Existing GNRT owned/managed by Sustrans/RPL, negating land ownership issues. A new trotting strip is not specified but may be possible in some areas. It is unlikely to be possible along the whole length however.	Small pinch points may remain. There is a risk that creating a continuous trail increases usage rates to the extent that provision is no longer sufficient. There is no intention to provide new lighting. This accords with guidance where route is primarily anticipated to be used for leisure purposes (Sustrans).

Table 11: Proposed provision – Station Road, Queensbury

Station Road, Queensbury (To be read in conjunction with GA Sheet 11)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
Resurfacing		Station Road (North end to April Gardens)	Resurfacing existing road at grade.	Station Road is part-adopted. Land and legal negotiations are likely to be required.	Gradient exceeds maximum 8% for new ramps. As an existing road this is acceptable, but it is recognised that the gradient may be uncomfortable for some users.
Cycling in mixed traffic environment		Station Road (April Gardens to A647)	Alterations to street environment to provide safe conditions for cycling in mixed traffic. Alterations may include formalisation of parking provision and reduction of speed limit to 20mph.	Removal/formalisation of parking and speed restrictions may face public opposition.	Station Road is a no through road with low traffic volume. Reduction of speed limit would ensure southern end of Station Road is suitable for all users.

5.3.2. Corridor costs: Keighley to Station Road, Queensbury

There is only one alignment within the Keighley to Station Road corridor, therefore for this corridor, alignment and corridor costs are synonymous.

Total alignment length = 16.2 km

Table 12: Corridor cost – Keighley to Station Road, Queensbury

	Construction Costs (without preliminaries)	Construction Preliminaries[1] (@ 15%)	Contingency[2] (@ 10%)	Design & development[3] (@ 8%)	Ecology[4] (@ 15%)	Land & Legal[5] (@ 10%)	Route Infrastructure Total	Queensbury Tunnel Refurbishment Total	Total
Costs excluding Optimism Bias & VAT (£)	6,415,930	962,390	737,832	649,292	880,014	490,124	10,135,582	-	**10,135,582**

[1]Calculated as percentage of construction costs without preliminaries. Applied to whole scheme.
[2]Calculated as percentage of construction costs with preliminaries. Applied to whole scheme.
[3]Calculated as percentage of construction costs with preliminaries and contingency. Applied to whole scheme.
[4]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[5]Calculated as percentage of construction costs without preliminaries. Applied to individual links.

5.3.3. Additional improvements: Keighley to Cullingworth

The route alignments put forward in this study have been informed by discussions with representatives from CBMBC, Calderdale Council, the Great Northern Railway Trail group, and Queensbury Tunnel Society at the alignment feasibility stage. Between Keighley and Cullingworth, the proposed alignment represents a pragmatic suggestion that is likely to be achievable in the short term. Stakeholders are aware of the merits of seeking to pursue the suggested alignment at this stage, despite the challenging gradients present predominantly in the northern section. However, there is potential for additional improvement of the route between Keighley and Cullingworth:

Adding stretches of the disused railway line and Lees Moor Tunnel (Figure 8)

- Improving existing at-grade crossings on Headley Lane and Cockin Lane

It is assumed that the additional opportunities would be pursued separately from the overall route development. Therefore, costs for these improvements are excluded from the cost estimates presented in this study.

Additional stretches of disused railway line

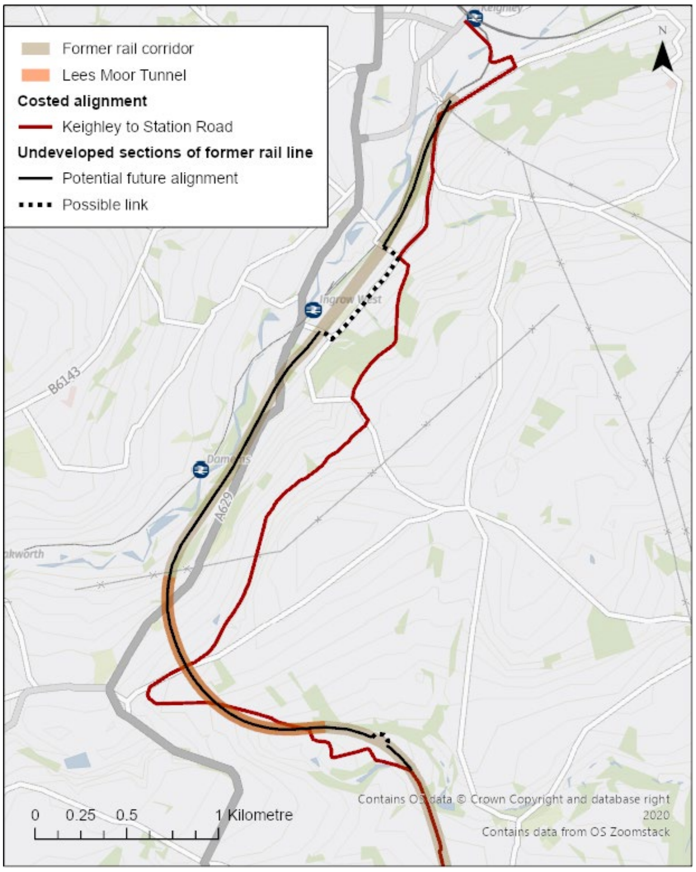

Figure 8: Undeveloped former railway line between Keighley and Cullingworth

Greater use of the former railway line has the potential to enhance possible tourism opportunities, particularly in the context of delivery of the Most Advantageous and Attractive or next-preferred route options outlined in Chapter 6. It is recommended that where sections of the disused railway between

Keighley and Cullingworth remain available for future use, consideration is given as to whether steps can be taken to ensure this opportunity is protected.

Development of the former railway corridor is not without additional challenge (not least the need to incorporate several additional structures, see Table 13). Exploring the potential for use of Lees Moor Tunnel would be key to the future development of this alternative alignment. Lees Moor Tunnel is currently in private ownership, and in active use as a storage facility. At 1.4km in length, Lees Moor Tunnel is a structure that is likely to be a costly option for the provision of a cycling and walking route along its length. However, long-term, an alternative alignment through the tunnel has the potential to avoid some of the steepest gradients on the existing alignment.

Table 13: Structures relevant to future possible upgrades between Keighley and Station Road, Queensbury

Structure name and approximate location	Description	Ownership	Current condition/use if known
Keighley Goods Tunnel	Beneath Parkwood Street in Keighley. Stone/brick.	DfT[1]	No severe defects noted in 2017[2]. Northern portal is buried. Southern portal is bricked up.
Hainworth Lane Bridge	Hainworth Lane passes over bridge.	Unknown	Unknown. Believed to be clear beneath bridge.
Unknown Tunnel	Tunnel beneath Oakvale, Keighley	Unknown	Unknown. No records identified.
A629 Halifax Road Bridge	Halifax Road passes over bridge.	Unknown	Unknown. Infilled.
Damems Lane Bridge	Damems Lane passes under (no longer existing) bridge.	Unknown	Abutments remain.
Lees Moor Tunnel **(GA3, GA4)**	This structure is a historic stone/brick tunnel between Ingrow and Cullingworth. The tunnel is currently used to store caravans. The southern (Cullingworth) portal is sealed with concrete block wall. The northern (Ingrow) portal is secured with lockable gates and shutters within a steel frame extension.	Private 3rd Party	Unknown. Condition report dated March 2017[2] recommends replacement of brickwork, repointing and water control/drainage works be carried out prior to 2018/2020 at several locations within the tunnel.
Headley Lane Bridge (K145a)	Bridge supporting Headley Lane.	Unknown	Unknown. Records have not been identified. Bridge currently bypassed. Structural inspection and repairs would be required to enable crossing under Headley Lane. Not part of proposed alignment but could form improved crossing point in future.

1: Owned by the Secretary of State for Transport, managed by HRE, 2: Examination reports for Keighley Goods Tunnel (ELR: SDK/63A) and Lees Moor Tunnel (ELR: SDK/55B), Carillion (2017)

Improved crossings

Proposals presented in this study include improvement of the existing GNRT. This includes widening the path and providing a new adjacent trotting strip where practicable, and resurfacing areas where degradation has occurred. As use of the trail increases, particularly if the trail links to wider corridors and a route through Queensbury Tunnel, it may be desirable to improve the at-grade crossings at Headley Lane (K145a) and Cockin Lane (K146).

Headley Lane Bridge remains in place and could be incorporated into the existing alignment in the future, removing the need to cross Headley Lane. However, this would require substantial realignment of the path to sit within the railway cutting to the north and south of Headley Lane, and assessment and any required repairs to the bridge. The cutting and bridge surrounds are heavily vegetated. It is likely that incorporation of the bridge into the path alignment would be costly. Headley Lane is narrow, and while visibility of the current crossing point could be improved, the width of the existing carriageway naturally limits the speed of most vehicles. It is suggested that proposals to reincorporate the bridge are deferred at this stage in deference to further development of the wider route, but steps are taken to ensure that re-incorporation of the bridge remains possible. Minor improvements to the crossing could be incorporated into future stages of design in this section.

Cockin Lane is a wider road than Headley Lane with reportedly higher traffic flows, but with carriageway narrowing in the location of the crossing. Previously the railway passed over Cockin Lane on a bridge (since demolished) between embankments, but unlike the Headley Lane no historical structure remains. Therefore, provision of a grade-separated crossing would require a new structure to be constructed. This study is concerned with establishing feasibility of the routes as a whole and therefore, costs for improvement of the crossing have not been included at this design stage. However, provision of a grade-separated crossing should be considered as a priority if one of the Tunnel routes is progressed. This could be as a stand-alone scheme or as part of the wider GNRT route improvements.

5.4. Discussion: Keighley to Station Road, Queensbury

The suggested alignment between Keighley and Station Road is included in the Draft Bradford District Local Plan Policies Map 2020-2038 (Figure 9). The route supports policy TR1, part F: "Identify, protect and develop appropriate facilities and high-quality infrastructure for active travel modes (walking, cycling and horse riding). Including identified strategic routes and networks as well as local routes and links where opportunities arise, linking into national and regional routes."

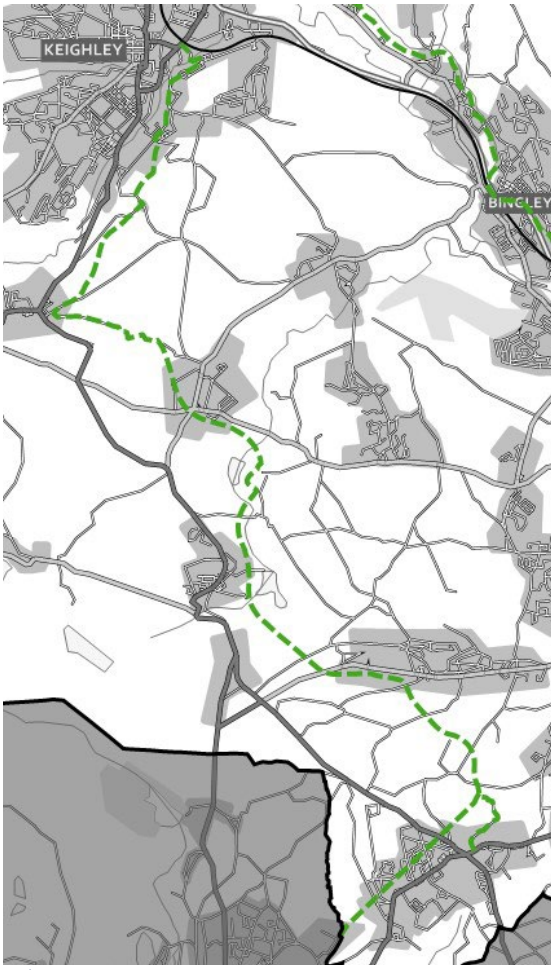

Figure 9: Extract from Draft Bradford District Local Plan Policies Map 2020-2038, showing the Keighley to Station Road alignment and Queensbury Tunnel.

From a leisure perspective, linking Keighley and Queensbury provides an opportunity to build on the existing popularity of the GNRT. Creation of a continuous route has the potential to reduce the current demand for vehicle use to access the GNRT. This opportunity gains further significance when considering how restoration of Queensbury Tunnel would increase demand along the existing traffic-free route.

Strategically, in conjunction with the adjoining corridors this alignment provides an alternative connection between Keighley and the wider area. Future rail and MTS provision is not planned between Keighley and Bradford/Halifax (West Yorkshire Connectivity Infrastructure Plan) so provision of a continuous active travel corridor enables a choice of mobility, particularly between Keighley and

Halifax. While distances are relatively large, the advent and growth of e-bike use further increases the potential for this corridor to provide alternative mobility options. Located in a largely rural corridor, the Keighley to Station Road, Queensbury alignment also serves to support inclusive growth in smaller communities, in line with the aspirations of the WY Strategic Economic Framework.

Summary of Design Challenges

There are clear benefits to providing this alignment, but topographically the Keighley to Station Road, Queensbury corridor is challenging. Provision that fully addresses the guidance of LTN 1/20 is unachievable, in particular the principles of comfort and directness. This is as a result of the varied topography throughout the area. The proposals in this feasibility study represent a pragmatic solution which will be suitable for most users. A summary of the constraints and rationale to address them are described below.

Between Keighley (K101) and Cross Roads (K113) two main physical challenges are present:

- Constrained highway conditions with a lack of suitable options to exit the town to the south
- Gradient

Coney Lane and Park Lane in Keighley are insufficiently wide to provide the necessary separated cycle lanes to protect users from high volumes / speeds of traffic. Choices of provision between K101 and K106 are as a result of this constraint:

The choice to route up the steeper Quarry Road (K102 – K103, approx. 15%, 50m), as opposed to shallower grade roads to the east (11% or 14%, ~50m) is based on a desire to avoid conflict with traffic using the industrial estate, which includes large goods vehicles. While the steepest option, Quarry Road minimises the need for users to move through the industrial estate, and allows them to join Parkwood Street where the road will be filtered.

The shared use path on Park Lane is the only means by which separation can be achieved between users and traffic. Reduction of traffic volumes along Park Lane is highly unlikely due to a lack of alternative route options. The average gradient on Park Lane (12%) exceeds the recommended maximum, but as a pre-existing highway, there is no scope to ease this.

Consideration should be given as to whether it would be appropriate to begin the Keighley to Station Road alignment at the start of Hainworth Road (K106). This would avoid the initial sections exiting Keighley but would also raise issues of coherence, with users travelling to and from Keighley town centre left to navigate challenging road conditions. It is likely that a lack of provision to the town centre would result in low use of the route due to safety concerns.

Locations with gradient challenges

In addition to the sections described above, steep grades are present on:

- Hainworth Road (K107 – K109): 10% average, max 16%
- Moor Bottom Lane (K110 – K111): 14% for 50m on approach to existing footpath
- Sudgen End Farm track (K114 – K115): extended section of 7%, max at 12%

- Station Road, Queensbury (K147 – K148): average 10%

Hainworth Road (K107-K109)

Hainworth Road (K107 – K109) is an unadopted road open to through traffic. The existing surface is poor, which limits vehicular use primarily to access only, with the occasional off-road through-vehicle. Installation of a modal filter is proposed to prevent vehicular through-traffic. Alternative overland alignments feature similar gradients or constrained highway conditions. The presence of local plan site KY26/H may introduce opportunities to ease gradients along part of Hainworth Road. Conversely, the presence of ancient woodland to the south of the local plan site prevents works extending beyond the alignment of the road in the vicinity of the proposed modal filter.

Moor Bottom Lane (K110 – K111)

Moor Bottom Lane is a short section of track linking Hainworth and an existing footpath. Alternative provision to reach the existing footpath would require numerous landowner negotiations, and deviation from the Local Plan alignment. This is not thought to be commensurate with the short stretch of steep gradient at this point.

Sudgen End Farm track (K114 – K115)

Sugden End Farm track is an existing bridleway. As with other links, alternative overland alignments are not easily available.

Station Road, Queensbury (K147 – K148)

Station Road is an unadopted road in poor condition with numerous potholes and a generally degrading surface. Despite challenges with gradient, Station Road is the preferred route between the GNRT and Queensbury, benefiting from a lack of through traffic and a comparatively direct alignment. The adoption of Station Road and improvement to its condition are part of the 'more ambitious' plans for the TCF-funded West Bradford Cycle Superhighway Extension Project.

For each of the links above, it is considered that the benefits of the traffic free nature of the link outweighs the challenges introduced by the gradient. With a smooth surface specified and resting places provided, further design will seek to minimise the challenge presented by the gradient for most users.

Delivery Challenges

Challenges between Keighley and Station Road can generally be categorised as:

- Landowner issues: route crosses private land or unadopted highway, requiring land purchase, access negotiation or highway adoption.
- Ecological constraints: route passes by areas of priority habitat, requiring mitigation and compensation. Required ecological surveys may identify additional ecological constraints.

- Stakeholder issues: proposals to filter existing through routes are likely to meet with opposition. The route will also require multiple upgrades to existing public rights of way, and creation orders where none currently exist. These processes also have the potential to meet with public opposition.

Specific instances of these challenges are detailed in the design schedule and summarised at the end of this chapter (Table 29).

Tunnels

Between Denholme and Thornton (K130 to K143) six disused structures are present in the former railway corridor, of which three are tunnels. Delivery challenges carry particular significance for tunnels because their presence implies that a corresponding direct route on the surface is unsuitable for use. Should a tunnel prove unsuitable for use, it is likely that an alternative surface alignment will be indirect, uncomfortable, or both. In addition to particular ecological risks associated with tunnels (namely the possible presence of bats and bat roosts), likely challenges include transfer of ownership and ensuring structures are safe for public use. An ecological assessment of the issues in all potential alignments is included in Appendix G.

The tunnels and structures included in this alignment have not been inspected for their condition, as this is outside the scope of this commission. It is also known that some are in private ownership. However, it is considered that the potential benefits associated with their inclusion outweigh the risks. Connecting Hewenden and Thornton Viaducts via these six structures has the potential to significantly enhance the user experience along the already well-known and well-used GNRT. Should development of this alignment be coupled with a decision to retain Queensbury Tunnel, there is a potential to create an iconic traffic-free route in West Yorkshire.

Other risks and opportunities

There is a risk that works to improve the condition of Station Road may lead to higher vehicle numbers seeking to park at the base of the climb to access the GNRT, particularly if improvements are delivered as part of the wider network proposals set out in this study. In order to mitigate potential negative effects of increased demand, it is suggested that vehicle access to Station Road is restricted to residents, their visitors, and disabled people only. Consultation with residents is recommended to establish the preferred approach to achieving such a restriction.

Local plan sites adjacent to Hainworth Road and Station Road, Queensbury have the potential to introduce additional vehicular traffic onto the proposed route. Sensitive development of these sites will be required, and it is recommended that appropriate conditions are attached to any developments on these sites to avoid compromising the proposed provision. Local plan sites also represent an opportunity to provide additional links for pedestrians and cycles to the route thus increasing the potential for its use.

Stakeholder feedback

A preliminary draft of the route proposals and feasibility study was shared with key stakeholders in August 2022. A summary of all feedback received from stakeholders is provided in Appendix H, along with Sustrans' responses and actions. Actions are divided into four categories: no action, amend study, consider at later design stage, and record response. The following feedback falls into the “record response” category. Feedback on route proposals in this category is considered by Sustrans to be important to acknowledge in the main body of the study but has not resulted in any material change to the study draft.

GNRTDG:

- Stated preference of options considered appears to coincide with suggested alignment.
- Suggest that the section between Keighley town centre and Hainworth should be considered separately to any funding bid for the wider routes.

QTS:

- Support proposal to connect existing sections of GNRT via disused railway alignment
- Suggest that Cockin Lane crossing improvements be included at the outset, rather than as part of future options
- Adoption and improvement of Station Road, Queensbury must be regarded as fundamental to the core network. Support proposal to restrict access to Station Road to residents, visitors and deliveries etc. only.

5.5. West Bradford

Location

The West Bradford corridor contains two possible alignments: the highway option along Thornton Road, and the greenway option to Queensbury via Clayton. Each of these alignments is situated entirely within the jurisdiction of CBMDC. The corridor starts at Godwin Street, West Bradford. The highway alignment passes Girlington, Crossley Hall, Lower Grange and Hill Top to reach Thornton Road Primary School. The greenway alignment passes near Listerhills and Lidget Green, before ascending to and through Clayton to Queensbury. The highway alignment is entirely situated on public highway. The greenway alignment follows a mixture of existing rights of way, public highway and private land.

Existing walking and cycling infrastructure in the highway option includes footways and intermittent advisory cycle lanes along Thornton Road. Along the greenway option, existing provision includes footpaths linking Deep Lane with Cemetery Road at the east and Town End Road at the west. Deep Lane itself is designated as a bridleway, as is a link to Crossley Hall. South of Clayton a network of footpaths cross fields between Baldwin Lane and Station Road, Queensbury. The proposed greenway alignment links these existing rights of way to provide two sections of largely traffic-free route, connected by highway-based provision along The Avenue and Baldwin Lane. The proposed alignments would connect the existing NCN 66 running north to south through Bradford with the GNRT (NCN 69) to the west.

Topography

The topography of the West Bradford corridor varies slightly with alignments. Thornton Road gradually ascends from east to west, with gentle gradients increasing from 1-2% near Bradford to 3% at the Thornton End. Along the greenway alignment a similar pattern of gradually increasing gradient is evident. However where the highway alignment gains approximately 130m, the greenway alignment rises approximately 180m. At a similar length to the highway option, gradients are steeper along the greenway option, but remain mostly below 5% with short sections of 5-8% in the steepest parts.

Flooding and Drainage

Along the highway alignment, short sections of Thornton Road are situated within flood zone 2, at medium risk of flooding. Along the greenway alignment, Preston Road at the eastern end is situated with flood zone 2. The steep-sided Clayton beck runs to the north of the proposed alignment, but it is only where the route crosses Bull Greave Beck that it re-enters a flood zone. At Bull Greave beck the alignment sits within flood zone 3. No further areas of the alignment are within a river flood zone in this corridor.

A drainage assessment has not been carried out within the corridor. However, alignments have been reviewed by CBMDC. A culvert at the southern end of Deep Lane has recently been repaired, allowing this route to dry out in recent months, after years of frequent inundation due to surface run-off.

Structures

Few structures are present within the West Bradford corridor. Table 14 identifies those relevant to the suggested alignments.

Table 14: Relevant structures in West Bradford corridor

Structure name	Description	Ownership	Current condition/use if known
Bull Greave Beck Bridge (B110)	Wooden deck with metal railings.	Unknown	Fair, but too narrow to support new cycle path. Non-culverted replacement solution required.
Middle Brook Beck Bridge (B111b)	Concrete deck over unknown supports.	Unknown	Presumed fair. In use as vehicle route.
Retaining wall to south of Deep Lane	Dry stone retaining wall with Armco barrier at crest.	Unknown	Poor. Responsibility for stabilisation lies with landowner to south of Deep Lane. Retained land is listed as local plan housing site.

5.5.1. Proposed provision: West Bradford

Table 15 and Table 16 describe the general nature of different interventions proposed in the West Bradford corridor. Limited details are provided for the Thornton Road option, as this scheme is to be developed and funded through the TCF West Bradford Cycle Superhighway Extension. Details of the current state of proposals are available on the WYCA website[xxvi].

The suggested solutions are considered to be feasible following a number of site visits, collation of information from desk study research, and consultation with a small number of key stakeholders.

Each recommendation should be subject to further investigation at future design stages prior to implementation.

It is intended that the tables are read in conjunction with the general arrangement drawings. A full breakdown of each section identified in the general arrangement drawings is available in the design schedule in Appendix E. Within the tables, provision is grouped by infrastructure type to provide a summary of the key information available in the schedule. For each provision type, the relevant key symbol from the GAs is shown, to assist with cross referencing.

Table 15: Proposed provision – West Bradford, Thornton Road option

West Bradford: Thornton Road Option (To be read in conjunction with GA Sheet 9 and 18 - 20)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
Provision developed by others	(black bar)	Thornton Road	Provision of one way/two way separated cycle tracks along Sunbridge Road and /or Thornton Road, from Godwin Street to Thornton Primary School.	Delivered under TCF West Bradford Cycle Superhighway Extension scheme. Phase 1 – City Centre to outer ring road. Phase 2 – Outer ring road to Thornton Primary School. Link to Thornton Primary School and GNRT (and coherent route to Keighley/Queensbury Tunnel spur) is reliant on Phase 2 being delivered.	Thornton Road is one of the busiest roads in Bradford. Separation along full length of proposed route should be provided to ensure safe use for all users to reach traffic-free links.

Table 16: Proposed provision – West Bradford, Clayton option

West Bradford: Clayton Option (To be read in conjunction with GA Sheet 11 and 17 - 20)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
Cycling in mixed traffic environment	(purple bar)	Preston Street	Alterations to street environment to provide safe conditions for cycling in mixed traffic. Alterations may include the addition of modal filters/bus gates, formalisation of parking provision, speed limit reductions and traffic calming features.	Implementation of modal filter and formalised parking may face opposition.	Traffic speeds and volumes unknown. It is anticipated that with the installation of a modal filter and other measures the road will meet the conditions defined in LTN1/20 Figure 4.1.
Two-way cycle track	(blue bar)	North of Princeville Road	Separated cycle track to avoid conflict with movements in and out of industrial sites.	Planning permission granted for layout that precludes suggested alignment. Negotiation required to achieve satisfactory integration with scheme.	
One-way separated cycle track	(orange bar)	The Avenue	1.5m stepped cycle tracks between footway and carriageway.	Requires construction in active highway. Reallocation of road space may result in opposition from users of The Avenue.	The Avenue is 30mph road. Stepped cycle tracks are suitable for any volume of vehicles at 30mph (LTN1/20 Figure 4).

West Bradford: Clayton Option (To be read in conjunction with GA Sheet 11 and 17 - 20)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
Shared use path		Baldwin Lane Clayton Roundabout Cemetery Road crossing	Shared use footways to connect with existing toucan crossing on Cemetery Road. Extend western footway to create 3m shared use space on Baldwin Lane.	Requires construction in active highway. Pinch points at north end of Baldwin Lane preclude separated cycle tracks.	Shared use facilities are not generally recommended in urban settings. Baldwin Lane is not considered to be an urban setting. Provision of a shared use facility in this stretch allows continuity for the wider cycle route. Clayton Roundabout and Cemetery Road meets conditions for shared use at and around junctions, where cycles are likely to be moving more slowly.
3m wide traffic free route		West of Cemetery Road to mid-way up Deep Lane.	Asphalt surfaced path with sub base extended beyond path width. Motion sensitive lighting to enable secure use after dark.	Constrained construction environment within Deep Lane. Mix of PRoW status: private access track, footway, bridleway. Upgrade/provision orders will be required as appropriate. New bridge required over Bull Greave Beck. Beck should not be culverted. High ecological risk will require full surveys to be completed and likely mitigation. Results may impact on proposals for lighting.	If route becomes popular, risk that provision will be lower than recommended minimum width for high usage levels.
4.5m wide traffic free route		Listerhills Warehouse to Asda Southern section of Deep Lane and spur to Town End	Asphalt surfaced path with sub base extended beyond path width. Motion sensitive lighting to enable secure use after dark.	At West Bradford end, route passes through multiple development sites. May require negotiation with developers to achieve standard required. Footpath upgrade/bridleway creation orders will be required.	If route becomes popular, risk that provision will be lower than recommended minimum width for high usage levels.
Trotting Strip		North Clayton	Compacted sub-base with seeded topsoil layer.	Route through proposed local plan development site. Future planning and negotiation required.	
Resurfacing		West of Cemetery Road	Resurfacing existing road at grade.	Upgrade from footpath to bridleway required. Private driveway – land and legal negotiations likely to be required.	

5.5.2. Corridor costs: West Bradford

Clayton Option

Total alignment length (Clayton option) = 7 km

Table 17: Alignment cost – West Bradford, Clayton option

	Construction Costs (without preliminaries)	Construction Preliminaries[1] (@ 15%)	Contingency[2] (@ 10%)	Design & development[3] (@ 8%)	Ecology[4] (@ 15%)	Land & Legal[5] (@ 10%)	Route Infrastructure Total	Queensbury Tunnel Refurbishment Total	Total
Costs excluding Optimism Bias & VAT (£)	2,462,771	369,416	283,219	249,232	203,922	141,022	3,709,582	-	**3,709,582**

[1]Calculated as percentage of construction costs without preliminaries. Applied to whole scheme.
[2]Calculated as percentage of construction costs with preliminaries. Applied to whole scheme.
[3]Calculated as percentage of construction costs with preliminaries and contingency. Applied to whole scheme.
[4]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[5]Calculated as percentage of construction costs without preliminaries. Applied to individual links.

Thornton Road Option

Total alignment length (Thornton Road option) = 6.9 km

Costs for the Thornton Road option are not included within this analysis. This is based on the assumption that the Thornton Road TCF-funded scheme will be delivered using a separate budget, regardless of the implementation or otherwise of the proposals in this feasibility study.

5.5.3. Discussion: West Bradford

The suggested alignments connecting West Bradford to Thornton, and Clayton and Queensbury support the Regional Schematic Network concept, set out in the Bradford Cycle Strategy (Figure 10). The highway option is also identified within the District Schematic Network.

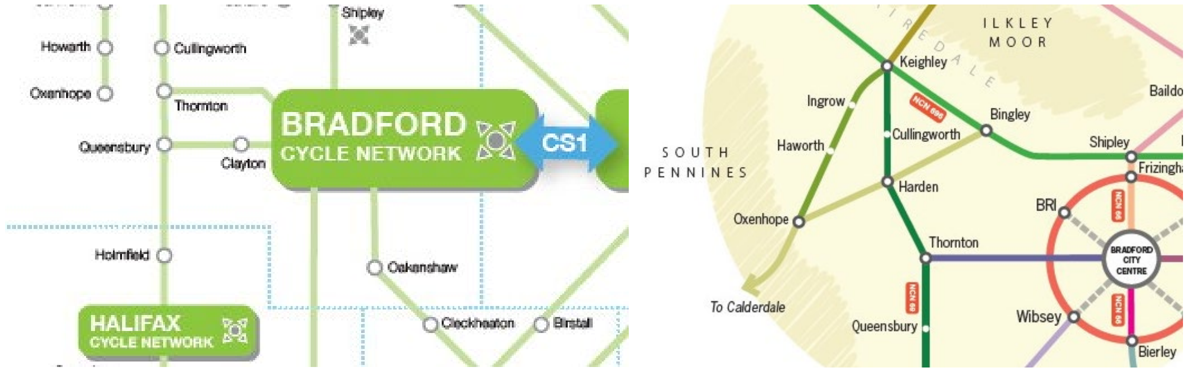

Figure 10: Extracts from Bradford Cycle Strategy Regional (L) and District (R) Schematic Networks, showing links between West Bradford and Thornton, Clayton and Queensbury

The two alignments in the West Bradford corridor contrast in character. The highway alignment is a highly visible facility alongside the busy Thornton Road, while the greenway alignment is mostly traffic free. Connecting Clayton with West Bradford via Deep Lane has long been the subject of a local campaign, with advocates promoting the possibility of use for school and work travel. It is envisioned that the highway option would be primarily used by commuters and utility users, whereas the greenway would support a mix of utility use to and from Clayton, and longer distance leisure use between West Bradford and the wider Bradford and Calderdale area.

Strategically, neither Thornton nor Clayton are identified as towns for future rail or MTS provision (West Yorkshire Connectivity Infrastructure Plan). Both are included in proposals for improved bus connectivity. Creation of active travel options to Clayton and Thornton will provide additional mobility choice.

Design Challenges

Design challenges identified in this section are all related to the Clayton option, as design and delivery of the Thornton Road option will be completed as part of the West Bradford Cycle Superhighway Extension project.

Limited space is available in the following locations along the alignment:

- Deep Lane (B111a – B113a): constrained by dry stone walls and vegetation
- Baldwin Lane (B118 – B119): pinch points prevent separate cycle lane provision
- Approach to Station Road, Queensbury (B120 – B123): pinch points along existing right of way

Deep Lane was a historically sandy/grassy lane, but decades of run-off from a broken pipe has resulted in a degraded and eroded surface. The broken pipe has recently been repaired. To achieve a 3m width, sections of the lower lane may require filling to raise the ground level between the dry-stone walls. The presence of the dry-stone walls also introduces challenges associated with the gradient of the lane. Although not generally steep, a slope is present along the whole length of Deep Lane. The constrained nature of the lane raises the possibility of conflict between uphill and downhill users. To minimise conflict it may be necessary to introduce intermittent chicanes to slow downhill traffic. Any such chicanes would be designed to allow passage of the LTN1/20 cycle design vehicle. Opportunities exist to incorporate aspirations for a linear park along Deep Lane into such design features. Where the lane ceases to be constrained a wider 4.5m provision is proposed.

On Baldwin Lane, there is insufficient carriageway width to provide separated cycle lanes. Therefore, it is proposed to extend the western footway to create a shared use path. It is considered that pedestrian use along Baldwin Lane is likely to be relatively low. With an extensive network of footpaths in the area, it may also be possible to sign alternative options from Clayton centre, reducing further the numbers of pedestrians required to use the shared use facility. Alternative options avoiding Baldwin Lane were considered but discounted due to the presence of steep gradients and level changes. On balance, Baldwin Lane is considered the best option to link Clayton and Queensbury, and benefits from linking into existing rights of way, albeit that extended lengths of footpath will require upgrading to bridleway.

West of Baldwin Lane existing footpaths provide a logical alignment that links with Station Road, Queensbury. Between B121 and B122 the landowner has diverted the existing right of way to pass their property to the north. On rejoining the alignment to the south of the buildings, the path passes through a narrow gap between a barn and fence. Towards B123, the right of way passes through a residential garden to join Station Road. In order to achieve the proposed 3m width it is assumed that the path will join the original right of way alignment east of the barn, and the right of way is realigned to pass south of the residential properties at B123.

Delivery Challenges

Along the greenway option, delivery challenges can be classified as follows:

- Landowner issues: route crosses private land requiring land purchase and access negotiation.
- Ecological constraints: route passes by areas of priority habitat, requiring mitigation and compensation. Required ecological surveys may identify additional ecological constraints.
- Stakeholder issues: The proposed filter on Preston Street may face public opposition as Preston Street forms a link between Thornton Road and Legram Lane

While most of the route follows established rights of way, these are primarily footpaths, and applications to upgrade these to bridleways will be required. In some areas, there may be scope to use realignment or links with local plan sites to support upgrade applications. Between B102 and B103, planning permission has recently been granted (18/04052/NMA01) to build an exhibition centre and a number of industrial units. If constructed as shown, this will preclude the provision as shown in GA 19. Negotiation with the developer is recommended to seek a mutually agreeable solution.

Ecological issues along the corridor are described in Appendix G, and ecological surveys will be required during future design stages. There is the potential for bats to be present within the retaining wall alongside Deep Lane, which may impact on the level of provision possible in this area.

Other risks and opportunities

The provision of the Thornton Road highway alignment is entirely dependent on third parties. Should this fail to go ahead, it would significantly reduce the potential for residents of Girlington, Crossley Hall, Lower Grange and Hill Top to choose active travel for utility journeys. Furthermore, it would prevent them from being able to reach the wider leisure network safely. The inclusion of the Thornton Road alignment presents an opportunity to increase the extent of the proposed routes in this study at no extra cost to the overall scheme. However, reliance on the Thornton Road Cycle Superhighway progressing to delivery to provide direct connectivity between Bradford and Keighley should also be considered a risk.

The proposed greenway alignment runs through local plan sites near Cemetery Road (B103 – B104) and Town End Road (B114 – B115). There is an opportunity available to ensure the alignment is included as part of the conditions for development of these sites. Conversely, local plan sites adjacent to Deep Lane and Baldwin Lane do not directly impact on the alignment, but have the potential to influence what is possible in terms of delivery. Sensitive development of these sites will be required and it is recommended that appropriate conditions are attached to any developments on these sites, to avoid compromising the proposed provision. Local plan sites also represent an opportunity to provide additional links for pedestrians and cycles to the route thus increasing the potential for its use. In the case of Deep Lane, there is an opportunity to link any repairs required to the dry-stone retaining wall to development of the local plan site.

Stakeholder feedback

A preliminary draft of the route proposals and feasibility study was shared with key stakeholders in August 2022. A summary of all feedback received from stakeholders is provided in Appendix H, along with Sustrans' responses and actions. Actions are divided into four categories: no action, amend study, consider at later design stage, and record response. The following feedback falls into the "record response" category. Feedback on route proposals in this category is considered by Sustrans to be important to acknowledge in the main body of the study but has not resulted in any material change to the study draft.

CFG:

- Support use of Deep Lane, based on opportunity to reduce congestion, particularly during the school run.
- Suggested alternatives to sections of the Clayton option were put forward. All alternative route suggestions are recorded (along with all other stakeholder feedback) in Appendix H, with Sustrans' responses to the feedback.

QTS:

- Baldwin Lane alignment considered sub-optimal.

- Suggested alternative alignment between Clayton and Station Road, Queensbury. All alternative route suggestions are recorded (along with all other stakeholder feedback) in Appendix H, with Sustrans' responses to the feedback.
- Preference for off-road connection from Cemetery Road to Queensbury Tunnel

5.6. Holmfield to Queensbury: Tunnel and Alpine Options

Location

The Holmfield to Queensbury corridor includes the Queensbury Tunnel link and the alternative non-tunnel alpine option. Both of these options lie entirely within the jurisdiction of CBMDC, with the border with Calderdale marking the southern extent of the corridor. The Queensbury Tunnel option includes the tunnel and links to Brow Lane to the south and the GNRT to the north. The alpine option links Brow Lane with the southern end of Station Road overland ascending the steep slopes behind the southern Queensbury Tunnel portal, before meandering along the edge of Queensbury to join Station Road. There is little existing cycling and walking infrastructure in this corridor, but the restoration and re-opening of Queensbury Tunnel as an active travel route is the subject of a campaign by the Queensbury Tunnel Society, with national and international support.

Topography

One of the highest parishes in England, Queensbury village sits on a summit bordered by steeply sloping ground to the north, south and west. The village is bisected by the A647 running east to west, and the A644 running north to south. These roads broadly follow the least steep alignments between Queensbury and the surrounding areas. An elevation difference of 100m exists between Brow Lane and the top of Station Road, Queensbury. Queensbury Tunnel was constructed to avoid the Queensbury plateau, passing beneath the village at depths of up to 115m below ground level. The former Queensbury Station was located near the northern portal, approximately at the bottom of Station Road. The tunnel option uses the former tunnel to provide a shallow-grade (1 in 100) route ascending from Calderdale to the Bradford District. In contrast, travelling from south to north the alpine option begins with a steep ascent to the lower Queensbury plateau. From Roper Lane the undulating alignment continues to ascend overall to reach Station Road.

Flooding and Drainage

A narrow strip of flood zone 3 exists to the south of Queensbury Tunnel southern portal (H215). There are known issues with drainage and water ingress to Queensbury Tunnel. The southern portal is submerged beneath a pool of water most of the time. The pool is fed by a combination of groundwater entering the tunnel and water descending its ventilation shafts and flowing south towards the portal. Site visit observations suggested that run-off from Strines Beck also contributes to the pool. Water pooling at the southern portal is effectively dammed by the infill in the Strines Cutting.

No flood risk is identified at the northern portal. Site visit observations identified areas of wet ground between the main GNRT path and the portal approach path.

Dewatering of the tunnel and provision of mechanisms to ensure it remains dry will be necessary to provide an active travel route through the tunnel. Previously, dewatering has been achieved using pumping equipment. A potential opportunity to re-establish gravity drainage through the infilled southern approach cutting has been cited by Queensbury Tunnel Society, though it is acknowledged that such an approach would incur significant capital costs. A drainage assessment has not been carried out.

Structures

Queensbury Tunnel is the major structure present in the Holmfield to Queensbury Corridor. Table 18 lists relevant structures along the two alignments.

Table 18: Relevant structures between Holmfield and Queensbury

Structure name	Description	Ownership	Current condition/use if known
Queensbury Tunnel (H215-H216)	Brick and masonry tunnel.	DfT[1]	Poor. A full report on the condition of Queensbury Tunnel and required remediation has been completed by Jacobs.
Shibden Beck crossing (H120-H121)	Concrete culvert	Unknown	Assumed fair. In use for vehicular plant access by Yorkshire Water.

1: Owned by the Secretary of State for Transport, managed by HRE

5.6.1. Proposed provision: Holmfield to Queensbury

Table 19 and Table 20 describe the proposals for the Queensbury Tunnel and alpine options between Holmfield and Queensbury.

The suggested solutions are considered to be feasible following a number of site visits, collation of information from desk study research, and consultation with a small number of key stakeholders. However, it should be noted that despite avoiding the challenges associated with Queensbury Tunnel, the alpine alignment is highly problematic. The suggested alignment represents a least-worst option in the face of multiple constraints. Each recommendation should be subject to further investigation at future design stages prior to implementation.

It is intended that the tables are read in conjunction with the general arrangement drawings. A full breakdown of each section identified in the general arrangement drawings is available in the design schedule in Appendix E. Within the tables, provision is grouped by infrastructure type to provide a summary of the key information available in the schedule. For each provision type, the relevant key symbol from the GAs is shown, to assist with cross referencing.

Table 19: Proposed provision – Holmfield to Queensbury, Tunnel option

Tunnel Option (To be read in conjunction with GA Sheets 11 - 13)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
3m wide traffic free route	▬ ▬ (blue)	Brow Lane to access ramp	Asphalt surfaced path with sub base extended beyond path width. Motion sensitive lighting to enable secure use after dark.	Bridleway creation order will be required.	Assumed gradient of 1 in 20.
Route access ramp	▬▮▬ (light green)	Southern portal approach	Earthworks ramp with 3/4m asphalt path & lighting.	Intersects with existing planning application 08/00645/FUL. Requires stakeholder negotiation.	Assumed gradient of 1 in 20.
4.5m wide traffic free route	▬ ▬ (dark green)	Queensbury Tunnel, approach to northern portal.	Shared asphalt path, lighting, CCTV and gates. Drainage for path use provided within path works. Tunnel drainage works by third parties.	Provision of cycle track reliant on remediation of tunnel structure in advance by third parties. Construction will require working within confined space. Previous studies suggest that tunnel environment is too wet for roosting bats. However, there remains an ecological risk associated with tunnel – final specification and times of operation will be dependent on results of ecological surveys. Tunnel is long and some users may feel insecure. Lighting and CCTV to be installed to reassure users of their security. Bridleway creation order will be required.	If route becomes popular, risk that provision will be lower than recommended minimum width for high usage levels. Provides direct, gently graded option to link Halifax with GNRT and wider network.

Table 20: Proposed provision – Holmfield to Queensbury, Alpine Option

Alpine Option (To be read in conjunction with GA Sheets 11 -13)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
Cycling in mixed traffic environment		Roper Lane, Shibden Head Road, Long Lane, Old Mill Dam Lane	Varying levels of alterations to existing street layout to support safe cycling in mixed environment. Potential alterations include installation of modal filters, carriageway narrowing, creation of pinch points and lowering speed limits.	Modal filters may face opposition from users where existing cut-throughs are being removed. Requires construction within active highway.	Measures based on assumed vehicle volumes, and designed to create appropriate conditions for mixed use. Actual vehicle use required to confirm alterations will result in suitable provision.
One-way separated cycle track		Brighouse Road to Station Road	1.5m stepped cycle tracks between footway and carriageway.	Space for cycle tracks will require carriageway width reduction on busy A-road links. On-street parking removal required – likely to face opposition. Working in active carriageway.	Complies with guidance for high vehicle volumes on 30 mph roads.
3m wide traffic free route		Brow Lane to Roper Lane Over Shibden Brook to Hazel Hurst Road Alongside Trinity Academy Bradford	Asphalt surfaced path with sub base extended beyond path width. Fencing and lighting to be provided to enable use after dark.	Challenging construction conditions where path ascends sloping ground (Brow Lane to Roper Lane). Mining surveys required prior to construction on Windy Bank to Roper Lane. Extended ascent likely to be unattractive to some users. Resting spaces and speed calming measures to be included in detailed design to mitigate this. Bridleway upgrade/creation orders will be required. Land acquisition may also be required. Ecological surveys required in all traffic-free areas. Alpine links generally in areas of higher ecological risk so construction mitigation and compensation are likely to be required.	The section of traffic free route and linking areas of resurfacing and improvement are problematic with existing space constrained between walls in places, and steep uneven gradients. It may be possible to reduce gradient with additional land take, but this is likely to be challenging. Gradients may therefore exceed recommended levels.
Resurfacing		Link between Shibden Head Road & traffic free route	Existing surfacing renewed.	Bridleway upgrade/creation orders will be required. Land acquisition may also be required.	
Improved existing traffic free route		Link between Long Lane and traffic free route	Existing surface renewed and path widened.	Bridleway upgrade/creation orders will be required. Land acquisition may also be required.	

5.6.2. Corridor costs: Holmfield to Queensbury Options

Queensbury Tunnel option

Total alignment length = 3 km

Table 21: Alignment cost – Holmfield to Queensbury, Tunnel option

	Construction Costs (without preliminaries)	Construction Preliminaries[1] (@ 15%)	Contingency[2] (@ 10%)	Design & development[3] (@ 8%)	Ecology[4] (@ 15%)	Land & Legal[5] (@ 10%)	Route Infrastructure Total	Queensbury Tunnel Refurbishment Total [6]	Total
Costs excluding Optimism Bias & VAT (£)	1,279,226	191,884	147,111	129,458	69,506	46,338	1,863,523	22,259,087	**24,122,610**

[1]Calculated as percentage of construction costs without preliminaries. Applied to whole scheme.
[2]Calculated as percentage of construction costs with preliminaries. Applied to whole scheme.
[3]Calculated as percentage of construction costs with preliminaries and contingency. Applied to whole scheme.
[4]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[5]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[6]Taken from Jacobs 2921 report, minus risk cost (see section 6.2.2)

Alpine option

Total alignment length = 4.7 km

Table 22: Alignment cost – Holmfield to Queensbury, Alpine option

	Construction Costs (without preliminaries)	Construction Preliminaries[1] (@ 15%)	Contingency[2] (@ 10%)	Design & development[3] (@ 8%)	Ecology[4] (@ 15%)	Land & Legal[5] (@ 10%)	Route Infrastructure Total	Queensbury Tunnel Refurbishment Total	Total
Costs excluding Optimism Bias & VAT (£)	2,403,605	360,541	276,415	243,245	282,710	184,723	3,751,239	-	**3,751,239**

[1]Calculated as percentage of construction costs without preliminaries. Applied to whole scheme.
[2]Calculated as percentage of construction costs with preliminaries. Applied to whole scheme.
[3]Calculated as percentage of construction costs with preliminaries and contingency. Applied to whole scheme.
[4]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[5]Calculated as percentage of construction costs without preliminaries. Applied to individual links.

5.6.3. Discussion: Holmfield to Queensbury

The Holmfield to Queensbury corridor forms a key connection between the other corridors presented in this feasibility study. The choice to retain or discount Queensbury Tunnel is in part dependent on the potential to provide an alternative overland alignment linking Halifax with Bradford and Keighley. Bradford Council identify support for the green cycleway campaign related to Queensbury Tunnel as an example of existing activity in their sustainability agenda[xiv]. Taking a final decision on the retention or otherwise of Queensbury Tunnel was listed as one of the top 10 priorities in the 2017 Action Plan for the Bradford Cycle Strategy (2016-2026)[xxvii]. As shown in Figure 10, a link between Holmfield and Queensbury forms part of the Regional Schematic Network, though it is not specified whether this link should be under- or over ground.

Design Challenges

Each of the options between Holmfield and Queensbury face considerable challenges. However, the majority of design-related constraints are associated with the Alpine option. Queensbury Tunnel requires significant restoration works, but if completed the tunnel would provide a wide, gently sloping (1 in 100) corridor to support high-quality cycling and walking infrastructure. The restoration of Queensbury Tunnel is considered a delivery challenge.

In contrast to the tunnel option, numerous design challenges are present along the alpine alignment:

- Constrained highway conditions
- Steep or extended gradients

Alpine zig-zag (H116 – H117). All routes examined between Halifax and Queensbury include extended ascents. Constraints on highway alignments prevent provision of separated cycle tracks, which would be required to keep users safe. The land above the tunnel portal provides an opportunity to provide a traffic-free path with a maximum 5% gradient, with resting places to break the ascent. However, significant delivery challenges are associated with this section. The infrastructure required to provide a satisfactory level of comfort and safety for users ascending and descending the zig-zags would dramatically alter the appearance of the hillside.

The most direct option from the top of the zig-zag alignment and Roper Lane would be along Halifax Road to the High Street. However, insufficient carriageway widths along the A647 prevent the provision of separated cycle tracks on this busy road. This is further compounded by extensive on-street parking for residential homes along the road, schools and a bus route on the link. An alternative alignment is therefore necessary. The constraints of this alignment have resulted in an indirect alignment being proposed. Despite being indirect between Roper Lane and Station Road, seen in the context of a longer leisure journey, it is considered that the detours within Queensbury itself are preferable to ensure a safe passage through the village.

Shibden Brook: The proposed alignment Crosses Halifax Road to Shibden Head Road, descending to meet an existing footpath public right of way which crosses Shibden Brook and re-ascends to meet Hazel Hurst Road (H118 – H121). Gradients on this alignment average 10%. Between Brewery Lane and Shibden Brook a vehicle access track provides access to Yorkshire Water pumping station. As the track ascends to Hazel Hurst Road it is bounded by dry stone walls. There is sufficient width between the walls to allow the construction of a 3m cycle lane. Additional land take would be necessary to ease the gradient below 10%.

Delivery Challenges

Both the tunnel and alpine options within this corridor present significant delivery challenges.

The restoration of Queensbury Tunnel is required before it can be considered for the installation of cycle infrastructure. The cost to restore the tunnel has been estimated to be £22.3 million (£24.1 million including cycling and walking infrastructure) with annual tunnel maintenance costs of £24,000. However, strong public support exists for this option, and landowner positions are known.

The alpine option is estimated to cost substantially less at £3.7 million, however, a great deal of uncertainty is associated with the suggested alpine alignment. Construction of the zig-zag ascent (B116 – B117) is reliant on suitable ground conditions being confirmed. The area was previously mined for coal and fireclay, so this stability is not guaranteed. If the ground were to require stabilisation before construction could commence, any estimated costs for this stretch of the route would be likely to increase significantly. Where the alpine route follows established rights of way, these are primarily footpaths, and applications to realign and upgrade these paths to bridleways will be required. Whilst this option could be achievable as an alternative to the tunnel, it is considered to be extremely challenging to deliver a continual through route and infrastructure that would provide a suitable level of service for prospective users.

Likely ecological constraints are present in both the tunnel and alpine options. Tunnels traditionally provide a suitable roosting environment for bats, however, previous studies suggest that Queensbury Tunnel may be too wet to support this activity. In addition, it is possible that works to stabilise the tunnel will have mitigated the likelihood of bats being present in the tunnel. Surveys to confirm the presence or otherwise of bats and other protected species along the tunnel alignment will be required. The pond at the southern portal may have enabled aquatic species to become established. Along the alpine option, there are areas of open mixed habitat, and a small section of irreplaceable ancient woodland alongside Shibden Brook. These habitats introduce challenges for delivery of the alpine alignment. A desk-based ecological assessment of the alignment is available in Appendix G.

In addition to the specific challenges identified above, stakeholder and landowner issues are likely along this alignment. The introduction of modal filters on Long Lane, and the creation of a new entrance to a recently complete housing development have the potential to raise opposition to the scheme. Many of the traffic-free links pass through private land, and the position of these landowners is generally not known.

Other risks and opportunities

The alpine alignment runs adjacent to local plan sites on Long Lane (H122 – H123) and Old Mill Dam Road (H125 – H126). These developments are likely to slightly increase the volume of traffic on carriageways where cycling in mixed traffic is proposed. It is not thought that the sites are sufficiently large for this to be an issue. At the eastern end of Old Mill Dam Lane, there is an opportunity to tie into the Bike Mill cycle repair shop. This has the potential to provide a focal point for the route in Queensbury Village itself.

Stakeholder feedback

A preliminary draft of the route proposals and feasibility study was shared with key stakeholders in August 2022. A summary of all feedback received from stakeholders is provided in Appendix H, along with Sustrans' responses and actions. Actions are divided into four categories: no action, amend study, consider at later design stage, and record response. The following feedback falls into the "record response" category. Feedback in this category is considered by Sustrans to be important to acknowledge in the main body of the study but has not resulted in any material change to the study draft.

CFG:

- Strongly support the use of Queensbury Tunnel as a walking and cycling route

GNRTDG:

- Strongly support use of Queensbury Tunnel for cycling and walking and believe that the tunnel option is the only attractive option to link Halifax and Bradford
- Do not believe it is worth spending money investigating the alternative [alpine] option further
- Consider tunnel option as offering strategic regional benefits as a connector of cycling networks

QTS:

- Recognise Sustrans attempt to provide alternative surface route between Holmfield and Queensbury, but regard it to be challenging, circuitous and unattractive, with potential to create problems with traffic flow
- Regard alpine option as further reinforcing the case for Queensbury Tunnel as the only viable cross-district link, and strongly advocate for the Queensbury Tunnel option.
- Provision of mobile phone coverage must be provided in Queensbury Tunnel, to mitigate personal security concerns, allow users to access usual communication methods, and provide opportunities for interactive installations

5.7. Halifax to Holmfield

Location

The Halifax to Holmfield corridor is the only corridor situated within the jurisdiction of Calderdale Council. The corridor starts at Halifax Railway Station, with both alignments following the same route through the town centre to Northgate. The highway alignment then includes northern Halifax, Lee Mount and Ovenden along its length. The greenway alignment follows Old Lane before becoming a traffic-free path across fields between Old Lane and Brow Lane. Links to Boothtown and Ovenden are also possible from the greenway alignment.

Existing walking and cycling infrastructure is limited in this corridor. At the southernmost extent of the corridor, a short spur links Halifax Railway Station with the existing Hebble Trail (NCN 69). A short length of off-road track through Beechwood Park is present on the highway alignment, but little other existing provision is evident.

Topography

With identical start and finish points, the overall topography of the two alignments in the Halifax to Holmfield corridor is very similar. A height difference of approximately 120m exists between Halifax Railway Station (~110m, H103) and the crossing at Brow Lane (~230m, H116). Between these points, the highway alignment climbs to a high point of 245m over the first two-thirds of its length, before undulating in its final third to Holmfield. In contrast, the greenway alignment is broadly continuous in ascent from south to north. For both alignments, gradients are approximately 5% along the majority of their length. Short sections of 8-9% are present in the steepest areas of the greenway alignment, and 12% on the highway alignment.

Flooding and Drainage

A short link present on both the highway and greenway options lies within flood zone 2 at Lee Bridge (~H203). At the eastern end of Old Lane (~H108) a further area of flood zone 2 lies immediately adjacent to the proposed alignment. A narrow strip of flood zone 3 is present between H112 and H113 (north of Royd Lane). This is the only section of river flood zone that affects the alignments in this corridor. A drainage assessment has not been carried out.

Structures

Table 23: Relevant structures in the Halifax to Holmfield corridor

Structure name	Description	Ownership	Current condition/use if known
Broad Tree Road Bridge (H109 – H110)	Overbridge, supporting Broad Tree Road.	DfT[1]	Unknown, assumed good. Bridge currently in use as vehicular road bridge.

1: Owned by the Secretary of State for Transport, managed by HRE

5.7.1. Proposed provision: Halifax to Holmfield

Table 24 and Table 25 describe the proposals for the highway and greenway options between Halifax and Holmfield.

The suggested solutions are considered to be feasible following a number of site visits, collation of information from desk study research, and consultation with a small number of key stakeholders. Each recommendation should be subject to further investigation at future design stages prior to implementation.

It is intended that the tables are read in conjunction with the general arrangement drawings. A full breakdown of each section identified in the general arrangement drawings is available in the design schedule in Appendix E. Within the tables, provision is grouped by infrastructure type to provide a summary of the key information available in the schedule. For each provision type, the relevant key symbol from the GAs is shown, to assist with cross referencing.

Table 24: Proposed provision: Halifax to Holmfield, Greenway Option

Halifax to Holmfield: Greenway Option (To be read in conjunction with GA Sheet 13 and 16 - 20)					
Provision	Key Symbol	Approximate Location(s)	Nature	Design/Delivery Challenges	Deviations/comments on Guidance*
Cycling in mixed traffic environment		Old Lane, Broad Tree Road, Horton Street	Alterations to street environment to provide safe conditions for cycling in mixed traffic. Alterations include the addition of modal filters, formalisation of parking provision, speed limit reductions and traffic calming features.	Provision in place on public highway. Introduction of modal filters and pinch points may face opposition. Requires working in active carriageway.	Cobbles to south of Old Lane present accessibility issues. Gradient (~10%) exceeds recommended maximum at south end of Old Lane and on Broad Tree Road.
Shared use path		Link between Broad Tree Road and Ovenden Way.	Eastern footway built out to provide 3m shared use space.	Construction alongside active carriageway.	Shared use provision within the urban environment is not generally recommended by LTN1/20. However this short section provides a link in an area where cycles are likely to be travelling slowly, to meet the junction between Ovenden Way and Ovenden Road.
Route access ramp		North end, Old Lane	Earthworks ramp with 3m asphalt path.	Landowner issues. Bridleway creation orders will be required for new route across private land.	There is space to ensure ramp meets gradient requirements.
3m wide traffic free route		Old Lane to Queensbury Tunnel	Asphalt surfaced path with sub base extended beyond width. Motion sensitive lighting to enable secure use after dark.	Path traverses sloped ground. Challenging construction conditions. Bridleway creation orders will be required for new route across private land. Landowner issues.	

Table 25 Proposed provision: Halifax to Holmfield, Highway Option

Halifax to Holmfield: Highway Option (To be read in conjunction with GA Sheet 13 and 16 - 20)					
Provision	**Key Symbol**	**Approximate Location(s)**	**Nature**	**Design/Delivery Challenges**	**Deviations/comments on Guidance***
Provision developed by others	(black line)	Halifax town centre to Ovenden Road, Ovenden Way and Cousin Lane	Schemes are a mixture of separated and non-separated cycle lanes.	Delivered under TCF/West Yorkshire Plus Travel Fund schemes to provide new cycle infrastructure between Halifax centre and Ovenden. Provision reliant on delivery of proposed schemes.	It is assumed schemes will be de developed in accordance with LTN1/20.
Cycling in mixed traffic environment	(purple line)	Heathy Lane, Beechwood Road, Moor Lane, Horton Street	Varied alterations to existing highway to accommodate cycling in the carriageway. Alterations may include formalised parking provision, buildouts, reduced speed limits, vertical traffic calming measures and modal filters.	Introduction of modal filters and pinch points may face opposition. Requires working in active carriageway.	It is assumed that measures proposed will be suitable to meet requirements of LTN1/20 Figure 4.1. Further investigation of traffic volume and speeds should be undertaken prior to detailed design.
Improved existing traffic free route	(cyan dashed line)	Beechwood Park	Resurfacing of track through Beechwood Park. Width of path allows segregation of cycles and pedestrians as part of improvement.	Passes through local Nature Reserve. Ecological impact unlikely if route remains aligned with existing track.	
Shared use path	(yellow line)	Link between existing NCN and start of TCF provision.	Eastern footway built out to provide 3m shared use space.	Construction alongside active carriageway.	Shared use provision within the urban environment is not generally recommended in LTN1/20. However in the absence of workable alternatives this is suggested to provide continuity of the wider cycle route.
Resurfacing	(beige dashed line)	Link east of Heathy Lane	Resurfacing existing road at grade.	Landowner unknown. Constrained construction conditions – link is bounded by high fences.	

5.7.2. Corridor costs: Halifax to Holmfield Options

Greenway option

Total alignment length = 3 km

Table 26: Alignment cost – Halifax to Holmfield, Greenway option

	Construction Costs (without preliminaries)	Construction Preliminaries[1] (@ 15%)	Contingency[2] (@ 10%)	Design & development[3] (@ 8%)	Ecology[4] (@ 15%)	Land & Legal[5] (@ 10%)	Route Infrastructure Total	Queensbury Tunnel Refurbishment Total	Total
Costs excluding Optimism Bias & VAT (£)	1,916,075	287,411	220,349	193,907	210,684	133,256	2,961,682	-	2,961,682
Total for alignment including Optimism Bias, excluding VAT	**£4,264,822**								

[1]Calculated as percentage of construction costs without preliminaries. Applied to whole scheme.
[2]Calculated as percentage of construction costs with preliminaries. Applied to whole scheme.
[3]Calculated as percentage of construction costs with preliminaries and contingency. Applied to whole scheme.
[4]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[5]Calculated as percentage of construction costs without preliminaries. Applied to individual links.

Highway option

Total alignment length = 4.7 km

Table 27: Alignment cost – Halifax to Holmfield, Highway option

	Construction Costs (without preliminaries)	Construction Preliminaries[1] (@ 15%)	Contingency[2] (@ 10%)	Design & development[3] (@ 8%)	Ecology[4] (@ 15%)	Land & Legal[5] (@ 10%)	Route Infrastructure Total	Queensbury Tunnel Refurbishment Total	Total
Costs excluding Optimism Bias & VAT (£)	1,130,695	169,604	130,030	114,427	65,725	37,712	1,648,193	-	1,648,193
Total for alignment including Optimism Bias, excluding VAT	**£2,373,398**								

[1]Calculated as percentage of construction costs without preliminaries. Applied to whole scheme.
[2]Calculated as percentage of construction costs with preliminaries. Applied to whole scheme.
[3]Calculated as percentage of construction costs with preliminaries and contingency. Applied to whole scheme.
[4]Calculated as percentage of construction costs without preliminaries. Applied to individual links.
[5]Calculated as percentage of construction costs without preliminaries. Applied to individual links

5.7.3. Discussion: Halifax to Holmfield

The alignments in the Halifax to Holmfield corridor coincide in part with existing proposals being developed for Halifax through the Transforming Cities Fund (TCF) and the West Yorkshire-plus Transport Fund (WY+TF). These proposals are at varying stages of development. Consultation for each of the schemes incorporated has been undertaken by Calderdale Council and their partners. In some cases, the outcomes of the consultation are not yet known.

The two alignments contribute to Calderdale's objective to increase the use of sustainable modes of transport, and address a limited provision for walking and cycling in Halifax. Additionally, the greenway alignment runs through a large site identified in the Calderdale Local Plan for future housing development. Provision of the greenway alignment will help to meet Calderdale's aspiration for integrating transport and housing development.

From a leisure perspective, the greenway alignment provides a near-direct connection between the existing Hebble Trail to the south of Halifax and the approach to the southern portal of Queensbury Tunnel, via Halifax railway station. This alignment provides an important opportunity to connect Halifax into a wider network of leisure cycling and walking routes. Connectivity with the railway station opens up possibilities for linear active trips, supported by rail travel back to an original destination.

The highway alignment builds on existing plans to improve provision between the town centre and Ovenden, and extends this provision to connect to the proposed approach to Queensbury Tunnel. In doing so, this would allow beneficiaries of the utility-focused TCF and WY+TF schemes to access the wider leisure cycling network without having to cross the town and areas where provision is lacking to access the greenway.

Design Challenges

Halifax to Holmfield corridor, two main design challenges are present:

- Limited options for off-road provision
- Gradient

Along the highway alignment, the lack of off-road potential is not a significant issue as utility-based routes can benefit from being visibly present. Designing to LTN1/20 guidance ensures that these highway-base routes are fit for purpose. However, the greenway alignment is more highway-based than would normally be expected for a so-called greenway, with several sections of cycling in a mixed traffic environment proposed.

The Old Lane (H108 – H112) provision builds on one of two options that has recently been consulted on as part of the Corridor Improvement Programme (Phase 2). The alternative option along the Ovenden Brook Valley was discounted at this stage due to constraints including flooding, ecological impact and the presence of a derelict Grade II* listed building. Selecting the Old Lane alignment means that a significant portion of the greenway alignment is on the highway. In the recent consultation, the portion of Old Lane south of Mill Lane (H108 – H109) remained open to traffic. This study suggests that use of Old Lane would require filtering on the southern section to be introduced, to ensure that users can confidently use the full width of Old Lane without risk of conflict with motor vehicles. There is an element of pragmatism in the suggested alignment, and possible improvements that could be considered to provide an improved traffic-free option are discussed at the end of this section.

Locations with gradient challenges

The Halifax to Holmfield corridor ascends from the town towards the approach to Queensbury Tunnel southern portal. Gradients are often no more than 5% but include extended sections of ascent. The following sections include gradients greater than 5%:

- Old Lane north of Dean Clough (~H108a): 10%
- Lee Bridge & Shroggs Road (~H203): 10%
- Ovenden Way (H204 – H205): 8%

Each of the sections listed above are highway based. While higher gradients are not ideal, their presence on routes that are otherwise more moderately sloping can be tolerated. To avoid the steepening on Old Lane would require a diversion to busier roads. Lee Bridge and Shroggs Road and Ovenden Way form part of the TCF-funded North Halifax Improved Streets for People proposals (Zones 2 and 3).

Delivery Challenges

Delivery challenges between Halifax and Holmfield can generally be categorised as:

- Landowner issues: route crosses private land or unadopted highway, requiring land purchase, access negotiation or highway adoption.
- Ecological constraints: route passes by areas of priority habitat, requiring mitigation and compensation. Required ecological surveys may identify additional ecological constraints.
- Stakeholder issues: proposals to filter existing through routes are likely to meet with opposition. The route will also require multiple upgrades to existing public rights of way, and creation orders where none currently exist. These processes also have the potential to meet with public opposition.

Specific instances of these challenges are detailed in the design schedule, and summarised at the end of this chapter (Table 29).

Other risks and opportunities

A significant uncertainty associated with the Halifax to Holmfield corridor is the necessity for third-party schemes to progress to construction. For both the highway and greenway alignments, links to the town centre and Halifax Railway Station are reliant on the progression of the WY+TF funded Halifax Town Centre (Phase 2) scheme. Beyond Northgate (H106), the greenway alignment is independent of third-party provision. However, the highway alignment depends on the TCF-funded North Halifax Improved Streets for People scheme reaching completion. While leveraging third-party schemes represents an opportunity on the one hand, failure of either of these schemes to progress as expected should be considered a risk.

The proposed greenway alignment runs through local plan site LP1229 (H113 – H114). There is an opportunity available to ensure the alignment is included as part of the conditions for development of this site. Sensitive development of local plan sites close to the proposed alignment will be required and it is recommended that appropriate conditions are attached to any developments on these sites to avoid compromising the proposed provision. Local plan sites also represent an opportunity to provide additional links for pedestrians and cycles to the route thus increasing the potential for its use.

Opportunities are also present within the Halifax to Holmfield corridor. Provision of the highway option will enable safe access to and from Beechwood Park, where a BMX pump track facility is already located. Provision of the greenway option creates an opportunity to steer the character of new development along the alignment. Providing a high quality link between the local plan site and railway station provides an opportunity to minimise the number of vehicles created by any future development in this area.

Potential for future improvement

Within the greenway option, the Old Lane section (H108 – H112) represents a likely deliverable alignment in the short term. Although Old Lane is highway-based, users are afforded a view over the old railway alignment and valley floor, and therefore, if suggestions for additional filtering are taken forward to delivery, it is considered an appropriate short-term option. In future, serious consideration should be given to the development of an active travel corridor along the valley floor. Creation of an alignment along the valley faces several constraints, including flooding, ecological impact and the presence of a derelict Grade II* listed building (Rawson's Mill). However, two local plan sites are identified in the area of a possible future alignment. There is, therefore, potential for a future alignment to be part of the conditions of development of the local plan sites.

In addition to the Grade II* listed structure in the valley, Table 28 lists other structures present along a possible future alignment. Figure 11 shows the line of possible future upgrade(s) to the alignment.

Table 28: Structures relevant to future possible upgrades between Halifax and Holmfield

Structure name	Description	Ownership	Current condition/use if known
Ladyship Lane (W of Old Lane, N of H111)	Abutments & Piers	DfT[1]	Unknown.
Old Lane Bridge (S of H112)	Overbridge, supporting Old Lane.	DfT[1]	Unknown, assumed good. Road currently in use as vehicular road bridge.
Station Bridge (H212 – H213)	Overbridge, supporting Holdsworth Road.	DfT[1]	Unknown, assumed good. Road currently in use as vehicular road bridge.

1: Owned by the Secretary of State for Transport, managed by HRE

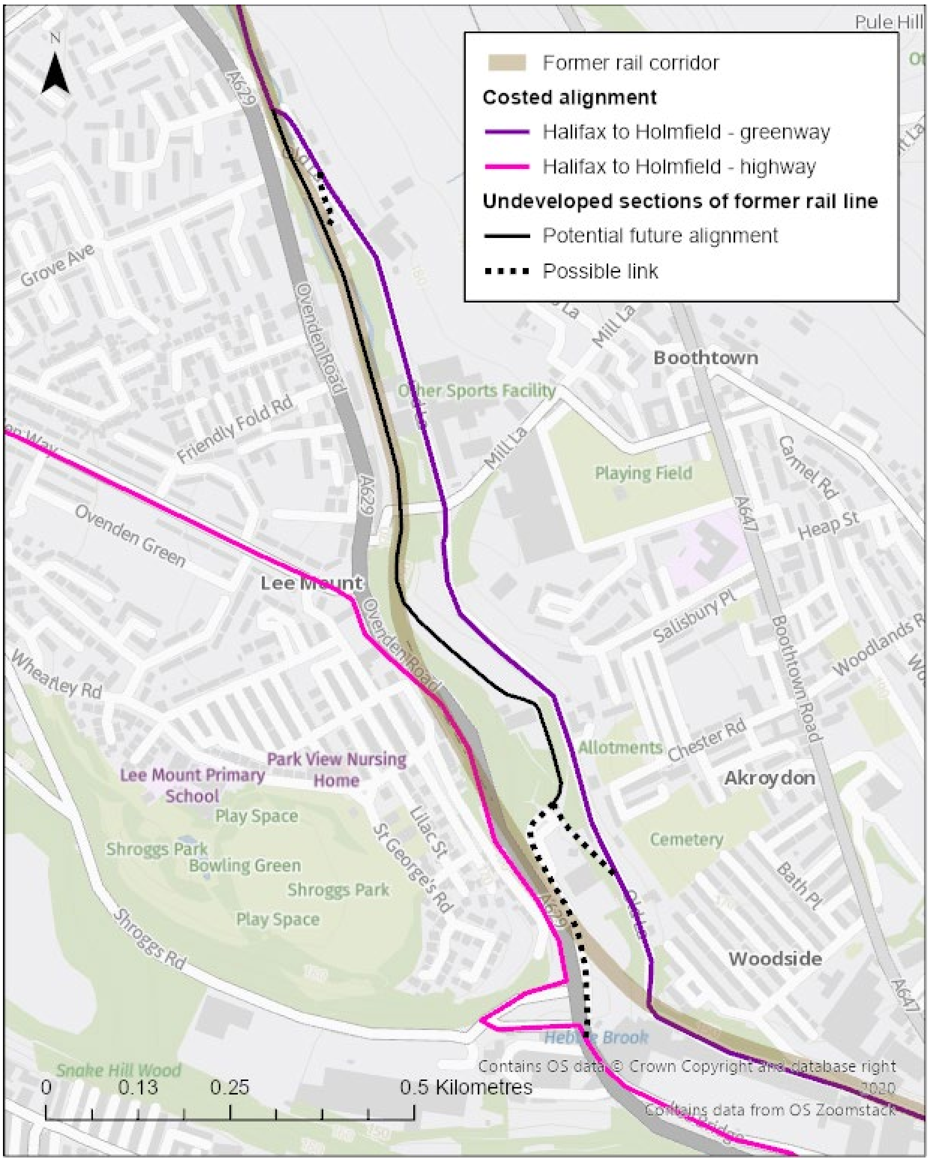

Figure 11: Possible future alternative alignments within the Halifax to Holmfield corridor

5.8. Constraints mapping

The previous sections describe challenges along each alignment, and further detail is included in the design schedule, provided in Appendix E. Where a constraint remains, it is indicated on the General Arrangement drawings with an exclamation mark. Table 29 lists the constraints associated with each of these symbols in a single table to be read alongside the General Arrangement drawings.

The design decision log in Appendix I provides further detail about the decisions to select particular routes and levels of provision, as well as any assumptions on which the design is based.

Table 29: Remaining constraints shown on general arrangement drawings

Type	Constraint Location	Description
Route choice	K102 – K103	Quarry Road gradient exceeds recommended maximum gradient. Shallower gradients are present at Cross Street and Grace Street to the east, but also exceed recommended maximums, and require users to travel further into industrial estate where large goods vehicles are present. Therefore Quarry road remains as steeper grade choice.
Route choice	H118 – H122a	Sections within this alignment exceed recommended gradients. Alternative provision along highway is not possible due to pinch points preventing suitable width of provision on busy road. Gradient discomfort considered to be a lower risk than that presented by an interface with motorised traffic in a confined space.
Provision	B113a	Route emerges onto busy narrow road. Spur provided to allow access to alignment from east, but main route diverted around constraint.
Provision	B118 – B119	Shared use provision to east of Baldwin Lane. Properties and highway width prevent installation of separated cycle provision.
Provision	H101 – H102	Shared provision provided to enable direct link to proposed traffic-free to north of Water Lane.
Provision	H110 – H204	Shared use provision provided to link to Highway Option Alignment. Junction reconfiguration at H204 could be designed to remove need for shared provision.
Provision	H116 – H117	Extended ramped ascent of hillside above Queensbury Tunnel southern portal. All overland options between Holmfield and Queensbury are steep. Highway options are constrained by width, preventing the inclusion of separated provision on busier roads. Minor roads are indirect and not considered to provide suitable conditions for cycling in mixed traffic. The traffic-free zig-zags are considered the 'least-worst' option, and it is acknowledged that the experience for some users of this infrastructure will not meet quality expectations. It is also acknowledged that delivery challenges remain.
Provision	K104 – K105	Park Lane provision is shared use due to lack of highway width to provide separated cycle lanes. Traffic speeds are low (30mph), but volumes high. No suitable alternative route was identified.
Provision	K118 – K119	Visibility emerging northwards is poor. Traffic flows assumed to be sufficiently low to allow constraint to be addressed with warning signs and markings.
Pinch point	K115 – K116	Width narrows to <3m between walls for short section at east end.
Pinch point	H211 – H212	Existing traffic-calming pinch point.
Gradient	K102 – K103 K104 – K105 K106 – K111 K114 – K115 K147 – K148 H108 – H108a H116 – H117 H120 – H121 B111a – B111b	Gradients in these areas exceed the recommended maximum. Unless specifically described elsewhere, it should be assumed that the choice to follow steeper links is based on a lack of more accessible options.
Ecological – irreplaceable habitat	K107 – K108 K120 – K121	An area of ancient woodland exists adjacent to the route. Detail design and construction will require this area to remain undisturbed. Licences to work in this area may be required.
Ecological – possible bat risk	K131 – K136 (x3) K139 – K142 (x2) H215 – H216 ~B112	Tunnels or retaining wall structures present. Tunnels often support bat activity. Presence of bats or other protected species to be confirmed or otherwise through ecological surveys.
Flood Risk	H112 – H113 ~H203 ~H108 H215 B101 – B202 B109 – B110 West of B204	Section of alignment lies within EA flood zone
Former mining location	H116 – H117	Alignment on former mining sites. A Coal Mining Risk Assessment will be required to confirm ground stability prior to construction.

One of the major delivery challenges present across the route is the need for numerous bridleway creation orders, or footpath upgrades. Figure 12 to Figure 14 summarise the rights of way requirements along each alignment.

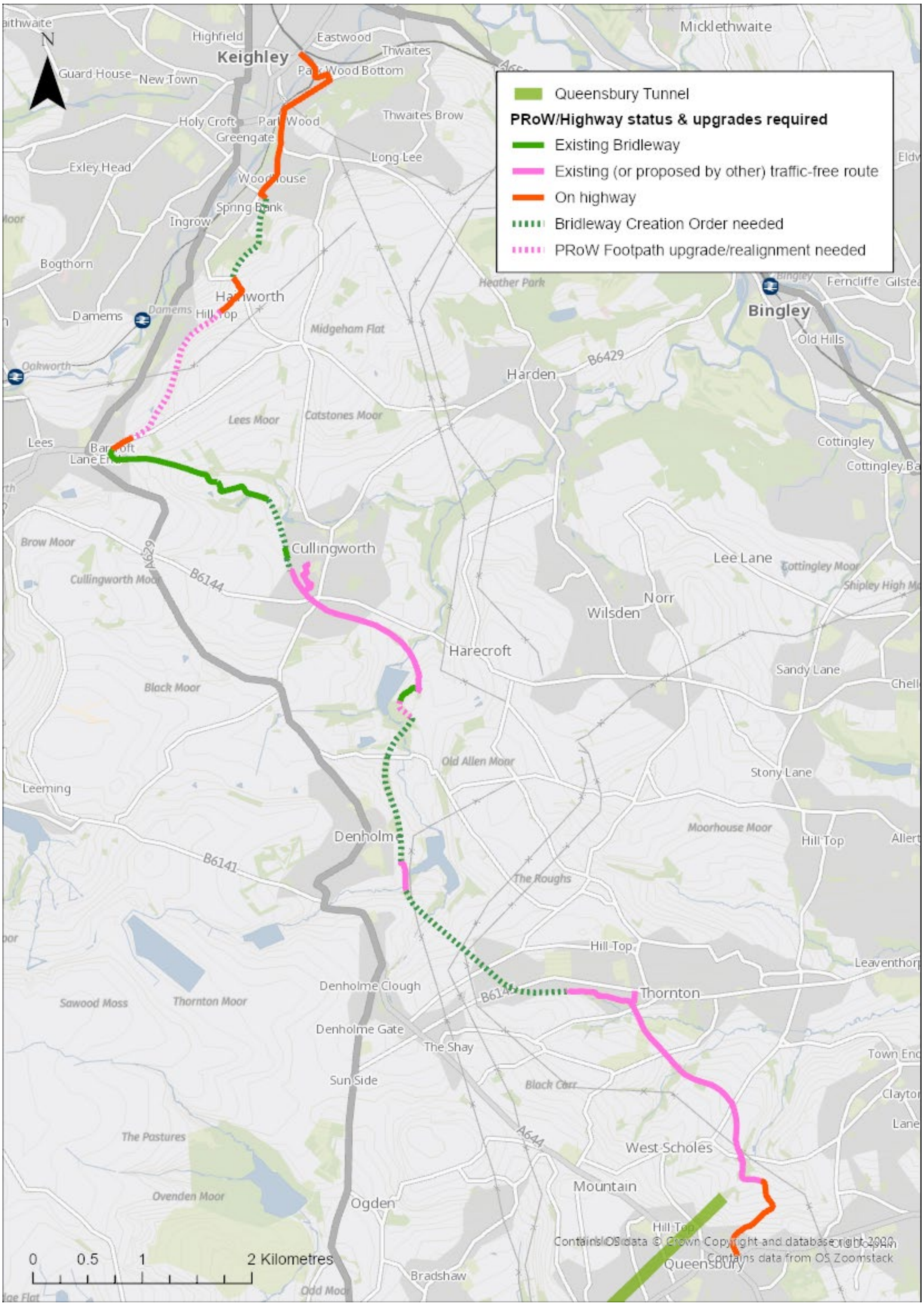

Figure 12: Rights of way status and future requirements, Keighley to Station Road, Queensbury corridor

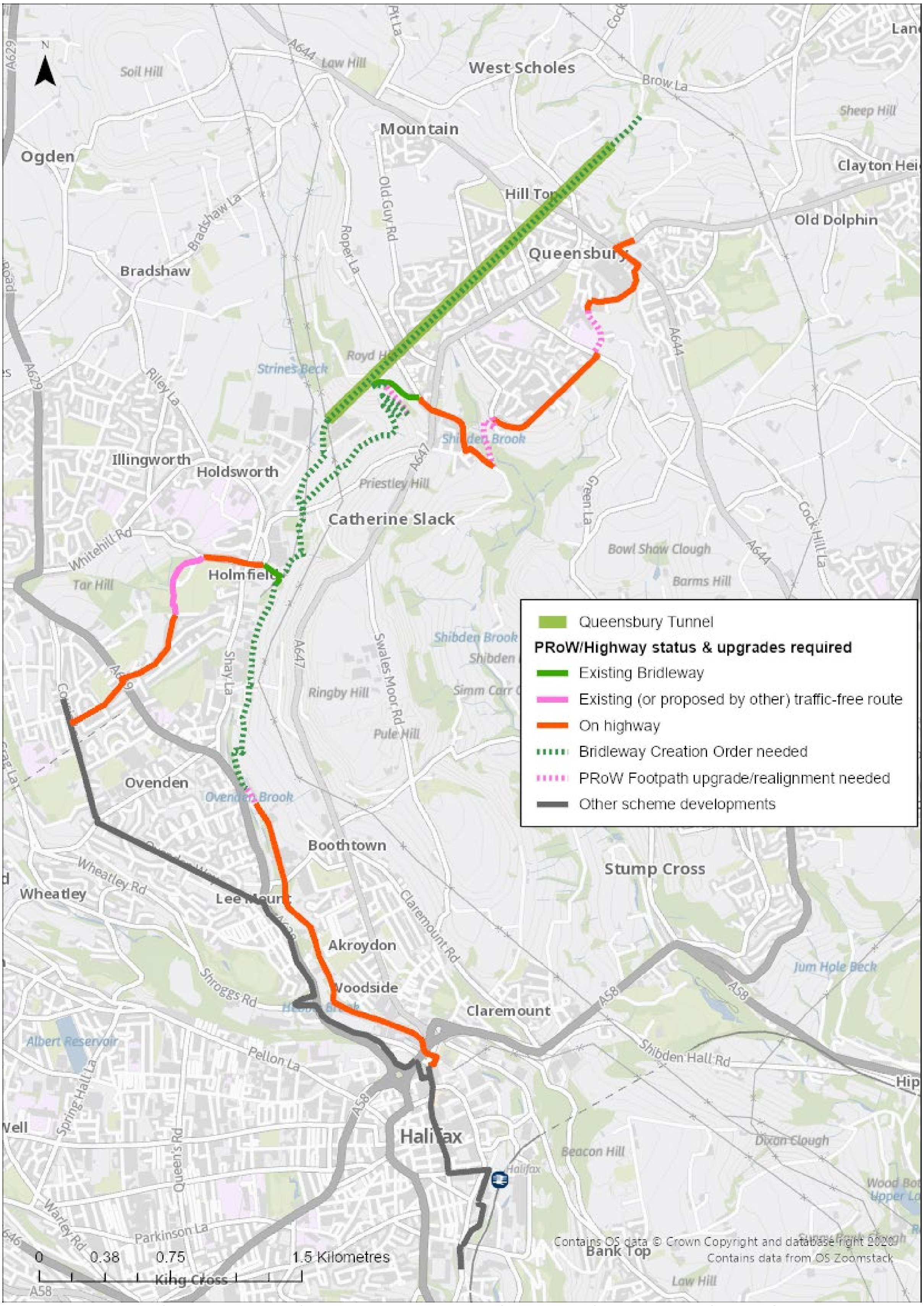

Figure 13: Rights of way status and future requirements, Halifax to Holmfield and Holmfield to Queensbury corridors

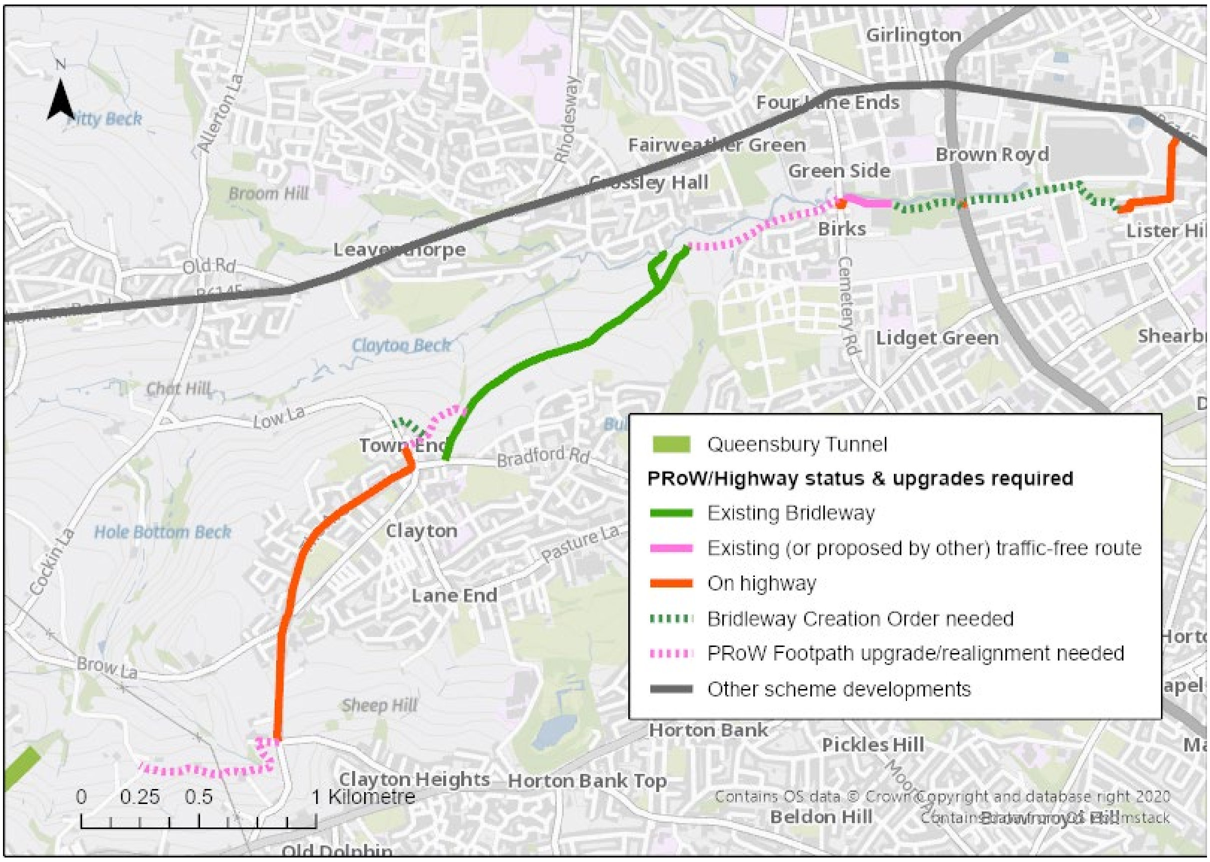

Figure 14: Rights of way status and future requirements, West Bradford corridor

6. Route Options

This chapter describes how alignments are combined to create route options, and how these options are anticipated to contribute to the local cycling and walking networks for tourism and other uses. The six route options comprise different combinations of alignments, but the alignments themselves do not change. Route costs are compared, with an explanation of the assumptions and exclusions associated with the costs, and how risk and uncertainty have been treated. A qualitative comparison of the six routes is also presented.

Route option rationale

The route options examined in this study are intended to provide an assessment of the potential to provide viable sustainable transport routes between Keighley, Halifax and Bradford, *with a focus on the value of Queensbury Tunnel as a potential link in the network*.

Three levels of provision were examined: a Most Advantageous and Attractive option, a Next Preferred option, and a Low Cost alternative. To ensure the best possible comparison between the options presented, the three levels all include the three major settlements of Keighley, Halifax and Bradford, and the minor settlement of Queensbury.

At each level, two route options have been suggested, one including Queensbury Tunnel and one following the 'Alpine' alignment. In this way, the effect of the inclusion of the tunnel on the value of each of the proposals can be tested. We have worked with CBMDC to agree our approach throughout the route development process.

The Most Advantageous and Attractive route option seeks to provide high quality provision for utility and leisure purposes. The Next Preferred option focuses on long-distance leisure use as its primary purpose. The low-cost alternative leverages existing proposals for utility-focused interventions through the Transforming Cities Fund and West Yorkshire Transport Plus fund, adding missing links to create a coherent network between the four strategic settlements of Bradford, Halifax, Keighley and Queensbury. The composition and nature of the route options are summarised in Table 30 and the subsequent figures. Table 31 provides a brief summary of each corridor. Full details of the alignments within each corridor are included in Chapter 5, and the accompanying general arrangement drawings.

Table 30: Route option summary

Options	Most Advantageous and Attractive	Next Preferred	Low Cost alternative
Figure Number	Figure 15 (Tunnel) Figure 16 (Non-tunnel)	Figure 17 (Tunnel) Figure 18 (Non-tunnel)	Figure 19 (Tunnel) Figure 20 (Non-tunnel)
Summary	Greenway and highway alignments are both included to provide a comprehensive network linking West Bradford, Halifax and Keighley.	Greenway alignments are selected in West Bradford and Halifax arms.	Highway alignments are included in West Bradford and Halifax arms
Rationale	Dual utility and leisure focused provision maximises benefits for communities and potential tourism opportunities centred on Queensbury Tunnel inclusion. Dual alignments allow access to route from wider population group, and minimise indirectness.	Maximises leisure benefit of Queensbury tunnel inclusion with onward largely traffic free options to link to Halifax, Bradford and Keighley. Traffic-free links within urban settings are lit to provide potential for additional utility use.	Leveraging proposed TCF schemes minimises costs of maintaining links between all three major towns/cities & Queensbury. Provision is utility focused. Inclusion of Queensbury Tunnel anticipated (but not yet confirmed) to be of less value in this option.

Table 31: Final corridor summaries

Corridor summaries	
Keighley to Station Rd, Queensbury **(all routes)**	Single route choice: predominantly off-road to join with existing GNRT. Character of this stretch is greenway with short connecting on-road sections. Future possibilities exist between Cullingworth and Keighley along the disused railway alignment and Lees Moor Tunnel and preservation of this alternative alignment should be considered as a condition of any future development permitted in this corridor.
West Bradford	Clayton Option (Most Advantageous, Next Preferred)
	Predominantly traffic-free provision via Deep Lane to Clayton. Separated /shared use provision along the Avenue and Baldwin Lane links to further traffic-free provision to Station Road.
	Thornton Road Option (Most Advantageous, Low Cost)
	Follows line of agreed TCF scheme to link West Bradford to GNRT at Thornton Primary School. Assumed separated provision along full length.
Holmfield to Queensbury	Including Queensbury Tunnel
	Restoration of Queensbury Tunnel: requires extensive structural stabilisation and restoration works. Provides a shallow-grade direct link between Halifax and Bradford/Keighley arms, with associated potential for high tourism and leisure value.
	Excluding Queensbury Tunnel: 'Alpine Option'
	Construction of Alpine zig-zags to create indirect link through Queensbury to Station Road. Multiple challenges present. Construction challenges of Alpine zig-zag are considerable. Constrained options in Queensbury prevent satisfactory provision of direct through route.
Halifax to Holmfield	Greenway Option (Most Advantageous, Next Preferred)

Corridor summaries	
	Greenway option: follows Old Lane out of Halifax centre before linking to tunnel portal via new route across fields. There is long-term potential to realign Old Lane section along the disused line itself. Provision of an improved alignment should be considered as a condition of any future development permitted in this corridor.
	Highway Option (Most Advantageous, Low Cost)
	Utilises Halifax Improved Streets for People alignment to Ovenden, then predominantly cycling in mixed traffic on quiet roads to southern portal.

6.1. Route figures

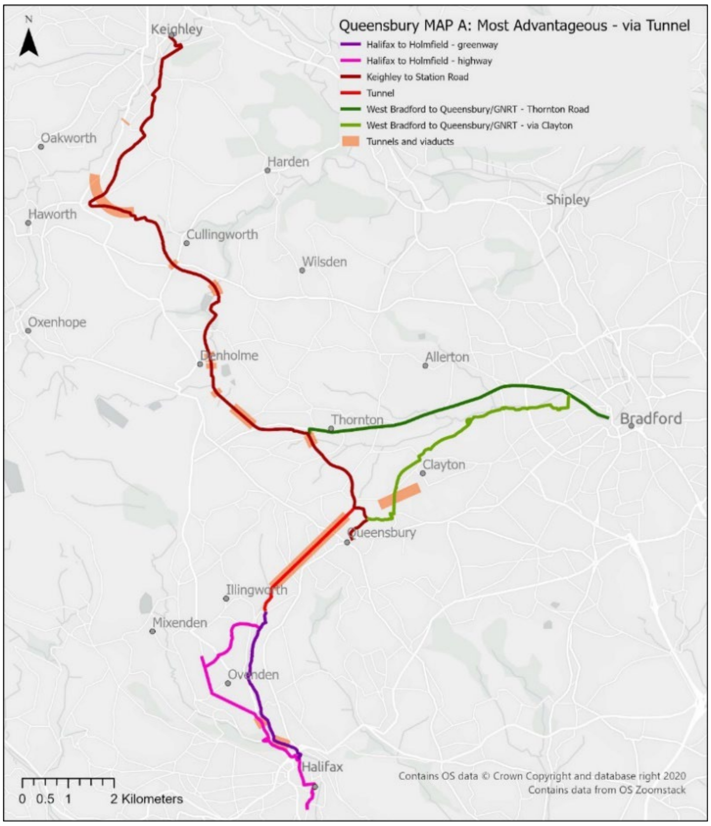

Figure 15: Most Advantageous & Attractive, including Queensbury Tunnel

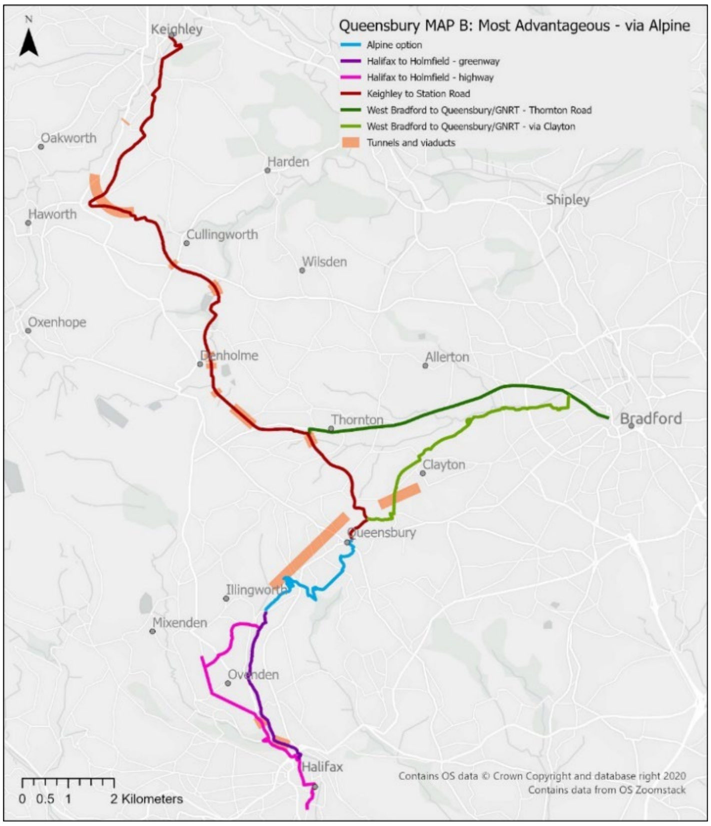

Figure 16: Most Advantageous & Attractive, excluding Queensbury Tunnel

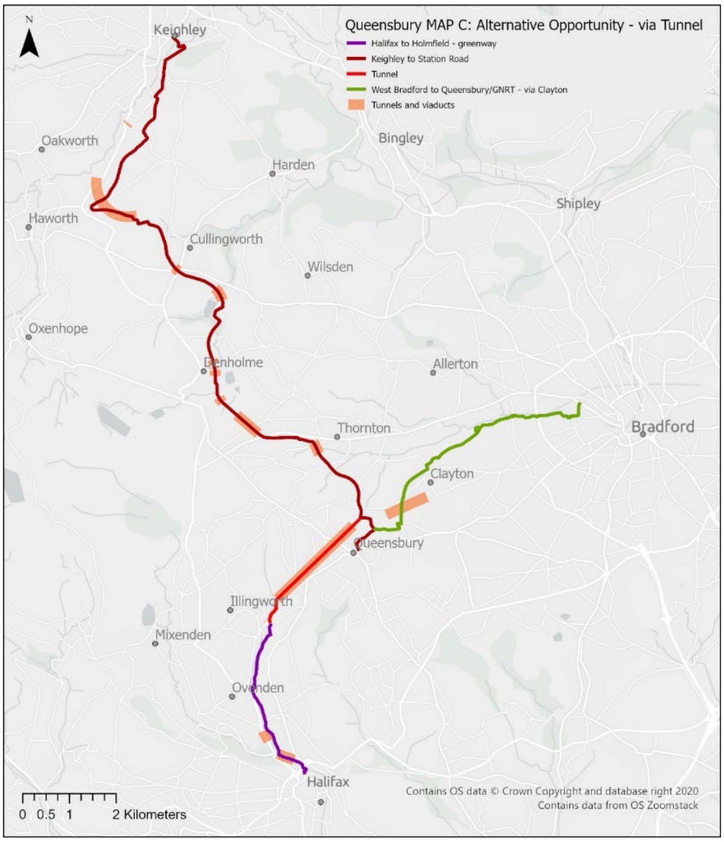

Figure 17: Next Preferred, including Queensbury Tunnel

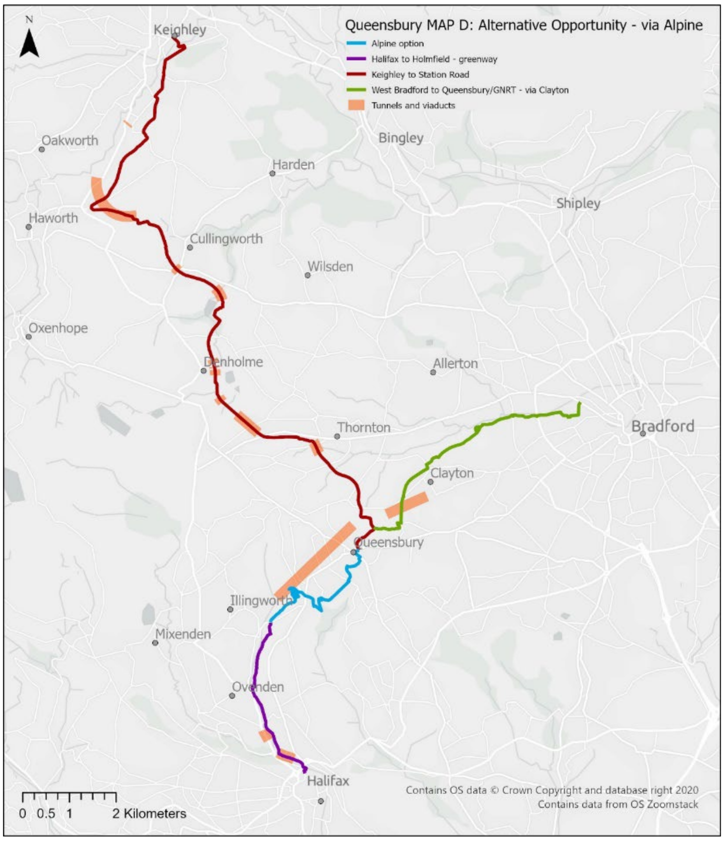

Figure 18: Next Preferred, excluding Queensbury Tunnel

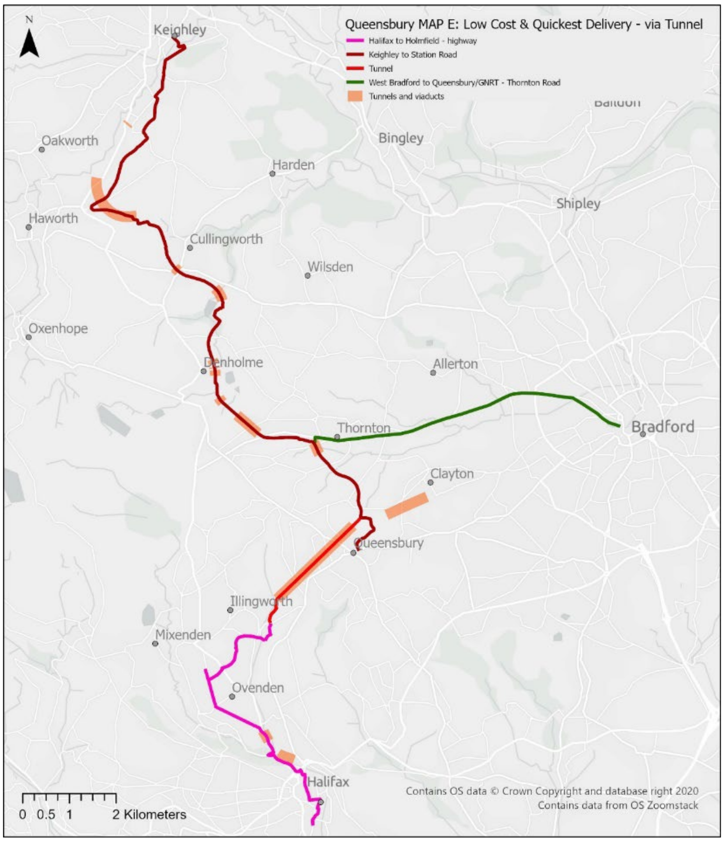

Figure 19: Low-Cost Alternative, including Queensbury Tunnel

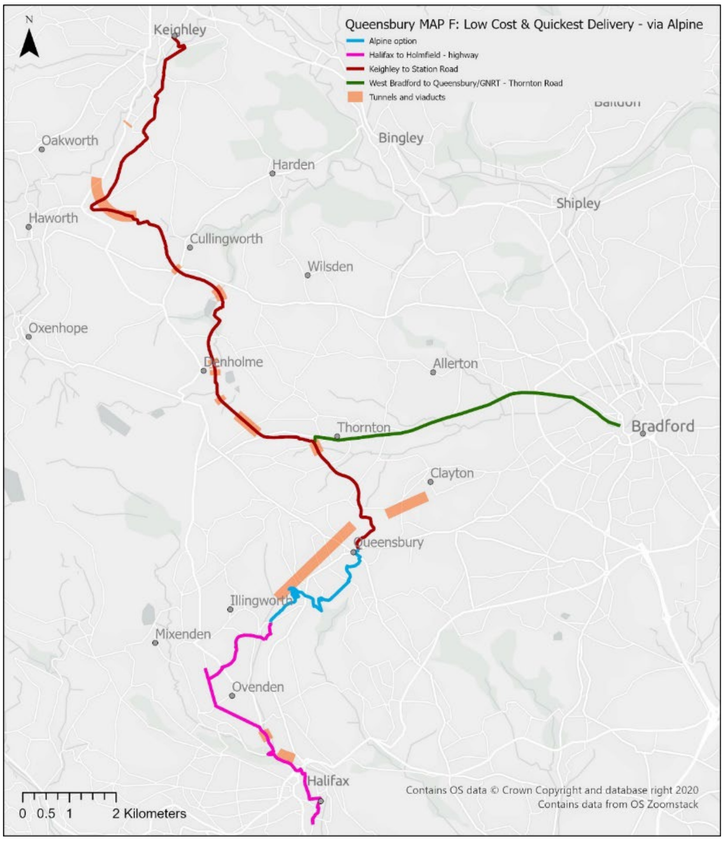

Figure 20: Low-Cost Alternative, excluding Queensbury Tunnel

6.2. Cost, risk and uncertainty

This section summarises the approach taken to developing cost estimates for the six route options described in this study. The cost estimates have been developed at a level of detail that is proportionate to the concept stage of design. Treatment of risk and uncertainty is also described.

For details of the corridors and alignments included in each option, see Chapter 5. Please note, corridor costs cannot be aggregated to route option costs directly, due to shared elements between some of the highway/greenway options. Costs for all sections of all alignments are provided in the design schedule, included in Appendix E. The design schedule also includes detail on the development, inclusions and exclusions for each costed item. All costs quoted exclude VAT.

The costs developed for each route are greater than those summarised in the 2017 Sustrans study. This reflects the level of detail applied to alignment concept designs, increased input from internal and external stakeholders and price increases since 2017. Due to an increased understanding of the delivery challenges associated with the routes, costs have been developed to be conservative.

Much consideration has been given as to how to represent uncertainty in the estimation of route costs, in particular those associated with the refurbishment of Queensbury Tunnel. The approach described has been agreed after extensive discussions between Sustrans, CBMDC, and the DfT. The approach is described in four parts:

- 6.2.1 focuses first on identifying the assumptions and exclusions associated with the base cost estimates for all alignments
- 6.2.2 describes the approach to risk costs for Queensbury Tunnel and non-Queensbury Tunnel elements
- 6.2.3 presents the costs for each route based on the agreed approach
- 6.2.4 explains how remaining uncertainties are managed

6.2.1. Assumptions and Exclusions

Costs for all sections of all alignments are provided in the design schedule, included in Appendix E. For all non-Queensbury Tunnel elements, costs have been developed based on the application of unit rates associated with the implementation of typical cycling infrastructure in the UK. These rates have been determined using a combination of information published by Highway Authorities across the UK, as well as rates recorded through the tendering of Sustrans construction projects, where appropriate.

Costs associated with the refurbishment of Queensbury Tunnel have been taken from Jacobs 2021 study. Exclusions to the costs prepared by Jacobs are stated within the April 2021 report as follows:

— "Any infrastructure relating to constructing a cycleway through the tunnel, including lighting, surfacing, drainage works, security, signage etc;

— Any work to the existing drainage channels beneath the track bed;

— Any work to the track bed itself;

— Any external/access works required outside of the tunnel portals and shafts.” (It was assumed that access to the tunnel at both portals will be available during the construction work)

— Dewatering costs (it was assumed that the tunnel will be de-watered prior to construction works and water levels maintained throughout by the existing pump at the southern portal)”

Costs for lighting, surfacing, security, and signage related to construction of a cycleway through the Tunnel are included in the Sustrans construction cost estimate. Drainage costs are also included, but account for the provision of basic drainage alongside the new cycle path, rather than works to the existing drainage channels beneath the track bed. Responses to clarification questions suggest that there are known to be collapses in the existing drainage. However, there is no specific information on the extent of these collapses.

Clarification questions submitted to Amco-Giffen and Jacobs via Historical Railways Estates (HRE) confirmed that the track bed should be strong enough to support the loads required for construction and use of a cycling and walking path. Therefore, no costs for strengthening of the track bed are included.

Access costs were excluded from the Jacobs estimate for Tunnel restoration. It is assumed that access to the northern portal has been proven during the safety works, and access to the southern portal is expected to be supported by the current landowner given a stance of support for a cycling and walking route through the Tunnel. Dewatering costs were also excluded. It is assumed that the existing pump can be re-activated with the support of the landowner.

Route infrastructure construction costs have been developed using the following assumptions:

- 15% uplift has been applied to account for ecological surveys, compensation and mitigation measures. It is assumed that ecological surveys will be required for all non-highway sections of the alignment.
- 10% uplift has been applied to account for land and legal issues relating to areas where the alignment crosses private land. This would typically account for the negotiation and purchase of land. Costs that could be incurred in the event of extraordinary legal challenges (e.g. public enquiries) are excluded.
- Cost estimates for the creation and /or upgrade of rights of way have been excluded. This is due to the highly unpredictable nature of the process.
- 15% uplift has been applied to each route for construction preliminaries. These include the main contractors’ costs associated with establishing and managing the site.
- 8% uplift has been applied to each route for design and development.
- A further 10% contingency has also been applied to each route option. This contingency accounts for unforeseen construction costs that haven't been determined through the design process.

No extraordinary allowance for ecological costs were made. This is because historical surveys suggest that the presence of roosting bats in Queenbsury Tunnel is decreased due to the wet condition of the tunnel. Furthermore, the completion of recent safety works within the tunnel suggests that the likelihood that protected species are present within the tunnel at this stage is reduced.

The 10% contingency applied to all routes is designed to account for unforeseen construction costs that have not been identified during the feasibility study process. However, there are some known exclusions particularly associated with Queensbury Tunnel that cannot be reasonably estimated due to a lack of available information as to the extent of any works that may be required:

— Any geotechnical works required to stabilise slopes at the Tunnel portals

— Drainage works to the existing track drainage

— Excavation and removal of material from the submerged Tunnel section

In agreement with CBMDC and the DfT, these known exclusions are managed through sensitivity testing applied to the economic analyses, alongside other remaining uncertainties. A description of the sensitivity testing approach is presented in section 6.2.4.

6.2.2. Treatment of risk

Based on the information provided within the Jacobs 2021 study and responses to clarification questions relating to construction assumptions, it is considered that the cost estimate for tunnel refurbishment was conservative at the time of completion. Further clarifications were also sought in relation to the risk costs and cost tolerance applied to the Jacobs estimate.

The responses via HRE confirmed that the risk cost applied to the Queensbury Tunnel cost estimate was assessed using a Quantified Risk Assessment (QRA), and optimism bias was specifically excluded from the work. The basis for this exclusion was that optimism bias is used at the early stages of a project, where information on risk is not available. Information on risk for Queensbury Tunnel **was** available, and optimism bias was therefore considered an inappropriate approach for the situation. Hence a QRA was undertaken.

The risk cost added to the baseline estimate was taken from the upper bound of a range of £0.39m to £4.12m, calculated with a 90% confidence range. This risk cost was based on a probabilistic assessment of eleven risks identified, including further deterioration of the tunnel lining. The responses to Sustrans clarifications include a reference to a ‘suspicion’ that further deterioration may have occurred. Given that further deterioration is explicitly included within the risk assessment on which the risk cost was based, it is considered that any such deterioration would be covered by this additional cost.

The risk cost described above was calculated using QRA methods and represents an approach to risk that is applied when risks are known. Optimism bias, in contrast, is a tool used when risks are unknown, at early stages of a project. Transport Analysis Guidance (TAG) Unit A1.2[xxviii] for scheme cost assessment states that QRA and optimism bias are **alternative** approaches to risk estimation and that one or the other should be used in scheme appraisals:

"There are two main elements of a scheme cost estimate that can be estimated and reported in scheme appraisals: base costs and adjustments for risk ***or*** *optimism bias"* (TAG, p1, emphasis ours)

The risk cost of (£4,123,000) applied to the Queensbury Tunnel estimate represents a 19% addition to the total construction, ventilation, design, development and supervision cost estimate (£22,259,087). In Sustrans original cost estimates the costs plus risk costs were subject to a 32% optimism bias, based on the assumption that Queensbury Tunnel estimates could be considered to be Stage 2 as set out in Table 8 of the transport appraisal guidance (TAG) unit A1.2. Discussions with DfT concluded that the assumption Queensbury Tunnel fell into the category of Stage 2 would not be supported, and furthermore, the Stage 1 value of 55% was likely to be an underestimate, since it is applicable to new tunnels, rather than tunnel refurbishments.

The following approach was agreed:

- Application of either QRA or optimism bias, but not both, in line with TAG guidance
- Application of optimism bias only for all elements of each route. This represents a more conservative approach than QRA alone for the Queensbury Tunnel estimates, but brings Queensbury Tunnel estimates into line with other sections of the route

Based on the approach above, the following levels of optimism bias were applied using rates derived from AMAT guidance, discussions with DfT economists, and DfT's transport appraisal guidance (TAG) Unit A1.2[xxix] as follows:

- 46% optimism bias applied to all non-tunnel elements (Table 8, Unity A1.2: Roads and active travel infrastructure, Stage 1)
- 55% optimism bias has been applied to all bridge and tunnel structural costs, excluding Queensbury Tunnel (Table 8, Unit A1.2: Bridges & Tunnels, Phase 1)
- 66% optimism bias has been applied to Queensbury Tunnel (based on the upper value in the range of OBs quoted for non-standard projects in Flyvbjerg[xxx]. Application of 66% would fit with guidance provided in Clause 3.5.13 of the TAG Unit A1.2 guidance: "…if the scheme or elements of the scheme are particularly novel, it might be appropriate to use uplifts in excess of those presented in Table 8."

An estimate tolerance of +/-30% was also provided with the Tunnel cost estimate. It was confirmed via HRE that this represents "*the estimator's assessment of the quality of data [used] to produce the estimate and the resulting uncertainty as to the veracity of the estimated costs derived from that data."* Plus or minus 30% has been used because that is "*fairly standard for [cost estimates] for HRE projects*." It was agreed that treatment of cost uncertainty would be considered using sensitivity analysis, rather than in the upfront cost estimates. A description of the sensitivity testing approach is presented in section 6.2.4.

6.2.3. Route costs

Table 32 shows base cost estimates and costs including optimism bias calculated using the approach described in section 6.2.2, for each of the six routes. The costs shown are the total costs for each route.

Table 32: Overall construction cost estimates for the six route options

	Total route length (km)	Queensbury Tunnel Refurbishment Cost	Other Infrastructure Costs (inc. QT cycling and walking infrastructure)	Total Option Cost	Total Option Cost with Optimism Bias (OB)
Most Attractive and Advantageous – Tunnel Option	44.5	£22,259,087	£19,439,003	£41,698,090	**£65,588,347**
Most Attractive and Advantageous – Alpine Option	46.6	£-	£21,326,719	£21,326,719	**£31,394,328**
Next Preferred – Tunnel Option	32.0	£22,259,087	£18,670,369	£40,929,456	**£64,466,141**
Next Preferred – Alpine Option	33.7	£-	£20,558,085	£20,558,085	**£30,272,122**
Low Cost Alternative – Tunnel Option	33.7	£22,259,087	£13,647,298	£35,906,385	**£57,125,912**
Low Cost Alternative – Alpine Option	35.4	£-	£15,535,014	£15,535,014	**£22,931,893**

Maintenance costs for each of the routes are shown in Table 33. In discussion with the Client, it was agreed that maintenance costs for all highway elements would be subsumed into the annual highway budget. Highway maintenance costs are therefore excluded.

Table 33: Annual maintenance costs for the six route options

	Total route length (km)	Queensbury Tunnel Maintenance per year	Other Tunnel Maintenance per year	Route Infrastructure Maintenance per year (non-highway)	Total Maintenance per year
Most Attractive and Advantageous – Tunnel Option	44.5	£24,090	£15,141	£322,567	£361,798
Most Attractive and Advantageous – Alpine Option	46.6	£-	£11,064	£391,760	£402,824
Next Preferred – Tunnel Option	32	£24,090	£15,141	£319,767	£358,998
Next Preferred – Alpine Option	33.7	£-	£11,064	£388,960	£400,024
Low Cost Alternative – Tunnel Option	33.7	£24,090	£15,141	£209,945	£249,176
Low Cost Alternative – Alpine Option	35.4	£-	£11,064	£279,138	£290,202

6.2.4. Dealing with remaining uncertainty

As described in section 6.2.1, it was agreed that known exclusions and cost uncertainties would be dealt with through sensitivity analyses, rather than trying to quantify known unknowns. In addition to the known unknown costs and the cost tolerance applied to the Jacobs estimate, sensitivity analysis was also applied to take account of increased inflation and construction delays.

The sensitivity analyses seek to establish how each of the uncertainties affects the final calculated BCR, for the Most Attractive and Advantageous route option with Queensbury Tunnel included. A full presentation of the sensitivity analyses and associated results for each of these five areas is presented in Appendix J. This section summarises the approach taken to the analysis in each case.

Cost tolerance – Jacobs 2021 study estimates

The effect of application of the tolerance of +/-30% to the Queensbury Tunnel refurbishment costs was tested. Increases or decreases were applied at the base costs stage, prior to entry into the AMAT tool. It is assumed that the cost variations being investigated in this sensitivity analysis would have no effect on uplifts. The assumption is based on the premise that the cost variations being investigated are variations in cost to deliver the same output, rather than variations in the quality of the final construction. Therefore, cost variations were input directly into the AMAT calculation spreadsheet. The variance in BCR as a result was recorded.

Known unknowns

Known unknowns for the tunnel cycling and walking infrastructure were identified during the cost estimation stage. Rather than estimate an additional contingency for these unknowns, the cost overruns required to cause a decrease in BCR below different value for money thresholds were calculated. Present Value Benefits remained constant for all calculations. The difference in Present Value Cost, and the associated percentage cost increase that would result in the differences was recorded.

Inflation and delay

Inflation over and above the GDP deflator was not included in the baseline construction costs. For sensitivity testing, the effects of inflation are applied assuming that real cost inflation is 4% over and above the GDP deflator, reflecting the difference between current (2022) construction cost inflation (approx. 6%) and long-run forecasts for inflation (approx. 2%). This acts as a sensitivity test to demonstrate the impact of inflation being higher than the 2.1% assumed general inflation.

Additionally, a sensitivity test has been carried out to illustrate the impact of a potential 2-year delay to construction starting. Under this scenario, the inflated costs are calculated from 2024 (instead of 2022) onwards accounting for increased inflation from this point. This sensitivity test (for potential 2-year delay) has been carried out at the base rate of inflation and at the higher rate of inflation. The variance in BCR as a result was recorded.

6.3. Route option comparison: project risks and benefits

This section considers the *relative* merits of the routes presented previously in this chapter. Routes are compared using a series of qualitative criteria, including user experience, fulfilment of strategic objectives, and risks to delivery of the route as intended. Consideration of how well each route fulfils the aspirations of the interest groups described in Chapter 3 is also provided. An extract from Table 30 is reproduced below to facilitate reference to the route summaries and figures.

Options	Most Advantageous and Attractive	Next Preferred	Low Cost alternative
Figure Number	Figure 15 (Tunnel) Figure 16 (Non-tunnel)	Figure 17 (Tunnel) Figure 18 (Non-tunnel)	Figure 19 (Tunnel) Figure 20 (Non-tunnel)
Summary	Greenway and highway alignments are both included to provide a comprehensive network linking West Bradford, Halifax and Keighley.	Greenway alignments are selected in West Bradford and Halifax arms.	Highway alignments are included in West Bradford and Halifax arms

Using the criteria, a quantitative assessment of the relative performance each route is developed. While scores are assigned to each route option, assessment of the relative success of each route remains subjective.

The criteria used for the assessment are as follows:

- User experience: how well, overall, does a route cater for the needs of all potential users compared to other route options? It can be assumed that issues of safety, intuitive use, and comfort on a micro scale (smooth surfaces, appropriate cross fall etc.) are met equally by all routes. Routes are compared from a whole route perspective: assessing elevation gain, and distance travelled between the three major settlements of Bradford Keighley and Halifax to determine relative performance.
- Strategic success: how well, overall, does a route satisfy the strategies and policies discussed in Section 2.1?
- Risks to delivery: how extensive are the delivery uncertainties associated with each route? None of the routes presented in this study will be straightforward to deliver, with multiple uncertainties present in all options.
    - Risks associated with development in potentially ecologically sensitive locations are considered for all routes
    - Risks associated with third-party delivery are used to provide a comparison between route options. Reliance on third-party delivery reduces the funding burden for some route options and can therefore be considered positive in one sense. However, alignments based on leverage of third-party schemes are at risk of changes to delivery dates and scope that would otherwise be within the control of the scheme providers. As cost and

benefit are assessed quantitatively elsewhere, this criterion is assessed based on the risk to delivery presented by reliance on third parties.

- Stakeholder satisfaction: based on feedback provided by stakeholders, a score is assigned as to how well each route satisfies stakeholder aspirations. Stakeholder feedback can be viewed for each alignment in Chapter 5 and Appendix H.

Scores are assessed on a relative basis and assigned as follows: a score of 3 means a route is considered to perform well in a category compared to other routes. A score of 1 means a route is considered to perform poorly compared to other routes. Assessment of the alpine and tunnel options for each route is applied after the initial score is assigned. If one or other of the alpine or tunnel options is considered to be more or less successful at meeting the criteria under consideration, the poorer performing option is adjusted down by 1 point.

User experience

- *Most Advantageous and Attractive*: of all the routes, this one provides the maximum choice for users wishing to embark on leisure or utility journeys. *Relative rating: 3*
- *Next Preferred:* decreases route choice with the omission of the Thornton Road and Halifax to Holmfield Highway options. Direct travel between Bradford and Keighley is compromised. Greenway options included retain a good experience for leisure users. *Relative rating: 2*
- *Low Cost:* decreases route choice with the omission of the Clayton and Halifax to Holmfield Greenway options. Direct travel between Bradford and Halifax and Bradford and Queensbury is compromised. Highway options reduce experience for leisure users. *Relative rating: 1*
- *Tunnel versus alpine*: inclusion of Queensbury tunnel minimises the need for elevation gain, and adds a unique draw for leisure and tourism use. Conversely, the alpine option adds elevation for users travelling to and from Halifax, and follows a complex and somewhat peripheral alignment through Queensbury itself. *Relative rating: -1 for alpine options*.

Strategic success

- *Most Advantageous and Attractive*: connects the highest number of strategic locations, and provides the greatest opportunity to contribute to strategic objectives of health, inclusive growth and mobility choice. *Relative rating: 3*
- *Next Preferred:* omission of the highway option bypasses population centres of Mixenden and Ovenden in the Halifax to Holmfield corridor. Thornton in the West Bradford corridor is also bypassed by this route. *Relative rating: 1*
- *Low Cost:* bypasses Clayton in the West Bradford corridor. Maintains provision through the most densely populated areas in all corridors. *Relative rating: 2*
- *Tunnel versus alpine*: Exclusion of Queensbury Tunnel in the alpine option removes the opportunity to contribute to development of the region’s heritage facilities. *Relative rating: -1 for alpine options*.

Delivery risk: presence of ecologically sensitive locations

- *Most Advantageous and Attractive*: with the longest overall development length, this route passes through the largest number of ecologically sensitive habitats. *Relative rating: 1*
- *Next Preferred:* omission of predominantly highway based alignments from this route does not appreciably reduce the ecological risk. *Relative rating: 1*

- *Low Cost:* exclusion of the greenway alignments from West Bradford and Halifax to Holmfield corridors reduces the ecological risk. *Relative rating: 3*
- *Tunnel versus alpine*: the ecological risks of the tunnel option and alpine option are considered comparable at this point in time. Tunnels are usually prime habitats for roosting and hibernating bats. However, the extended period of recent construction works may have reduced this risk. Conversely, extensive earthworks within former mine workings present on the alpine alignment has the potential to damage large areas of the existing habitat. *Relative rating: no differential. Note: the ecological risk associated with Queensbury Tunnel is likely to increase with time after cessation of stabilisation works.*

Reliance on third-party schemes

Scores relating to third-party works are likely to fluctuate with time dependent on decisions made during the progression of these schemes. Our assessment is made at a time when these schemes are not yet certain for delivery. Since initial development of the routes, the third-party Thornton Road TCF scheme has been reduced in initial scope, with development of the Cemetery Road to Thornton village section of the alignment being put on hold. This reduces the viability of the routes that rely on third party development. The scores are assigned based on the risk to delivery presented by reliance on third parties.

- *Most Advantageous and Attractive*: the route assumes the delivery of several third-party TCF & WY+TF schemes to achieve the assumed provision in the West Bradford and Halifax to Holmfield corridors. The reduction in scope of the Thornton Road Scheme reduces the benefits realised by this route option, but the presence of a second option in the West Bradford corridors reduces the impact of the third-party limitations. *Relative rating: 2*
- *Next Preferred:* only short lengths of third-party schemes are included in this route, *limiting the risk of changes being introduced*. *Relative rating: 3*
- *Low Cost:* wholly reliant on the delivery of third-party TCF and WY+TF schemes to achieve the assumed provision. *Relative rating: 1*
- *Tunnel versus alpine*: the use of the tunnel or otherwise has no bearing on the risk presented by non-completion of third-party schemes. *Relative rating: no differential.*

Stakeholder satisfaction

- *Most Advantageous and Attractive*: while suggestions for improvements were put forward, this route includes options most preferred by stakeholders. *Relative rating: 3*
- *Next Preferred:* while suggestions for improvements were put forward, this route includes options most preferred by stakeholders. *Relative rating: 3*
- *Low Cost:* this route does not reflect the preferences expressed by stakeholders providing feedback on route options. *Relative rating: 1*
- *Tunnel versus alpine*: non-local authority stakeholders expressed a clear preference for tunnel options over alpine options. *Relative rating: -1 for alpine option.*

Summary

Using the scores assigned above, a ranking for each route's relative performance can be established. This is shown in Table 34.

Table 34: Summary of qualitative assessment of route options

	Most Attractive and Advantageous - Tunnel Option	Most Attractive and Advantageous - Alpine Option	Next Preferred - Tunnel Option	Next Preferred - Alpine Option	Low Cost Alternative - Tunnel Option	Low Cost Alternative - Alpine Option
Overall user experience	3	2	2	1	1	0
Strategic Context	3	2	1	0	2	1
Ecological risk	1	1	1	1	3	3
Third-party delivery	2	2	3	3	1	1
Non-LA Stakeholder	3	2	3	2	1	0
Total relative score	12	9	10	7	8	5
Rank	1	3	2	5	**4**	**6**

6.4. West Yorkshire Mass Transit Vision

Evaluation of the feasibility of a new cycling and walking route in the study area cannot be completed without consideration of the West Yorkshire Mass Transit vision. There is a stated ambition to begin delivery of a mass transit system within West Yorkshire by the mid-2020s [ix]. Phase 1 is likely to focus on the creation of links between Bradford and Leeds. Later phases (Phases 2 and 3) include a link between Bradford and Halifax. Later phases may begin construction from the mid-2020s, with Phase 3 construction complete by 2035. It is not clear whether a link between Bradford and Halifax would fall into Phase 2 or Phase 3.

Early concepts for the Bradford Halifax link show that the use of Queensbury Tunnel to support mass transit is being considered, though it is noted that the initial priority for Queensbury tunnel is that "it is retained and becomes a walking and cycling route" (WY Mass Transit Vision 2040, p37). Stabilisation works on Queensbury Tunnel were completed in October 2021. These stabilisation works reduced the threat of further degradation of the tunnel, but were not intended to improve the condition of the tunnel to the extent that it is ready for use for walking and cycling. Further remediation works required to achieve a safe condition for the tunnel for use as a cycling and walking route are detailed and costed in Jacobs' 2021 study.

It is assumed that the works detailed by Jacobs would also render the tunnel suitable for use as a mass transit link. However, based on pinch points within the tunnel (5m widths where shaft stabilisation works have occurred), it is also assumed that the tunnel will not be able to support both a cycling and walking route and a mass transit corridor.

Consideration was given in the development of this feasibility study as to whether it would be possible to capture the comparative value of Queensbury Tunnel as a cycling and walking link or mass transit link. However, development of the vision for mass transit in the region remains at an early stage, and assessing the value of mass transit falls beyond Sustrans' area of expertise. It was concluded that such an exercise was unlikely to produce a meaningful analysis of the comparison. This position was agreed with the Client.

All analysis within this study is therefore considered without regard to mass transit, and the value or otherwise of using Queensbury Tunnel for a cycling and walking link is considered it its own right. If a decision is made to use the Tunnel for walking and cycling then future mass transit development should take this into account when developing a business case. Any future plans to repurpose the tunnel for mass transit should consider the effect that this would have on usage of the wider cycling and walking route if no mitigation measures are proposed. We suggest that any assessment of benefit of Queensbury Tunnel for future mass transit should consider:

- The impact of usage of the routes proposed in this study, if a tunnel based route option is developed with an expectation that the tunnel is repurposed at a future date
- The costs of providing suitable alternative cycling and walking connection between Holmfield and Queensbury, were the tunnel to be used for mass transit
- The impact on the wider route proposals that would arise from routing mass transit to and through Queensbury Tunnel

Regardless of the considerations above, it is recommended that any future mass transit system is specified to enable users to engage in multi-modal travel. For the avoidance of doubt, this means that users would be able to carry their cycle or similar with them on the mass transit vehicle, rather than an expectation that cycles or similar would be parked and an ongoing journey made by foot. This is especially important where mass transit serves rural and leisure locations.

7. Economic Appraisal Summary

Definitions

This chapter includes the use of the terms 'alignment', 'route' and 'scenario'. For the avoidance of any doubt:

- **Alignment**: intended path along which provision will be provided.
- **Route**: a combination of alignments.
- **Scenario**: a set of conditions used to evaluate the economic performance of a route. A route may be evaluated under multiple scenarios

7.1. Methodological Overview

Each of the six route options have been appraised for their economic benefits. This has principally involved an investigation of the estimated potential usage of each of the alignments, the interaction between alignments when grouped into routes, and the associated economic benefits. The scope of the economic appraisal centres around the Active Mode Appraisal Toolkit (AMAT) to provide Benefit-Cost Ratios, in line with government Transport Appraisal Guidance, as well as additional activities to capture aspects of the value for money case for the Queensbury Tunnel (and associated routes) as a walking and cycling route that are not currently included in AMAT. This includes appraisal of the estimated tourism usage and recreational expenditure on the route(s) as well as the potential heritage value and associated carbon impact of the scenarios.

An outline of the steps taken in the economic appraisal is as follows. A full explanation of the methodology is given in Appendix J of this document.

- Estimate baseline annual usage (number of users by mode and journey purpose) for each alignment
- Combine alignments into 6 routes, adjusting for double counting when estimating baseline annual usage for each scenario
- Estimate post intervention annual usage for each scenario; using past evidence from case studies of similar greenway and tunnel schemes and DfT's Capital Fund Uplift Tool as a sensitivity test
- Estimate the economic value of anticipated benefits against construction and maintenance costs using the DfT's Active Mode Appraisal Toolkit (AMAT), to obtain Benefit-Cost Ratios (BCRs) for each of the 6 route scenarios. Each route scenario is sensitivity tested using both the uplifts derived from the case studies and the recommended uplifts from the Capital Fund Uplift Tool (as a sensitivity test)

- Estimate the tourism benefit of the 6 routes, using the Leisure Cycling and Leisure Walking Expenditure Models
- Demonstrate the potential heritage value of the Queensbury Tunnel through switching values analysis
- Perform sensitivity testing for scenarios involving changes in cost for the tunnel

The economic appraisal process, including data inputs and outputs is illustrated in below, with a fuller explanation of each stage provided in Appendix J.

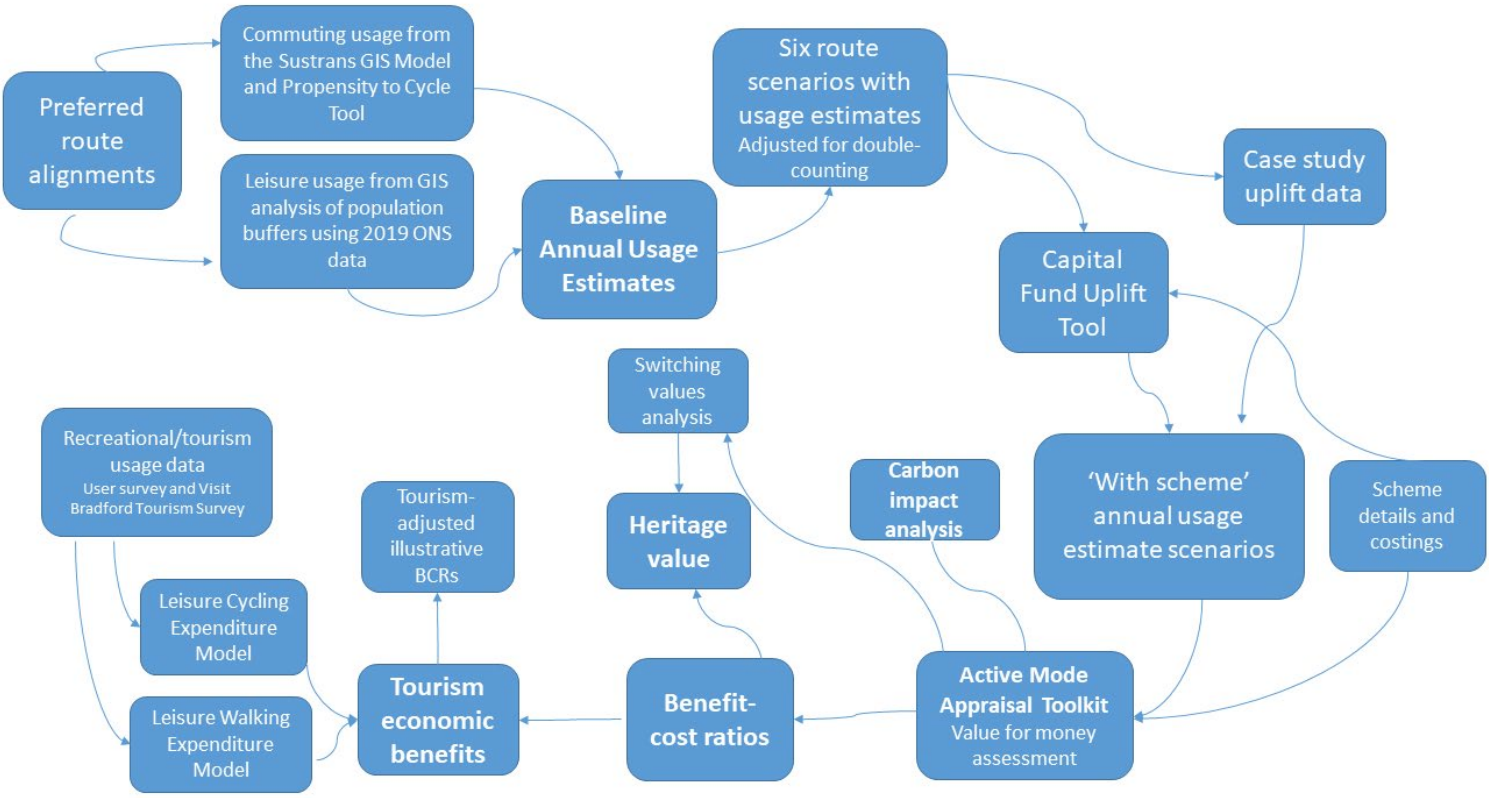

Figure 21: Economic appraisal process flowchart

7.2. Usage Levels

For each of the individual routes and scenarios, an estimate of the number of people walking and cycling for commuting and leisure purposes has been developed. These usage estimates form part of a usage forecasting exercise to develop 'with scheme' scenarios that are appraised against the baseline in the AMAT.

The usage estimates have been analysed for each route (i.e. combination of alignments) where double-counting of usage across alignments has been accounted for. The baseline walking and cycling usage estimates for each scenario are shown in Table 35. The usage is given as an Annual Usage Estimate (AUE): the estimated number of trips made over the course of a year. This is converted into a daily trip amount for the purposes of AMAT analysis. It should be noted that any estimates of baseline usage have a level of uncertainty inherent. The baseline estimates are based on population data, data from the National Travel Survey, and other assumptions.

Table 35: Baseline walking and cycling usage estimates for all scenarios

Route	Total Baseline Cycling trips	Total Baseline Walking trips	Total Scenario Baseline AUE
Most Advantageous & Attractive (Queensbury Tunnel Option)	613,525	2,673,474	**3,286,998**
Most Advantageous & Attractive (Alpine Option)	589,551	2,671,091	**3,260,642**
Next Preferred (Queensbury Tunnel Option)	496,686	2,102,872	**2,599,558**
Next Preferred (Alpine Option)	472,713	2,100,490	**2,573,203**
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	350,296	1,505,960	**1,856,256**
Low Cost & Quickest to Deliver (Alpine Option)	326,322	1,503,578	**1,829,900**

Table 36: Forecasted usage scenarios (walking and cycling)

Most Advantageous and Attractive				
Queensbury Tunnel Scenarios	**With' scheme - Daily trips (cycling)**	**With scheme' - AUE (cycling)**	**'With scheme' - Daily trips (walking)**	**With scheme' - AUE (walking)**
Case studies	11,834	2,958,542	19,117	4,779,165
Capital Fund Uplift Tool	5,422	1,355,549	23,756	5,939,016
Alpine Zig-Zag Scenarios	**With' scheme - Daily trips (cycling)**	**With scheme' - AUE (cycling)**	**'With scheme' - Daily trips (walking)**	**With scheme' - AUE (walking)**
Case studies	5,094	1,273,430	19,018	4,754,543
Capital Fund Uplift Tool	3,900	974,932	23,236	5,808,931
Next Preferred				
Queensbury Tunnel Scenarios	**With' scheme - Daily trips (cycling)**	**With scheme' - AUE (cycling)**	**'With scheme' - Daily trips (walking)**	**With scheme' - AUE (walking)**
Case studies	9,306	2,326,447	13,368	3,341,990
Capital Fund Uplift Tool	4,456	1,113,908	18,522	4,630,557
Alpine Zig-Zag Scenarios	**With' scheme - Daily trips (cycling)**	**With scheme' - AUE (cycling)**	**'With scheme' - Daily trips (walking)**	**With scheme' - AUE (walking)**
Case studies	4,084	1,021,059	14,955	3,738,872
Capital Fund Uplift Tool	3,433	858,291	20,922	5,230,587
Lowest Cost and Quickest to Deliver				
Queensbury Tunnel Scenarios	**With' scheme - Daily trips (cycling)**	**With scheme' - AUE (cycling)**	**'With scheme' - Daily trips (walking)**	**With scheme' - AUE (walking)**
Case studies	6,138	1,534,475	10,757	2,689,315
Capital Fund Uplift Tool	3,507	876,627	14,204	3,551,097
Alpine Zig-Zag Scenarios	**With' scheme - Daily trips (cycling)**	**With scheme' - AUE (cycling)**	**'With scheme' - Daily trips (walking)**	**With scheme' - AUE (walking)**
Case studies	2,819	704,856	10,705	2,676,368
Capital Fund Uplift Tool	2,455	613,760	15,340	3,835,012

7.3. Economic Benefits

The economic benefits of each scenario have been assessed using the Department for Transport (DfT's) Active Mode Appraisal Toolkit (AMAT). This appraises the Present Value Benefits and Present Value Costs of each route to provide a Benefit-Cost Ratio. The AMAT has been run with two uplift scenarios: a scenario based on case study evidence from comparable schemes and a scenario based on the DfT's Capital Fund Uplift Tool. Relevant case studies from past infrastructure projects were used to develop an uplift estimate for large infrastructure projects (comparable to the Queensbury Tunnel alignment) and cycling and walking pathways (comparable to other alignments included in the routes) separately. The uplifts for each scenario use the appropriate uplift estimate for each constituent alignment. The Capital Fund Uplift Tool provides low, middle and high uplift estimates and recommends the uplifts to use based on the Intrinsic Cycling/Walking potential of the local authority. For this scheme, the uplift tool recommended using the 'Low' cycling and 'Middle' walking uplifts. For details of the uplift process see Appendix section J.4.1.

The AMAT outputs are based on the usage estimates, scheme costs (including maintenance costs) as well as other inputs related to the scheme characteristics and appraisal parameters (e.g. decay rate).

Table 37: Active Mode Appraisal Toolkit Outputs – BCRs

Most Advantageous & Attractive (Queensbury Tunnel Option)				
	PVB (£'000s)	PVC (£'000s)	BCR	VfM Category
Case Studies	£133,753.07	£ 47,392.28	2.82	High
Capital Fund Uplift Tool	£ 90,701.57	£ 47,401.59	1.91	Medium
Most Advantageous & Attractive (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 68,623.09	£ 25,086.99	2.74	High
Capital Fund Uplift Tool	£ 55,771.88	£ 23,591.54	2.36	High
Next Preferred (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£105,985.27	£ 46,761.73	2.27	High
Capital Fund Uplift Tool	£ 77,035.57	£ 46,768.54	1.65	Medium
Next Preferred (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 52,700.03	£ 24,551.79	2.15	High
Capital Fund Uplift Tool	£ 65,438.64	£ 24,550.64	2.67	High
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 72,534.25	£ 40,584.60	1.79	Medium
Capital Fund Uplift Tool	£ 60,801.42	£ 40,588.19	1.50	Low
Low Cost & Quickest to Deliver (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 36,980.13	£ 18,537.63	1.99	Medium
Capital Fund Uplift Tool	£ 48,189.58	£ 18,536.51	2.60	High

The BCRs are dependent on the overall change in usage from baseline. As there exists uncertainty in the baseline usage numbers as described previously, there is also some uncertainty in the overall BCR. The modelling and BCRs presented represent a central tendency; as seen in previous usage data, many schemes over- or underperform when compared to the average change in usage. For the

BCR to decrease enough for the Most Advantageous and Attractive scenario to fall into the Poor VfM category (< 1), baseline usage would have to decrease by a factor of 2.8 (with the associated reduction in uplift).

7.4. Tourism Benefits

The Leisure Cycling and Leisure Walking Expenditure Models have been used to estimate the economic benefits of tourism usage on the proposed routes. These economic benefits represent expenditure by leisure or tourist users who are walking or cycling on the routes and the associated jobs supported by this recreational/tourism usage. A proxy survey site on the Spen Valley Greenway in Bradford in 2018 and data from the 2019 Visit Bradford tourism survey were used to provide the necessary inputs for the LCEM and LWEM, alongside the usage estimates in Table 36.

The expenditure figures represent a direct contribution to the local economy from this recreational/tourism usage and therefore a cashable benefit, in contrast to the monetised impacts in AMAT which do not represent real expenditure. As well as tourism-related expenditure, the model output indicates the number of Full-Time Equivalent (FTE) jobs that are supported by this level of expenditure. The tourism benefits displayed in this section represent an expenditure by local or regional tourists (rather than national), assuming that tourists will opt to visit the Queensbury Tunnel area instead of other locations in the country. The BCRs including tourism benefits therefore represent the 'local' rather than 'national' value for money.

A comparison of the AMAT BCRs and a BCR with these additional tourism benefits included is shown in Table 39. For more detail on the tourism expenditure outputs and the tourism-adjusted BCRs see Appendix section J.4.3. Only the results for the "Most Advantageous and Attractive" options are presented here; results for the rest of the route options are presented in Appendix J, section 0.

Table 38: Leisure Cycling and Leisure Walking Expenditure Output

Most Advantageous & Attractive (Queensbury Tunnel Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£1,385,204.48	£7,493,360.49	£8,878,564.96	30	164	194
Capital Fund Uplift Tool	£634,727.83	£9,311,935.46	£9,946,663.29	14	204	218
Most Advantageous & Attractive (Alpine Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£808,004.83	£7,041,148.15	£7,849,152.98	18	154	172
Capital Fund Uplift Tool	£329,850.44	£8,853,666.61	£9,183,517.05	7	194	201

Table 39: Comparison of AMAT BCRs and adjusted BCRs with tourism benefit.

Scenarios		AMAT BCRs	AMAT BCR + Tourism benefit	Difference
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	2.82	3.01	0.19
	Capital Fund Uplift Tool	1.91	2.12	0.21
Most Advantageous & Attractive (Alpine Option)	Case Studies	2.74	3.05	0.31
	Capital Fund Uplift Tool	2.36	2.75	0.39

7.5. Heritage Benefits

The Queensbury Tunnel structure is expected to have a significant heritage value because of its industrial heritage. This potential heritage value is external to the monetised impacts included in AMAT, but an important aspect of the business case for the tunnel as a walking and cycling route which would provide access to its industrial heritage for users. The extent of the heritage benefits will be influenced in part by the extent to which the original lining in the Tunnel is retained, which is not yet determined.

Switching values analysis has been carried out to estimate the potential heritage value of the Queensbury Tunnel. The original AMAT outputs for Present Value Benefits, Present Value Costs and BCRs are in Table 37. Table 40 shows the results of the switching values analysis for the three scenarios which involve Queensbury Tunnel. A full explanation of the switching values analysis is given in Appendix J.

Based on the usage scenarios modelled below, the per-user heritage value of the Queensbury Tunnel ranges from £13.00 to £24.50. This range of values is credible and demonstrates that if heritage value were included in the value for money assessment, there are grounds to consider the out-turn BCRs as being higher than the AMAT BCRs. The full results of the switching values analysis applied to all route options is given in section J.5.3.

Table 40: Heritage value – switching values analysis

Most Advantageous & Attractive (Queensbury Tunnel Option)					
	Switching values: If BCR was rounded up to the next VfM category				
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ user (£)**
Case Studies	2.82	4.00	£189,569.13	£55,816.06	£24.50
Capital Fund Uplift Tool	1.91	2.00	£94,803.18	£4,101.61	£13.00

7.6. Carbon Impact

The greenhouse gas emissions outputs from the Active Mode Appraisal Toolkit have been used to estimate the potential carbon impact of each of the scenarios using the cash value of carbon from TAGA3.4. The estimated carbon impact of each of the “Most Attractive and Advantageous” scenario, based on the usage figures modelled in AMAT, is shown in Table 41. The full table of Carbon Impacts results for all route options is given in section J.5.4.

Table 41: Carbon impact analysis - Most Advantageous & Attractive

Most Advantageous & Attractive - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£291.09	3,390.73
Uplift Tool	£166.58	1,940.39

Most Advantageous & Attractive - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£97.37	1,134.24
Uplift Tool	£57.60	670.99

7.7. Option Comparison

The following section compares the BCRs across different route options according to the Present Value Benefit (£) per additional user walking or cycling on the routes. The additional users represent both the additional users walking and cycling combined, based on a comparison between the ‘with scheme’ and ‘without scheme’ annual usage estimates.

Table 42: Option comparison - £/additional user

Scenarios		Additional users per year (walking and cycling)	Present Value Benefits (£’000)	Value per additional user, £ / user
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	4,450,709	£ 133,753.07	£ 30.05
	Capital Fund Uplifts Tool	4,007,567	£ 90,701.57	£ 22.63
Most Advantageous & Attractive (Alpine Option)	Case Studies	2,767,331	£ 68,623.09	£ 24.80
	Capital Fund Uplifts Tool	3,523,221	£ 55,771.88	£ 15.83

8. Summary and recommendation

This study has examined three viable sustainable transport routes between Keighley, Halifax and Bradford, representing a Most Advantageous and Attractive option, a Next Preferred option, and a Low Cost alternative. For each of these routes, options incorporating and excluding Queensbury Tunnel have been developed to concept design level, to create six routes overall.

Discussions of the challenges, benefits and opportunities associated with specific alignments and routes were presented in Chapters 5 and 6. Chapter 7 provided a summary of the economic assessment of each of the routes. Routes have been compared using the Active Mode Appraisal Toolkit (AMAT). Present value costs, benefits and BCRs for each scheme have been presented based on case study evidence from comparable schemes and the DfT's Capital Fund Uplift Tool.

If usage in line with the case study averages can be achieved, routes presented generally represent high value for money (i.e. a BCR between 2 and 4). Given the evidence of changes seen in usage in the 60 case studies evaluated, the ambition of local and national government, the necessary direction of travel of levels of walking and cycling uptake, and the size of populations connected by this new and unique network of high quality routes, it is justifiable to expect that the case study BCR scenarios will be realised.

The following tables set out the various metrics for comparison of the various routes. Table 43 summarizes each of the routes compared for BCRs, benefits, and option cost. While BCRs are fairly narrowly distributed, the "Most Advantageous and Attractive" option including the tunnel ranks highest on both BCR and PVB. There is a wider variation in costs and benefits, with the "Most Advantageous and Attractive" option with the tunnel costing the most. Costs are shown with optimism bias included. For each metric, the most favourable result is highlighted in green.

Table 43: Summary comparison of cost, benefits and BCRS for all routes (case study scenarios)

Route	BCR	Present Value Benefit	Present Value Cost
Most Advantageous & Attractive (Queensbury Tunnel Option)	2.82	£133,753,070	£47,392,280
Most Advantageous & Attractive (Alpine Option)	2.74	£68,623,090	£25,086,990
Next Preferred (Queensbury Tunnel Option)	2.27	£105,985,270	£46,761,730
Next Preferred (Alpine Option)	2.15	£52,700,030	£24,551,790
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	1.79	£60,801,420	£40,584,600
Low Cost & Quickest to Deliver (Alpine Option)	1.99	£48,189,580	£18,537,630

Table 44 compares routes taking into account tourism value. The most favourable result for each metric is again highlighted. The "Most Advantageous and Attractive" route, with the inclusion of Queensbury Tunnel ranks highest for total tourism expenditure, while the option without the tunnel ranks slightly higher on value per additional user.

Table 44: Summary comparison of tourism impact for all routes (case study scenario)

Route	Total Tourism Expenditure (LWEM + LCEM)	Value per additional user
Most Advantageous & Attractive (Queensbury Tunnel Option)	£8,878,564.96	£1.99
Most Advantageous & Attractive (Alpine Option)	£7,849,152.98	£2.23
Next Preferred (Queensbury Tunnel Option)	£5,010,015.44	£1.59
Next Preferred (Alpine Option)	£5,942,741.31	£1.69
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	£3,541,740.96	£1.38
Low Cost & Quickest to Deliver (Alpine Option)	£4,561,673.69	£1.74

As has been demonstrated throughout this study, there are many considerations to take into account when considering the relative merits of new cycling and walking infrastructure. Table 34 is reproduced below, showing the relative performance of each route based on a series of qualitative criteria. For descriptions of these criteria and the scoring system used, please refer to section 6.2.4.

Summary of qualitative assessment of route options (reproduced from Table 34)

	Most Attractive and Advantageous - Tunnel Option	Most Attractive and Advantageous - Alpine Option	Next Preferred - Tunnel Option	Next Preferred - Alpine Option	Low Cost Alternative - Tunnel Option	Low Cost Alternative - Alpine Option
Overall user experience	3	2	2	1	1	0
Strategic Context	3	2	1	0	2	1
Ecological risk	1	1	1	1	3	3
Third-party delivery	2	2	3	3	1	1
Non-LA Stakeholder	3	2	3	2	1	0
Total relative score	12	9	10	7	8	5
Rank	1	3	2	5	4	6

Using the values in the tables above, the six routes are ranked from most-favourable to least favourable under each metric. The highest and lowest ranked options are highlighted for each category.

Table 45: Summary ranking of route options by economic criteria (case study scenario)

	Total Option Cost	Present Value Benefit	BCR	Total Tourism Expenditure (LWEM + LCEM)	Value per additional user, £ / user	Qualitative criteria
Most Advantageous & Attractive (Queensbury Tunnel Option)	6	1	1	1	2	1
Most Advantageous & Attractive (Alpine Option)	3	3	2	2	1	3
Next preferred (Queensbury Tunnel Option)	5	2	3	4	5	2
Next preferred (Alpine Option)	2	5	4	3	4	5
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	4	4	6	6	6	4
Low Cost & Quickest to Deliver (Alpine Option)	1	6	5	5	3	6

8.1. Phasing considerations

Delivery of any of the routes presented in this study, with their length and complexity will likely follow a multi-phased approach. Historically, and given the low level of consistent multi-year funding for walking and cycling schemes, it has been very difficult to deliver continuous routes connecting large settlements in a short period of time. To quickly realise the benefits of a high-quality network of routes between Bradford, Halifax and Keighley, it would be necessary to progress development of the phases concurrently with targeted funding, management and resource.

Long term, provision of a route with the highest level of connectivity should be the ambition, supported by a vision that requires that all phases will eventually be delivered. This report does not seek to suggest a final phasing sequence for delivery. Instead, key considerations that may contribute to a phasing strategy are identified.

Sections for consideration for earlier phases of delivery are likely to be those on which the rest of a route is dependent, or those that connect existing well-used sections of any of the proposed routes. Sections meeting these criteria include:

- Land agreements. For greenway alignments, considerable effort to secure landowner agreement will be required. Commencing this process at the earliest opportunity will unlock the potential for the timely delivery of alignments, and can be conducted concurrently with delivery of sections where necessary funding and agreements are already secured (e.g. TCF funded schemes).
- Bradford to Thornton TCF Phase 2. Since the route options for this study were developed, the TCF link between Bradford and Thornton has been divided into two phases, with the first phase extending from Bradford city centre to Cemetery Road. Early delivery of phase two of this TCF scheme is considered important in the development of the routes presented in this study, to provide access from Bradford to the wider route network.
- GNRT link between Cullingworth and Thornton. The GNRT links existing NCN into a continuous stretch, linking several strategic towns and villages between Keighley and Bradford. Coupled with delivery of phase two of the TCF scheme outlined above, early delivery of the GNRT sections will maximise connectivity opportunities with relatively little new infrastructure.
- Queensbury Tunnel stabilisation, for all tunnel options. The tunnel is the key connector between Bradford and Calderdale. Early stabilisation of the tunnel to prevent further deterioration is key to ensuring estimates provided by Sustrans and Jacobs are relevant and reliable when considering route feasibility.

When considered in the context of the routes as a whole, the following sections could form later phases, based on the assumptions stated. However, later delivery of these sections compromises other more local objectives that could be realised, as explained. Balancing local and whole-route needs will form a key aspect of any final phasing strategy:

- Halifax to Holmfield, greenway option. Based on the assumption that the TCF-funded Halifax to Ovenden alignment is delivered as planned in 2022/23. Delivery of the TCF scheme would provide the bulk of the connectivity required to link Halifax town centre with Holmfield. Completion of the highway alignment would enable access to either the tunnel or alpine options with relatively little new infrastructure compared to the greenway option. The process of landowner agreements should be started well in advance of envisaged delivery.
- West Bradford (Clayton option). Based on the assumption that the TCF-funded Bradford to Thornton link is provided early in a phasing plan, providing a link between Bradford and the wider route network. However, deferment of the Clayton option would mean opportunities to connect Clayton with Bradford for commuter and school use would not be realised in the short term. If Phase 2 of the TCF-funded Bradford to Thornton scheme were to be significantly delayed, delivery of the Clayton option would increase in priority.

The above observations do not include all sections of the proposed routes. However, the selected alignments demonstrate both the interconnectivity of the alignments across the routes, and the need to consider how each alignment may benefit not just the route as a whole, but local connectivity. As well as considering the proposed network as whole, this report provides a large volume of smaller walking and cycling infrastructure opportunities particularly for CBMDC to progress.

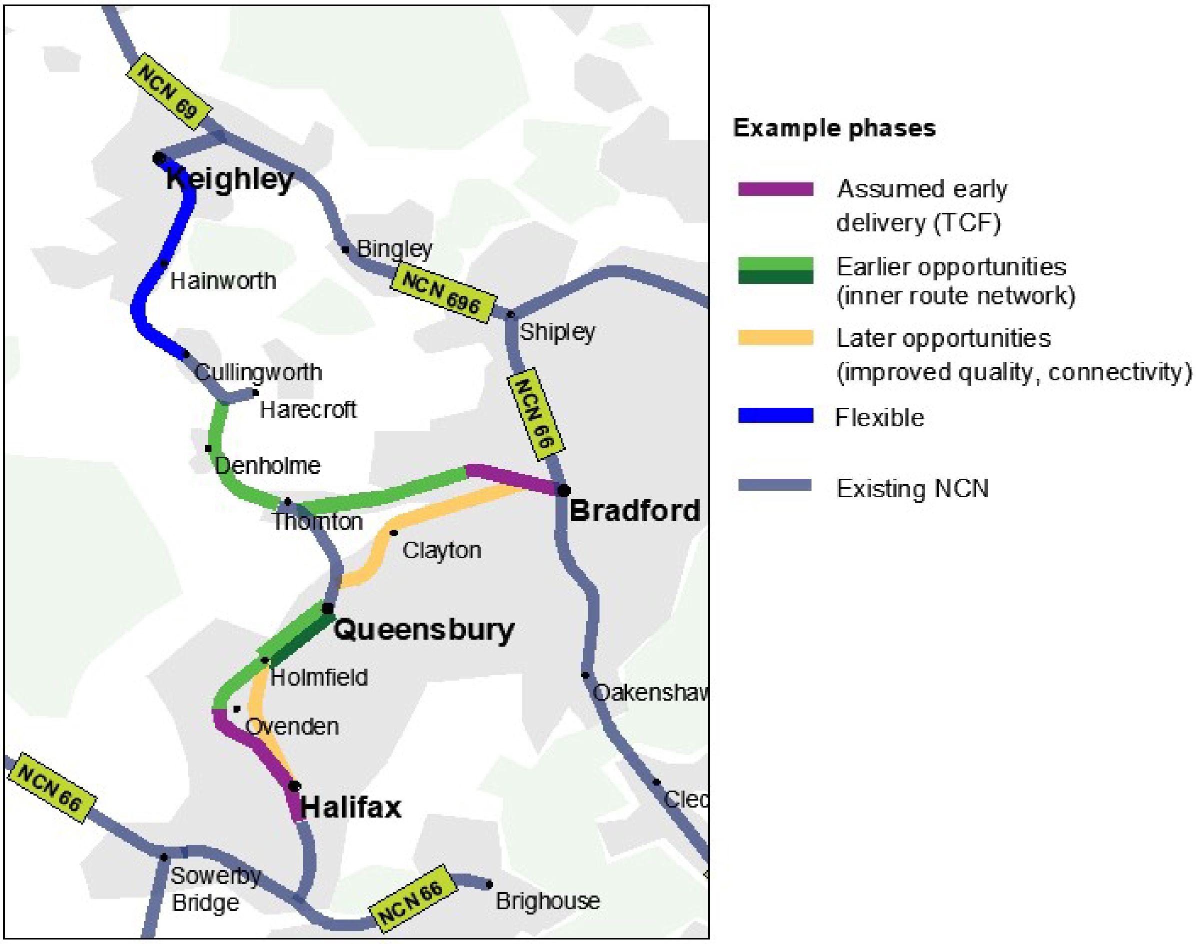

Figure 22: Example phasing for delivery of all alignments discussed in this feasibility study.

Figure 23 provides an estimate of the delivery timescale for each example phase. Design and consents durations reflect the relative challenge considered to be associated with each phase group. These periods may be subject to change based on the outcome of any future public engagement, which has not been within the scope of this study. Early engagement with landowners is likely to be necessary for all traffic-free sections of the proposed routes, if estimates for design, consent and construction of later opportunities are to be realised. If a tunnel route is determined to be the appropriate option to pursue, restoration of the tunnel is recommended at the earliest opportunity. Access to and use of the tunnel is likely to strengthen the case for development of the later opportunities, which build on the TCF inner network to provide a high-quality, traffic-free network to support the leisure and tourism benefits associated with its use.

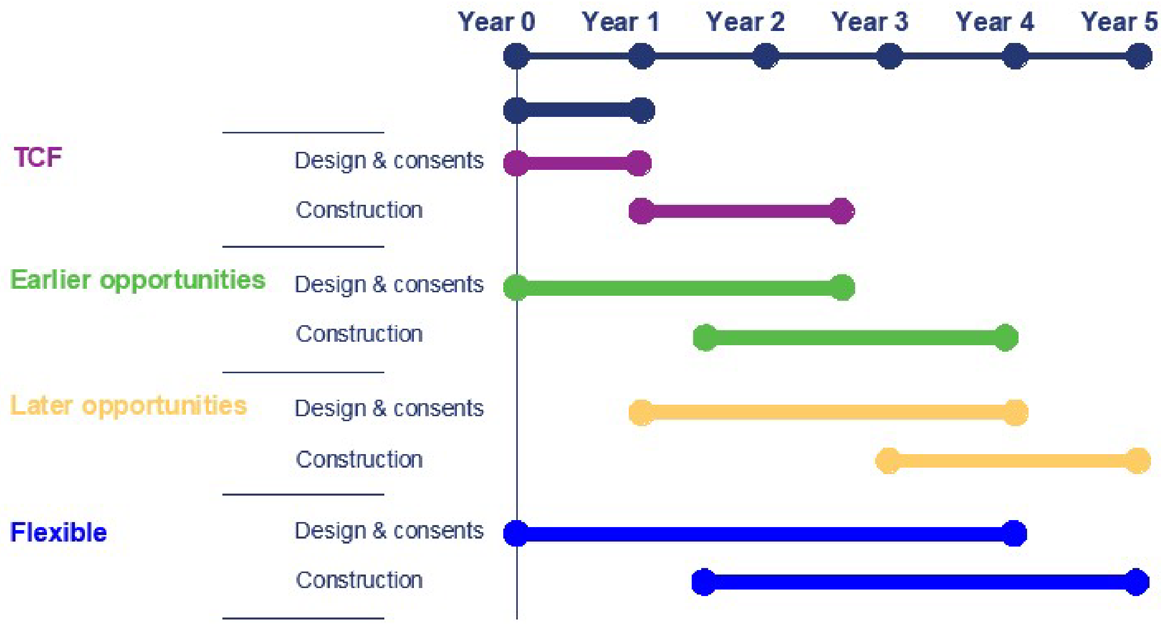

Figure 23: Estimated duration for each phase of works.

8.2. Sustrans recommendation

A significant amount of work has been undertaken to prepare this study to the brief prepared by CBMDC. The study has sought to set out the many opportunities, benefits, variables, risks and uncertainties associated with nearly 50km of new or improved routes. The requirements of the brief were to set out 3 viable sustainable transport routes both incorporating and excluding Queensbury Tunnel (i.e. a total of six (6) options) which represent the Most Advantageous and Attractive option, Next Preferred option and a Low Cost alternative. This has been helpful to focus in on a desired method of comparison of options. It should be noted that there are myriad ways that inclusion or omission of individual alignments would alter the potential costs, quality, opportunities, risks and benefits presented in this study. Sustrans now has a very significant level of data associated with these alignments and the potential for further route development and comparison of scenarios exists.

Using the methodology set out in this study, it can be seen that no single route option rises to the top for all metrics being compared. However, it is clear to see that the Most Advantageous & Attractive (Queensbury Tunnel Option) is the most impactful scheme in that it provides the highest level of quality and benefits albeit for a high delivery cost. It is Sustrans' assessment that the Alpine Option for each route is valuable for the purposes of comparison but would in practice be a highly compromised solution in terms of level of service for users.

Sustrans vision is to create a society where the way we travel creates healthier places and happier lives for everyone, and our mission is to make it easier for people to walk and cycle. With respect to connecting Bradford, Halifax and Keighley with a high-quality network of traffic-free paths, we would naturally like to see the most impactful scheme progressed to achieve the highest levels of walking and cycling. The level of funding required for provision of any of these options is likely to be highly demanding on existing local funding streams.

Nevertheless, development of an iconic and nationally significant network of routes between these sizeable northern conurbations has multiple benefits over and above purely hard economic factors. Restoration of the tunnel would not only provide a flagship walking and cycling scheme, but also complement and celebrate the industrial heritage of the area, increasing the potential for both recreational and heritage tourism.

This cross-boundary traffic-free network that would connect isolated urban schemes separated by challenging topography, containing suburban towns and rural fringe villages, represents a significant opportunity to contribute to numerous national and local government objectives addressing climate change, air quality, and health outcomes.

Appendix A: Corridor & Alignment Appraisal

Appendix B: Preferred Alignments Report

Appendix C: General Arrangement Drawings

Appendix D: Designers Risk Register

Appendix E: Cost Estimates & Design Schedule

Appendix F: Project Risk Register

Appendix G: Ecological Desk Study

Due to a limited project timescale, extensive study area and significant uncertainty over future delivery of any scheme, the ecological survey presented here is based on the use of data from Natural England's MAGIC Map and assessment of Google and Ordnance Survey maps, site photographs and professional judgement.

Any statement about possible ecological challenges is subject to change where physical surveys have not been conducted. Full ecological surveys will be required prior to detailed design, planning submissions and construction. The assessment presented in this appendix should be considered in this context, and no liability for unforeseen ecological barriers will be accepted. Cost estimates will include a percentage uplift for all non-highway elements of the scheme, to reflect the considerable uncertainty surrounding the ecological status of the proposed alignments.

Appendix H: Stakeholder Feedback

Table 46: Collated stakeholder feedback

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
The Clayton Footpath Group (02/09/2022) (CFG: Clayton Footpath Group)	1	Strongly support the use of QT as a cycle and walking route.	• Use of route would have a significant impact on the economy of the area.	Acknowledged	Record response
	2	Support for the Deep Lane option based on current congestion, especially for the school run.	• A traffic free route linking pupils on the South side of the valley (Clayton, Scholemoor and Lidget Green) attend schools on the North side of the valley (Beckfoot Thornton and Dixons Allerton) would encourage many to walk or cycle to school with considerable benefits for their general health and education success. • The study and options for West Bradford does not include the impact on the current road congestion, especially for the school run.	Acknowledge	Record Response

	3	Strong support for the traffic free Clayton Deep Lane option based on concerns regarding Cycling Superhighways for commuters.	• Three dangers embodied in the Cycling Superhighways for people who are cycling quickly as commuters: Bus stops, side roads joining the main road and parked cars.
			  ○ Bus stops involve people walking or waiting on the cycle way without paying attention to cyclists.
			  ○ Side roads mean that the drivers joining the main road have first to look out for cyclists before they look out for traffic on the main road.
			  ○ Parked cars mean that passengers exiting the parked car would have to look out for cyclists before opening the door.
			• These upgraded cycling highways probably make it safer for short journeys within the local community and for families cycling along main roads, but not for commuters who are wanting to go quickly.
				Sustrans note the concerns associated with the Cycle Superhighway concept. Issues associated with third party schemes are outside the scope of the commission.
				However, it should be noted that the proposed traffic-free shared use path along Deep Lane is unlikely to be suitable for “commuters who are wanting to go quickly” without potential conflict with other users, and Sustrans have recommended that measures are included to ensure considerate use of this alignment in later design stages. This of course is highly dependent on the subjective meaning of “quickly”. The traffic-free sections will however remove hazards described associated with vehicle traffic.
					No action

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action ***(No action/ Amend study/ record response/ Consider at subsequent design stage)***
	4	Suggest it would be better to extend the route length in the Freemans Grattan Holdings Listerhills Warehouse property, putting the route close to the beck, to join and run along Musselburgh Street, based on safety and avoiding serious congestion on Preston Street. MAP 21	• The feasibility study comments that the traffic speeds and volumes on Preston Street are unknown (page 52, Table 15). In fact, it is a very convenient route from West Bradford to North Bradford avoiding the serious congestion on the ring road and therefore is heavily used by cars and vans. • If the route length is extended it would then be possible to cross Preston Street directly and use Handel Street and Norcroft Road, thus greatly increasing the safety of the route.	Consideration was given to route through Warehouse property. It was considered that route through car park with vehicle movements was unsatisfactory. However, if Preston Street traffic volumes are unsuitable, the relative suitability of each option should be re-evaluated. A route through the warehouse would require co-operation from landowner.	Re-consider at subsequent design stage
	5	Suggest improving cycling links around Lidget Green Primary School and apply for further funding to deliver heritage benefits. MAP 20	• Request improving the bridge over the beck at Grid Reference (13503310) to make it suitable for cycling and link up with old footpaths across the derelict land north of the route to provide a safe link to Thornton Road. • Improved cycling links would strengthen a further heritage funding application by CFG for upgrading the area around the bridge into a small ecology and geology park for schools.	Current proposals include linking Middlebrook Walk to West Bradford alignment via bridge at (SE130329). Potential for additional/alternative bridge improvement at suggested location (approx. B109) can be investigated.	Consider at subsequent design stage.
	6	Suggest linking the route into the Scholemoor estate via the footpath along and outside the Scholemoor Cemetery West wall. MAP 20	• Links will enable secondary students in Scholemoor to easily cycle traffic free to the secondary schools to the north of the valley. • This too would be included in further heritage funding applications if not included here. •	Unintended omission. As with links to Eastern Clayton, should have been shown as future connection.	Amend study (GAs)
	7	Problems with route through Clayton. MAP 19, 18	• Current footpath between B113 and B114 is delightful and should remain as is. • The route from B114 to B115 would be difficult to implement since the area is already crowded and the suggested 3m wide traffic free route would disrupt a working farmyard or would have to squeeze through 1m wide gaps between buildings.	Feedback noted. Issues have been considered during design process. Future design stages would be used to address constraints.	Record response, Consider at subsequent design stage alongside suggested alternative routes (Ref. 9 & 10).

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
			• The Route from B115 to B116 is already congested with parked cars, farm machinery, and suffers from considerable traffic flow. • The Trotting strip which "avoids properties and links to West Bound bridleway" joining B114 to B114a is much preferred. • The use of the Avenue B117 to B118 – see feedback above on cycling superhighways. The traffic free alternatives would be much preferred, or if it is to be the Avenue: a shared path on the Southwest side. • The route up Baldwin Lane from B118 to B119 on map number 11. The path is well used particularly by people in morning and evening who use the 676 buses to Halifax or work in Queensbury. Areas on the East side and West side of Baldwin Lane are allocated for housing which would make it much more urban. Already there is considerable traffic along Baldwin Lane. The path is currently about 1 metre wide. To make it a shared path would mean it would have to be widened. • A similar shared path on one side of the Avenue (Southwest side) where it could be wider than 2 metres would be much preferred to the cycling superhighway solution proposed. (See note above on cycling superhighways).		
	8	Suggest alternative route through Clayton: Holts Lane to Queensbury Station route. Marked purple on accompanying map.	• Following the line of the old, suggested Clayton Bypass and proposed Trotting Route. • Widening and resurfacing bridleways. • Joining Brow Lane which is under the current Sustrans Cycle Route and is already traffic calmed.	Suggested route was partially evaluated at initial alignment feasibility stage. Sections 1 to 4 of CFG alternative was considered viable. Sections 5&6 were not considered viable due to width available on steep hillside, and challenging connection to existing GNRT.	Re-consider at subsequent design stage (lower priority)
	9	Suggest alternative route through Clayton: Oakleigh to Back Lane route.	• Crossing from Deep Lane into Wolseley Street. • Surfacing Wolseley Street.	Suggested route was evaluated at initial alignment feasibility stage. It is acknowledged that this would be a	Reconsider at subsequent design stage (higher priority)

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
		Marked green on accompanying map.	• Following Back Lane which is a reasonably surfaced traffic free bridleway. • Joining Broadfolds and School Street. • Crossing into Victoria Park and widening footpath around the edge of the park. • Marking a shared cycleway and footpath on Reva Syke Road where there is very little traffic and continues as a bridleway. •	more attractive route that the highway-based proposals, but it was discarded due to challenging connectivity (level difference) at Wolseley Street, and several areas of constrained width with no option to widen (around school, between properties on Reva Syke Road).	
	10	Suggest alternative route to Queensbury Station from the Back Lane Baldwin Lane junction (point B119). Marked blue on accompanying map.	• The Sustrans suggested route to Station Road and Queensbury station is a bit tortuous requiring short steep climbs and lots of land alteration around farm buildings and gardens. • Use very old footpath, no longer recognised (see OS map of the area 1891). •	Suggested ancient footpath no longer included on definitive map. Existing proposals largely follow definitive footpath. It is anticipated that status alteration would be easier than bringing disused path back into being. Feasibility study sought to connect Queensbury and Clayton and has been designed to minimise elevation loss between the two. It is assumed that localised gradient changes would be addressed during detailed design stages.	No action
The Great Northern Railway Trail Development Group (07/09/2022) (GNRT: Great Northern Railway Trail)	11	Phasing – Keighley to Thornton – concerned this section will be the last in the phasing programme.	• Agree with the need to phase implementation of the overall scheme due to capital costs. • Sections of the GNRT are already in place and showcase its potential, whilst the existing A629 is a "death trap". Further reasoning for prioritising this section: 1) GNRT is completely within CBDMC district and therefore under the administrative control of Bradford Council. Unsure of Calderdale Council's support for a tunnel. 2) GNRT is connecting two large areas of population (Bradford and Keighley), along with growing small settlements in Denholme, Cullingworth, Wilsden, and Thornton.	Feedback on phasing is acknowledged and concurs with feedback received from other stakeholders. While reasons for amended phasing set out by GNRT are sound, the report is neutral and cannot represent specific interests of any stakeholder group. Phasing will be revisited, but a "case for priority" will not be presented.	Amend study

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action ***(No action/ Amend study/ record response/ Consider at subsequent design stage)***
			3) GNRT already has two sections open to the public which are popular and iconic in the Bradford district. 4) GNRT will create a boost to tourism with the strong Bronte links at Haworth and the Keighley and Worth Valley Railway. 5) GNRT will enable a safe route to primary and secondary schools. 6) GNRT will connect outlying settlements like Denholme with no sustainable transport links and have had little or no public investment in the past. The A629 poses traffic problems for cyclists and walkers and the GNRT is crucial to provide a sustainable alternative. 7) GNRT links the Doe Park Recreation Centre, a Bradford Council outdoor facility not mentioned in the study. 8) A lot of the groundwork has already been carried out for the missing sections of route. 9) The GNRT scheme commands the strong support of public and local MPs. A public consultation has already taken place.		
	12	Phasing – there needs to be an awareness that off-road sections need to be secured by way of land agreements with landowners or by means of creating public bridleways.	• This takes considerable time and needs to be done concurrently with other built phases so that there is a momentum and a seamless ongoing work programme to open the whole route as one overall scheme. • Landowner and political discussions have already taken place which will assist in land negotiations and could shorten securing land agreements with landowners.	Acknowledged – further detail on elements required will be provided.	Amend study
	13	Phasing – Denholme and Cullingworth – this section should be done as an immediate first phase.	• Believe this is an easily deliverable section. • There has been no co-operation from Bradford Council despite ongoing pressure from local parish/town councils for several years.		

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
	14	Route options – West Bradford Cycle Superhighway – does not consider this scheme to deliver the potential benefits of a valley bottom scheme.	• Understand that the scheme is at an advanced stage. • Recommend that the alternative option be retained as a future link out of Bradford City Centre to benefit the residents of Lidget Green and Clayton. • The valley bottom route shows a much lower cost and considerably greater overall benefits (Table 3, page 21). • There is a need to change cultural behaviour in adjoining residential areas where cycling and walking may not be accepted modes of travel for short journeys such as in Girlington. • The Thornton Road route, possibly through Thornton village, will lead to a delay in connecting with the GNRT. The latest option to take the route through Thornton village should be forgone as this route provides no merit.	Delivery of the West Bradford Superhighway is out of scope for Sustrans influence. However, if the route is delivered, opportunities to connect to the wider leisure network (GNRT/Clayton option) should be pursued. Table referenced is from 2017 report. Costs and calculation methodology have both been updated since.	No action

	15	Route options – Keighley to Cullingworth – some of the options involve on-road routes which are quite steep/dangerous.	• Some options not suitable for inexperienced or young cyclists.
			  • Preference is option 1b (Page 98).
			  • The route for getting out of Keighley town centre and onto Hainworth should be done separately to the main funding bid.
			  • There is potential in the long run to encourage sustainable tourism using the cycling infrastructure in the Worth Valley, with its operating heritage railway and strong links with the Bronte literary sisters in Haworth.
				Southern portion of Option 1b is partially included (Map 3 of 20).
				Northern portion of Option 1b was considered during initial alignment feasibility, and discounted due to extreme gradient and cobbled surface of Hainworth Lane.
				Suggestions for works/funding packages are out of scope of initial feasibility report.
					Record response

	16	Route options – Queensbury Tunnel – strongly support the use of the tunnel for cycling and walking.	• Believe the only attractive option to link Halifax with Bradford is to pursue the tunnel option. • It is not worth spending money to investigate, design and implement an alternative. • The use of the tunnel has strategic benefits regionally because it is a key connector of cycling networks in undulating Pennine areas.	Feedback acknowledged	Record response

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
Queensbury Tunnel Society (07/09/2022)	17	Support the study's stated preference for connecting the existing sections of Great Northern Railway Trail via the old railway alignment.	• Developing the Holmfield-Cullingworth section as a rival to the Peak District's Monsal Trail, with the prospect of delivering much-needed economic benefits to settlements along the route.	Feedback acknowledged	Record response
	18	Suggest the provision of a grade-separated crossing on Cockin Lane from the outset, not as a possible future option.	• The nature, speed and volume of traffic on Cockin Lane justifies the provision of a grade-separated crossing from the outset.	Acknowledged	Record response Re-consider during future design stage
	19	The adoption and improvement of Station Road, Queensbury must be regarded as fundamental to the core network.	• Connects a major settlement to the Greenway. • National Highways' have previously failed to carry out appropriate repairs to the road following previous tunnel repair programmes. • Restricting access to residents only (plus visitors, deliveries etc.) and relevant maintenance/utility companies would be vital.		Record response
	20	Phasing of the West Bradford Cycle Superhighway – sections outside the city centre should be prioritised.	• The recent splitting of the West Bradford Cycle Superhighway into two phases is noted and accepted as a pragmatic response to budgetary constraints.	Delivery specifics of the West Bradford Superhighway are out of scope for feasibility study.	No action
	21	Preference for off-road connection from Cemetery Road to Queensbury Tunnel – via Deep Lane/Clayton or the valley floor.	• Would prove cheaper, more attractive and result in greater usage. • Would better serve new/proposed Local Plan developments. • Avoids risks associated with street furniture, moving hazards and intersecting junctions. • On-road may be easier to deliver, but not better.	Feedback acknowledged	Record response
	22	Suggested Baldwin Lane-Station Road link is difficult to deliver and sub-optimal.	• Due to length, gradient and proximity of residential properties.	Acknowledged	Record response
	23	Preference for alignment to follow the former railway & pass over the top of Clayton Tunnel.	• Recognise that this would involve compromise over gradients and significant earthwork.	This alignment was considered during initial alignment feasibility, and discounted due to issues cited.	Record response Re-consider at subsequent design stage

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
	24	Phasing of the Queensbury Tunnel Greenway – stabilisation of the tunnel should be prioritised.	• Ongoing low-level deterioration of the tunnel will only increase costs over time • Sprayed concrete encapsulation of the RamArch erected between Nos. 3 & 4 Shafts should be undertaken soon, before it is affected by the prevailing conditions.	Sustrans agree that further deterioration of the tunnel should be prevented.	Amend study
	25	Enforcement action should also be started against National Highways	• Remove the aggregate fill within and below No.2 Shaft, installed under emergency development (Class Q) powers in October 2019 and retained unlawfully.	Recommendations for enforcement action are beyond the scope of the feasibility study.	No action.
	26	Report makes an incorrect statement regarding body of water at the southern entrance of Queensbury Tunnel.	• QTGFS states the body of water is "fed by run-off from Strines Beck". • Historical records demonstrate the sources are groundwater penetrating the lining at various locations, water descending the ventilation shafts (particularly Nos. 2, 4 & 8 Shafts) and water entering the former track drainage at the north end; this all runs down the 1:100 (1%) gradient to collect at the south end, unable to escape because of the infill.	Site investigations showed evidence of run-off from the Beck feeding the pool. However, additional sources acknowledged.	Amend study
	27	Gravity drainage is viable and should not be discounted as an option to remove ingressing water.	• QTGFS focuses only on the provision of pumping equipment, which is recognised as the cheapest and most feasible option. • The reinstatement of gravity drainage by directional drilling through the infilled southern approach cutting has been the subject of low-level investigations and is viable.	New information.	Amend study
	28	The QTGFS fails to acknowledge the QTS position that mobile phone coverage *must* be provided in Queensbury Tunnel.	• Technically not difficult to achieve • Connectively would help to mitigate perceived risks around personal security, allow users to enjoy normal communications whilst passing through and provide opportunities for interactive art/historical installations.	Acknowledged.	Record response
	29	Ecology challenges are not expected to be substantial.	• Ecology study carried out by Jacobs for National Highways' proposed abandonment scheme suggests the tunnel is not used by bats for hibernation purposes.	The QTS position is recognised, and reference confirmed. However, a full ecological assessment will be required prior to future works.	Amend study

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action *(No action/ Amend study/ record response/ Consider at subsequent design stage)*
			• Wet nature of the structure at both ends reduces the likelihood of use for roosting.		
	30	Preference for the Queensbury Tunnel alignment over the 'Alpine' zig-zags.	• Recognise that the zig-zags could prove an attraction and would allow residents at the south end of village to access the Greenway for journeys to Halifax. • But concerned that the route is challenging, circuitous and unattractive, having the potential to create problems around traffic flows.	Acknowledged. Challenges associated with the alpine route are set out in sections 5.5.3 and 5.7.	Record response
	31	Object to the on-road Old Lane alignment.	• The lane presents adverse gradients, tight bends and a cobbled section • Would present unacceptable levels of risk if significant numbers of cyclists were expected to share the road with vehicular traffic, noting its nature, speed and volume. • For walkers, the footpath is narrow and mostly to one side of the road only; widening it would result in higher-risk conflict between vehicles and cyclists.	Position acknowledged. Old Lane alignment forms part of existing plans to improve cycling and walking links in Calderdale. As stated in the report, this alignment was included for pragmatic reasons, as it is likely to be delivered. Suggestions for improvement of the proposed delivery have been included. Language altered to reinforce need for improvements to existing third party proposals and need for future consideration of alternative route.	Amend study
	32	Preference for an off-road alternative that would involve less user risk and easier gradients.	• Suggest a route entering North Bridge car park, turning north-west to pass through Old Lane Tunnel, crossing the car park at the tunnel's north-west end via a new bridge to reach Lee Bank, and then heading north to pass the derelict mill before joining the former railway. • Would be more interesting and attractive.	An alternative route along the valley/disused railway line is preferred in the long term. This should be clear in the study. Language altered to reinforce.	Amend study
	33	Strongly advocate for the Queensbury Tunnel route.	• Offers an iconic and unique opportunity for heritage, adventure, commuting, tourism.	Position acknowledged	Record response
	34	Advocate for resurfacing of Station Road and support the proposal that the road be restricted to residents' and utilities' access.	• This would ensure Queensbury benefits from the scheme.	Position acknowledged. Study includes both proposals.	Record response

Stakeholder	Ref.	Feedback summary	Feedback detail	Sustrans response	Action ***(No action/ Amend study/ record response/ Consider at subsequent design stage)***
	35	Support access to the GNRT from Thornton.	• New house building along the top end of Thornton Road increases access need to the GNRT to reduce car dependency.	Position acknowledged	Record response
		Comments on report document regarding corrections to factual and typographical issues.	*Approximately x36 comments regarding factual, typographical and presentation issues.*	*Addressed where appropriate. Specific feedback on content listed above.*	

Appendix I: Design Decision Log

Appendix J: Economic Appraisal Methodology

Definitions

This appendix includes the use of the terms ‘corridor’, ‘alignment’, ‘route’ and ‘scenario’. For the avoidance of any doubt:

- **Corridor**: regions between named locations. Corridors contain alignments.
- **Alignment**: intended path along which provision will be provided.
- **Route**: a combination of alignments.
- **Scenario**: a set of conditions used to evaluate the economic performance of a route. A route may be evaluated under multiple scenarios.

J.1. Methodological Overview

The following section outlines the steps and application of a model to examine the likely impact of reopening the Queensbury Tunnel as part of a network of alignments that link Bradford to Halifax (to the south) and Keighley (to the north).

In order to estimate the possible impact of developing the alignments, baseline usage figures for cycling and walking in and around the proposed alignment are sourced from 2011 census using a GIS model as well as from the Propensity to Cycle (PCT), to calculate Annual Usage Estimates (AUEs), which is used as input for the Department of Transport’s Capital Fund Uplifts Tool and Active Mode Appraisal Toolkit (AMAT). The Capital Fund Uplift Tool uses total project cost figures, and cycle and walking figures to estimate 3 post-construction usage scenarios which we model in the AMAT.

The following steps have been taken as part of the economic appraisal process:

- Estimate baseline annual usage (number of users by mode and journey purpose) for each alignment.
- Combine alignments into 6 routes (listed in Table 30), adjusting for double counting when estimating baseline annual usage for each scenario
- Estimate post intervention annual usage for each route scenario; using past evidence from case studies on the usage impact of similar tunnel schemes and DfT’s Capital Fund Uplift Tool as a sensitivity test.
- Estimate the economic value of anticipated benefits against construction and maintenance costs using the AMAT, to obtain Benefit-Cost Ratios (BCRs) for each of the 6 route scenarios.

Each route scenario is sensitivity tested with the two uplift scenarios (12 scenarios evaluated in total)

- Estimate the tourism benefit of the 6 routes, using the Leisure Cycling and Leisure Walking Expenditure Models.
- Demonstrate the potential heritage value of the Queensbury tunnel through switching values analysis.
- Perform sensitivity testing for scenarios involving changes in cost for the tunnel

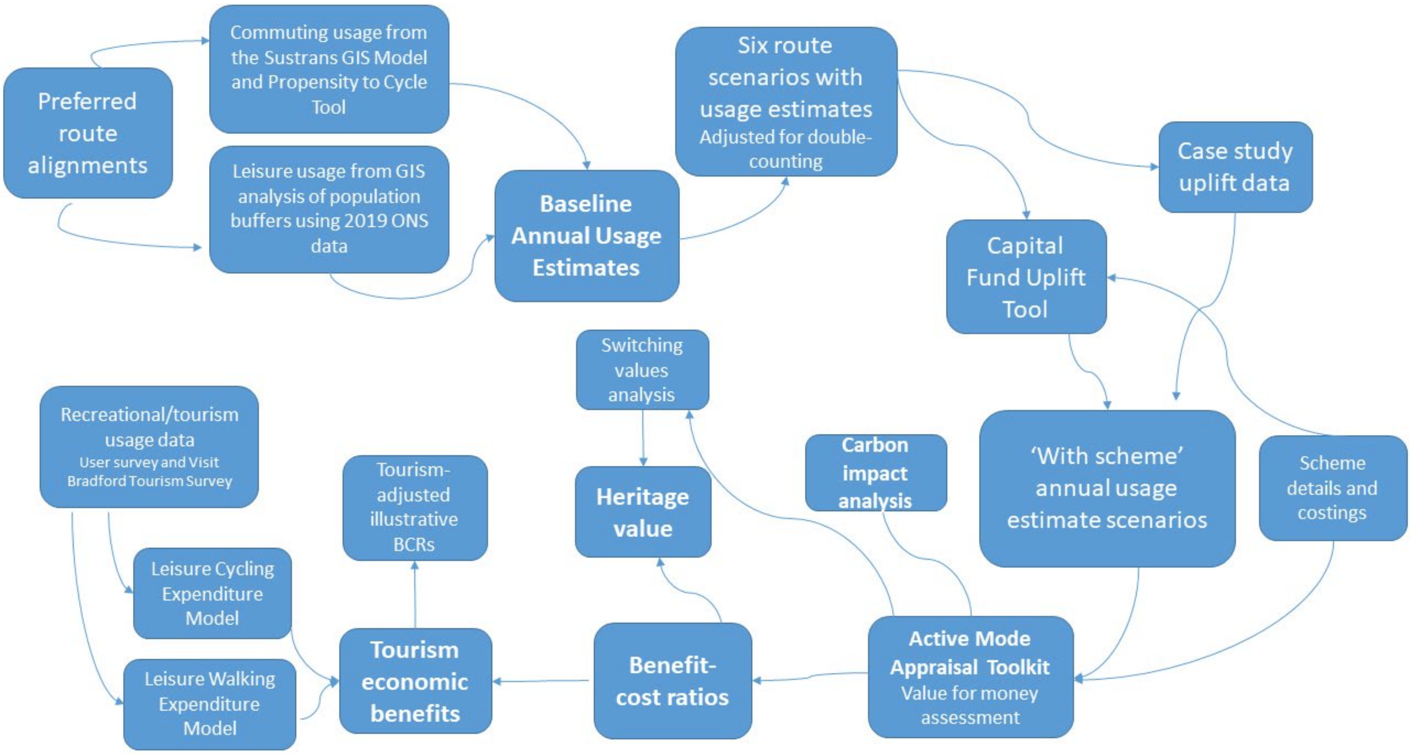

Figure 24: Economic assessment process flowchart

J.2. Estimating baseline annual usage

In order to use the DfTs Capital Fund Uplift Tool, the baseline annual usage estimate (AUE) for each alignment is required. In this (sub-)section the AUE methodology is outlined; this includes estimating annual usage for commuting and leisure journeys (for cyclists and pedestrians) before combining them to obtain a baseline annual usage estimate for each alignment. It should be noted that any estimates of baseline usage have a level of uncertainty inherent. The baseline estimates are based on population data, data from the National Travel Survey, and other assumptions. We used modelling techniques recommended by DfT and Sustrans where possible, and any assumptions that were needed were based on data and past experience.

J.2.1. Methodology for estimating the baseline annual usage – commuting

For the 2017 Queensbury Tunnel study, Sustrans developed a GIS model based on data from the Propensity to Cycle Tool. The Sustrans GIS Model takes into account the people who would use each alignment as part of their commuting journey from Census 2011 Travel to Work Origin Destination data at Census Output Area. The model outputs the total number of commuters using each alignment per day, so the number of commuters cycling or walking is obtained through applying the mode share split[1] of commuters in Bradford or Calderdale districts[2]. Where it was not feasible to use this Sustrans GIS Model output, the Propensity to Cycle Tool (PCT) itself was used to provide usage data for the alignment so that all baseline usage estimates are derived in a comparable way.

The Sustrans GIS model allows us to add in the proposed alignments for inclusion in the analysis, while the PCT only includes commuting cyclists on existing infrastructure. Using the raw data also allows us to include commuting pedestrians for analysis in our model. The PCT uses fastest trip while the Sustrans model uses the shortest trip to estimate a trip taken. Counts include only trips of 5 miles[3] or less in length and that use the proposed alignment for 500 metres[4] or more. These counts are shown in Table 47.

Table 47: Total, cycling and walking commuters using each alignment daily

Corridor	Alignment	Total route users commuting along this alignment, daily	Estimation of Alignment Users commuting by bicycle, daily	Estimation of Alignment Users commuting by foot, daily
Keighley – Station Road	Keighley - Station Road	1,113	9	129
Keighley – Station Road	Station Road[1]	41	0	5
Holmfield - Queensbury	Queensbury Tunnel	36	0	4
Holmfield - Queensbury	Alpine option	36	0	4
Halifax - Holmfield	Greenway option	2,111	21	237
Halifax - Holmfield	Highway option	2,207	19	256
West Bradford	Clayton option	917	8	106
West Bradford	Thornton Road option	4,789	40	556

1: Leisure and commuting use along the Station Road alignment is calculated using different methods, due to the extent of new data available in 2021 compared to Sustrans 2017 report. Where Station Road is not shown separately in a table, it can be assumed that the relevant data is included in the Keighley – Station Road alignment as a whole.

The Sustrans GIS model estimates the number of commuting people. With this output, we estimate the number of annual trips based on the following assumptions and considerations:

- We have assumed that part time workers commute 3 days a week
- Census 2011 reports that 31% of the workplace population in Yorkshire and Humber are part time workers. This percentage split has been applied to the total number of commuters

[1] http://www.ons.gov.uk/ons/rel/census/2011-census-analysis/method-of-travel-to-work-in-england-and-wales/rft-table-ct0015ew.xls - we have confidence in these figures as the figures for all of England (CT0015 / 2011) (3.2% bicycle / 10.9% on foot) are very similar to all England NTS figures (NTS04049 / 2015) (4.2% bicycle / 10.9% on foot)
[2] Calderdale figures are used for the Queensbury Tunnel to Halifax alignment, all others use Bradford figures. This assumption is made throughout this study.
[3] A distance deemed to be potentially made by cycle
[4] This indicates a significant use of the alignment

- We have assumed that 90% of commuters will make a return trip. The total daily trips below is calculated using the number of people undertaking a commuting trip plus 90% of these to account for return trips
- As the Travel to Wok data from the Census is an estimation taken from one day of the year (27th March 2011) seasonality needs to be taken into account. This is done by comparing the data from the Census to a number of cycle and pedestrian counters where the full year of data is available. We can then adjust the values estimates using the Census data to better reflect the typical daily usage across the year
- We have calculated that there are 220 annual working days for full time workers, taking annual leave and bank holidays into account. For a part time worker working 3 days a week this equates to 132 days
- We have assumed that the proportion who report to cycle or walk to work do so 80% of the time, allowing for a switch in transport mode for the remaining 20%. The number of days cycled or walking below represents 80% of the number of annual working days

After these factors are applied, annual usage estimates for commuting cyclists and pedestrians are calculated, and combined to produce an estimate of total baseline commuting for each alignment (Table 48).

Table 48: Estimation of cycling, walking and total baseline commuting AUE

Corridor	Alignment	Estimation of alignment users commuting by bicycle, daily	Estimation of alignment users commuting on foot, daily	Estimation of baseline AUE for commuting cyclists	Estimation of baseline AUE for commuting pedestrians	Estimation of baseline commuting AUE
Keighley – Station Road	Keighley - Station Road	9	129	2,992	36,397	39,389
Keighley – Station Road	Station Road[1]	0	5	-	1,373	1,373
Holmfield - Queensbury	Queensbury Tunnel	0	4	-	1,091	1,091
Holmfield - Queensbury	Alpine option	0	4	-	1,091	1,091
Halifax - Holmfield	Greenway option	21	237	6,758	66,774	73,533
Halifax - Holmfield	Highway option	19	256	6,758	66,774	73,533
West Bradford	Clayton option	8	106	2,464	30,202	32,666
West Bradford	Thornton Road option	40	556	12,778	157,274	170,051

1: Leisure and commuting use along the Station Road alignment is calculated using different methods, due to the extent of new data available in 2021 compared to Sustrans 2017 report. Where Station Road is not shown separately in a table, it can be assumed that the relevant data is included in the Keighley – Station Road alignment as a whole.

J.2.2. Methodology for estimating the baseline annual usage – leisure

Leisure journeys are defined as those for the pleasure of walking or cycling, or keeping fit. The percentage of adults in Bradford or Calderdale who cycle[5] or walk[6] at least once a month for recreational purposes has been applied to the local study population of people living within an accessible distance of each route.

The following assumptions and considerations are factored in the estimation:

- Trip: A trip is a one-way movement with one main purpose. Your outward and return journeys should be treated as two separate trips[7]. Based on this definition of a trip;
    - We take the population within a 3.6 miles buffer of each alignment as accessible for cycling, this is the average cycling trip distance from the National Travel Survey (NTS9910).
    - We take the population within a 3.6 miles buffer of each alignment as accessible for walking that is more than 1 mile long, this is the average walking trip distance (> 1 mile) from the National Travel Survey (NTS9910)
    - We take the population within a 0.7 miles buffer of each alignment as accessible for walking, this is the average walking trip distance from the National Travel Survey (NTS9910)
- Since not everyone making a leisure trip will use the alignment, we assume 50% usage for off-road alignments (more appealing) and 20% usage for on-road alignments (less appealing). These were based on the lack of suitable infrastructure or other options for recreational walking and cycling along most of the proposed routes, especially in the more rural areas of the route. Much of the population along the route would not have many other options for safe routes for walking or cycling. Also, for many in the area, the proposed routes would in fact be the fastest and safest routes into the nearest town. These numbers are best guess estimates and are not based on counts or surveys but seem reasonable based on Sustrans past experience. For this study, all alignments are considered 'off road'.
- Annual figure is estimated by multiplying the monthly estimates by 12.

The local study population living within an accessible distance of each alignment for cycling or walking leisure trips is calculated in a GIS model, using Census 2011 population data[8]. A buffer of 3.6 miles for cycling, 3.6 miles for walking distance greater than 1 mile, and 0.7 miles for walking, was applied to each alignment. The only exceptions are for Queensbury Tunnel and Well Heads Tunnel, where buffers were applied to the point at each end of the tunnel rather than the whole tunnel length, as access is not possible at any other point as the tunnel is underground. The population is much greater for leisure cycling than leisure walking, due to the larger buffer of accessibility for cycling.

[5] DfT walking and cycling statistics Table CW0104 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536501/cw0104.ods
[6] DfT walking and cycling statistics Table CW0105 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536499/cw0105.ods
[7] Definition of a trip: https://www.gov.uk/government/statistics/national-travel-survey-2020/national-travel-survey-2020-notes-and-definitions
[8] Census 2011 Headcounts and Household Estimates for Postcodes in England and Wales

J.2.3. Methodology for estimating population of route users

Population estimates were calculated within various distances along the walking and cycling network, of a series of route options. Distances along the course of the route options were calculated using the Open Route Service directions algorithm accessed via an API within the ORS plugin within QGIS desktop program. The population estimates were calculated using data from the Office of National Statistics Lower Layer Super Output Area population estimates mid-2019 dataset[9].

Input Data

- ONS Lower Layer Super Output Area population estimates mid-2019
- Queensbury Tunnel combined route options and individual route segments

Processing

- Open Route Service directions algorithm
- ArcGIS Pro
- QGIS

Methodology

1. Identify route options

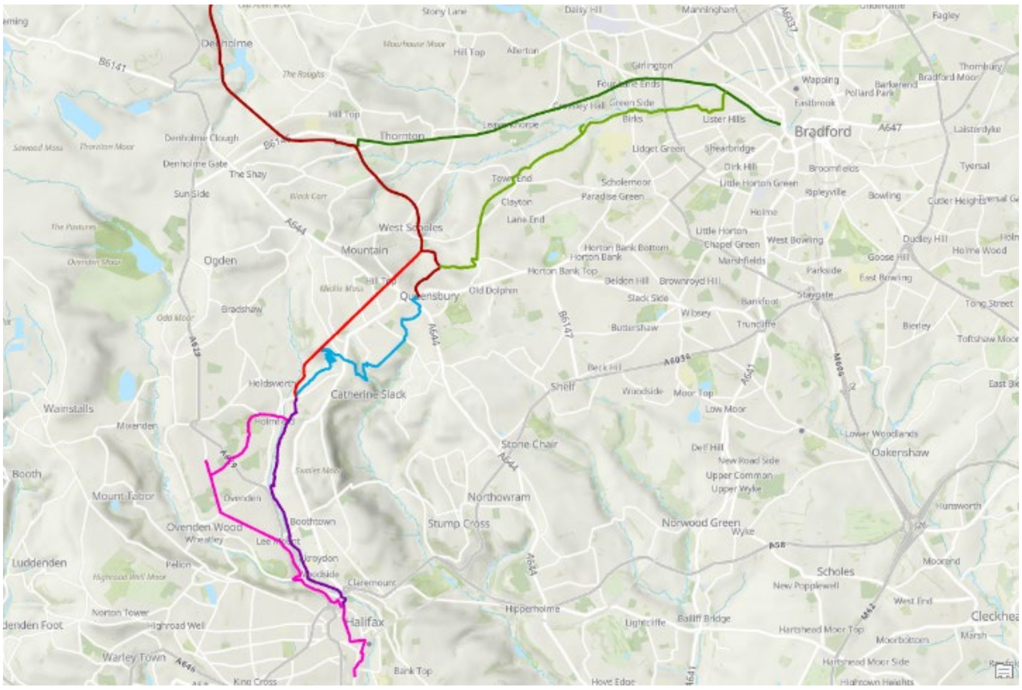

Figure 25: The seven alignments which make up the various route options

9 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimatesnationalstatistics

2. Generate points at 100 metre intervals along the length of each alignment

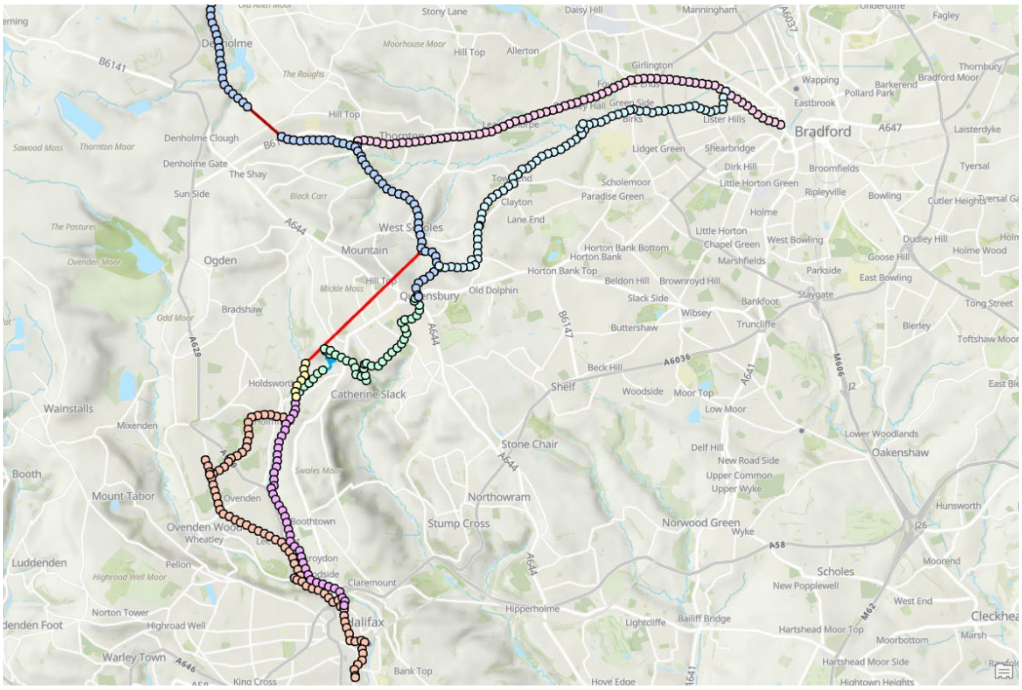

Figure 26: Points created at 100m intervals

3. Run each route option through the ORS directions algorithm separately for each journey scenario to create travel distance isochrones from each of the points along the alignments:

- Short walk – 1,300 metres
- Long walk – 5,800 metres
- Cycling – 5,800 metres

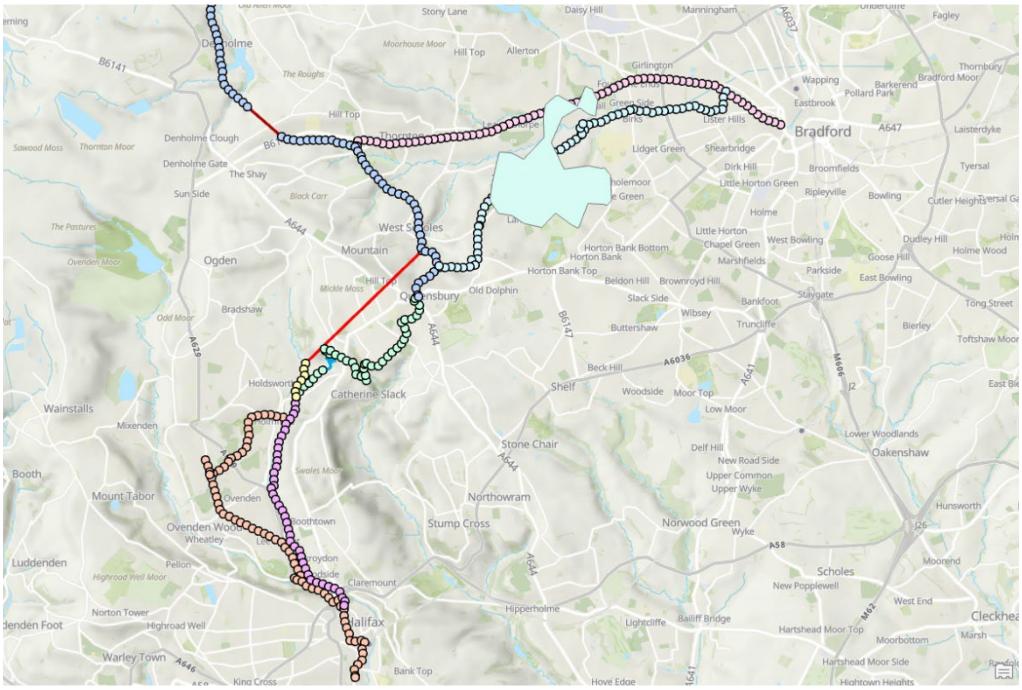

Figure 27: Individual travel time isochrones are created from each point

4. Dissolve the individual isochrones of the three journey scenarios together to create 'route option buffers'.

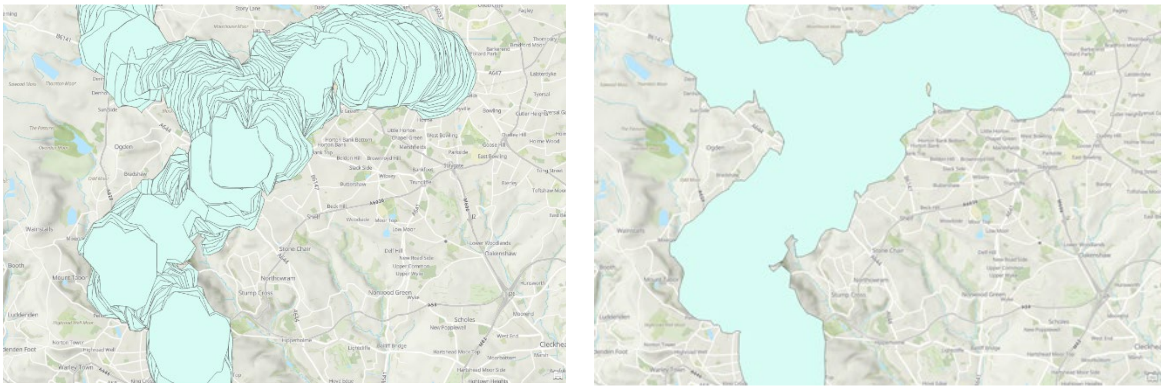

Figure 28: Left hand side – overlapping travel time isochrones along the alignments. Right hand side – alignment isochrones are dissolved to form a single buffer for each route option.

5. Intersect the route option buffers with ONS Output Areas.

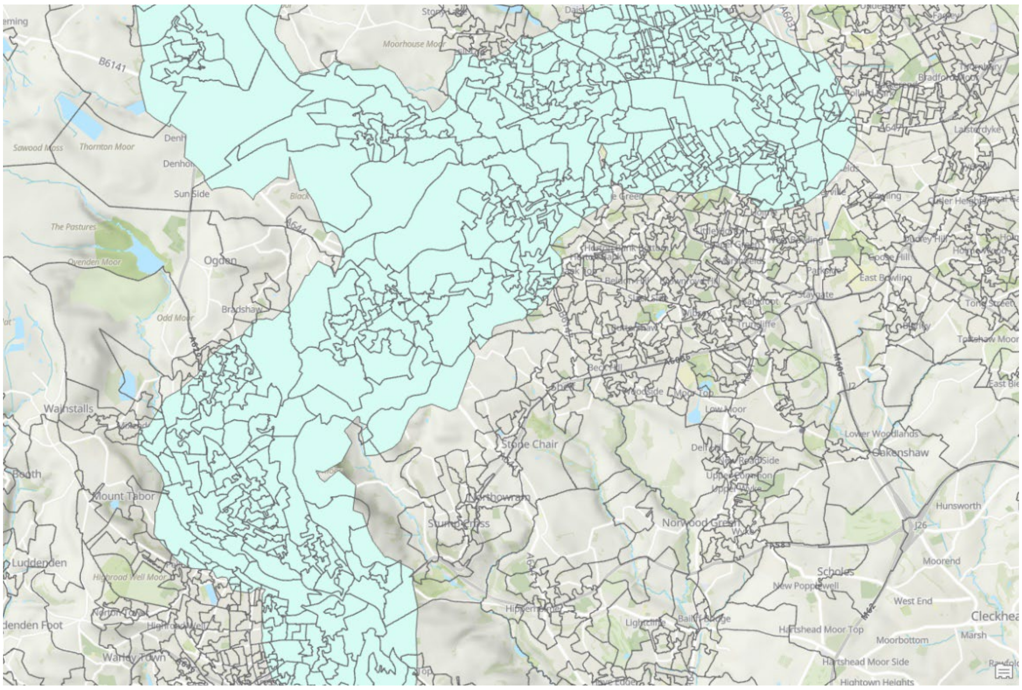

Figure 29: Route option buffer is intersected with the mid-2019 Output Area data

6. Calculate the population by:

- Summing the population of the Output Areas which are entirely within the route option buffer.
- Where the buffer overlaps part of an Output Area, including a percentage of the total population of that Output Area which is in proportion to the percentage of output area which is intersected by the route option buffer. In other words, where only half of the spatial area of an Output Area falls within the route option buffer, only half the population is carried through.

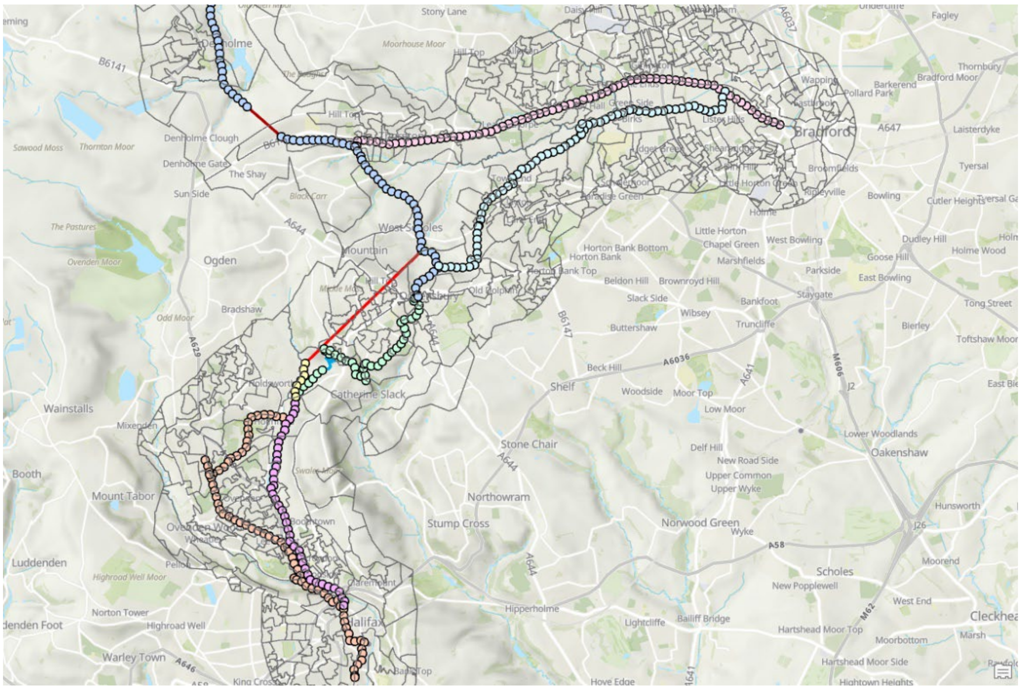

Figure 30: Populations within the intersected Output Areas are summed to create the overall population

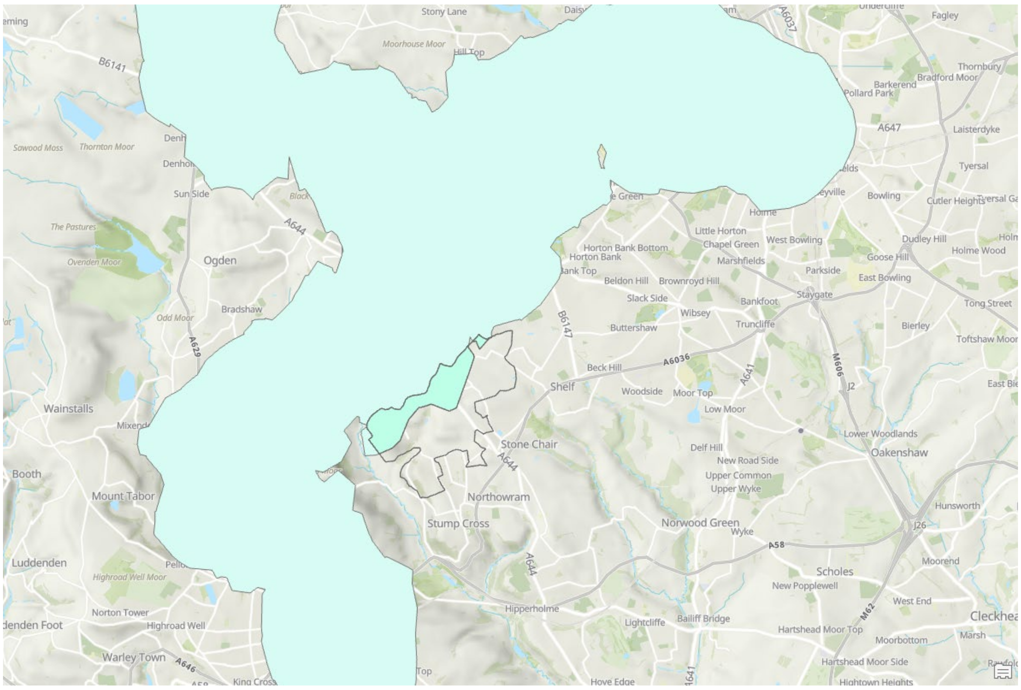

Figure 31: Where only part of the Output Area is intersected by the buffer, a proportion of the population is included

J.2.4. Combined annual usage estimates

After these factors and above methodology are applied, annual usage estimates for leisure cyclists and pedestrians are calculated and combined to produce an estimate of total baseline leisure use for each alignment (see Table 49).

Table 49: Estimation of cycling, walking and total baseline leisure AUE

Corridor	Alignment	Route type and % of leisure journeys using alignment	Study population accessible for cycling	Study population accessible for walking	Estimation of baseline AUE for leisure cycling	Estimation of baseline AUE for leisure pedestrians	Estimation of baseline AUE
Keighley – Station Road	Keighley - Station Road	Off road – 50%	309,520	361,116	167,141	1,165,681	**1,332,822**
Holmfield - Queensbury	Queensbury Tunnel	Off road – 50%	228,316	243,365	154,113	785,583	**939,696**
Holmfield - Queensbury	Alpine option	Off road – 50%	223,735	241,795	120,817	780,514	**901,331**
Halifax - Holmfield	Greenway option	Off road – 50%	171,031	203,585	138,535	834,290	**972,825**
Halifax - Holmfield	Highway option	On road – 20%	171,828	220,301	55,672	361,118	**416,790**
West Bradford	Clayton option	Off road – 50%	403,403	481,043	217,838	1,552,806	**1,770,644**
West Bradford	Thornton Road option	On road – 20%	403,089	487,050	87,067	628,879	**715,947**

J.2.5. Baseline Annual Usage Estimate

The baseline cycling and walking AUEs are combined to calculate the baseline AUEs for each alignment. These AUEs are based on modelled data, rather than walking and cycling counts. It would not be possible to carry out walking and cycling counts in the area as the infrastructure under investigation does not currently exist, therefore these estimates are based on modelled data. As such, there is considerable uncertainty in these estimates. In particular, there is uncertainty around the assumption that between 20-50% of cycling and walking trips for people within 3.6 miles of the scheme would take place along the proposed routes.

Table 50: Baseline AUE for each alignment

Corridor	Alignment	Estimation of baseline cycling commuting and leisure AUE	Estimation of baseline walking commuting and leisure AUE	Estimation of baseline AUE
Keighley – Station Road	Keighley - Station Road	170,133	1,202,078	**1,372,211**
Keighley – Station Road	Station Road[1]	0	1,373	**1,373**
Holmfield - Queensbury	Queensbury Tunnel	154,113	786,674	**940,787**
Holmfield - Queensbury	Alpine option	120,817	781,605	**902,422**
Halifax - Holmfield	Greenway option	145,294	901,064	**1,046,358**
Halifax - Holmfield	Highway option	62,431	427,893	**490,323**
West Bradford	Clayton option	220,302	1,583,007	**1,803,309**
West Bradford	Thornton Road option	99,845	786,153	**885,998**

1: Leisure and commuting use along the Station Road alignment is calculated using different methods, due to the extent of new data available in 2021 compared to Sustrans 2017 report. Where Station Road is not shown separately in a table, it can be assumed that the relevant data is included in the Keighley – Station Road alignment as a whole.

J.3. Combining multiple alignments into routes

Once the baseline AUEs are developed for each individual alignments, the next stage of analysis is carried out on combinations of alignments referred to as routes. Considering the alignments individually initially allowed for the estimation of annual usage based on the alignments' characteristics. In this next step we combine the individual alignment AUEs for each route and remove any overlap of users who may be counted on more than one alignment (i.e. double counting).

J.3.1. Accounting for double counting – baseline AUEs

Commuting trips

We know from the Sustrans GIS model outputs that 456 of the 9,007 users (5%) counted commuting along all seven alignments commuted along at least two of the alignments. This proportion would be double counted if the users from multiple alignments are added up. We've established that 0.8% of commuting trips per person per year in Bradford are made by bicycle, and 11.6% of commuting trips are on foot. By removing 5% of these 0.8% and 11.6% of cycling and walking commuting trips respectively, we can account for double counting.

Leisure trips

The overlap in leisure trips is affected by the study population living within an accessible distance of each alignment. For alignments where catchment areas overlap, the population in this overlapping area (see Figure 28) will be double counted when simply totalling the users from multiple alignments in each route. The same GIS program and method can be used to account for double counting, using the following process:

- We sum the population with access to individual alignments (1)
- We calculate the population with access to the route as a whole, using the dissolved buffers around each route (2)
- Subtracting (2) from (1) provides the amount of double counting to be accounted for.

Double counting figures from all routes were then averaged together to determine a single double counting correction factor to use for all routes.

Table 51: Accounting for double counting – baseline AUEs (cycling and walking trips)[10]

Route	Total Baseline Cycling trips	Total Baseline Walking trips	Total Scenario Baseline AUE
Most Advantageous & Attractive (Queensbury Tunnel Option)	613,525	2,673,474	**3,286,998**
Most Advantageous & Attractive (Alpine Option)	589,551	2,671,091	**3,260,642**
Next preferred (Queensbury Tunnel Option)	496,686	2,102,872	**2,599,558**
Next preferred (Alpine Option)	472,713	2,100,490	**2,573,203**

Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	350,296	1,505,960	**1,856,256**
Low Cost & Quickest to Deliver (Alpine Option)	326,322	1,503,578	**1,829,900**

The baseline AUEs for the routes (see Table 51) are then taken forward as an input in the Capital Fund Uplift Tool.

J.4. Estimating post intervention annual usage

J.4.1. Methodology for estimating post intervention annual usage – cycling and walking

Data from case studies were used to derive an average uplift. This data is based on infrastructure projects that have been monitored by Sustrans. The following criteria were used in selecting the relevant case studies:

- Pre- and post-intervention usage data needed to be available, either from manual counts or automatic counters.
- Interventions should include either cycle and pedestrian tracks, greenways or large infrastructure projects (such as bridges or tunnels). Uplifts for the greenway alignments were derived from the cycle and pedestrian tracks case studies. Uplifts for the tunnel alignments were derived from the large infrastructure schemes (e.g. tunnels and bridges).
- Interventions should take place in MSOAs that are similarly classified as those through which the proposed routes pass. Interventions from Urban Major Conurbations were not included.

The Capital Fund Uplift Tool was used as a sensitivity test to compare uplifts and BCRs to those found using the case studies. The tool estimates the increase in weekday cycling and walking trips from new infrastructure. This estimation is based on inputs for scheme cost, evaluation of evidence for cost-effectiveness of past spending by infrastructure type and estimates for the relative cost-effectiveness of spending by area[11]. The Capital Fund Uplift Tool is used to estimate cycling and walking uplift for all the route routes. The following key inputs have been used in the Capital Fund Uplift Tool to obtain estimates for number of cycling and walking trips per weekday with the proposed intervention.

- Local authority
- Total scheme cost (£, 2021 prices)
- Walking trips per weekday without the intervention (AUEs divided by number of working days in a year, minus weekends and bank holidays = 250 days)
- Cycling trips per weekday without the intervention (AUE divided by number of working days in a year, minus weekends and bank holidays = 250 days)

[11] See DfTs 2021/22 Capital Fund Value for Money Guidance

- A breakdown of scheme cost by infrastructure type; cost was shared between cycling and walking infrastructure.

The Capital Fund Uplift Tool produces a Low, Medium, and High uplift for each proposed intervention and then recommends which uplift to use based on the Intrinsic Cycling/Walking Potential for the local authority in which the intervention is proposed. For Bradford, the Capital Fund Uplift Tool recommends using the Low uplift for cycling and the Medium uplift for walking. The recommended uplifts were used for this analysis.

Routes that contained the Queensbury Tunnel alignment were split between the tunnel and the greenway alignments for purposes of generating uplifts. Uplifts for the Queensbury Tunnel alignment were only calculated once, as the alignment and cost for the tunnel do not change between route options.

Table 52: Average uplifts for major infrastructure interventions (tunnels) and cycling and walking paths (greenways).

Intervention type	Mode	Without- to with-intervention percentage average	Range
Tunnel	**Cycling**	216%	94-867%
	Walking	178%	70-574%
Greenway	**Cycling**	541%	77-2,952%
	Walking	179%	61-754%

Table 53: Daily usage uplifts generated by using the Case Study data and the Capital Fund Uplift Tool

Route	Cycling		Walking	
	Case Studies	Capital Fund Uplift Tool	Case Studies	Capital Fund Uplift Tool
Queensbury Tunnel	1,332	2,358	5,579	5,796
Most Advantageous & Attractive (QT option, greenway alignments only)	10,875	3,725	16,495	21,032
Most Advantageous & Attractive (Alpine option)	5,094	3,900	19,018	23,236
Next Preferred (QT option, greenway alignments only)	8,347	2,758	12,409	16,825
Next Preferred (Alpine option)	4,084	3,433	14,955	20,922
Low Cost & Quickest to Deliver (QT option, greenway alignments only)	5,179	1,809	8,135	11,480
Low Cost & Quickest to Deliver (Alpine option)	2,819	2,455	10,705	15,340

J.4.2. Active Mode Appraisal Toolkit (AMAT) analysis

A separate version of the AMAT is created for each route based on the uplifts generated from the Case Study averages and the Capital Fund Uplift Tool. The AMAT was developed by the Department for Transport to allow scheme promoters to simply and robustly appraise the value for money of walking and cycling schemes. It quantifies some of the key benefits from active travel including improved health and lower workplace absenteeism, environmental and congestion benefits from reduced car miles and journey quality benefits from safer and more pleasant travel.

The following inputs have been used in the AMATs to obtain Benefit Cost Ratio (BCR) of each route. All default inputs are maintained, with the exception of optimism bias:

- Appraisal period: This represents the number of years over which the benefits of the intervention are assumed to occur, the default is 20 years
- Local area type: Types include, London, Inner and Outer Conurbation; Other Urban; or Rural
- Number of cycling/walking trips **without** the proposed intervention: AUEs converted to average trips per weekday assuming on average 250 weekdays per year excluding bank holidays.
- Number of cycling/walking trips **with** the proposed intervention: The forecasted uplift in cycling and walking due to a scheme.
- How much of an average cycling/walking trip will use the intervention: An estimate for the percentage of an average cycling or walking trip which is on the scheme itself.
- Total intervention cost: An estimate for the upfront costs of delivering the scheme and any on-going maintenance and renewal costs for the scheme's assumed life (typically 20 years).
- Cost information and optimism bias – costs and optimism bias used for each route are shown in Table 32.

Benefit Cost Ratios (BCR)

The estimated BCRs are judged according to the value for money categories described in the 2013/14 Highways Agency technical note[12] (see Table 54).

Table 54: Value for money categories[13]

Value for money category	Benefit-cost ratio
Very High	4 or higher
High	2 to 4
Medium	1.5 to 2
Low	1 to 1.5
Poor	0 to 1
Very Poor	Less than 0

[12] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361412/PS_2013-15_-_4.19_The_Percentage_of_Major_Project_Spend_which_is_Assessed_as_Good_or_Very_Good.pdf

[13] See DfTs 2021/22 Capital Fund Value for Money Guidance

The estimated economic impact in the form of BCRs is calculated over a 20 year appraisal period and include benefits and costs from the following:

- Congestion benefit – Reduced vehicle kilometres results in reduced congestion for road users
- Infrastructure maintenance – Reduced vehicle kilometres results in reduced damage to done to road surfaces etc.
- Accident – Reflects the effect of reducing vehicle kilometres on road safety. It is not the direct benefit of increased cycle safety.
- Local air quality – Reduced vehicle kilometres results in reduced amount of pollutants emitted.
- Noise – Reduced vehicle kilometres results in reduced amount of noise produced on roads.
- Greenhouse gases – Reduced vehicle kilometres results in reduced in greenhouse gas emissions.
- Reduced risk of premature death – Due to increased physical activity.
- Absenteeism – Due to increased physical activity.
- Journey ambience – Improved experience due to cycle lanes, showers, reduced crowding etc.
- Indirect taxation – Reduced vehicle kilometres reduced tax revenue e.g. fuel duty.
- Government costs

For the routes including the Queensbury Tunnel, AMATs were produced separately for the Tunnel alignment and the greenway alignments using the uplift numbers in Table 53, with the costs split between the two sections as detailed in Table 32 and Table 33. The PVB and PVC from each section were then combined, and the BCR for the route as a whole was calculated using the formula:

$$BCRcombined = \frac{PVBtunnel + PVBgreenway}{PVCtunnel + PVCgreenway}$$

Table 55: AMAT outputs for the Tunnel alignment and greenway alignments for each scenario.

Scenario	PVB (£'000s)	PVC (£'000s)
Most Advantageous and Attractive (greenways)	£117,726.15	£20,610.02
Next Preferred (greenways)	£89,958.35	£19.979.47
Low Cost (greenways)	£56,507.33	£13,802.33
Tunnel only alignment (greenways)	£16,026.92	£26,782.27

Table 56: Final AMAT Outputs

Most Advantageous & Attractive (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 133,753.07	£47,392.28	2.82	High
Capital Fund Uplift Tool	£ 90,701.57	£47,401.59	1.91	Medium
Most Advantageous & Attractive (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 68,623.09	£ 25,086.99	2.74	High
Capital Fund Uplift Tool	£ 55,771.88	£ 23,591.54	2.36	High
Next Preferred (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 105,985.27	£ 46,761.73	2.27	High
Capital Fund Uplift Tool	£ 77,035.57	£ 46,768.54	1.65	Medium
Next Preferred (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 52,700.03	£ 24,551.79	2.15	High
Capital Fund Uplift Tool	£ 65,438.64	£ 24,550.64	2.67	High
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 72,534.25	£ 40,584.60	1.79	Medium
Capital Fund Uplift Tool	£ 60,801.42	£ 40,588.19	1.50[1]	Low
Low Cost & Quickest to Deliver (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 36,980.13	£ 18,537.63	1.99	Medium
Capital Fund Uplift Tool	£ 48,189.58	£ 18,536.51	2.60	High

1. Rounded up from 1.49, hence Low

The BCRs for each route option and each uplift scenario are presented in

Table 56 in the 'BCR' column. BCRs range from 1.50 to 2.82, ranging in VfM categories from low to high. Only one scenario is in the low range. The Most Attractive and Next Preferred scenarios which include the Queensbury Tunnel resulted in higher BCRs when using the case study uplift data compared to the Alpine option. The Capital Fund Uplift Tool resulted in higher BCRs for the Alpine option. When using the case study uplifts, the highest BCR for options including the tunnel and options including the Alpine zig-zag come from the Most Advantageous and Attractive scenarios (2.82 and 2.74, respectively). When using the Capital Fund Uplift Tool, the Most Advantageous and Attractive scenario including the tunnel had the highest BCR (1.91) for the options including the tunnel. The Next Preferred option including the Alpine zig-zag had the highest (2.67) for the Alpine scenarios.

The BCRs are dependent on the overall change in usage from baseline. As there exists uncertainty in the baseline usage numbers as described previously, there is also some uncertainty in the overall BCR. The modelling and BCRs presented represent a central tendency; as seen in previous usage data, many schemes over- or underperform when compared to the average change in usage. For the BCR to decrease enough for the Most Advantageous and Attractive scenario to fall into the Poor VfM category (< 1), baseline usage would have to decrease by a factor of 2.8 (with the associated reduction in uplift).

Quantifying the risk of such a decrease in usage is difficult, as the baseline usage numbers are a projection for routes that do not yet exist. To quantify the risk, we would need to create baseline counts for other similar routes using the described methodology based on the NTS and population data, then compare the projections to actual counts. To do so would be well beyond the scope of the project.

To compare the benefits for each additional user, the number of additional users was determined by comparing the 'with scheme' forecasted usage estimates with their baseline equivalents for walking and cycling.

Table 57: Additional users per scenario

Scenarios		'Without scheme' AUE (cycling)	'Without scheme' AUE (walking)	'With scheme' - AUE (cycling)	'With scheme' - AUE (walking)	Additional riders (cycling)	Additional users (walking)	Additional users per year (walking and cycling)
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	613,525	2,673,474	2,958,542	4,779,165	2,345,018	2,105,691	4,450,709
	Capital Fund Uplift Tool			1,355,549	5,939,016	742,024	3,265,542	4,007,567
Most Advantageous & Attractive (Alpine Option)	Case Studies	589,551	2,671,091	1,273,430	4,754,543	683,879	2,083,451	2,767,331
	Capital Fund Uplift Tool			974,932	5,808,931	385,381	3,137,840	3,523,221
Next Preferred (Queensbury Tunnel Option)	Case Studies	496,686	2,102,872	2,326,447	3,341,990	1,829,760	1,239,117	3,068,878
	Capital Fund Uplift Tool			1,113,908	4,630,557	617,222	2,527,684	3,144,906
Next Preferred (Alpine Option)	Case Studies	472,713	2,100,490	1,021,059	3,738,872	548,347	1,638,382	2,186,729
	Capital Fund Uplift Tool			858,291	5,230,587	385,578	3,130,097	3,515,675
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	Case Studies	350,296	1,505,960	1,534,475	2,689,315	1,184,179	526,331	2,367,534
	Capital Fund Uplift Tool			876,627	3,551,097	1,183,356	2,045,137	2,571,468
Low Cost & Quickest to Deliver (Alpine Option)	Case Studies	326,322	1,503,578	704,856	2,676,368	378,534	1,172,791	1,551,324
	Capital Fund Uplift Tool			613,760	3,835,012	287,438	2,331,434	2,618,872

The value per additional rider was determined using the present value benefits estimated from the AMAT and dividing by the additional user (walking and cycling) in each scenario.

Table 58: Route comparison – value per additional user

Scenarios		Additional users per year (walking and cycling)	Present Value Benefits (£'000)	Value per additional user, £ / user
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	4,450,709	£ 133,753.07	£ 30.05
	Capital Fund Uplifts Tool	4,007,567	£ 90,701.57	£ 22.63
Most Advantageous & Attractive (Alpine Option)	Case Studies	2,767,331	£ 68,623.09	£ 24.80
	Capital Fund Uplifts Tool	3,523,221	£ 55,771.88	£ 15.83
Next Preferred (Queensbury Tunnel Option)	Case Studies	3,068,878	£ 105,985.27	£ 34.54
	Capital Fund Uplifts Tool	3,144,906	£ 77,035.57	£ 24.50
Next Preferred (Alpine Option)	Case Studies	2,186,729	£ 52,700.03	£ 24.10
	Capital Fund Uplifts Tool	3,515,675	£ 65,438.64	£ 18.61
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	Case Studies	2,367,534	£ 72,534.25	£ 30.64
	Capital Fund Uplifts Tool	2,571,468	£ 60,801.42	£ 23.64
Low Cost & Quickest to Deliver (Alpine Option)	Case Studies	1,551,324	£ 36,980.13	£ 23.84
	Capital Fund Uplifts Tool	2,618,872	£ 48,189.58	£ 18.40

J.5. Full Results – Additional Impact Analysis

J.5.1. Sensitivity testing

Various sensitivity tests were performed to observe how the BCR would change under various circumstances. For the purposes of the sensitivity testing, the Most Advantageous and Attractive option including the tunnel with the case study uplifts was used as the benchmark case.

Delayed construction and inflation costs

Construction may be delayed due to potential legal challenges or other unforeseen circumstances. The effect of delaying construction for two years on the BCR of the Most Attractive and Advantageous options were analysed in the AMAT. Nominal costs were adjusted for inflation using 2.1% assumed general inflation.

In addition to performing sensitivity testing for a construction delay using the average inflation assumed in the AMAT, testing was also performed assuming a higher rate of inflation at 4% to account for the current general inflation above and beyond the AMAT assumptions, both for an on-time construction start and a 2-year delay.

Table 59: Effects of a 2-year construction delay

Construction delay	PVB (£'000)	PVC (£'000)	BCR	Difference from benchmark
Benchmark	£133,753.10	£47,392.28	2.82	
On time w/ 4% inflation	£133,753.07	£49,003.39	2.73	-0.09
2-year delay	£128,766.56	£46,407.53	2.77	-0.05
2-year delay w/ 4% inflation	£128,776.56	£48,723.94	2.64	-0.18

Tunnel cost variance

To account for possible cost differences for the tunnel (both over- and underestimates), AMATs were produced for the circumstances of +30% tunnel cost and -30% tunnel cost. These were then compared to the benchmark case.

Table 60: Cost over- and underrun analysis

Cost scenario	PVB (£'000)	PVC (£'000)	BCR	Difference from benchmark
Benchmark	£133,753.07	£47,392.28	2.82	
+30% Tunnel cost	£133,753.07	£54,626.32	2.45	-0.37
-30% Tunnel cost	£133,753.07	£40,159.32	3.33	+0.51

In addition to the sensitivity testing, the cost overrun needed to decrease the BCR into lower VfM categories were also calculated. The baseline falls into the High VfM, so the overruns needed to decrease the category of the BCR to Medium, Low, and Poor were determined. This sensitivity test was performed on both Most Attractive and Advantageous route options.

Table 61: Cost overrun needed to change VfM category

New VfM Category	PVB (£'000)	Projected PVC (£'000)	BCR	Difference in PVC (£'000)	Overall % PVC increase	Tunnel % PVC increase
Most Attractive and Advantageous – Tunnel option						
Medium	£133,753.07	£66,876.53	2	£19,484.25	41.11%	80.77%
Low	£133,753.07	£89,168.71	1.5	£41,776.43	88.15%	173.19%
Poor	£133,753.07	£133,753.07	1	£86,360.79	182.23%	358.02%

Most Attractive and Advantageous – Alpine option					
New VfM Category	**PVB (£'000)**	**Projected PVC (£'000)**	**BCR**	**Difference in PVC (£'000)**	**Overall % PVC increase**
Medium	£68,623.09	£34,311.55	2	£9,224.56	36.77%
Low	£68,623.09	£45,748.73	1.5	£20,661.74	82.36%
Poor	£68,623.09	£68,623.09	1	£43,536.10	173.54%

Tunnel design life

The baseline analysis assumes a 20-year design life. As the tunnel is a durable structure with a current lifespan of much longer than 20 years, an AMAT was produced that assumed a design life of 60 years. Baseline annual maintenance costs were extended to correlate to a 60-year design life. No changes were made to the design life of the greenway alignments.

Table 62: Tunnel design life analysis

Asset life	PVB (£'000)	PVC (£'000)	BCR	Difference in PVB (£'000)	Difference in PVC (£'000)
20 years (benchmark)	£133,753.07	£47,392.28	2.82		
60 years	£162,426.02	£47,651.19	3.41	£28,672.96	£258.91

Extended tunnel alignment

For the benchmark analysis, only the alignment including the Queensbury Tunnel used the "Tunnel" data from the case study data to generate uplifts; all other alignments used the "Greenways" data to generate their uplifts. The analysis excluded other alignments from the "Tunnel" section of the route because the other alignments could be viewed as a separate network on their own. The sections north of the tunnel and south of the tunnel could be used for active travel without going through the tunnel. Sensitivity testing was performed to show changes in BCR when extending the "Tunnel" section to the alignments immediately north and south of the Queensbury Tunnel. South of the tunnel includes the two Halifax to Holmfield alignments, and north includes the Keighley to Station Road alignment. Given the high tourism and heritage potential of the tunnel, this approach may better capture the usage of the routes specifically for access to the tunnel, although it does ignore the use of the alignments outside of the tunnel for local travel.

Table 63: Extended tunnel segment sensitivity testing results

Scenario	PVB (£'000)	PVC (£'000)	BCR	Difference from benchmark
Tunnel only (benchmark)	£133,753.07	£47,392.28	2.82	
Extended tunnel to north and south	£95,734.57	£47,624.70	2.01	-0.81
Extended tunnel to north only	£113,861.30	£44,316.59	2.57	-0.25

J.5.2. Tourism model

In addition, the economic impact of cycling tourism is estimated. Sustrans' Cycle Route Economic Impact Model, referred to here as the *tourism model*, was first developed in 2007 by Sustrans in conjunction with the University of Central Lancashire, and is used to estimate a total annual spend and a 'spend per head' for all recreational users. The model has since been updated and a comparable version for walking has been created. They models are now referred to as the Leisure Cycling and Leisure Walking Expenditure Models.

The inputs for the tourism model primarily come from specific recreational usage-related questions asked in a user survey, with outputs including the total annual spend and a 'spend per head' for all recreational users. It also calculates the number of FTE roles supported by this level of expenditure. The output from the tourism model is in terms of expenditure and jobs supported; separated into leisure cycling expenditure (LCE) and leisure walking expenditure (LWE). The jobs supported output is based on the employment that is supported by the level of tourism expenditure that might be anticipated for the estimated number of tourist trips being made on the routes (e.g. in hospitality, accommodation, food service industries, etc.).

Unfortunately there have been no user surveys undertaken in the vicinity of any of the proposed routes/corridors, so proxy survey data from a comparable location has been used. Proxy survey data captured in 2018 from a site on the Spen Valley Greenway in Bradford was used in combination with data from the 2019 Visit Bradford tourism survey to provide the necessary model inputs. The Spen Valley Greenway data was chosen due to it being the nearest survey site to the Queensbury Tunnel proposed routes with recent survey data (i.e. within the last 5 years) and the necessary recreational usage questions to provide inputs for the model. Data from the 2019 Visit Bradford Tourism Survey was used to derive the inputs for home-based vs holiday usage based on the responses given on what type of trip each visitor was making.

Table 64 Recreational expenditure (LWEM and LCEM) and jobs supported

Most Advantageous & Attractive (Queensbury Tunnel Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£1,385,204.48	£7,493,360.49	£8,878,564.96	30	164	194
Capital Fund Uplift Tool	£634,727.83	£9,311,935.46	£9,946,663.29	14	204	218
Most Advantageous & Attractive (Alpine Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£808,004.83	£7,041,148.15	£7,849,152.98	18	154	172
Capital Fund Uplift Tool	£329,850.44	£8,853,666.61	£9,183,517.05	7	194	201
Next preferred (Queensbury Tunnel Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£1,089,253.96	£5,891,921.52	£6,981,175.48	24	129	153
Capital Fund Uplift Tool	£521,537.16	£7,662,707.33	£8,184,244.49	11	168	179
Next preferred (Alpine Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£897,314.94	£7,382,563.28	£8,279,878.23	20	162	182
Capital Fund Uplift Tool	£329,850.44	£8,853,666.61	£9,183,517.05	7	194	201

Low Cost & Quickest to Deliver (Queensbury Tunnel Option)						
	LCEM Expenditure	LWEM Expenditure	Total Tourism Expenditure (LWEM + LCEM)	Jobs Supported (LCEM)	Jobs Supported (LWEM)	Jobs Supported (LWEM + LCEM)
Case Studies	£718,448.72	£4,216,638.17	£4,935,086.88	16	92	108
Capital Fund Uplift Tool	£410,441.20	£5,567,844.81	£5,978,286.01	9	122	131
Low Cost & Quickest to Deliver (Alpine Option)						
	LCEM Expenditure	LWEM Expenditure	Total Tourism Expenditure (LWEM + LCEM)	Jobs Supported (LCEM)	Jobs Supported (LWEM)	Jobs Supported (LWEM + LCEM)
Case Studies	£661,690.76	£5,693,910.71	£6,355,601.47	15	125	140
Capital Fund Uplift Tool	£253,767.13	£6,764,801.80	£7,018,568.93	6	148	154

Benefit Cost Ratios (BCR) including tourism benefits

Tourism expenditure is not valued in the Active Mode Appraisal Toolkit (AMAT). The proposed routes around Queensbury Tunnel are expected to attract tourism-related usage, as seen with past schemes of a similar nature such as the Monsal and Tissington Trails in Derbyshire and Bath Two Tunnels scheme.

To provide a holistic estimate for the economic impact of each scenario, illustrative BCRs are derived which show the Benefit-Cost Ratios from AMAT as well as the estimated leisure cycling and walking expenditure. The Present Value Benefit (PVB) is added to the total tourism expenditure (i.e. LWEM + LCEM) (Table 65), and divided by the Present Value Cost (PVC) calculated in the AMAT. It should be noted that the tourism expenditure represents a cashable benefit, which is different to the monetised impacts derived in AMAT. In reality, these values should not be added together as they represent different types of economic value. The below table is for illustrative purposes only.

With the added tourism benefit, the highest BCR is 3.05 (judged as '*high*' in terms of value for money) which is derived from the Most Advantageous and Attractive options using the Alpine Zig-zag with the Case Study uplift. The highest BCR when including the Queensbury Tunnel is 3.01 and comes from the Most Advantageous and Attractive option.

Table 65 Calculating BCRs that include tourism benefit

Most Advantageous & Attractive (Queensbury Tunnel Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	Change in BCR
Case Studies	£133,753.07	£47,392.28	£8,878.56	£142,631.63	3.01	0.19
Capital Fund Uplift Tool	£90,701.57	£47,401.59	£9,946.66	£100,648.23	2.12	0.21
Most Advantageous & Attractive (Alpine Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	
Case Studies	£68,623.09	£25,086.99	£7,849.15	£76,472.24	3.05	0.31
Capital Fund Uplift Tool	£55,771.88	£23,591.54	£9,183.52	£64,955.39	2.75	0.39

Next preferred (Queensbury Tunnel Option)						
	PVB (£'000s)	**PVC (£'000s)**	**Total Tourism Expenditure (LWEM + LCEM) £'000s**	**Total Benefits (AMAT, LWEM, LCEM) - £'000s**	**LWEM & LCEM BCRs**	
Case Studies	£105,985.27	£46,761.73	£5,010.02	£110,995.29	2.37	0.11
Capital Fund Uplift Tool	£77,035.57	£46,768.54	£5,874.77	£82,910.34	1.77	0.13
Next preferred (Alpine Option)						
	PVB (£'000s)	**PVC (£'000s)**	**Total Tourism Expenditure (LWEM + LCEM) £'000s**	**Total Benefits (AMAT, LWEM, LCEM) - £'000s**	**LWEM & LCEM BCRs**	
Case Studies	£52,700.03	£24,551.79	£5,942.74	£58,642.77	2.39	0.24
Capital Fund Uplift Tool	£65,438.64	£24,550.64	£6,592.52	£72,031.16	2.93	0.27
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)						
	PVB (£'000s)	**PVC (£'000s)**	**Total Tourism Expenditure (LWEM + LCEM) £'000s**	**Total Benefits (AMAT, LWEM, LCEM) - £'000s**	**LWEM & LCEM BCRs**	
Case Studies	£72,534.25	£40,584.60	£3,541.74	£76,075.99	1.87	0.09
Capital Fund Uplift Tool	£60,801.42	£40,588.19	£4,291.24	£65,092.66	1.60	0.11
Low Cost & Quickest to Deliver (Alpine Option)						
	PVB (£'000s)	**PVC (£'000s)**	**Total Tourism Expenditure (LWEM + LCEM) £'000s**	**Total Benefits (AMAT, LWEM, LCEM) - £'000s**	**LWEM & LCEM BCRs**	
Case Studies	£36,980.13	£18,537.63	£4,561.67	£41,541.80	2.24	0.25
Capital Fund Uplift Tool	£48,189.58	£18,536.51	£5,038.38	£53,227.96	2.87	0.27

Comparing BCRs and LWEM & LCEM BCRs

In all the scenarios the inclusion of tourism benefits resulted in an increase in the BCRs; the increase ranged from 0.19 - 0.39. Note: Sums that do not seem to add up are due to decimals that were rounded off.

Table 66 Comparison between AMAT BCRs and BCRs that include tourism benefits

Scenarios		AMAT BCRs	AMAT BCR + Tourism benefit	Difference
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	2.82	3.01	0.19
	Capital Fund Uplift Tool	1.91	2.12	0.21
Most Advantageous & Attractive (Alpine Option)	Case Studies	2.74	3.05	0.31
	Capital Fund Uplift Tool	2.36	2.75	0.39
Next preferred (Queensbury Tunnel Option)	Case Studies	2.27	2.42	0.15
	Capital Fund Uplift Tool	1.65	1.82	0.17
Next preferred (Alpine Option)	Case Studies	2.15	2.48	0.34
	Capital Fund Uplift Tool	2.67	3.04	0.37
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	Case Studies	1.79	1.91	0.12
	Capital Fund Uplift Tool	1.50	1.65	0.15
Low Cost & Quickest to Deliver (Alpine Option)	Case Studies	1.99	2.34	0.34
	Capital Fund Uplift Tool	2.60	2.98	0.38

J.5.3. Heritage benefit

The Queensbury Tunnel structure is expected to have a significant heritage value because of its industrial heritage. This potential heritage value is external to the monetised impacts included in AMAT, but an important aspect of the business case for the tunnel as a walking and cycling route which would provide access to its industrial heritage for users.

To demonstrate the potential impact of including this heritage value in the cost-benefit assessment, two 'heritage BCR' scenarios have been modelled using switching values analysis. This models the heritage value of the Queensbury Tunnel by estimating what it would be equivalent to (in terms of present-value benefits) to adjust the AMAT BCRs to a certain level. This calculation is only applied to the scenarios including Queensbury Tunnel, as these are the scenarios where heritage value should form part of the value-for-money analysis.

The scenario for modelling the potential heritage value involve modelling one BCR scenario:

What would the additional benefit in terms of heritage be equivalent to if the BCRs were rounded up to the next VfM category?

This scenario uses the AMAT BCRs as a starting point and rounds up to the next VfM category[14].

The calculation then works out what the net Present Value Benefit would be at this increased BCR scenario. BCRi denotes the BCR scenario for the switching value analysis. The following equations illustrate how the heritage value is derived.

$$BCRi = \frac{Present\ Value\ Benefits + Heritage\ Value}{Present\ Value\ Costs}$$

$$Heritage\ Value = (BCRi\ x\ Present\ Value\ Costs) - Present\ Value\ Benefits$$

The heritage value from the switching values analysis is then divided by the population figures derived from the GIS modelling that determined the population buffers around the routes as part of the baseline usage estimate derivation to test whether this level of heritage value is credible.

The original AMAT outputs for Present Value Benefits, Present Value Costs and BCRs are in

Table 56. Table 67 shows the results of the switching values analysis for the three scenarios which involve Queensbury Tunnel.

Based on the BCR scenario modelled below using both the case study and Capital Fund Uplift Tool uplifts, the per-trip heritage value of the Queensbury Tunnel ranges from £13.00 to £33.00 across the nine usage scenarios. The maximum heritage value of £33.00 is ascribed to the Next Preferred scenario with uplifts from the case studies. This range of values is credible and demonstrates that if

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918479/value-for-money-framework.pdf

heritage value were included in the value for money assessment, there are grounds to consider the out-turn BCRs as being higher than the AMAT BCRs if these heritage benefits are included.

Table 67 Heritage value – switching values analysis

Most Advantageous & Attractive (Queensbury Tunnel Option)					
		Switching values: If BCR was rounded up to the next VfM category			
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ trip (£)**
Case Studies	2.82	4.00	£189,569.13	£55,816.06	£24.50
Capital Fund Uplift Tool	1.91	2.00	£94,803.18	£4,101.61	£13.00
Next Preferred (Queensbury Tunnel Option)					
		Switching 1: If BCR was rounded up			
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ trip (£)**
Case Studies	2.28	4.00	£187,046.94	£81,061.67	£33.00
Capital Fund Uplift Tool	1.65	2.00	£93,537.08	£16,501.51	£16.28
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)					
		Switching 1: If BCR was rounded up to next VfM category			
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ trip (£)**
Case Studies	1.80	2.00	£81,169.20	£8,634.96	£19.22
Capital Fund Uplift Tool	1.50	2.00	£81,176.37	£20,374.95	£18.33

J.5.4. Carbon impact

The analysis of the carbon impact of the various usage scenarios was carried out using the greenhouse gas emissions output from the Active Mode Appraisal Toolkit. The estimated tonnes of CO_2 saved was derived from the AMAT greenhouse gas emissions output and the cash value per tonne of CO_2 from TAG Databook A3.4.

The cash value of carbon per tonne of CO2 was taken as an average from the central values in TAGA3.4 for the years relevant to the appraisal period (2021 to 2040). This is equivalent to £85.85 per tonne of CO_2.

Table 68 Carbon impact analysis – all scenarios

Most Advantageous & Attractive - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£291.09	3,390.73
Uplift Tool	£166.58	1,940.39

Most Advantageous & Attractive - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£97.37	1,134.24
Uplift Tool	£57.60	670.99

Next Preferred - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£230.09	2,680.16
Uplift Tool	£143.44	1,670.80

Next Preferred - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£90.91	1,058.90
Uplift Tool	£108.31	1,261.67

Low Cost/Quickest to Deliver - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£155.77	1,814.41
Uplift Tool	£117.88	1,373.16

Low Cost/Quickest to Deliver - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£63.70	741.95
Uplift Tool	£80.72	940.20

Notes

i Creating Growth, Cutting Carbon Making Sustainable Local Transport Happen, DfT (2011)

ii Cycling and Walking Investment Strategy, DfT (2017)

iii Transport Investment Strategy: Moving Britain Ahead, DfT (2017)

iv Gear Change: A bold vision for cycling and walking, DfT (2020)

v Decarbonising Transport: A Better, Greener Britain, DfT (2021)

vi Transport Strategy 2040, WYCA (2017)

vii Strategic Economic Framework: Our Vision, WYCA (2020)

viii Connectivity Infrastructure Plan: A bold ambition for West Yorkshire, WYCA (2021)

ix West Yorkshire Mass Transit Vision 2040: A new transport system to support the Northern Powerhouse, WYCA (2021)

x Keeping the Wheels Spinning: Bradford District Cycle Strategy 2016 – 2026, CBMDC (2016)

xi Calderdale Transport Strategy 2016-2031, Calderdale Council (2016)

xii Connecting people and place for better health and wellbeing: A Joint Health and Wellbeing Strategy for Bradford and Airedale 2018 - 2023, CBMDC (2018)

xiii Wellbeing Strategy For Calderdale 2018 – 2024, Calderdale Council (2018)

xiv City of Bradford MDC Sustainable Development Action Plan 2020-2021, CBMDC (2020)

xv Local Infrastructure Plan, CBMDC (2021)

xvi Culture is our plan: A cultural strategy for Bradford District 2021 – 2031 [Text only version], (2021)

xvii West Yorkshire Location Transport Plan 2011-2026 (LTP3) Bradford Local Implementation Plan, CBMDC (2011)

xviii https://www.change.org/p/securing-a-beneficial-future-for-queensbury-tunnel

xix http://www.queensburytunnel.org.uk/index.shtml

xx Ancient highway into Bradford is dry once again, Telegraph & Argus (2021)

xxi https://gnrtdg.wordpress.com/

xxii Active and Economic Performance: A ‘What Works’ review of evidence from cycling and walking schemes, Sustrans (2017)

xxiii Monsal Trail voted UK’s favourite cycle route, Peak District National Park (2015)

xxiv Record numbers enjoy Peak District countryside as Monsal Trail celebrates milestone birthday, Peak District National Park (2021)

xxv Cyclists to link iron viaducts in new 300 mile route, Friends of Bennerley Viaduct (2021)

xxvi https://www.yourvoice.westyorks-ca.gov.uk/thorntoncycle

xxvii http://www.cyclebradford.org.uk/wp-content/uploads/ACTION-PLAN-Top-10.pdf

xxviii Transport Analysis Guidance (TAG) Unit 1.2: Scheme costs

[xxx] Flyvbjerg, B. (2004): Procedures for Dealing with Optimism Bias in Transport Planning, p.4