



**Haweswater Aqueduct Resilience Programme - Proposed Marl Hill
Section**

Environmental Statement

Volume 2

Chapter 3: Design Evolution and Development Description

June 2021



Water for the North West



Haweswater Aqueduct Resilience Programme - Proposed Marl Hill Section

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3. Design Evolution and Development Description

- 1) This chapter sets out the need for the Proposed Programme of Works, which centres on the condition of the existing aqueduct. It also outlines the potential solutions that were considered prior to adoption of the preferred option, and the design development process for the Proposed Marl Hill Section. It provides a description of the Proposed Marl Hill Section, including the new tunnel route, the design of the aqueduct and the envisaged construction methods and approaches. Chapter 3 also describes the proposed construction traffic routes which would serve the construction compounds, and provides the basis of assessment for Chapters 6 - 19 of this Environmental Statement (ES).

3.1 Needs Case

- 2) In the early 2000s United Utilities began planning major investment, which spanned over ten years, to ultimately enable the Haweswater Aqueduct to be taken out of service for the first time in over 60 years. The aim was to identify any future service risk to customers supplied by this ageing asset.
- 3) Several major steps had to first be taken including the £250 million construction of the West East Link Main (WELM), completed in 2011. The WELM, along with other activities such as upgrading Lostock Water Treatment Works to increase flow capacity, made it possible to take the Haweswater Aqueduct out of service (referred to as an *outage*) in 2013. A subsequent outage in 2016 allowed for more detailed investigations and some minor, targeted repairs.
- 4) Arranging and implementing outages on the aqueduct requires many months of planning, and the outages are very limited in terms of allowable duration (approximately four to six weeks), the time of year they can be delivered (normally October when demand for water is at its lowest) and the frequency (outages are only possible every two years). These tight constraints limit how much inspection work can be undertaken during each aqueduct outage. Due to the extensive works required, it would not be possible to deliver the Proposed Programme of Works during an outage.
- 5) The data collected from the inspections in 2013 and investigations in 2016 uncovered areas of concern in the single line tunnel sections of the Haweswater Aqueduct relating to both future water supply and water quality risks. It is anticipated that the condition of these single line tunnel sections would continue to deteriorate, and therefore a solution is required to address the risks to water supply and water quality.
- 6) The need for the Proposed Marl Hill Section is driven by the same need as the overall Proposed Programme of Works i.e. there is a requirement to replace part of an ageing asset to secure a water supply into the future, and to mitigate potential risks to drinking water quality.

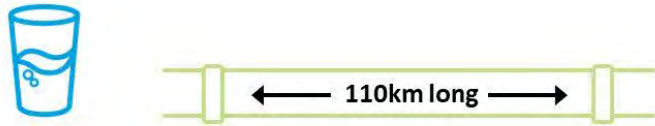
3.1.1 The Existing Marl Hill Section

- 7) The existing Haweswater Aqueduct is a major feat of engineering. The pipeline, built between 1933 and 1955, has successfully served customers in Cumbria, Lancashire and Greater Manchester for over sixty years (see Illustration 3.1 below).
- 8) To maintain the integrity of the network, United Utilities is proposing to replace all five tunnel sections along the length of the aqueduct from Cumbria to Greater Manchester.
- 9) The fourth of the five tunnel sections (when viewed from north to south), known as the Proposed Marl Hill Section, extends from Bonstone, south of the River Hodder near Newton-in-Bowland, to Bashall Eaves, north of Waddington (Illustration 3.2 below).
- 10) The Proposed Marl Hill Section would be constructed by tunnel boring techniques below ground level, with short open-cut surface trenching sections at each end making connections back to the existing aqueduct. The new tunnel would be bored north from a launch shaft at Braddup, with a reception shaft at Bonstone. Further details on the tunnel boring technique and associated construction works are provided in this chapter. It is important to note that the replacement section of tunnel needs to connect into the existing aqueduct at the end of each existing multi-line siphon section. The location of the proposed tunnel shafts, and associated compounds, is therefore determined by the location of the existing connection points between the single line sections and the multi-line siphon sections.

- 11) Once the Proposed Marl Hill Section has been constructed, it would be tested and commissioned before the existing tunnel sections of the Haweswater Aqueduct are decommissioned.

Illustration 3.1: The existing Haweswater Aqueduct

The Haweswater Aqueduct (HA)



Serving Cumbria, Lancashire and Greater Manchester

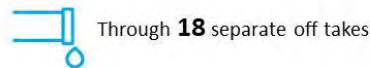
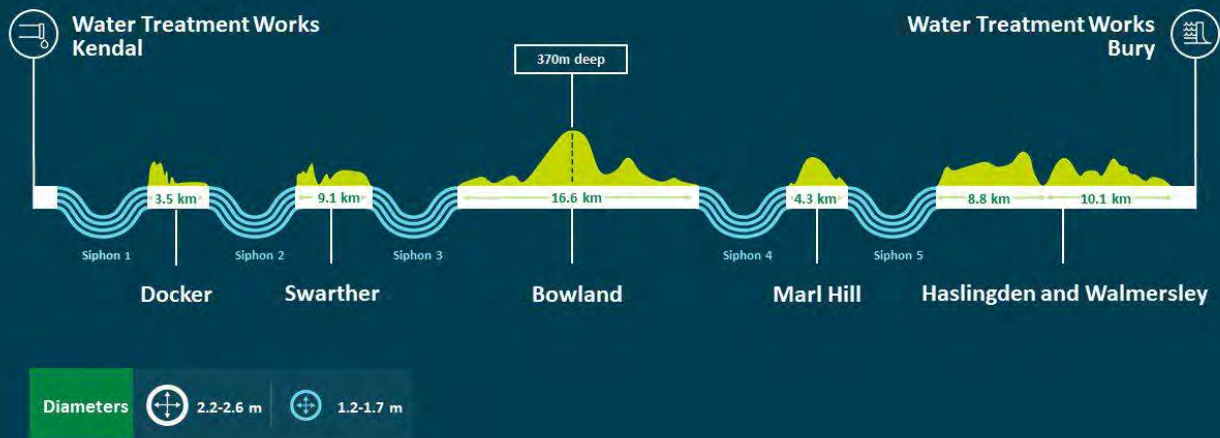


Illustration 3.2: The existing Haweswater Aqueduct outlining the different sections

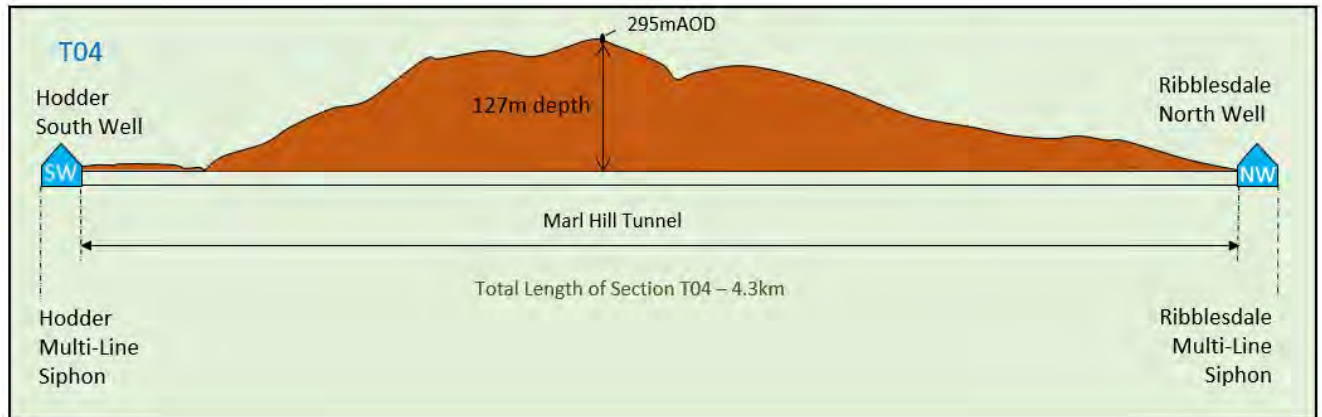
The Haweswater Aqueduct



- 12) The total length of the existing Marl Hill section is 4.2 km comprising:
- The Marl Hill Conduit (0.5 km)
 - The Marl Hill Tunnel (3.7 km).

- 13) The existing Hodder multi-line siphon is located to the north of the Marl Hill section and the existing Ribblesdale multi-line siphon is located to the south of the Marl Hill section.
- 14) At its deepest point the existing Marl Hill Tunnel is approximately 127 m below ground level (Illustration 3.3)

Illustration 3.3: Cross section for the Marl Hill Section of the Haweswater Aqueduct



3.2 Consideration of Alternatives

- 15) This section describes the alternatives that were considered to address the identified need to protect the water supply provided by the existing Haweswater Aqueduct. Given that maintaining water supply is a necessity, these considerations focused primarily on the level of intervention required, such as whether there were opportunities for repair and protection instead of replacement.
- 16) During 2017 United Utilities undertook an extensive process to identify and assess a full range of options to provide a reduction in the risk to customer supplies. These options were appraised against cost, environmental and technical considerations, and additionally a range of proposals were tested through extensive customer and stakeholder engagement.
- 17) The Proposed Programme of Works (namely replacement of five tunnel sections) was chosen as the preferred baseline solution following an exhaustive three stage optioneering exercise which considered many potential combinations of engineering and operational solutions. The optioneering process followed three steps:
 - Coarse option screening
 - Coarse solution screening
 - Fine solution screening.
- 18) *Coarse option screening* aimed to remove unviable options through application of the following three criteria:
 - Technical feasibility – Options were reviewed in respect of whether they would be technically possible and buildable in Asset Management Period (AMP) 7 / 8. Each AMP is a five year period with AMP7 presently running from 2020 to 2025 and AMP8 from 2025 to 2030
 - Statutory / Environmental Feasibility – Options were reviewed to evaluate the likelihood of permission being granted for the works to be constructed. United Utilities considered whether each proposed option had the potential to impact on important designated sites such as Special Areas of Conservation (SAC)
 - Addressing the need – An assessment was made of the impact that the option could have in supporting the need for improving the resilience of the Haweswater Aqueduct's supply through Cumbria and Lancashire and into Greater Manchester.

- 19) *Coarse solution filtering* grouped options into solutions, calculated simplified bill impacts, assessed risk reduction and screened out solutions using a dominance criterion (i.e. solutions with lower risk reduction for higher bill impact were removed).
- 20) *Fine solution filtering* of the options considered Ofwat’s resilience principles, most notably: ‘resilience in the round’ (Principle 1); ‘Naturally resilient’ (Principle 2); ‘Customer engagement’ (Principle 3); ‘Broad option set’ (Principle 4); and ‘Best value solution’ (Principle 5).
- 21) The approach to Robust Decision Making (RDM) was to consider three main areas to inform selection of a preferred solution that would provide best value for customers. The three areas were as follows:
- Customer engagement: focused customer research to understand customer preferences for risk reduction and associated costs via the impact on their bills
 - Cost benefit assessment (CBA): a detailed CBA using specific and standard economic metrics
 - Multi-criteria Decision Analysis: a wider analysis looking at resilience in the round covering metrics beyond those provided by customers and included within the CBA. The five ‘Decision Metrics’ used in the multi-criteria analysis were:
 - Bill impact
 - Economic impact
 - Resilience risk
 - Environmental impact
 - Willingness to pay benefit.
- 22) Every five years, statutory Water Resources Management Plans (WRMPs) set out a water company’s intended approach to managing water resources for at least the next 25 years. Five solutions were chosen as part of the fine filtering process and were presented in United Utilities’ final WRMP, which was published in 2019.¹ These five solutions are described in Table 3.1. An additional four solutions, informed by customer preference and forming the nine referred to in Table 3.1, were tested in the CBA and multi-criteria analysis.

Table 3.1: Outcome of the Robust Decision Making Approach

Solution	Description	Evaluation/Reasoning
A	Volumetric (new and / or modified alternative supply) and targeted repairs of the Haslingden and Walmersley tunnel section (with a new and / or modified treatment installation).	Unrepaired sections of Haslingden and Walmersley and all upstream tunnel sections continue to deteriorate with associated risk to quality and supply. Insufficient risk reduction to water quality and risk of supply interruptions.
B	Replacement of the Haslingden and Walmersley tunnel and UV/Metals Treatment (new and / or modified treatment installations).	Unrepaired upstream sections continue to deteriorate with associated risks to supply. Insufficient risk reduction to water quality and risk of supply interruptions.
C	Turn Haweswater Aqueduct to raw water and provide three new and / or modified treatment installations at strategic supply points. Solution included new and / or modified alternative supplies and new and / or modified service reservoirs.	Solution included new and / or modified alternative supplies and new and / or modified service reservoirs – addresses quality issues, however, all sections continue to deteriorate with associated risk to supply.
D	Replacement of all single line (tunnel) Haweswater Aqueduct sections	Addresses the risk to water quality and of supply interruptions

¹ https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/wrmp-2019---2045/final-water-resources-management-plan-2019.pdf [Accessed: June 2021]

Solution	Description	Evaluation/Reasoning
E	Volumetric (new and / or modified alternative supplies and new and / or modified treatment installations) and replacement of all Haweswater Aqueduct tunnel sections.	Addresses the risk to water quality and of supply interruptions but significant increase in bill impact to achieve nominal increase in risk reduction compared to preferred Solution D.
F	Replacement of the Haslingden and Walmersley tunnel section, conversion to raw water aqueduct and provide three new and / or modified treatment installations at strategic supply points.	Addresses quality issues however, sections not replaced continue to deteriorate with associated risk to supply. Greater cost and less risk reduction than the preferred Solution D.
G	Haweswater Aqueduct volumetric (new and / or modified alternative supply) and lining of all tunnel sections.	Addresses quality and supply issues. Significant increase in bill impact and lesser risk reduction compared to preferred Solution D. Thickness of lining reduces diameter and capacity of Haweswater Aqueduct.
H	Haweswater Aqueduct volumetric (new and / or modified alternative supply), targeted repair of all single line aqueduct sections and conversion to raw water aqueduct.	Addresses quality issues however unrepaired tunnel sections continue to deteriorate with associated risk to supply which is largely mitigated by the new sources. Greater cost and less risk reduction than the preferred Solution D.
I	Over-pumping and lining of all Haweswater Aqueduct tunnel sections.	Addresses quality and supply issues. Significant increase in bill impact and lesser risk reduction compared to preferred Solution D. Thickness of lining reduces diameter and capacity of the Haweswater Aqueduct. Insufficient risk reduction as preferred by customers.

- 23) To support United Utilities' decision making, the solutions were subject to Environmental and Social costings, Strategic Environmental Assessment, Habitats Regulations Assessment and Water Framework Directive Assessment. The outcomes of these assessments, together with consultees' views on the Draft WRMP19, were used to inform the selection of the preferred solution.
- 24) Of the five solutions considered, only Solution A (and the associated Solution F) involved no development works in an area designated as AONB or National Park. Solution A, however, was assessed as being insufficient in reducing the risk to water quality and supply interruptions. Only Solutions D and E addressed both the water supply and water quality resilience concerns of the deteriorating condition of the tunnel sections of the Haweswater Aqueduct. The Programme of Works is common to both Options D and E and there is no other feasible way of securing a resilient water supply. Replacing all of the tunnel sections of the aqueduct requires connecting into the existing infrastructure at locations within the designated areas of the Yorkshire Dales National Park and Forest of Bowland AONB and these designated areas cannot be avoided.
- 25) Option D was ultimately selected as the preferred option as it delivers the long-term resilience benefits and delivers the best value to customers. It comprises a full replacement of each single line tunnel section of the existing aqueduct conveying drinking water from a water treatment works near Kendal (Cumbria) downstream to a water treatment works near Bury. The additional costs of Option E were considered not to be justified.
- 26) This was presented in the draft WRMP (February 2019), submitted to the Secretary of State for Environment, Food and Rural Affairs. After receiving approval from the Secretary of State on 23 July

2019, the final WRMP was published in August 2019, including the intention to proceed with the Proposed Programme of Works.

- 27) United Utilities' comprehensive option identification and appraisal process means that, from a very large pool of options, only the most appropriate has been selected in the final WRMP. This has been through Strategic Environmental Assessment and an extensive consultation process with regulators and customers, and has been included within a WRMP approved by the Secretary of State and OFWAT. It has shown that alternative options outside the Forest of Bowland AONB offered insufficient risk reduction to water quality and risk of supply interruptions. The only feasible means of securing a long term resilient water supply is therefore through replacement all of the tunnel sections of the existing Haweswater Aqueduct, which requires connection into the existing infrastructure at locations within the designated areas of the Yorkshire Dales National Park and Forest of Bowland AONB.

3.3 General Approach to Design

- 28) United Utilities started the initial design in 2018 and commenced ground investigation (GI) and environmental surveys in 2019. The various planning applications for the Programme of Works will be submitted in 2021. Pending the timing and outcome of the planning decision by Ribble Valley Borough Council, construction of the Proposed Marl Hill Section could start in 2024. Enabling works, such as off-site highway modifications and the Proposed Ribble Crossing, if taken forward as part of an approved scheme, may start sooner, in 2023.

- 29) There are various technical requirements that have influenced the design of the Proposed Programme of Works, including:

- A need for the replacement aqueduct section to be connected to retained sections of pipework
- To maintain a gravity flow along its entire length of the Proposed Marl Hill Section and, ultimately, along the full length of the Haweswater Aqueduct
- A need for the Proposed Programme of Works to be designed, built and operated safely
- A potential requirement for an aqueduct outage to enable connection of the newly-built tunnels into the existing infrastructure. This is potentially a considerable undertaking and one that could only be delivered over a short timescale, nominally four weeks during the month of October. There is an alternative to full outage; periods of reduced aqueduct flow when individual multi line siphon pipes can connect the new tunnel sections to the existing aqueduct

- 30) Extensive site investigations were undertaken along the route of the Proposed Programme of Works in 2019 and 2020 to characterise the underlying geology and ground conditions. Boreholes were drilled to considerable depths below ground level, reflecting the depth at which tunnel sections of the aqueduct would be constructed. To supplement intrusive investigations, geophysical surveys were carried out and geotechnical models were constructed to describe the ground conditions. Areas where there are believed to be high groundwater pressures were also identified. Ground investigations have continued into 2021 to inform the detailed design stage.

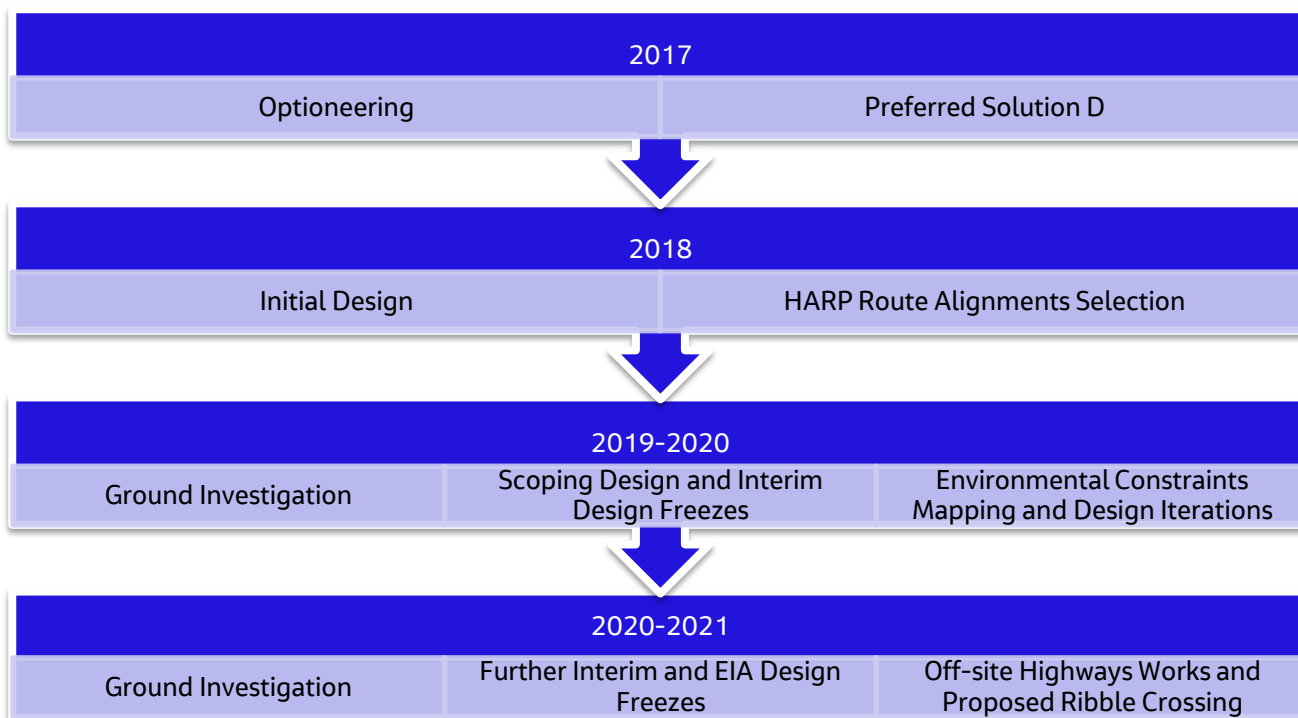
3.4 Design Evolution

- 31) The Proposed Marl Hill Section has been subject to an iterative design process, whereby engineering design has evolved in response to engineering/technical, stakeholder and EIA inputs. Alternatives have been considered through this process where feasible to reflect enhanced design and construction knowledge, respond to stakeholder feedback, or to avoid or reduce environmental impacts.

- 32) The design evolution of the Proposed Marl Hill Section and the way in which environmental considerations and comments received during consultation have influenced the decision-making are described in this section, with a timeline included as Illustration 3.4 below.

- 33) Route alignment was defined through an assessment process as described in Section 3.4.1, followed by refinement of the design as described in Section 3.4.2.

Illustration 3.4: Design Change Timeline



3.4.1 Route Alignment Refinement

34) Following the selection of the preferred solution (Solution D) for the Programme of Works, five route alignment options were developed for the Proposed Bowland Section (Table 3.2).

Table 3.2: Route alignment options for the Proposed Marl Hill Section

Route Option	Proposed Alignment
Option 1	Tunnel alignment to the east of the existing Haweswater Aqueduct, with a short section of open cut to connect onto the existing aqueduct. Tunnel alignment with a slight curve at the north end to maintain minimum cover as it crossed the valley but then straight for the remaining length.
Option 2	Tunnel alignment to the west of the existing Haweswater Aqueduct, with a section of open cut (approximately 400 m in length) to connect onto the existing aqueduct. Route allowed for a straight tunnel drive as the minimum acceptable cover could be maintained along the entire route.

35) Prior to the 2019 Scoping Report submission (refer to Chapter 4: EIA Methodology), an appraisal of the route alignment options was undertaken. This included a review of the information from an environmental, engineering, safety and cost perspective. The environmental considerations comprised:

- Biodiversity
- Land use allocations and committed developments
- Woodlands, arboriculture, landscape and visual amenity
- Community and human health
- Water environment and flood risk
- Land quality, soils, agriculture
- Noise and vibration

- Site access, materials and haulage routes.

3.4.2 Design Refinement

36) The engineering design process for this scale of project requires ongoing development and refinement to achieve the design finally submitted with the planning application. To assist the EIA process and provide a mechanism for environmental input into design, several 'design freeze' milestones were established. These milestones enabled the EIA team to review the proposals at key points in the process and provide feedback to the engineering design team to inform design refinement. The four key design points were:

- Design and construction outlines used in the 2019 Scoping Reports
- Interim Design Freeze in late 2019 / early 2020
- EIA Design Freeze 1
- EIA Design Freeze 2.

Scoping Design

37) As described in Chapter 4: EIA Methodology, EIA scoping was undertaken in two stages, with initial design work undertaken in 2019 leading to submission of the Scoping Report in October 2019.² Engineering design and access studies continued through 2020. While some of these changes were notable on other sections of the Programme of Works, the design changes were relatively minor on the Proposed Marl Hill Section. Nevertheless, in the interests of consistency with other proposed replacement sections, it was decided to submit an addendum to the Scoping Report in February 2021³, describing the changes and the implications for the EIA. The text in this section refers to the content of the original Scoping Report, with the changes reflected in the Scoping Addendum covered in Section 3.4.3: EIA Design Freeze 2 below.

38) The Proposed Marl Hill Section would be constructed in a tunnel below ground level over approximately 4.1 km with a small additional distance (approximately 200 m) of open-cut trenching at the surface to transition from the new tunnel to the retained multi-line sections. The total length of the proposed aqueduct section would be 4.3 km.

39) The development envelope⁴ for surface-based activities associated with the Proposed Marl Hill Section would encompass approximately 53 hectares (ha) of predominantly agricultural land. This includes the indicative development envelope for construction accesses, construction areas and proposed discharge pipe.

40) The design submitted at scoping followed Option 1 with two construction area locations:

- Construction Area A (Bonstone Compound)
- Construction Area B (Braddup Compound).

Interim Design Freeze

41) As the design of the development evolved with further detail from the ground investigation, field surveys and consultation responses, there was an interim design freeze involving further refinement of the development envelope boundaries. At the time of the interim design freeze, the preferred base option for United Utilities was Option 1. This option was consistent with the design submitted with the scoping reports, but included the following updates:

42) Construction Area A boundaries were revised with the construction access reducing in width where it joins onto the B6478/Slaidburn Road.

² Haweswater Aqueduct Resilience Programme Proposed Marl Hill Section - EIA Scoping Report (October 2019)

³ Haweswater Aqueduct Resilience Programme Proposed Marl Hill Section - EIA Scoping Report Addendum (February 2021)

⁴ The area of land encompassed within a planning application boundary

- 43) Construction Area B boundaries were revised including and an increase in the width of the construction access track where it joins onto the B6478/Slaidburn Road, removal of the construction compound/laydown area and increase in size of the construction compound/laydown area within the indicative development envelope.

EIA Design Freeze 1

- 44) For EIA Design Freeze 1, at the Bonstone Compound, refinements were made to the indicative development envelope.
- 45) At the Braddup Compound, the overflow was removed from the west of the compound, the corridor for the construction access track was reduced in width, and the indicative development envelope was reduced in the north and extended in the south.

EIA Design Freeze 2

- 46) At this stage there were no substantial changes to the design presented EIA Design Freeze 1.

3.5 Development Description

- 47) This section describes the Proposed Marl Hill Section, as assessed and reported in the technical Chapters 6-19 of this ES and presented of Figure 3.1:
- Section 3.5.1 provides an overview of the replacement aqueduct, described from north to south, while Section 3.5.2 summarises the activities associated with the three main phases of construction works: enabling, main construction works and commissioning
 - Associated above- and below- ground structures are described in Section 3.5.3 to 3.5.5
 - Sections 3.5.6 to 3.5.8 describe the establishment of the proposed construction compounds and proposed activities within them, tunnel construction and open-cut connections to the existing aqueduct
 - Section 3.5.9 outlines the off-site highways works, including a park and ride facility and construction vehicle holding area in the Clitheroe district, noting that the nature and scope of these works, and their likely significant effects, are reported in Volume 5 of the ES
 - Section 3.5.10 describes the Proposed Ribble Crossing, noting that this element of the Proposed Marl Hill Section is reported in detail in Volume 6 of the ES.
- 48) The Proposed Marl Hill Section is located entirely within Ribbles Valley Borough Council.

3.5.1 Route of the Proposed Marl Hill Section

- 49) The 4.3 km route of the Proposed Marl Hill Section passes below a mixture of moorland and agricultural areas. It runs from the pastoral landscape of the Hodder valley, continuing southwards below the moorland of Waddington Fell before then terminating in the agricultural, pastoral landscape to the north of Waddington.
- 50) The Proposed Marl Hill Section would be constructed by a Tunnel Boring Machine (TBM) below ground level with short open-cut surface trenching sections at each end making connections back to the existing aqueduct. The new tunnel would be bored in a northerly direction from a shaft at the south end of the tunnel. The Marl Hill tunnel would have a launch compound (referred to as the Braddup Compound) approximately 4.5 km to the northwest of Clitheroe with a second, reception shaft approximately 1.5 km south of Newton-in-Bowland (referred to as the Bonstone Compound). Further details on the tunnel boring and associated works are provided within this chapter.
- 51) Once the new section of aqueduct has been constructed, the existing tunnel section would be decommissioned, with the new asset being tested and commissioned before the existing section of aqueduct is decommissioned.

3.5.2 Construction Activities

52) Table 3.3 lists the construction-related activities which are expected during each of the three phases of the proposed construction works.

Table 3.3: Split of construction activities per phase

Works Phase	Activities
Enabling Works	<ul style="list-style-type: none"> ▪ Off-site highway works and satellite compounds ▪ Establishing construction access ▪ Watercourse diversions, as required⁵ ▪ Vegetation clearance ▪ Soil stripping and storage ▪ Public Rights of Way diversions ▪ Earthworks, including the creation of working areas for static plant and machinery ▪ Establishing plant, machinery and other facilities at the within the working areas.
Main Construction Works	<ul style="list-style-type: none"> ▪ Shaft construction ▪ Management of material/ waste arisings ▪ Tunnel construction ▪ Open-cut pipework construction
Commissioning Works	<ul style="list-style-type: none"> ▪ 'Turning' of flows from the old to the new aqueduct ▪ Land reinstatement.

3.5.3 Overflows

53) The Ribblesdale north well structure facilitates the transition from single line to multiline flow. To protect the multiline section from excess flows the north well includes an overflow weir. The overflow weir allows water flows to pass over it and an overflow pipeline conveys the excess flows to Bashall Brook. A new north well structure would be constructed and include an overflow weir for the same purpose. The outlet from the new overflow weir would be connected to the existing overflow pipeline.

3.5.4 Valve House Buildings

54) At each end of the Proposed Marl Hill Section, there would be a transition from the existing United Utilities infrastructure via buried pipework and underground chambers to the proposed tunnel. These transitions would take place in valve house buildings, single storey structures approximately 11 m wide and 12 m long. Valve houses on the Proposed Marl Hill Section would be required at the Bonstone and Braddup compounds. New valve house buildings would be similar in size and appearance to the existing structures.

55) Existing valve houses would be retained at each location. An existing valve house building in a rural location is shown in Illustration 3.5 below.

⁵ The need for temporary drainage and drainage strategies has been explored for the main compounds. Temporary watercourse diversions or crossings, if unavoidably necessary, would be developed in consultation with the regulatory authorities. Further details are provided in Chapter 7: Water Environment, and outline Drainage Strategies are presented in support of the Planning, Design and Access Statements for both planning applications.

In Illustration 3.5: Typical valve house building – rural setting



3.5.5 Air Valves on the Proposed Aqueduct

- 56) Air valves would be local to the proposed valve house buildings to release any trapped air in the below ground connection pipework. Access to these would be restricted to routine maintenance with access by foot or light vehicles. Air valves would be installed in buried chambers with localised ground raising and grass banking around an access cover.

3.5.6 Construction Compounds

- 57) Two main construction compounds would be required for the Proposed Marl Hill Section, and the following text provides an overview of these compounds, with more detailed supporting information provided in Appendix 3.1. Satellite compounds are addressed in Volume 5 of the ES, being reported as part of the off-site highways works.
- 58) Main construction compounds would be located at the start and end of the tunnelled sections, and as such would be the main hubs of construction activity. The establishment of compounds would typically require:
- Creation of site access
 - Vegetation clearance, including felling of trees and hedge removal outside ecologically sensitive times of the year
 - Topsoil stripping, with storage for reinstatement
 - Earthworks to create level areas in the sites
 - Creation of platforms for working machinery where necessary
 - Site drainage installed where required
 - Site fencing, hoarding and lighting
 - Provision of offices, workshops and welfare cabins
 - Delivery and storage areas for materials.
- 59) The specific activities undertaken at both main construction compounds would vary according to construction techniques and local requirements. Table 3.4 provides a summary of the key activities and features, with further detail provided in Appendix 3.1.

Table 3.4: Key Activities / Works at Main Construction Compounds

Key Activities/Works		Bonstone	Braddup
Shaft construction and tunnelling activities	TBM reception shaft	One	n/a
	TBM launch portal	n/a	One
	Rock blasting potentially required?	No	No
Reception and Launch Structures	Approximate measurements	Shaft 15 m diameter by approximately 10-15 m deep.	Shaft 15 m diameter by approximately 10-15 m deep.
Material / waste arisings	Surplus material arisings	Approximately 4,000 m ³ from shaft construction. Approximately 4,500m ³ from open cut pipework connections.	Approximately 4,000 m ³ from shaft construction. Approximately 11,000m ³ from open cut pipework connections. Approximately 80,000 m ³ tunnel arisings.
	Material destination	Waddington Fell Quarry (subject to separate planning permission).	Waddington Fell Quarry (subject to separate planning permission).
	Slurry treatment	No	No
	Grout batching / mixing	Yes	Yes
Water	Removal of suspended solids	Excess water from tunnelling activities would be pumped to temporary attenuation / storage lagoons. Here, suspended solids would be removed prior to water being discharged to local receiving watercourses.	Excess water from shaft construction activities would be pumped to temporary attenuation / storage lagoons. Here, suspended solids would be removed prior to water being discharged to local receiving watercourses.
	Site drainage	Yes	Yes
	Watercourse modification / 'in channel' works	No culverting works proposed.	Extension of the existing culverts of up to six watercourses.
Public & Private Access	Maintained	One (PRoW footpath 113-29-FP 44)	
	Proposed temporary closure/ diversion	Two (PRoW footpath 3-29-FP 42 and 3-29-FP 43)	Two (PRoW footpath 3-43-FP 8 and 3-5-BW 1)
Access to compound ⁶		From the M6 Junction 31 <i>via</i> the A59. Vehicles under 3.5 m in height would access <i>via</i> Pimlico Link Road and Chatburn Road/ Clitheroe Road, through	From the M6 Junction 31 <i>via</i> the A59. Vehicles under 3.5 m in height would access <i>via</i> Pimlico Link Road and Chatburn Road/ Clitheroe Road, through Chatburn and along West Bradford Road. Vehicles over 3.5 m in height would use Pimlico Link Road and Chatburn Road /

⁶ An alternative transport route to the Newton-in-Bowland compound would be provided by the Proposed Ribble Crossing. This route is considered in Volume 6 of the ES.

Key Activities/Works	Bonstone	Braddup
	<p>Chatburn and along West Bradford Road.</p> <p>Vehicles over 3.5 m in height would use Pimlico Link Road and Chatburn Road / Clitheroe Road through Chatburn, Grindleton and along West Bradford Road.</p> <p>This proposal represents Haulage Route Option 1. Haulage Route Option 2 (the Proposed Ribble Crossing) is assessed in Volume 6 of the ES.</p>	<p>Clitheroe Road through Chatburn, Grindleton and along West Bradford Road.</p> <p>This proposal represents Haulage Route Option 1. Haulage Route Option 2 (the Proposed Ribble Crossing) is assessed in Volume 6 of the ES.</p>
Power supply	Diesel generating sets.	Diesel generating sets.
Utilities	<p>Water for the compound would be drawn from the existing aqueduct. Wastewater from welfare units would be removed by tanker off site for treatment elsewhere. A diversion of existing overhead electric cables would be required to facilitate the shaft construction.</p>	<p>Water for the compound would be drawn from the existing aqueduct. Wastewater from welfare units would be removed by tanker off site for treatment elsewhere. A diversion of existing overhead electric cables would be required to facilitate the shaft construction.</p>
Artificial Lighting	<p>Lighting during evening and night-time hours local to reception shaft required to facilitate 24 hour working.</p> <p>Lighting in wider compound area to be limited to security lighting and sufficient to enable general safe working on an 'as required' basis, rather than higher level construction lighting.</p>	<p>Lighting during evening and night-time hours local to launch shaft required to facilitate 24 hour working.</p> <p>Lighting in wider compound area to be limited to security lighting and sufficient to enable general safe working on an 'as required' basis, rather than higher level construction lighting.</p>
Connection to existing aqueduct and permanent works.	<p>Open-cut connection from new tunnel to existing Haweswater Aqueduct.</p> <p>A new permanent valve house building served by a permanent access track.</p>	<p>Open-cut connection from new tunnel to existing Haweswater Aqueduct.</p> <p>A new permanent valve house building served by a permanent access track.</p>

3.5.7 Tunnel Construction

- 60) The Proposed Marl Hill Section is anticipated to be constructed using a Single Shield TBM. This type of TBM has been selected as the ground mainly comprises only two rock types. The replacement tunnel between the Bonstone and Braddup Compounds would be approximately 3 m internal diameter and 3.6 m external diameter.
- 61) The Marl Hill tunnel would be driven from the Braddup compound with above-ground temporary works to support the operation and maintenance of the TBM. The above-ground activities may require 24 hours per day working. The temporary construction works areas would provide an area for plant, machinery, equipment, welfare, offices and vehicle movements. Surplus excavated material from the tunnelling works would be brought to the surface and dewatered prior to being transported to the nearby

Waddington Fell Quarry for final placement. Tunnel segments and consumables would enter the tunnel at the portal. The different tunnel components including connections to the existing aqueduct are summarised in Table 3.5 below.

Table 3.5: Tunnel Components and Connections

Tunnel Section	Description	Construction Technique	Approx. Distance	Approx. Depth (below ground level)
Bonstone Connection	Connection from existing Haweswater Aqueduct to new tunnel shaft	Open-cut	200 m	n/a
Marl Hill tunnel	Tunnel from Bonstone compound to Braddup compound	Tunnel boring machine	4.1 km	120m
Braddup connection	Connection from the new Marl Hill tunnel to the existing aqueduct	Open-cut	400 m	n/a

3.5.8 Open-Cut Connections

- 62) Open-cut trenching would be required only when connecting the new section of tunnel into the existing Haweswater Aqueduct. Topsoil and subsoil would be carefully stripped from the land (if not already removed during preparation of the main compound) and stored appropriately within the planning application boundary for later reinstatement of the connection easement.
- 63) The construction area would be fenced off and used for storage of excavated material and pipes, with temporary access being constructed to move equipment, vehicles, personnel and materials along the length of the pipeline. At both main compounds trenches would be excavated within the planning application boundary and connecting pipes laid in them prior to backfilling with imported and / or appropriate excavated material.
- 64) Illustration 3.6 below shows an aerial photograph of an open-cut section of the Haweswater Aqueduct under construction in Cumbria in 2019.

Illustration 3.6: Example of an open-cut construction area



- 65) At the Bonstone site, the new connection could comprise four pipes (each approximately 1.2 m internal diameter) laid in a single trench connecting the existing multiline pipeline to a new valve house. While other connection options are available this construction approach has been adopted as the basis of assessment for the EIA. In the valve house water flow would transition into a single pipeline (circa 3 m internal diameter) that would connect to the new tunnel.
- 66) At the Braddup site the new aqueduct would consist of a single pipeline (circa 3 m internal diameter) that would convey flow to a new Braddup valve house. The new aqueduct would be laid in a trench. At the new valve house flow would transition into four pipes (each circa 1.2 m internal diameter) laid in single trench connecting the new well structure to the existing multiline pipeline.

3.5.9 Off-site Highways Works

- 67) In consultation with the highways authority, Lancashire County Council, the need for selected off-site highways works has been included as part of the design of the Proposed Marl Hill Section to enable the safe movement of construction vehicles and other road users on the public highway over the lifetime of the project. The Proposed Marl Hill Section Volume 5 report makes reference to a total of 24 separate highways works⁷ associated with the Proposed Marl Hill Section. This total comprises 21 road widening sections, one passing place and two junction modifications. In addition, there would be one parking restriction in Chatburn village.
- 68) The total number of off-site highways works that could be required is, however, dependent on the outcome of the decision-making around construction traffic routes in the Clitheroe area. In the event that the Proposed Ribble Crossing is selected as the preferred construction traffic route (refer to Appendix 3.1 for construction traffic route options), fewer off-site highways works would be required (one passing place and sixteen sections of road widening). A final decision on the construction traffic route(s) in the Clitheroe area would be taken during the planning determination phase.
- 69) Within the scope of the off-site highways works, two satellite compounds are proposed. One is a proposed construction vehicle holding area within the curtilage of the Ribblesdale Cement Works. It is

⁷ There are 30 highways proposals in Ribble Valley Borough Council's administrative area, of which 26 works are road widening, two are passing places and two are junction modifications. The 30 Ribble Valley Borough Council highways works and one traffic restriction serve both the Bowland and Marl Hill compounds, except for five road widening sections and one passing place which would be constructed for construction vehicles accessing the Newton-in-Bowland compound only.

proposed that here some construction vehicles would be held for short periods of time before being released back onto the construction traffic route(s) towards the Bonstone and Braddup compounds. This could be in response to alleviating traffic flows on the local road network during busier times of the day, or delivering plant and materials on a 'just in time' basis. The second satellite compound would be a park and ride facility making use of the existing Ribblesdale Cement Works staff car park on the west side of West Bradford Road. The purpose of the Park and Ride Facility would be to reduce flows of private cars and light good vehicles further north on the local road network by offering a shuttle bus service to and from the Bonstone and Braddup compounds.

- 70) Further engineering details on off-site highways works are presented in Volume 2 Appendix 3.1, while an environmental assessment of the works is presented in Volume 5 of this ES. To ensure comprehensive and robust reporting in the ES, the cumulative effects of the off-site highways works (Volume 5), the Proposed Ribble Crossing (Volume 6) and the Proposed Bowland Section (Volume 2) are considered in Volume 2 Chapter 19. Similarly, a summary of the likely significant effects associated with the Proposed Bowland Section, the Proposed Ribble Crossing and the off-site highways works is presented in Volume 2 Chapter 21.

3.5.10 Proposed Ribble Crossing

- 71) The Proposed Ribble Crossing provides a means of allowing construction traffic to access the Slaidburn Road towards the Bonstone and Braddup compounds without passing through most of the communities in the local area that would otherwise be affected by traffic using the public highway.
- 72) The proposal is for a dedicated haul route crossing open countryside to the north of Clitheroe, leaving the West Bradford Road near the Ribblesdale Cement Works and crossing the River Ribble *via* a temporary bridge in proximity to the existing West Bradford Bridge. The route would head west and then north to re-join West Bradford Road between Waddington and Waddington and West Bradford Primary School.
- 73) The Proposed Ribble Crossing would be a two lane carriageway approximately 7.7 m wide and approximately 1.45 km in length. The road and bridge would both be temporary structures in place for the duration of the construction of the Proposed Marl Hill Section. The road would be fully removed and the land reinstated once the tunnel construction works have been completed. During the construction works the road would be reserved for the use of all construction traffic, and would be suitable for heavy goods vehicle use, including exceptional loads. No vehicles other than those associated with construction of the Proposed Marl Hill Section (and the Newton-in-Bowland compound of the Proposed Bowland Section) would be permitted to use the Proposed Ribble Crossing.
- 74) Further engineering details on the Proposed Ribble Crossing can be found in Volume 6, while an environmental assessment is presented in the same volume. To ensure comprehensive and robust reporting in the ES, the cumulative effects of the Proposed Ribble Crossing (Volume 6), the off-site highways works (Volume 5), and the Proposed Bowland Section (Volume 2) are considered in Volume 2 Chapter 19. Similarly, a summary of the likely significant effects associated with the Proposed Bowland Section, the Proposed Ribble Crossing and the off-site highways works is presented in Volume 2 Chapter 21.

3.6 Construction Code of Practice

- 75) The following section outlines the structure and content of an outline Construction Code of Practice (CCoP) which has been developed by United Utilities. The outline CCoP describes the nature and scope of good practice techniques and management approaches that would be adopted during construction of the Proposed Marl Hill Section.
- 76) The information contained in the CCoP has supported the EIA process and the assessment of environmental effects, but it also provides a framework for the planning authorities to develop planning conditions based on the mitigation measures proposed in the ES. It is also intended that the CCoP would be used by United Utilities in directing its contractors towards sustainable construction approaches, and providing a basis for the development of further, site-specific mitigation proposals.

- 77) The outline CCoP is presented in Appendix 3.2 of the ES and is structured as follows:
- Introduction (Section 1) – Purpose of the document and structure
 - Environmental Management (Section 2) - Outlines how environmental protection and the control of pollution would be managed from EIA through to construction and implementation
 - Communications and community / stakeholder liaison (Section 3) – Outlines the communications strategy during construction with the affected communities and relevant stakeholders
 - General Site Operations (Section 4) – Outlines general management standards/procedures to be applied across all construction sites
 - General Requirements by environmental topic (Section 5) – Sets out the measures that would be implemented to limit the disturbance from construction activities and reduce environmental impacts, as far as reasonably practicable. For ease of reference and consistency this follows the chapter structure outlined within the supporting ESs.
- 78) The CCoP is supplemented by site-specific environmental mitigation measures as follows:
- Schedule of Mitigation (as per Appendix 20.1)
 - Environmental Masterplan (illustrating the locational requirements of the mitigation as per Figure 20.1).
- 79) The Schedule of Mitigation comprises a compilation of the measures proposed in each of the topic chapters of the ES. Some of the mitigation measures are site-specific and relate to actions proposed at particular locations in connection with discrete environmental resources or construction or operation activities. Other mitigation measures are more generic, for example hedgerow reinstatement or watercourse protection.

3.7 Construction and Commissioning Programme

- 80) An indicative construction programme for the Proposed Programme of Works is shown in Illustration 3.7. This presents a high-level overview of when proposed construction works might be undertaken, subject to planning permission.

Illustration 3.7: Indicative construction programme

Build Phase	2023				2024				2025				2026				2027				2028			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Docker																								
Swarther																								
Bowland																								
Marl Hill																								
Haslingden & Walmersley																								

- 81) The construction programme for the Proposed Programme of Works would be phased so that some of the proposed new sections of aqueduct could start later and / or be completed sooner than others. Illustration 3.7 indicates that construction of the Proposed Marl Hill Section could commence in 2024, ultimately reaching completion and commissioning in 2026. Enabling works, such as off-site highway modifications and the Proposed Ribble Crossing, if taken forward as part of an approved scheme, may start sooner, in 2023. The indicative programme does not include reinstatement works, which may continue for several years beyond the completion of construction. The dates and durations are indicative and would be further developed once a contractor is appointed.
- 82) Connection and commissioning works would be undertaken following completion of the main construction works, although the precise timing of when these works would be undertaken would depend on the commissioning approach adopted by the Contractor. Section 3.8 describes the two connection and commissioning options available.

- 83) Land reinstatement would be carried out progressively, starting as early as practicable at each of the construction compounds. This may involve land restoration activities being commenced in appropriate locations at the main compounds whilst construction and commissioning activities are still underway. Land reinstatement works could continue for several years beyond the completion of construction works.
- 84) Decommissioning of the existing section of Haweswater Aqueduct would commence as early as feasible following completion of the connection and commissioning works. Decommissioning could extend beyond the end of 2028 for those HARP sections where the connection and commissioning works are undertaken towards the end of the overall programme, such as on the Proposed Marl Hill Section.

3.7.1 Hours of Working

- 85) Tunnelling and above-ground activities at the launch site would require 24 hours a day, seven days a week (24/7) operations. This would include soil and rock arisings being transported to the surface, handling of materials and water works operation. Other round-the-clock works would include:
- Above ground activities to support tunnel works at construction compounds
 - 24/7 above ground support to tunnelling including maintenance, security, ventilation, refuelling
 - Vehicle movements associated with tunnel shift changes based on a 12-hour shift pattern.
- 86) Commuter movements, would take place between 06:45 to 08:00 and 18:45 to 20:00 (two shifts), HGVs and abnormal load movements would be between 09:00 to 14:45 and 16:00 to 18:45. Construction traffic would be restricted between 08:00 to 09:00 and 14:45 to 16:00 to avoid possible conflicts with school drop-off and collection periods. These times would be reviewed and agreed with the relevant highways authority nearer to the start of construction activities to consider the most up-to-date school schedules.
- 87) It is anticipated that above ground activities at the launch sites and all other surface locations would adopt the following working hours:
- Monday to Friday 07:00 to 19:00
 - Saturday 07:00 to 13:00
 - Sunday by exception, no deliveries
 - Bank Holidays by exception, no deliveries
 - 24/7 during four week connection outages including two, four week outages with 24/7 working at each point of connection to the existing Haweswater Aqueduct between April and October
 - Exceptions to the above by agreement with the planning authority e.g. full day Saturday, Sundays and Bank Holidays by exception.

3.8 Commissioning

3.8.1 Connection of New Section to Existing Aqueduct

- 88) There are two options for connecting the new infrastructure to the existing Haweswater Aqueduct, depending on the construction technique to be adopted by the contractor. The two options are either a '*non-outage approach*' using a multi-line to multi-line connection, or a '*full outage approach*' using a single-line to single-line connection. These are shown in illustrations 3.8 and 3.9.
- 89) At the current stage of design development, it is not known which of these connection and commissioning options would be adopted by the contractor for the Proposed Marl Hill Section, and this would only be confirmed during the detailed design stage. However, for the purposes of the planning application and EIA, a multi-line to multi-line connection has been assumed on the basis that it represents the reasonable worst-case scenario with regard to area of land required and depth of excavation.

- 90) In relation to the commissioning of the new infrastructure following connection, it has been concluded that there are no material differences between the non-outage and full outage approaches from an environmental perspective – this is because the scale, intensity and duration of works, and discharges to the water environment would be similar. The only notable difference between the two commissioning options is the timing of when the connection and commissioning works can take place:
- For the non-outage approach connection and commissioning could take place during June / July or September / October each year (eight-week periods)
 - Alternatively, for the full outage approach connection and commissioning could take place only during September / October every two years (during a four-week period) due to operational constraints on other parts of United Utilities' regional supply network.
- 91) This means that the non-outage approach allows four opportunities every two years for connection and commissioning, whereas the full outage approach only allows a single connection and commissioning opportunity every two years. The non-outage connection and commissioning approach therefore has programme benefits over the full outage connection and commissioning approach due to the increased flexibility of when the works can take place, potentially allowing earlier completion.
- 92) As it is not possible at this stage of design development to confirm which of the two approaches might be adopted; both are described below as well as being incorporated into the indicative construction programme included in Section 3.7.

3.8.2 Commissioning of the Tunnels and Connections

- 93) Whichever of the two connection approaches is adopted, the same three-phase approach to cleaning the new tunnel and connections would be adopted prior to the commencement of connection, as summarised below:
- Strip out of tunnelling infrastructure to include all rails, communication lines, debris and surface contamination on retreat from the tunnel
 - Vehicle mounted deep clean of the internal surface of the pipe
 - Final disinfection and sampling.
- 94) Once commissioned, cleaned and tested to meet the required Water Quality standards, the new tunnel and connecting pipelines would be connected to the existing aqueduct. The connection work would commence and be completed within 14 days of final disinfection to comply with Mains Hygiene principles.

Illustration 3.8: Non-outage connection

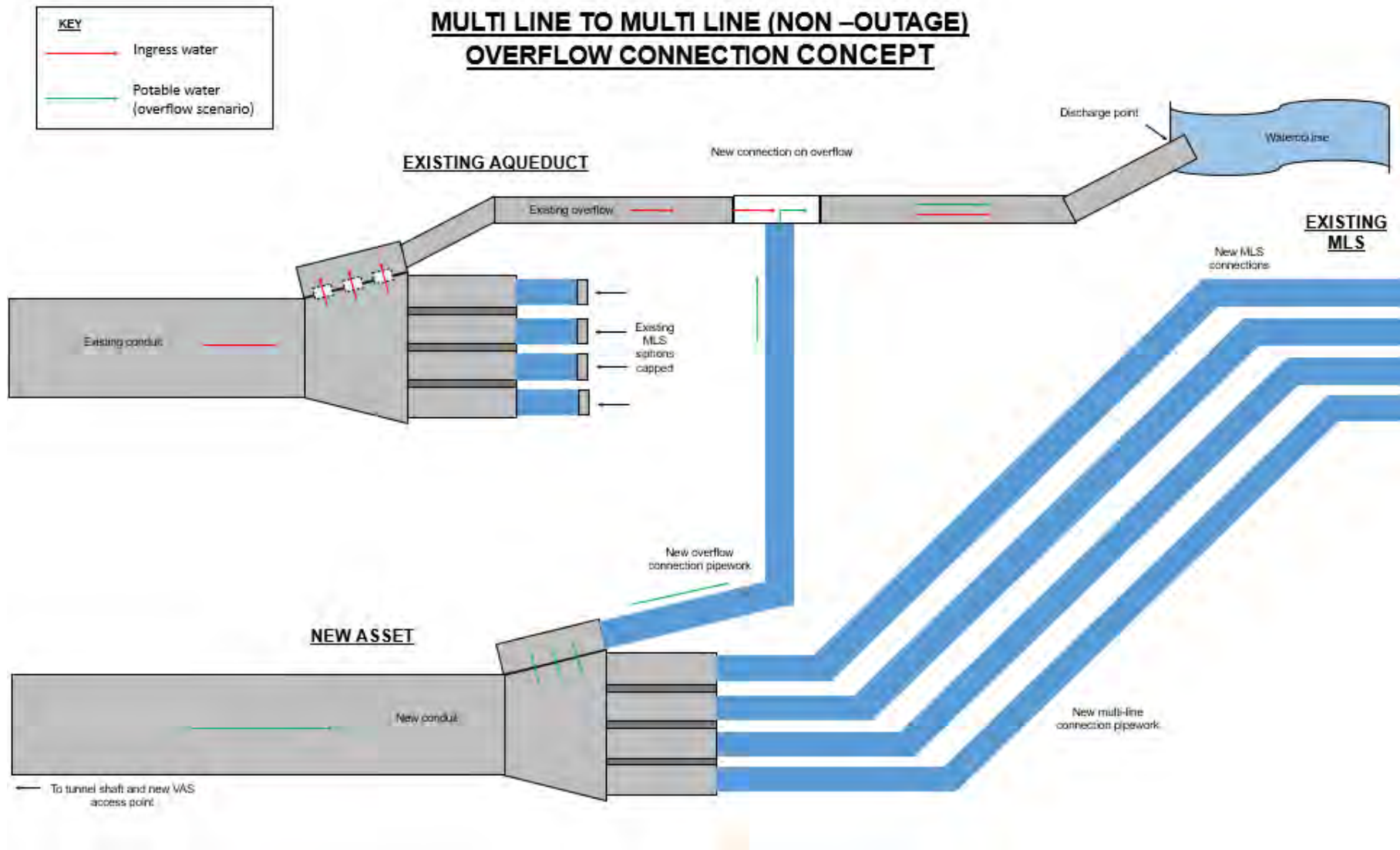
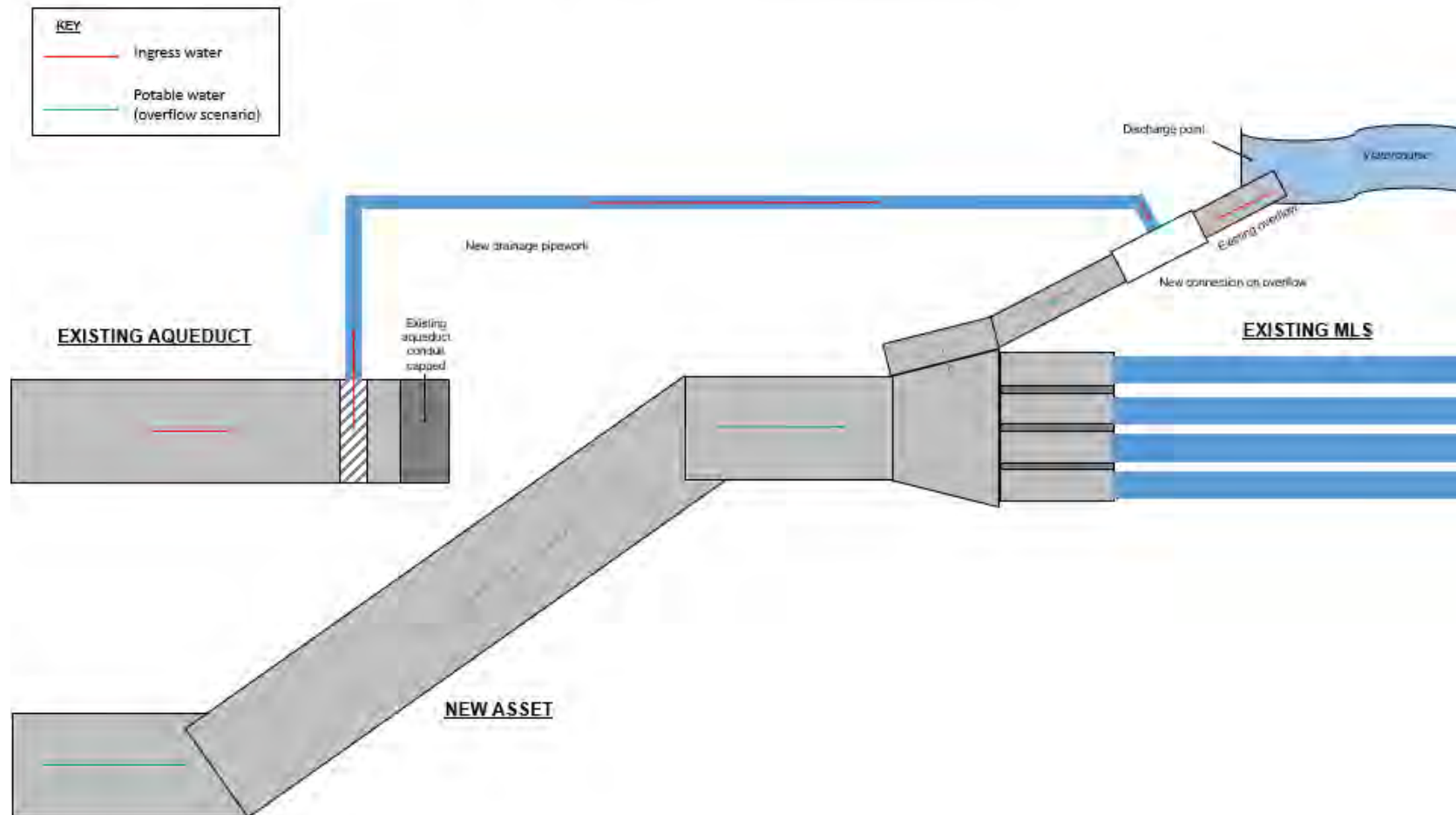


Illustration 3.9: Full outage connection

**CONDUIT TO CONDUIT (OUTAGE)
OVERFLOW CONNECTION CONCEPT**



3.8.3 Land Reinstatement

- 95) Land used for temporary compounds and open-cut pipeline construction would be reinstated after completion of construction works, with temporary access roads being removed. Where launch and reception facilities (e.g. shafts) are present, these would be covered and reinstated at ground level.
- 96) Access tracks would be reinstated to the original land on completion of the commissioning works with agreement of the landowner.
- 97) Each of the proposed compounds are located on third party land which may be acquired or entered under the land entry powers afforded by the Water Industry Act.

3.8.4 Operational Access

- 98) Operational access along the line of the new aqueduct would be similar to the existing asset. Stiles or access gates would be provided at field boundaries to enable a walk over survey along the route of the aqueduct to take place.
- 99) Operational activities in relation to the valve house buildings and access buildings would generally be restricted to light vehicle access to service valves and to take water quality samples. The operational phase of the new aqueduct would give rise to very low volumes of traffic. Further details surrounding approaches to the transport planning study are presented in Chapter 16: Transport Planning.

3.8.5 Decommissioning of the Existing Asset

- 100) Following completion and commissioning of the new aqueduct, sections of the existing aqueduct would be taken out of service. A future maintenance and usage strategy for the redundant sections of aqueduct is being prepared. This strategy would include protection of existing structures above the redundant sections and dealing with any flows arising from the decommissioned aqueduct.