Haweswater Aqueduct Resilience Programme - Proposed Marl Hill Section

Environmental Statement

Volume 4

Appendix 7.2: GWDTE Assessment

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1. Overview

1) This appendix follows the UK Technical Advisory Group (UKTAG) guidance[1] to identify, prioritise and assess the impacts of the Proposed Marl Hill Section on Groundwater Dependent Terrestrial Ecosystems (GWDTEs).

2) This appendix only discusses potential impacts on groundwater flows and quality that support ecosystems. Other impacts on vegetation and habitats are discussed in Chapter 9A: Terrestrial Ecology.

3) In some instances, the ecological sites listed in Chapter 9A: Terrestrial Ecology have been grouped together within this assessment to form one larger GWDTE site. In most cases, this is due to the habitats being of similar nature, geographically connected, and/or hydrologically linked. Where this is the case, this is clearly stated in the relevant habitats and vegetation sections for each site.

4) The overarching GWDTE assessment area is defined as a 200 m buffer (as shown in Annexe A: Site-specific Figures for CSMs in this appendix) in all directions around the surface works of the Proposed Marl Hill Section (see Chapter 7: Water Environment). Within this assessment area, the zone of influence of dewatering for the nearest shaft has been used as a buffer around all surface works items as a way of prioritising those sites which could experience significant direct or indirect effects as a result of the Proposed Marl Hill Section, and which would require the creation of individual Conceptual Site Models (CSMs). This is referred to as the refined GWDTE assessment area.

5) As shown on Figure 7.7, there are seven sites which lie within the refined GWDTE assessment area for the Proposed Marl Hill Section, for which individual CSMs have been developed. Potential additional GWDTEs that lie outside of the priority area for assessment and which do not have individual CSMs are listed in Section 3.8.

6) Further details on the approach adopted to identify GWDTEs, the information and data available for their assessment, their prioritisation and value attribution, and the limitations associated with the assessment are provided in Chapter 7: Water Environment, to which this report forms an appendix.

[1] UKTAG (2005) Draft Protocol for Determining "Significant Damage" to a "Groundwater Dependant Terrestrial System".

2. Design Evolution

7) Section 3 describes the potential impacts that could occur because of the Proposed Marl Hill Section, including during the enabling, construction, commissioning and operation phases.

8) However, reducing potential impacts on ecological receptors and GWDTEs has already been encompassed into the various stages of design development (where possible).

9) It is therefore important to capture and record the design considerations made to date, which are of relevance to GWDTEs. In particular, existing roads to provide partial and complete access to the Bonstone Compound and Braddup Compound, respectively, were used. This has removed the need to construct two new access roads, in alternative locations.

10) The design at the Bonstone Compound, Braddup Compound and associated shafts is however constrained by a number of factors:

- The access road proposed, to avoid impacts on residents / landowners and to reduce impacts on sensitive trees and hedgerows (Bonstone Compound only)
- The steep topography which limits the compound location, footprint and access
- The level of the existing Haweswater Aqueduct
- The pipe connections constrained by hydraulics and connecting with the existing aqueduct
- The need to keep the proposed shaft some distance away from the existing aqueduct
- The complex connections required
- The exact connection point to the existing Haweswater Aqueduct, which is hard to determine at this stage and requires a degree of flexibility.

11) As a result of these constraints, no further design options could be identified to minimise the impacts to GWDTEs.

12) However, Chapter 7: Water Environment records additional mitigation measures proposed to further reduce the potential impacts predicted to the identified GWDTEs.

3. Site Specific GWDTE Assessments

3.1 New Laithe

3.1.1 Site Setting, Topography and Hydrological Catchment

13) The site lies in an area of agricultural land immediately east of Brown Banks Wood and 240 m west of the B6478 (Hallgate Hill). An access track to New Laithe forms the southern site boundary.

14) An unnamed Ordinary Watercourse flows east to west along the northern boundary of the site. During a hydrogeological walkover survey undertaken in April 2020, a north-south trending valley, approximately 200 m long, was found in the west of the site. The valley was dry along most of its length, but the northernmost 20 m contained a small amount of flowing water that discharged to the unnamed Ordinary Watercourse.

15) Several other dry, north-south trending drainage ditches, and shallow valley features were also noted across the site. Immediately east of the site, is an unnamed Ordinary Watercourse that flows north in a deeply incised river valley and is also a tributary of the watercourse that flows along the northern site boundary.

16) The site generally slopes towards the northwest, with the elevation of the site ranging from 210 metres above Ordnance Datum (mAOD) in the southeast, to 154 mAOD in the north-west. The hydrological catchment for the site extends approximately 1.1 km east to Standridge Hill, where the ground reaches an elevation of 345 mAOD.

3.1.2 Soils and Geology

17) Soils at the site are described as slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage[2]. The exception is the southeast corner of the site, where slowly permeable, wet very acid upland soils, with a peaty surface and impeded drainage are described.

18) Geological mapping indicates that the site is underlain by superficial deposits of glacial till, comprising clay, sand and gravel[3]. Bedrock at the site is the Hodder Mudstone Formation, comprising mudstone with subordinate limestone, siltstone and sandstone. A northwest-southeast trending fault cuts across the bedrock in the west of the site 3.

19) During a hydrogeological walkover survey undertaken in April 2020, outcrops of bedrock were observed along the valley sides of the unnamed Ordinary Watercourse in the northeast corner of the site. This is broadly consistent with British Geological Survey (BGS) data, which shows a small area northeast of the site where superficial deposits are absent.

20) There are no available historical borehole records close to the site to verify published geological mapping [3]. At the time of writing, there were also no GI data available for the Marl Hill Section.

3.1.3 Groundwater

21) There are no nearby Environment Agency (EA) or BGS groundwater monitoring locations. There are also no available historical borehole records or GI data close to the site to provide an indication of groundwater seeps, strikes, or rest water levels.

22) A hydrogeological walkover survey was carried out for the site in April 2020, which generally identified boggy ground conditions in the north and northwest of the site, i.e. in the topographically lowest areas. The small watercourse in the west of the site was found to start flowing 20 m upgradient of the site's northern boundary and the larger unnamed Ordinary Watercourse, within a predominantly dry valley. It is unclear whether the tributary issued from a spring or a buried land drainage pipe outfall.

[2] http://www.landis.org.uk/soilscapes/
Cranfield Soil and Agrifood Institute (2020) *Soilscapes viewer*. [Online] Available from: URL. [Accessed: July 2020].
[3] http://mapapps2.bgs.ac.uk/geoindex/home.html
British Geological Survey (2020a) *Onshore GeoIndex*. [Online] Available from: URL. [Accessed: July 2020].

23) The observations made during the walkover survey generally correlate well with BGS data, which shows that there is potential for groundwater flooding to occur to property or infrastructure situated below ground level in the north of the site[4]. Adjacent to the Ordinary Watercourse and its tributary in the far north, northeast and northwest of the site, there is potential for groundwater flooding to occur at surface level. There is limited potential for groundwater flooding to occur on higher ground throughout the remainder of the site.

3.1.4 Habitats and Vegetation

24) A Phase 1 Habitat Survey was carried out for the site by Bowland Ecology Ltd. in August 2019[5]. This was supplemented with a high-level National Vegetation Classification (NVC) survey in July 2020[6], in conjunction with the Scotland & Northern Ireland Forum for Environmental Research (SNIFFER) WFD95 Wetland Typology methodology[7]. A detailed description of the data collected, and methodologies used for the terrestrial ecology surveys can be found in Chapter 9A: Terrestrial Ecology.

25) As shown in Annexe 1, three north-south trending strips of marsh / marshy grassland habitat were identified at New Laithe, which merge together in the north of the site where the topography starts to flatten.

26) In the west, the Ecology Survey Data Report recorded a possible affinity with M23 *Juncus effuses / acutiflorus-Galium palustre* rush-pasture. According to the UKTAG guidance, this plant community has a high to moderate groundwater dependency[8]. However, the marsh / marshy grassland habitat present in the dry valley was considered too small and degraded by cattle poaching / grazing to accurately attribute a high-level NVC community in this area.

27) M25 *Molinia caerulea-Potentilla erecta* mire vegetation was found to dominate in the east of the site, with a moderate to low groundwater dependency. However, the Ecology Survey Data Report states that it may have been too early in the season to accurately identify an NVC affinity in this area. This is similar to the far north of the site, where affinities with three NVC communities were identified at TR4.GW6 (all mire vegetation types with a moderate to low groundwater dependency). This was also attributed to the surveys being undertaken too early in the season to accurately classify a high-level NVC type.

28) The remainder of the site was found to comprise areas of semi-improved neutral grassland habitat.

29) There are no ecological designations present within the site. Table 1 summarises the habitat, vegetation, and wetland typology information recorded at the site, as well as the groundwater dependencies assigned by the UKTAG guidance 8 (where possible).

Table 1: UKTAG Derived Groundwater Dependency for Vegetation Encountered at New Laithe

Phase 1 Habitat Type	Ecology Site ID / Location	WFD95 Wetland Type	High-level NVC Community	Groundwater Dependency
B5 – Marsh / marshy grassland	TR4.GW4	2a – Marshy grassland	M23	High to moderate
	TR4.GW5	2a – Marshy grassland	M25b	Moderate to low
	TR4.GW6	2a – Marshy grassland	M25 / M26 / M27[3]	Moderate to low / Moderate to low / Moderate to low
B2.2 – Semi-improved neutral grassland	No ID given – throughout the site	N/A	N/A	N/A

[4] British Geological Survey (2020b) Susceptibility to groundwater flooding. A dataset provided by Groundsure Limited.
[5] Bowland Ecology Ltd. (2020a) TR4 Phase 1 Habitat Assessment Report. A report produced for United Utilities PLC.
[6] Bowland Ecology Ltd. (2020b) TR4 GWDTE Habitat Assessment Report. A report produced for United Utilities PLC.
[7] SNIFFER (2009) WFD95: A Functional Wetland Typology for Scotland – Project Report. Edinburgh, SNIFFER.
[8] UKTAG (2009) *op. cit.*

3.1.5 Initial Conceptual Site Model

30) Illustration 1 shows a conceptualised cross-section running west to east through the north of the site Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and guideline groundwater dependencies supporting vegetation and habitats.

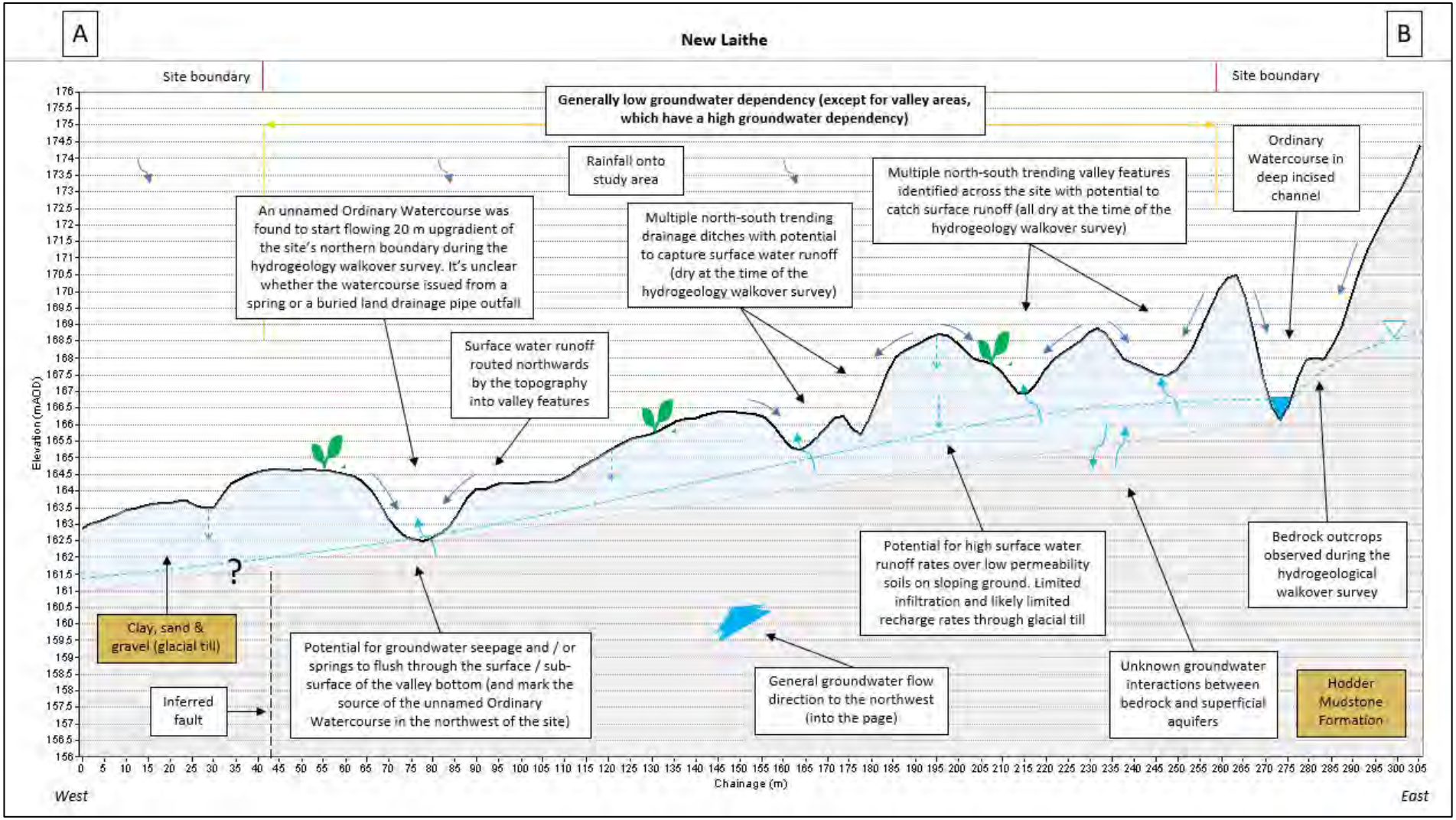
31) The valley in the west of the site has potential to receive direct groundwater inputs from the bedrock aquifer and is expected to have a high groundwater dependency. In part, this may be due to the incised nature of the valley, which has potentially eroded through the base of the glacial till deposits in this location. When the water table rises following recharge events in the wider catchment, shallow groundwater emergence in the base and sides of the valley is likely, marking the source of the tributary of the unnamed Ordinary Watercourse which flows north.

32) Similar mechanisms are likely to be present in the drainage ditches and valleys identified in the north of the site. Groundwater and surface water flows from the steep hillside to the south are most likely to be routed towards the drainage ditches and valleys. As the topography starts to flatten, shallow groundwater and surface water runoff can accumulate in the base of these valleys, and groundwater levels are generally expected to be shallow for prolonged periods of time in these locations. The valleys and ditches in the north of the site are therefore also considered to have a high groundwater dependency.

33) In the spurs of higher ground between the drainage ditches and valleys, and generally upslope in the centre and south of the site, the presence of low permeability soils and greater thicknesses of glacial till deposits means that infiltration and recharge rates are likely to be low. With no evidence of shallow groundwater emergence in these locations, the centre and south of the site, and the spurs of higher ground between the ditches and valleys in the north, are expected to have a low groundwater dependency.

34) Annexe 1 shows the distribution of groundwater dependency at the site. Given the absence of an ecological designation at the site, according to Chapter 7: Water Environment, the sensitivity of the GWDTE is medium to low, depending on the groundwater dependency.

Illustration 1: Conceptual Site Model for New Laithe



3.1.6 Assessment of Effects

35) The site lies immediately east of the Bonstone Compound area, with the proposed temporary access track running east to west through the south and southwest of the site.

Enabling Works

36) The site lies outside of the estimated dewatering zone of influence for the attenuation pond and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted (see Table 2).

37) Groundwater flow disturbance could occur due to compaction-related construction activities and earthworks that do not require dewatering, i.e. topsoil stripping and construction of the temporary access track. The Bonstone Compound is situated downgradient of the site and so no impacts are predicted due to activities within the compound area. Topsoil stripping within the access area would involve excavation to a maximum depth of 0.5 m. In the south and southwest of the site, i.e. within the works footprint, impacts to groundwater flows and levels would be direct and major. This would result in a Large significance of effect. These works could also cause moderate changes to groundwater flows and levels immediately downgradient of the proposed access track, which would result in a Moderate or Slight significance of effect, depending on the groundwater dependency. Negligible or no impacts are expected elsewhere within the site. It should also be noted that topsoil stripping and vegetation clearance could lead to a complete loss of GWDTE habitats. This is assessed separately within Chapter 9A: Terrestrial Ecology.

38) Ground disturbance due to topsoil stripping and vegetation clearance could also impact on groundwater quality at the site, due to mobilisation of suspended solids and associated solutes (see Chapter 7: Water Environment). As topsoil stripping would reach a maximum depth of 0.5 m, significant migration of suspended solids is unlikely, due to the filtering effect of aquifer material. In addition, the Construction Code of Practice (CCoP) includes embedded mitigation measures associated with controlling silt pollution. However, due to the direct footprint of the proposed access track, there is potential for moderate magnitude changes in groundwater quality in the south and southwest of the site. This area has a low groundwater dependency, consequently this would result in a Slight significance of effect. Minor magnitude changes in groundwater quality would be expected immediately downgradient of the works area, resulting in effects with a Slight or Neutral significance, depending on the groundwater dependency of areas. No impacts would be expected throughout the remainder of the site.

39) The CCoP also refers to guidance on Pollution Prevention measures, including the development of a Construction Environmental Management Plan (CEMP). The migration of contaminants from the access track area as a result of accidental spills and leaks of fuels and chemicals (including cement and sewage) would likely lead to a moderate magnitude change in groundwater quality in the south and southwest of the site, resulting in a Slight significance of effect. Immediately downgradient of the works area, minor magnitude changes in groundwater quality are expected, which would result in a Slight or Neutral significance of effect, depending on the groundwater dependency. No impacts are predicted throughout the remainder of the site.

Construction

40) The site lies outside of the estimated dewatering zones of influence for the proposed shaft and open-cut connections and is not downgradient of these activities. Therefore, no impacts on groundwater levels and flows at the site due to construction phase dewatering are predicted.

41) As the temporary access track passes through the south and southwest of the site, any ground compaction caused by heavy haulage vehicles and plant, could create a local barrier to groundwater flows from the south / southwest. This would represent a direct impact to shallow groundwater levels and flows, with a major magnitude change expected in the south and southwest of the site. Although the contributing groundwater catchment upgradient of the site is extensive, effects with a Large significance are anticipated in the south and southwest of the site due to the direct nature of the impacts. Immediately downgradient of the access track, moderate magnitude changes in groundwater levels and

flows are expected, resulting in a Moderate or Slight significance of effect, depending on the groundwater dependency. Elsewhere within the site, negligible or no impacts are predicted.

42) There are several embedded mitigation measures contained within the CCoP for managing silt pollution (for suspended solids transport), and leaks and spills of fuels and chemicals. However, these measures only reduce the likelihood of contaminating groundwater, and do not affect the severity or consequence of an event occurring. Should groundwater become contaminated from use of the temporary access track, the impact on groundwater quality in the south and southwest of the site would be minor, resulting in a Neutral significance of effect. Immediately downgradient of the access track, negligible impacts on groundwater quality would likely occur, with no impacts predicted elsewhere within the site.

Operation

43) There are no permanent below ground structures proposed within the vicinity of the site to locally alter groundwater levels and flows supporting GWDTEs. No impacts to the site are therefore predicted.

Summary

44) A summary of the potential impacts to the site is provided in Table 2.

Table 2: Summary of Effects to New Laithe

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Magnitude of Impact	Significance of Effect
High to low	None	Medium to low	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	No effect
High to low	None	Medium to low	Shaft dewatering (groundwater levels / flows)	Construction	No impact	No effect
High to low	None	Medium to low	Open-cut connection dewatering (groundwater levels / flows)	Construction	No impact	No effect
High	None	Medium	Intercept flows in short or long term, including ground compaction (groundwater levels / flows)	Enabling / Construction	Moderate adverse	Moderate
Low		Low			Major adverse	Large
High	None	Medium	Accidental leaks / spills, of fuels and chemicals, including cement and sewage (groundwater quality)	Enabling	Minor adverse	Slight
Low		Low			Moderate adverse	Slight
High	None	Medium	Mobilisation of suspended solids (groundwater quality)	Enabling	Minor adverse	Slight
Low		Low			Moderate adverse	Slight

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Magnitude of Impact	Significance of Effect
High to low	None	Medium to low	Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	No impact	No effect

3.2 Blue Gates

3.2.1 Site Setting, Topography and Hydrological Catchment

45) The site comprises a small patch of land situated 70 m east of the New Laithe site, and 70 m west of the B6478. The access track to New Laithe lies 30 m south of the site. Ordnance Survey maps show an unnamed Ordinary Watercourse issues 35 m north of the site.

46) During a hydrogeology walkover survey undertaken on 20 April 2020, four scrapes / ponds were found in the west and centre of the site, two of which were found to be dry. No overland flows were observed at the time of the walkover survey, but it was noted that the topography, combined with the ponds gently sloping edges, may allow some degree of connectivity between these features, with water likely to flow from east to west. A dry, shallow north-south trending drainage ditch was found in the east of the site.

47) The site slopes gently from east to west, with the elevation ranging from 215 mAOD in the east, to 205 mAOD in the northwest. The hydrological catchment for the site extends 950 m east to Standridge Hill, where the ground reaches an elevation of 345 mAOD.

3.2.2 Soils and Geology

48) Mapped soils are shown as slowly permeable, wet, very acid upland soils, with a peaty surface and impeded drainage[9].

49) Superficial deposits of glacial till cover the full extent of the site, although a small area where no superficial deposits are mapped is thought to be present close to the northern site boundary[10]. Bedrock at the site is shown to be the Hodder Mudstone Formation, comprising mudstone with subordinate limestone, siltstone and sandstone.

50) There are no available historical borehole records close to the site to verify published geological information[10]. At the time of writing, there were also no GI data available for the Marl Hill Section.

3.2.3 Groundwater

51) There are no EA or BGS groundwater monitoring locations, historical borehole records, or GI data available close to the site to provide an indication of groundwater seeps, strikes, or rest water levels.

52) BGS data show that there is limited potential for groundwater flooding to occur at the site[11]. This is generally consistent with the hydrogeological walkover survey, which was carried out in April 2020, and recorded no signs of shallow groundwater emergence.

[9] Cranfield Soil and Agrifood Institute (2020) *op. cit.*
[10] British Geological Survey (2020a) *op. cit.*
[11] British Geological Survey (2020b) *op. cit.*

3.2.4 Habitats and Vegetation

53) A Phase 1 Habitat Survey was carried out by Bowland Ecology Ltd. in August 2019[12], which was supplemented with a high-level NVC survey in April 2020[13], in conjunction with the SNIFFER WFD95 Wetland Typology methodology[14]. A detailed description of the data collected, and methodologies used for the ecology surveys can be found in Chapter 9A: Terrestrial Ecology.

54) As shown in Annexe 1, the entire site was classified as a marsh / marshy grassland habitat type. However, as stated in the Ecology Survey Data Report, the marsh / marshy grassland habitat present in the centre of the site was considered too small to accurately attribute a high-level NVC community in this area (see Table 3).

55) There are no ecological designations present within the site.

Table 3: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Blue Gates

Phase 1 Habitat Type	Ecology Site ID / Location	WFD95 Wetland Type	High-level NVC Community	Groundwater Dependency
B5 – Marsh / marshy grassland	TR4.GW10	2a – Marshy grassland	N/A	N/A

3.2.5 Initial Conceptual Site Model

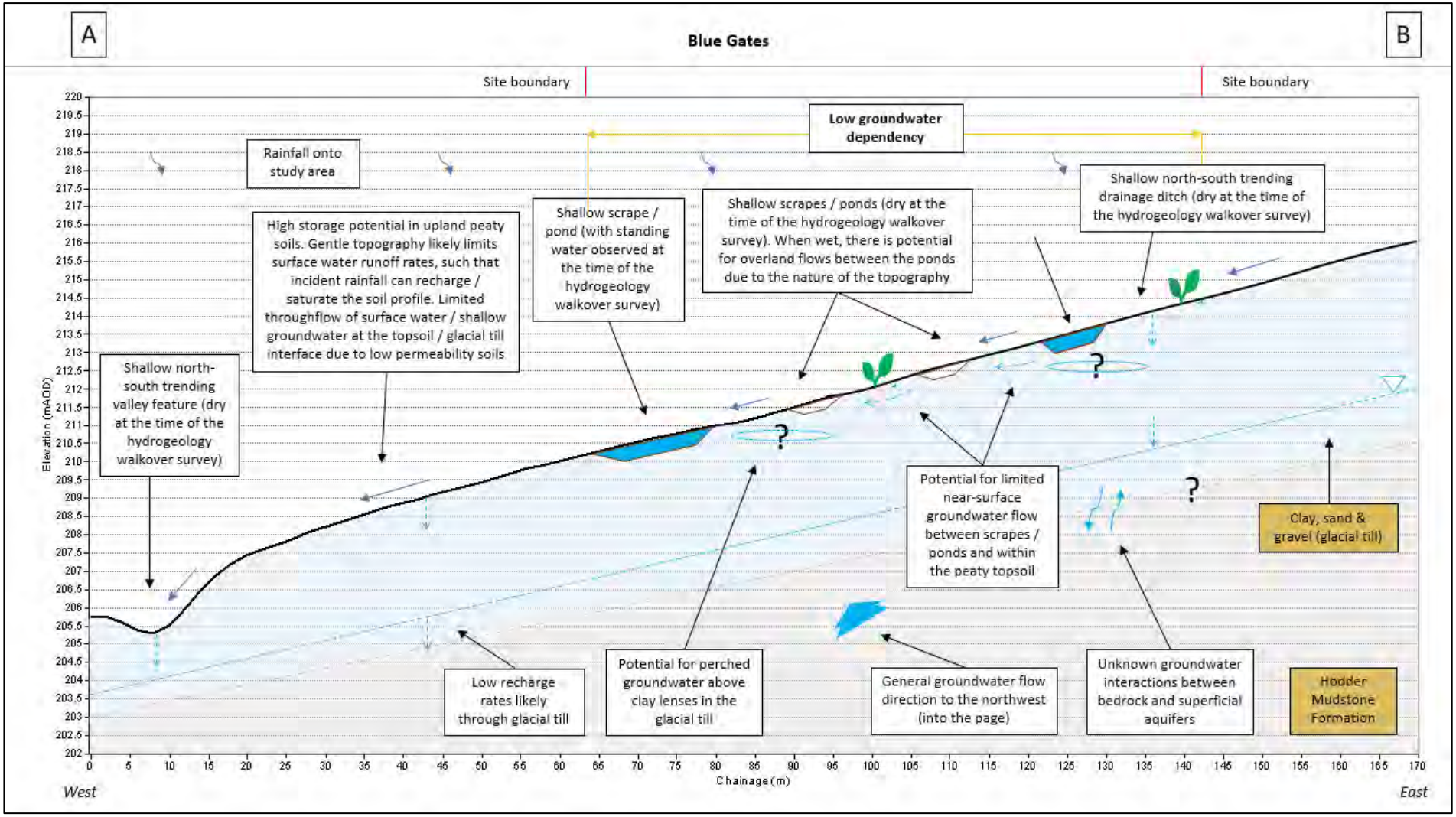
56) Illustration 2 shows a conceptualised cross-section running west to east through the site (Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and guideline groundwater dependencies supporting vegetation and habitats.

57) Surface water runoff from the large hydrological catchment to the east, would likely be captured by the shallow drainage ditches and scrapes / ponds identified during the hydrogeological walkover survey. Given the gently sloping topography in the area and the shallow sides of the scrapes / ponds, there is potential for overland flows to be routed west between these features, allowing them to be hydrologically linked. With no evidence of shallow groundwater emergence found at the site, it is unlikely that groundwater levels and flows are particularly shallow for prolonged periods of time. However, the presence of peaty soils means that rainfall could directly recharge the soil profile and saturate the ground surface. Potential for shallow groundwater flows cannot therefore be ruled out, either at the soil / glacial till boundary, or within the upper horizon of the superficial aquifer. However, shallow groundwater flows (if present) would likely be limited and discontinuous, such that the site is considered to have a low groundwater dependency.

58) Annexe 1 shows the groundwater dependency at the site. Given that there are no ecological designations present at the site, according to Chapter 7: Water Environment, the sensitivity of the GWDTE is low.

[12] Bowland Ecology Ltd. (2020a) *op. cit.*
[13] Bowland Ecology Ltd. (2020b) *op. cit.*
[14] SNIFFER (2009) *op. cit.*

Illustration 2: Conceptual Site Model for Blue Gates



3.2.6 Assessment of Effects

59) The site lies 25 m north and across-gradient of the Bonstone Compound access area (Annexe 1). The compound itself lies 430 m west of the site at its closest point.

Enabling Works

60) The site lies outside of the estimated dewatering zone of influence for the attenuation pond and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted (see Table 4).

61) Groundwater flow disturbance could occur from construction of the permanent access track to the south of the site. Topsoil stripping would be limited to a maximum depth of 0.5 m, but ground compaction of superficial deposits from use of the road by haulage vehicles could create a barrier to shallow groundwater flows partially sustaining the site from the south / southeast. Groundwater flow disturbances at the site, are however expected to be negligible, given the localised nature of the perched aquifers that may partially sustain GWDTEs at the site (if present). This would result in a Neutral significance of effect.

62) Ground disturbance due to topsoil stripping and vegetation clearance could also impact groundwater quality at the site, due to mobilisation of suspended solids and the potential for contaminant pathways to exist between the works area and the site. Topsoil stripping would be limited to a maximum depth of 0.5 m, and significant migration of suspended solids is therefore unlikely due to the filtering effect of aquifer material. In addition, considering the embedded mitigation measures referred to in the CCoP, the distance of the site from the proposed works area, and the localised nature of groundwater contributions expected to the site, the potential magnitude change in groundwater quality to the GWDTE is considered to be negligible. This would result in a Neutral significance of effect.

63) Considering the pollution prevention measures referred to in the CCoP, the migration of contaminants from the access track area, as a result of accidental spills and leaks (of fuels and chemicals) would likely lead to a negligible magnitude change in groundwater quality at the site, resulting in a Neutral significance of effect.

Construction

64) The site lies outside of the estimated dewatering zones of influence for the proposed shaft and open-cut connection structures and does not lie downgradient of these activities. No impacts on groundwater levels and flows at the site due to construction phase dewatering are therefore predicted.

65) There are several embedded mitigation measures contained within the CCoP for managing silt pollution (for suspended solids transport), and leaks and spills of fuels and chemicals. In addition, based on the distance of the proposed access track from the site, the filtration capability of aquifer material, and the localised nature of groundwater contributions expected to the site, any changes to groundwater quality at the site are expected to be negligible. This would result in a Neutral significance of effect.

Operation

66) There are no permanent below ground structures proposed within the vicinity of the site to locally alter groundwater levels and flows supporting GWDTEs. No impacts to the site are therefore predicted.

Summary

67) A summary of the potential impacts to the site is provided in Table 4.

Table 4: Summary of Effects to Blue Gates

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
Low	None	Low	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	N/A
			Shaft dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Open-cut connection dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Intercept flows in short term, including ground compaction (groundwater levels / flows)	Enabling	Negligible	Neutral
			Accidental leaks / spills, of fuels and chemicals, including cement and sewage (groundwater quality)	Enabling / Construction	Negligible	Neutral
			Mobilisation of suspended solids (groundwater quality)	Enabling / Construction	Negligible	Neutral
			Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	No impact	N/A

3.3 Braddup House

3.3.1 Site Setting, Topography and Hydrological Catchment

68) The site is situated in an area of agricultural land with access tracks present along the northern and western boundaries of the site. Sandy Ford Brook Ordinary Watercourse lies 150 m to the east.

69) The site slopes gently southwards from an elevation of 171 mAOD in the northwest, to 158 mAOD in the south. A hydrogeological walkover survey was carried out at the site in April 2020, which found a dry drainage ditch present along the southern site boundary. The ditch enters a culvert beneath the access track in the southwest corner of the site. A second dry drainage ditch was identified along the northern site boundary.

70) The natural hydrological catchment for the site extends 450 m northwest, where the ground reaches an elevation of around 195 mAOD. However, the drainage ditch along the northern site boundary may intercept overland flows, thus artificially altering the surface water catchment for the site.

3.3.2 Soils and Geology

71) Soils at the site are described as slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage[15].

72) During a hydrogeological walkover survey carried out for the site in April 2020, a shallow excavation into made ground was observed in the north of the site. Fragments of brick, plastic, clay pipe and suspected asbestos cement were identified at the surface of the excavation.

73) Geological mapping indicates that the site is underlain by superficial deposits of glacial till, comprising clay, sand and gravel[16]. Bedrock at the site is the Hodder Mudstone Formation, comprising mudstone with subordinate limestone, siltstone and sandstone. A northwest-southeast trending fault cuts across the bedrock immediately east of the site boundary. A second fault runs northwest to southeast, approximately 30 m to the south.

74) There are no available historical borehole records close to the site to verify published geological mapping [16]. At the time of writing, there were also no GI data available for the Marl Hill Section.

3.3.3 Groundwater

75) There are no EA or BGS groundwater monitoring locations close to the site. There are also no available historical borehole records or GI data available at the time of writing to provide an indication of groundwater seeps, strikes, or rest water levels.

76) BGS data suggests that there is limited potential for groundwater flooding to occur at the site[17]. This is broadly consistent with the findings of a hydrogeological walkover survey, which was carried out at the site in April 2020, where no evidence of groundwater emergence was observed.

77) The hydrogeological walkover survey did however note the presence of a shallow excavation in the north of the site. The excavation had exposed a plastic chamber which connected three land drainage pipes. If a sub-surface land drainage network exists at the site, groundwater levels may be artificially lowered.

3.3.4 Habitats and Vegetation

78) A Phase 1 Habitat Survey was carried out for the site by Bowland Ecology Ltd. in July 2019[18]. No NVC or SNIFFER surveys were undertaken at the site (see Chapter 9A: Terrestrial Ecology for a detailed description of the data collected, and methodologies used for the ecology surveys in the Proposed Marl Hill Section).

79) As shown in Annexe 1, the site is dominated by marsh / marshy grassland habitats, surrounded by large expanses of poor semi-improved grassland. In the north of the site, there are two small patches of tall ruderal habitat.

80) There are no ecological designations present within the site.

[15] Cranfield Soil and Agrifood Institute (2020) *op. cit.*
[16] British Geological Survey (2020a) *op. cit.*
[17] British Geological Survey (2020b) *op. cit.*
[18] Bowland Ecology Ltd. (2020a) *op. cit.*

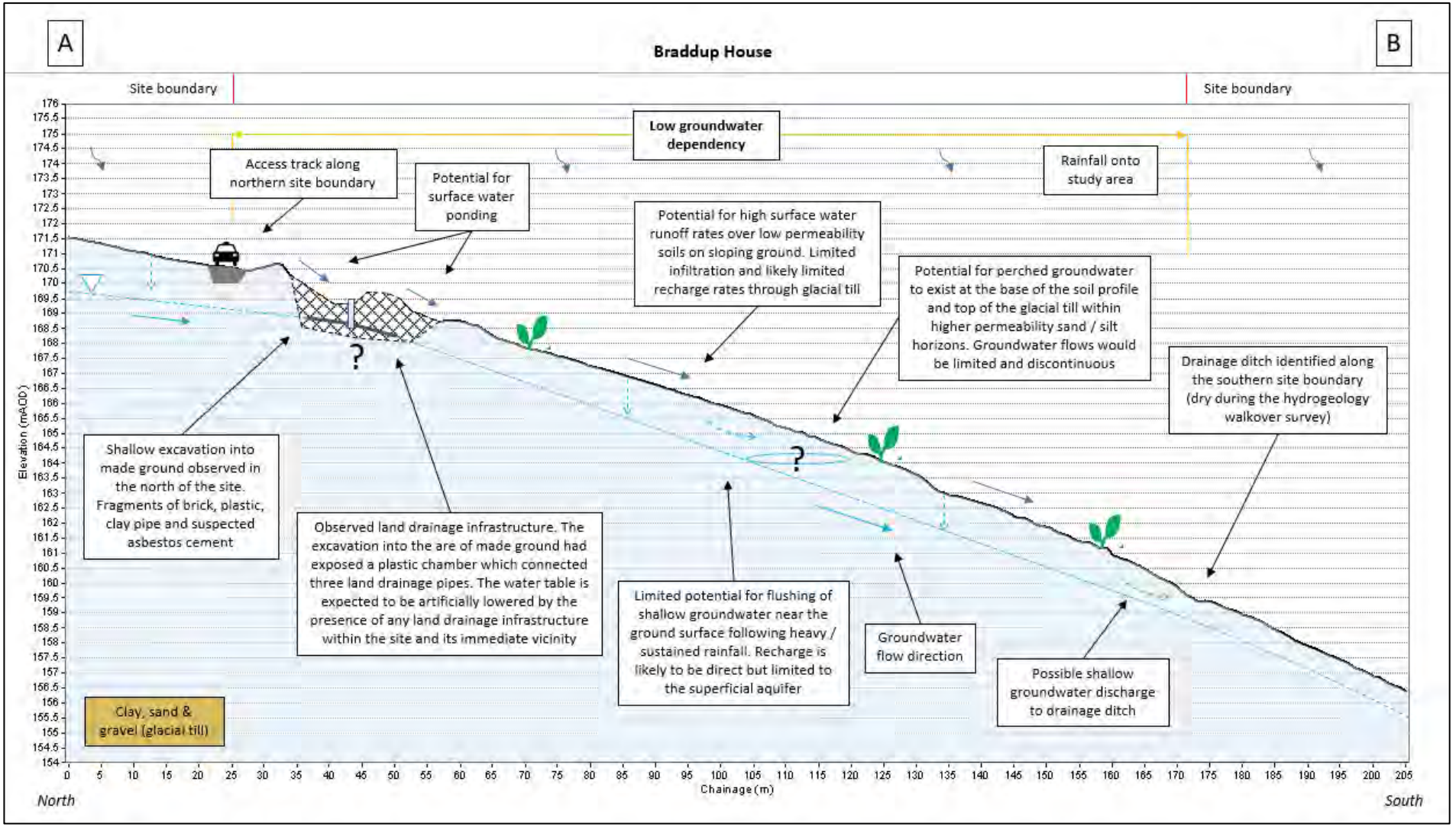
3.3.5 Initial Conceptual Site Model

81) Illustration 3 shows a conceptualised cross-section running north to south through the centre of the site (Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and groundwater dependencies supporting vegetation and habitats present.

82) Within the site and its surrounding catchment, infiltration is likely to be limited by low permeability soils and the corresponding potential for surface water runoff generation is expected to be high. As the topography is gently sloping, direct recharge to the superficial aquifer is possible, and there is potential, therefore, for limited groundwater flows to occur within the more permeable horizons of the glacial till, in the form of localised perched aquifers. However, contributions to the habitats at Braddup House are expected to be minor (if present). In addition, if a sub-surface land drainage network exists at the site, groundwater levels would be artificially lowered, such that the area of marsh habitat at the site is considered to have a low groundwater dependency.

83) Annexe 1 shows the distribution of groundwater dependency at the site. Given the absence of ecological designations at the site, the sensitivity of the GWDTE is low according to Chapter 7: Water Environment.

Illustration 3: Conceptual Site Model for Braddup House



3.3.6 Assessment of Effects

84) The entire site lies within the footprint of the Braddup Compound area, with the proposed open cut multi-line connection in the south and east of the site, and the proposed overflow structure in the north.

Enabling Works

85) The site lies outside of the estimated dewatering zone of influence for the attenuation pond (see Chapter 7: Water Environment) and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted.

86) Groundwater flow disturbance could occur within the compound area due to compaction-related construction activities and earthworks, such as topsoil stripping (excavation to a maximum depth of 0.5 m) and construction of the access track. This would result in a site-wide, direct and major impact on shallow groundwater flows. This would result in a Large significance of effect.

87) Ground disturbance, for e.g. due to topsoil stripping and vegetation clearance, could also impact groundwater quality due to mobilisation of suspended solids. Implementation of the embedded mitigation measures referred to in the CCoP would significantly reduce the likelihood of suspended solids causing a deterioration in groundwater quality at the site. However, given the consequence of such an event occurring, the risk remains high, and the migration of suspended solids to the GWDTE would result in a moderate impact on groundwater quality at the site due to the direct nature of the works footprint. This would result in a Slight significance of effect.

88) Accidental spills and leaks of fuels and chemicals have the potential to introduce contaminants into groundwater sustaining GWDTE habitats at the site. The embedded mitigation measures contained within the CCoP would significantly reduce the likelihood of an incident. However, if a spill or leak did occur, this would lead to a moderate impact on groundwater quality at the site, resulting in a Slight significance of effect.

Construction

89) The site lies 160 m south of the proposed shaft and outside of the estimated zone of influence for dewatering. Although the site lies downgradient of the activity, given the distance, no impacts on groundwater levels and flows at the site are predicted.

90) Excavations for the multi-line connection and overflow structures could also require dewatering and cause a groundwater drawdown across several parts of the site. Consequently, groundwater flows supporting the habitats present would also experience a direct and major impact on groundwater flows and levels due to dewatering, which would result in a Large significance of effect.

91) As the access track would lie adjacent to the northern site boundary, and perpendicular to the likely shallow groundwater flow direction, any ground compaction caused by heavy haulage vehicles and plant, could create a barrier to groundwater flows from the north. However, as the shallow groundwater flows sustaining the GWDTE are expected to be very localised and minor, potentially within perched aquifer lenses, any changes to upgradient groundwater flows would likely lead to a minor magnitude change at the site. This would result in a Neutral significance of effect.

92) There are several embedded mitigation measures contained within the CCoP for managing silt pollution (for suspended solids transport), and leaks and spills of fuels and chemicals. However, these measures only reduce the likelihood of contaminating groundwater, and do not affect the severity or consequence of an event occurring. Should groundwater become contaminated within the upgradient works footprint, or from use of the temporary access track, the impact on groundwater quality throughout the centre and east of the site would be minor, resulting in a Neutral significance of effect.

Operation

93) The below ground multi-line connection and overflow structures have the potential to permanently alter local groundwater flows and levels within the site. Although permanent significant changes to

groundwater levels and flows are unlikely, localised changes to groundwater levels and flows could occur within the north, south and east of the site, which could be of significance for such a sensitive receptor. In these areas, this would result in a Slight significance of effect.

94) In addition, the open-cut construction method proposed for the multi-line connection and overflow structures, means that the trenches would be backfilled with arisings or a granular bedding material. Depending on the nature of the backfill material, a preferential groundwater flowpath or barrier to groundwater flow could be created. Moderate impacts in groundwater levels and flows in the north, south and east of the site are therefore predicted, which due to the direct nature of the impact, would result in a Slight significance of effect.

Summary

95) A summary of the potential impacts to the site is provided in Table 5.

Table 5: Summary of Effects to Braddup House

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
Low	None	Low	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	N/A
			Shaft dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Open-cut connection dewatering (groundwater levels / flows)	Construction	Major Adverse	Large
			Overflow dewatering (groundwater levels / flows)	Construction	Major Adverse	Large
			Intercept flows in short term, including ground compaction (groundwater levels / flows)	Enabling	Major Adverse	Large
			Accidental leaks / spills, of fuels and chemicals, including cement and sewage (groundwater quality)	Enabling	Moderate Adverse	Slight
			Mobilisation of suspended solids (groundwater quality)	Enabling	Moderate Adverse	Slight

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
			Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	Moderate Adverse	Slight

3.4 Whinny Lane West

3.4.1 Site Setting, Topography and Hydrological Catchment

96) The site comprises an irregularly shaped area of agricultural land located approximately 175 m west of Whinny Lane. The site slopes to the southeast from an elevation of 184 mAOD in the northwest, to an elevation of 174 mAOD in the south-east. There is a relatively flat area in the centre of the site.

97) Sandy Ford Brook Ordinary Watercourse generally flows north to south along the western site boundary. During a hydrogeological walkover survey undertaken at the site in April 2020, the brook was found to flow within a relatively shallow, but incised channel.

98) The northeast of the site was found to comprise a shallow topographic basin, which was dry at the time of survey. A small stone building was also present in the north of the site.

99) The hydrological catchment for the site extends approximately 315 m north where the ground reaches an elevation of around 200 mAOD.

3.4.2 Soils and Geology

100) Soils at the site are described as slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage[19].

101) Mapped superficial geology comprises glacial till[20]. Bedrock at the site is shown to be the Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated), comprising interbedded limestone and mudstone.

102) There are no available historical borehole records close to the site to verify published geological information [20]. At the time of writing, there were also no GI data available for the Marl Hill Section.

3.4.3 Groundwater

103) There are no EA or BGS groundwater monitoring locations close to the site. There are also no available historical borehole records or GI data available at the time of writing to provide an indication of groundwater seeps, strikes, or rest water levels.

104) BGS data suggests that there is limited potential for groundwater flooding to occur across most of the site[21]. The only exception is in the far south of the site, adjacent to Sandy Ford Brook, where there is potential for groundwater flooding to occur to property or infrastructure situated below ground level.

105) A hydrogeological walkover survey was carried out at the site in April 2020, which noted boggy ground conditions in the south and west of the site close to Sandy Ford Brook. These observations are generally

[19] Cranfield Soil and Agrifood Institute (2020) *op. cit.*
[20] British Geological Survey (2020a) *op. cit.*
[21] British Geological Survey (2020b) *op. cit.*

consistent with BGS flood susceptibility data and suggests that groundwater levels may be shallow in these locations. No other evidence of groundwater emergence was observed.

3.4.4 Habitats and Vegetation

106) A Phase 1 Habitat Survey was carried out by Bowland Ecology Ltd. in July 2019[22], which was supplemented with a high-level NVC survey in April 2020[23], in conjunction with the SNIFFER WFD95 Wetland Typology methodology[24] (see Chapter 9A: Terrestrial Ecology for a detailed description of the data collected, and methodologies used for the ecology surveys).

107) A marsh / marshy grassland habitat type was recorded throughout the site, surrounded by swathes of poor semi-improved grassland. The high-level NVC survey identified M23 *Juncus effuses /acutiflorus-Galium palustre* rush-pasture vegetation in the centre of the site, although the Ecology Survey Data Report notes that this was difficult to assign. According to the UKTAG guidance, an M23 plant community has a high to moderate groundwater dependency[25].

108) There are no ecological designations present within the site.

109) Habitat, vegetation, and wetland typology information recorded at the site is summarised in Table 6, along with groundwater dependencies assigned by the UKTAG guidance[26].

Table 6: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Whinny Lane West

Phase 1 Habitat Type	Ecology Site ID / Location	WFD95 Wetland Type	High-level NVC Community	Groundwater Dependency [26]
B5 – marsh / marshy grassland	TR4.GW15	2a – marshy grassland	M23	High to moderate

3.4.5 Initial Conceptual Site Model

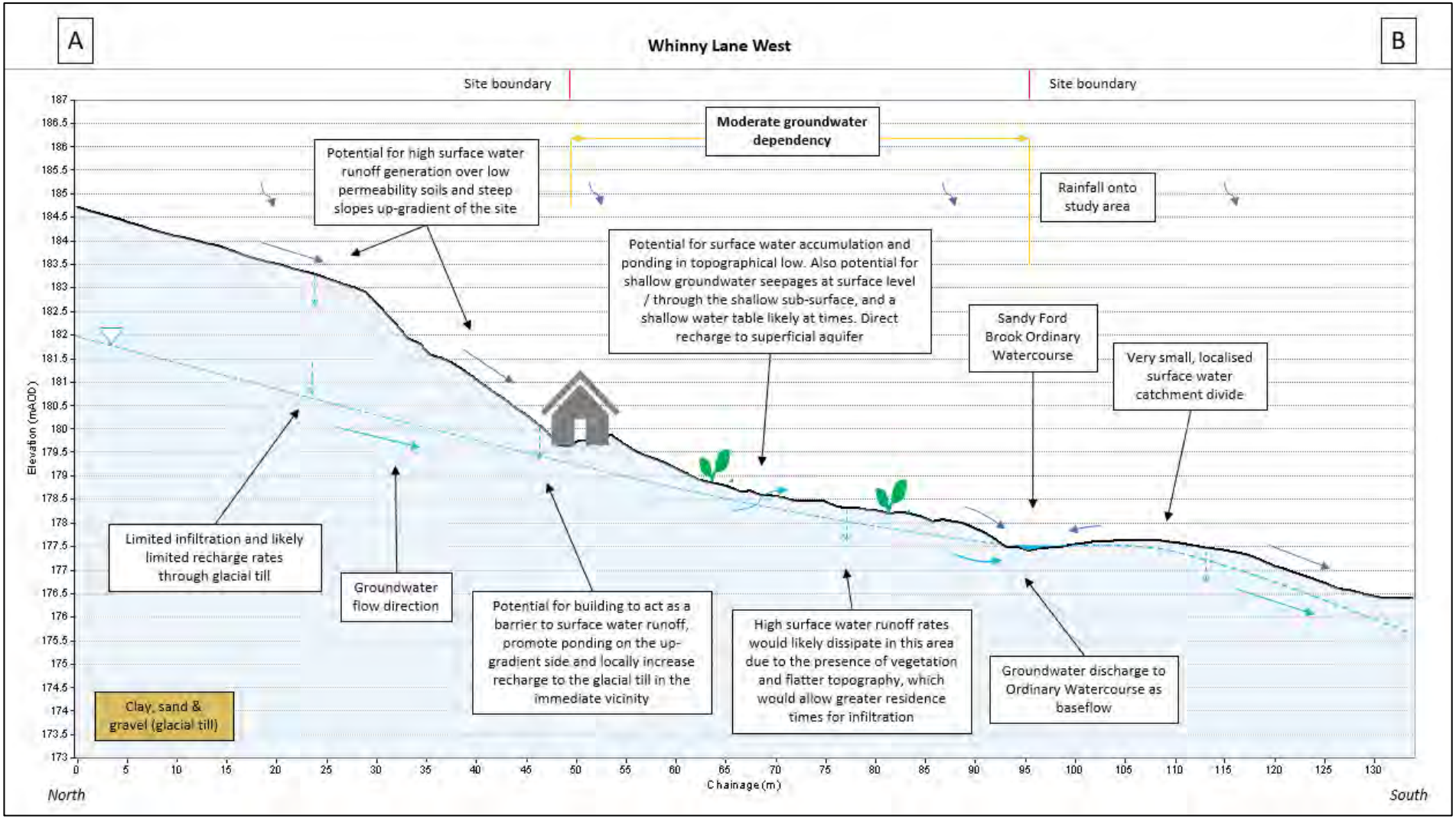
110) Illustration 4 shows a conceptualised cross-section running north to south through the centre of the site (Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and guideline groundwater dependencies supporting vegetation and habitats.

111) Groundwater within the glacial till generally flows southwards, locally discharging to Sandy Ford Brook Ordinary Watercourse. Upgradient of the site, infiltration rates are expected to be limited by low permeability soils. Potential for surface water runoff generation would therefore be high, also caused by the steep topography and the size of the contributing hydrological catchment to the north. The drop in topography along the northern site boundary, may allow the water table to intersect or approach the ground surface, at times. Due to the flatter topography within the site itself, surface water runoff would likely accumulate, also allowing increased infiltration and recharge rates. With a combination of both surface water ponding and shallow groundwater levels and flows likely sustaining the marsh / marshy grassland habitats present at the site, the GWDTE is considered to have a moderate groundwater dependency.

112) Annexe 1 shows the distribution of groundwater dependency at the site. Given that there are no ecological designations at the site, according to Chapter 7: Water Environment, the sensitivity of the GWDTE is medium.

[22] Bowland Ecology Ltd. (2020a) *op. cit.*
[23] Bowland Ecology Ltd. (2020b) *op. cit.*
[24] SNIFFER (2009) *op. cit.*
[25] UKTAG (2009) op. cit.
[26] UKTAG (2009) *op. cit.*

Illustration 4: Conceptual Site Model for Whinny Lane West



3.4.6 Assessment of Effects

114) The site lies 9 m east of the Braddup Compound area at its closest point and is generally situated partially across-gradient and partially downgradient in terms of groundwater flow. However, Sandy Ford Brook flows along the entire western site boundary and separates the site from the works footprint.

Enabling Works

115) The site lies outside of the estimated dewatering zone of influence for the attenuation pond and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted (see Table 7).

116) Groundwater flow disturbance could occur within the compound area due to compaction-related construction activities and earthworks that do not require dewatering, such as topsoil stripping, vegetation clearance and construction of the temporary access track. Topsoil stripping would involve excavation to a maximum depth of 0.5 m. Given that the site is located on the other side of Sandy Ford Brook, no impacts on groundwater levels and flows are expected at the site.

117) Ground disturbance due to topsoil stripping and vegetation clearance could also impact on groundwater quality at the site due to mobilisation of suspended solids. Similarly, accidental spills and leaks of fuels and chemicals have the potential to introduce contaminants to groundwater sustaining GWDTE habitats at the site. However, due to a combination of the embedded mitigation measures referred to in the CCoP, along with the site being located on the other side of Sandy Ford Brook, no impacts on groundwater quality are expected at the site.

Construction

118) The site lies outside of the calculated dewatering zones of influence for the proposed shaft, open-cut connection and overflow structures. Therefore, no impacts on groundwater levels and flows at the site due to construction phase dewatering are predicted.

119) In addition, the proposed shaft and open-cut excavations (required for the connection and overflow structures) lie 80 m across and downgradient of the site boundary at their closest point, and no impacts on groundwater quality (i.e. from a release of suspended solids and / or leaks of fuels and chemicals) are therefore expected at the site.

Operation

120) There are no permanent below ground structures proposed within the vicinity of the site to locally alter groundwater levels and flows supporting GWDTEs. No impacts to the site are therefore predicted.

Summary

121) A summary of the potential impacts to the site is provided in Table 7.

Table 7: Summary of Effects to Whinny Lane West

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
Moderate	None	Medium	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	N/A
			Shaft dewatering (groundwater levels / flows)	Construction	No impact	N/A

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
			Open-cut connection dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Overflow dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Intercept flows in short term, including ground compaction (groundwater levels / flows)	Enabling	No impact	N/A
			Accidental leaks / spills, of fuels and chemicals, including cement and sewage (groundwater quality)	Enabling / Construction	No impact	N/A
			Mobilisation of suspended solids (groundwater quality)	Enabling / Construction	No impact	N/A
			Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	No impact	N/A

3.5 Whinny Lane East

3.5.1 Site Setting, Topography and Hydrological Catchment

122) The site lies approximately 200 m east of Whinny Lane and comprises a rectangular strip of land either side of an east-west trending access track. The access track joins the B6478 (Slaidburn Road) 280 m east of the site.

123) Four unnamed Ordinary Watercourses flow north to south through the site, including along both the eastern and western site boundaries. During a hydrogeological walkover survey carried out at the site in May 2020, all four watercourses were observed to flow within incised channels and were culverted underneath the access track in the centre of the site. Moderate flows were observed in the western-most watercourse, with low flows observed in the others.

124) The site extends some 460 m along a steeply sloping hillside and lies perpendicular to the topographic gradient. The elevation of the site ranges from 178 mAOD in the northeast, to 169 mAOD in the south.

125) The hydrological catchment for the site extends approximately 2 km north to Waddington Fell, where the ground reaches an elevation of 370 mAOD.

3.5.2 Soils and Geology

126) Soils at the site are described as slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage[27].

127) Geological mapping indicates that the site is underlain by superficial deposits of glacial till, comprising clay, sand and gravel[28]. Bedrock at the site is the Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated), comprising interbedded limestone and mudstone.

128) There are no available historical borehole records close to the site to verify published geological mapping[28]. At the time of writing, there were also no GI data available for the Marl Hill Section.

3.5.3 Groundwater

129) There are no EA or BGS groundwater monitoring locations close to the site. There are also no available historical borehole records or GI data available at the time of writing to provide an indication of groundwater seeps, strikes, or rest water levels.

130) A hydrogeological walkover survey was carried out at the site in May 2020. No evidence of groundwater emergence was observed during the survey, although some standing water was found close to the western site boundary.

131) BGS data suggests that there is limited potential for groundwater flooding to occur in the west of the site, but potential for groundwater flooding to occur to property or infrastructure situated below ground level in the east[29]. In the far east of the site, there is potential for groundwater flooding to occur at surface level, between two Ordinary Watercourses, which lie only 50 m apart.

3.5.4 Habitats and Vegetation

132) A Phase 1 Habitat Survey was carried out for the site by Bowland Ecology Ltd. in February 2020[30]. No NVC or SNIFFER surveys were undertaken at the site (see Chapter 9A: Terrestrial Ecology for a detailed description of the data collected, and methodologies used for the ecology surveys in the Proposed Marl Hill Section).

133) As shown in Illustration 5, several small isolated patches of marsh / marshy grassland habitat were found immediately north of the access track in the western half of the site. Two thin north-south trending strips of marsh were also recorded either side of two Ordinary Watercourses within the site. In all instances, the areas of marsh / marshy grassland habitat were surrounded by expanses of poor semi-improved grassland and / or semi-improved neutral grassland. The Phase 1 Habitat mapping also shows a small pond adjacent to the western site boundary, which generally correlates with the area of standing water identified during the hydrogeology walkover survey.

134) There are no ecological designations present within the site.

[27] Cranfield Soil and Agrifood Institute (2020) *op. cit.*
[28] British Geological Survey (2020a) *op. cit.*
[29] British Geological Survey (2020b) *op. cit.*
[30] Bowland Ecology Ltd. (2020a) *op. cit.*

3.5.5 Initial Conceptual Site Model

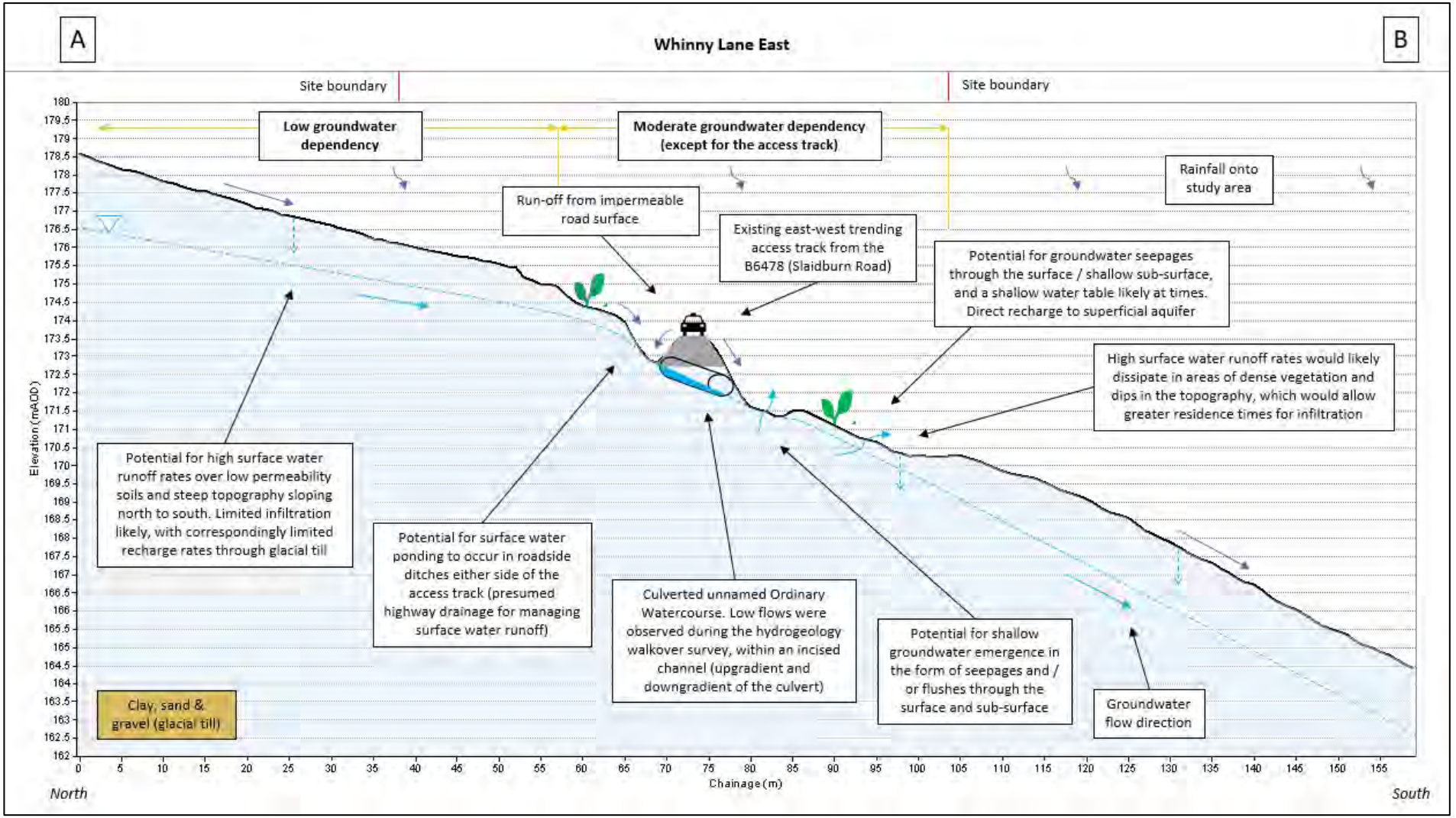
135) Illustration 5 shows a conceptualised cross-section running north to south through the centre of the site (Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and guideline groundwater dependencies supporting vegetation and habitats.

136) In the north of the site and upgradient of the site boundary, there is potential for high surface water runoff rates over low permeability soils and steeply sloping topography. Infiltration rates are likely to be limited and corresponding recharge rates to the underlying superficial aquifer are also likely to be low, such that the water table is not expected to be particularly shallow in these areas. The north of the site is therefore considered to have a low groundwater dependency.

137) Upgradient of the access track, there is a break in the topography, which may allow the water table (at times) to approach the ground surface. The presence of drainage ditches either side of the access track means that surface water runoff (from both the contributing catchment to the north, and / or the highway), could accumulate in the base of these channels. With increased residence times for infiltration, recharge to the underlying till would likely increase, further enhancing the potential for a shallower groundwater table in these locations. Within the ditches and their immediate surrounding areas, shallow groundwater emergence is therefore possible. Due to the nature of the topography at the site, this could sustain a flushing mechanism through the surface / sub-surface. The ditches, and any other localised topographic depressions at the site, could therefore be moderately groundwater dependent.

138) Annexe 1 shows the distribution of groundwater dependency at the site. Given that there are no ecological designations at the site, according to Chapter 7: Water Environment, the sensitivity of the GWDTE is medium to low, depending on the groundwater dependency.

Illustration 5: Conceptual Site Model for Whinny Lane East



3.5.6 Assessment of Effects

139) The proposed Braddup Compound access area runs east to west through the centre of the site. The main compound area lies 370 m west of the site at its closest point.

Enabling Works

140) The site lies outside of the estimated dewatering zone of influence for the attenuation pond and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted (see Table 8).

141) Groundwater flow disturbance could occur due to general compaction-related construction activities, such as topsoil stripping and construction of the temporary access track. Topsoil stripping would involve excavation to a maximum depth of 0.5 m, but the impacts on groundwater flows would be direct and major in the centre of the site. This would result in a Large or Moderate significance of effect, depending on the groundwater dependency of areas within the site. Moderate changes to groundwater levels and flows could occur in the south of the site, due to groundwater flow disturbance propagating downgradient from the immediate works footprint. This would result in a Moderate or Slight significance of effect, depending on the groundwater dependency. In addition, although topsoil excavation depths are limited, groundwater levels may be shallow (at times, and in certain locations), such that the activity may create localised and minor dewatering effects that extend upgradient and partially into the north of the site. This would result in a Slight or Neutral significance of effect, depending on the groundwater dependency. No impacts to groundwater levels and flows are expected in the far north of the site.

142) Ground disturbance due to topsoil stripping and vegetation clearance associated with the proposed access track, could also impact on groundwater quality due to mobilisation of suspended solids. Implementation of the embedded mitigation measures referred to in the CCoP would significantly reduce the likelihood of suspended solids causing a deterioration in groundwater quality at the site. However, given the consequence of such an event occurring, the risk remains high, and migration of suspended solids to the GWDTEs would result in a moderate adverse impact on groundwater quality in the centre of the site. This would result in a Moderate or Slight significance of effect, depending on the groundwater dependency. Downgradient of the works area, and in the south of the site, minor impacts on groundwater quality could arise due to the groundwater flow direction and potential contaminant pathways. This would result in a Slight or Neutral significance of effect, depending on the groundwater dependency. The north of the site lies upgradient of the proposed access track and is therefore unlikely to experience any impacts on groundwater quality.

143) Accidental spills and leaks of fuels and chemicals have the potential to introduce contaminants into groundwater sustaining GWDTE habitats at the site. The embedded mitigation measures contained within the CCoP would significantly reduce the likelihood of an incident. However, if a spill or leak did occur, this would lead to a moderate adverse impact on groundwater quality in the centre of the site, resulting in a Moderate or Slight significance of effect. Minor impacts on groundwater quality would be expected in the south of the site, i.e. downgradient of the works area, which would result in a Slight or Neutral significance of effect, depending on the groundwater dependency. No impacts on groundwater quality are predicted in the north of the site.

Construction

144) The site lies outside of the calculated dewatering zones of influence for the proposed shaft, open-cut connection and overflow structures. Therefore, no impacts on groundwater levels and flows at the site due to construction phase dewatering are predicted.

145) As the temporary access crosses through the centre of the site, any ground compaction caused by heavy haulage vehicles and plant, could create a barrier to groundwater flows from the north. This would represent a direct impact to shallow groundwater levels and flows, with a major magnitude of change expected. Effects with a Large or Moderate significance (depending on the groundwater dependency of areas) are therefore anticipated in the centre of the site, due to the direct nature of the works footprint. Downgradient of the access track, moderate changes in groundwater levels and flows could occur, which

would result in a Moderate or Slight significance of effect, depending on the groundwater dependency. The impact on upgradient groundwater flows in the north of the site would likely be negligible, resulting in a Neutral significance of effect.

146) Considering the embedded mitigation measures contained within the CCoP, for managing silt pollution (for suspended solids transport), and leaks and spills of fuels and chemicals, minor magnitude changes in groundwater quality could be expected in the centre of the site, from use of the temporary access track during the construction phase. This would result in a Slight or Neutral significance of effect, depending on the groundwater dependency. Downgradient of the access track, negligible impacts on groundwater quality could occur, which would result in a Neutral significance of effect. The north of the site, which lies upgradient of the access track, is unlikely to experience any impacts on groundwater quality.

Operation

147) There are no permanent below ground structures proposed within the vicinity of the site to locally alter groundwater levels and flows supporting GWDTEs. No impacts to the site are therefore predicted.

Summary

148) A summary of the potential impacts to the site is provided in Table 8.

Table 8: Summary of Effects to Whinny Lane East

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
Moderate to low	None	Medium to low	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	N/A
			Shaft dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Open-cut connection dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Overflow dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Intercept flows in short term, including ground compaction (groundwater levels / flows)	Enabling / Construction	Major Adverse	Large
			Accidental leaks / spills, of fuels and chemicals,	Enabling	Moderate Adverse	Moderate

			including cement and sewage (groundwater quality)			
			Mobilisation of suspended solids (groundwater quality)	Enabling	Moderate Adverse	Moderate
			Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	No impact	N/A

3.6 Slaidburn Road West

3.6.1 Site Setting, Topography and Hydrological Catchment

149) The site lies immediately east of the Whinny Lane East site and approximately 70 m west of the B6478 (Slaidburn Road). The site comprises a rectangular area of land situated immediately north of the east-west trending access track that joins Slaidburn Road and runs through Whinny Lane East.

150) An unnamed Ordinary Watercourse flows north to south through the west of the site and enters culvert beneath the access track along the southern site boundary. During a hydrogeological walkover survey carried out at the site in May 2020, the Ordinary Watercourse was found to be mostly dry. A further north-south trending valley feature was found in the east of the site, with some standing water present in the base of the channel.

151) The site generally slopes towards the south, from an elevation of 178 mAOD in the northwest of the site, to 171 mAOD in the site's southeast corner. The hydrological catchment for the site extends approximately 900 m north, where the ground reaches an elevation of 220 mAOD.

3.6.2 Soils and Geology

152) Soils at the site are described as slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage[31].

153) Mapped superficial geology comprises glacial till[32]. Bedrock at the site is shown to be the Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated), comprising interbedded limestone and mudstone.

154) There are no available historical borehole records close to the site to verify published geological mapping 32. At the time of writing, there were also no GI data available for the Marl Hill Section.

[31] Cranfield Soil and Agrifood Institute (2020) *op. cit.*
[32] British Geological Survey (2020a) *op. cit.*

3.6.3 Groundwater

155) There are no EA or BGS groundwater monitoring locations close to the site. There are also no available historical borehole records or GI data available at the time of writing to provide an indication of groundwater seeps, strikes, or rest water levels.

156) A hydrogeological walkover survey was carried out at the site in May 2020, during which no evidence of groundwater emergence or wet ground was observed, except in the ditches / channels.

157) However, BGS data suggests that there is potential for groundwater flooding to occur at surface level across most of the site[33]. The only exception is the far northwest of the site, where there is potential for groundwater flooding to occur to property or infrastructure situated below ground level.

3.6.4 Habitats and Vegetation

158) A Phase 1 Habitat Survey was carried out by Bowland Ecology Ltd. in February 2020[34], which was supplemented with a high-level NVC survey in April 2020[35], in conjunction with the SNIFFER WFD95 Wetland Typology methodology[36] (see Chapter 9A: Terrestrial Ecology for a detailed description of the data collected, and methodologies used for the ecology surveys).

159) The site was found to predominantly comprise poor semi-improved grassland habitats. However, three north-south trending strips of marsh / marshy grassland habitat were identified in the east, west and centre of the site, associated with drainage ditches and valleys. Within the area of marsh / marshy grassland habitat in the centre of the site, M23 *Juncus effuses / acutiflorus-Galium palustre* rush-pasture vegetation was found, which according to the UKTAG guidance, is considered to have a high to moderate groundwater dependency[37].

160) There are no ecological designations present within the site.

161) Habitat, vegetation, and wetland typology information recorded at the site is summarised in Table 9, along with groundwater dependencies assigned by the UKTAG guidance 37.

Table 9: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Slaidburn Road West

Phase 1 Habitat Type	Ecology Site ID / Location	WFD95 Wetland Type	High-level NVC Community	Groundwater Dependency [37]
B5 – marsh / marshy grassland	TR4.GW24	2a – marshy grassland	M23	High to moderate
	No ID given – small strips in the east and west of the site	N/A	N/A	N/A
B6 – poor semi-improved grassland	No ID given – throughout most of the site	N/A	N/A	N/A

3.6.5 Initial Conceptual Site Model

162) Illustration 6 shows a conceptualised cross-section running west to east through the centre of the site (Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and guideline groundwater dependencies supporting vegetation and habitats present.

163) Similar to Whinny Lane East, groundwater within the glacial till is expected to flow southwards, broadly following the topography. Throughout most of the site, the presence of low permeability soils, significant thicknesses of glacial till deposits and steeply sloping topography, likely limits recharge rates

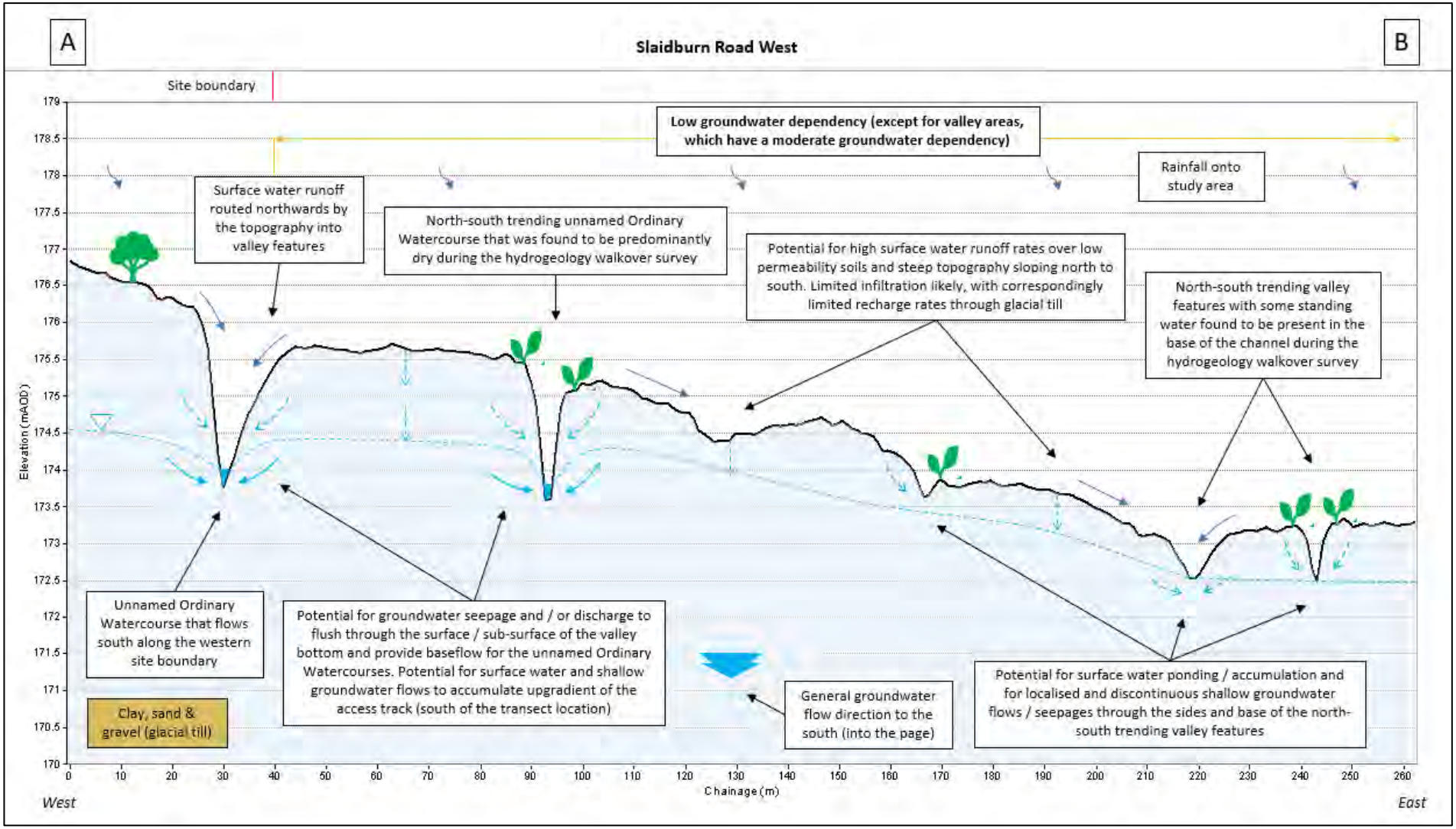
[33] British Geological Survey (2020b) *op. cit.*
[34] Bowland Ecology Ltd. (2020a) *op. cit.*
[35] Bowland Ecology Ltd. (2020b) *op. cit.*
[36] SNIFFER (2009) *op. cit.*
[37] UKTAG (2009) *op. cit.*

to the underlying superficial aquifer, such that groundwater levels are not expected to be particularly shallow. Most of the site is therefore considered to have a low groundwater dependency.

164) However, where watercourses have eroded the glacial till to create incised valley features, there is potential for both surface water runoff and localised shallow groundwater flows to discharge into these topographic lows. When the water table rises following sustained recharge events in the wider catchment, shallow groundwater emergence is possible in the base and sides of the valleys. However, groundwater contributions sustaining potential GWDTEs at the site are expected to be localised and minor. The areas of marsh habitat surrounding the valleys and ditches at the site are therefore considered to be moderately groundwater dependent.

165) Annexe 1 shows the distribution of groundwater dependency at the site. According to Chapter 7: Water Environment, the sensitivity of the GWDTE is medium to low, depending on the groundwater dependency of areas within the site.

Illustration 6: Conceptual Site Model for Slaidburn Road West



3.6.6 Assessment of Effects

167) The southern part of the site lies within the Braddup Compound access area, with the remainder of the site located upgradient of the access track in terms of groundwater flow.

Enabling Works

168) The site lies outside of the estimated dewatering zone of influence for the attenuation pond and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted (see Table 10).

169) Groundwater flow disturbance could occur due to general compaction-related construction activities, such as topsoil stripping and construction of the temporary access track. Topsoil stripping would involve excavation to a maximum depth of 0.5 m, but the impacts on groundwater flows would be direct and major in the south of the site. This would result in a Large or Moderate significance of effect, depending on the groundwater dependency of areas. Although topsoil excavation depths are limited, groundwater levels may be shallow at times (and in certain locations), such that the activity may create localised and minor upgradient dewatering effects that extend into the centre of the site. This would result in a Slight or Neutral significance of effect (also depending on the groundwater dependency). No impacts to groundwater flows are expected in the north of the site.

170) Ground disturbance due to topsoil stripping and vegetation clearance associated with the proposed access track, could also impact on groundwater quality due to mobilisation of suspended solids. Implementation of the embedded mitigation measures referred to in the CCoP would significantly reduce the likelihood of suspended solids causing a deterioration in groundwater quality at the site. However, given the consequence of such an event occurring, the risk remains high, and migration of suspended solids to the GWDTEs would result in a moderate adverse impact on groundwater quality in the south of the site. This would result in a Moderate or Slight significance of effect, depending on the groundwater dependency. The remainder of the site, which lies upgradient of the access track, is unlikely to experience any impacts on groundwater quality.

171) Accidental spills and leaks of fuels and chemicals have the potential to introduce contaminants into groundwater sustaining GWDTE habitats at the site. The embedded mitigation measures contained within the CCoP would significantly reduce the likelihood of an incident. However, if a spill or leak did occur, this would lead to a moderate adverse impact on groundwater quality in the south of the site, resulting in a Moderate or Slight significance of effect. No impacts on groundwater quality are expected upgradient of the works area.

Construction

172) The site lies outside of the calculated dewatering zones of influence for the proposed shaft, open-cut connection and overflow structures. Therefore, no impacts on groundwater levels and flows at the site due to construction phase dewatering are predicted.

173) As the temporary access crosses through the south of the site, any ground compaction caused by heavy haulage vehicles and plant, could create a barrier to groundwater flows from the north. This would represent a direct impact to shallow groundwater levels and flows, with a major magnitude of change expected. Effects with a Large or Moderate significance (depending on the groundwater dependency of areas) are therefore anticipated in the south of the site, due to the direct nature of the works footprint. The impact on upgradient groundwater flows in the remainder of the site would likely be negligible, resulting in a Neutral significance of effect.

174) Considering the embedded mitigation measures contained within the CCoP, for managing silt pollution (for suspended solids transport), and leaks and spills of fuels and chemicals, minor magnitude changes in groundwater quality could be expected in the south of the site, from use of the temporary access track during the construction phase. This would result in a Slight or Neutral significance of effect, depending on the groundwater dependency. The remainder of the site, which lies upgradient of the access track, is unlikely to experience any impacts on groundwater quality.

Operation

175) All permanent below-ground structures would be located 900 m from the site at their closest point, and no impacts to groundwater flows and levels supporting the GWDTE are therefore predicted.

Summary

176) A summary of the potential impacts to the site is provided in Table 10.

Table 10: Summary of Effects to Slaidburn Road West

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
Moderate to low	None	Medium to low	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	N/A
			Shaft dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Open-cut connection dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Overflow dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Intercept flows in short term, including ground compaction (groundwater levels / flows)	Enabling / Construction	Major Adverse	Large
			Accidental leaks / spills, of fuels and chemicals, including cement and sewage (groundwater quality)	Enabling	Moderate Adverse	Moderate
			Mobilisation of suspended solids (groundwater quality)	Enabling	Moderate Adverse	Moderate

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
			Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	No impact	N/A

3.7 Thornbers

3.7.1 Site Setting, Topography and Hydrological Catchment

177) The site comprises a northeast-southwest trending strip of land immediately east of the B6478 (Slaidburn Road). The elevation of the site ranges from 184 mAOD in the northeast, to 172 mAOD in the southwest.

178) An unnamed Ordinary Watercourse flows south approximately 20 m west of the site and immediately west of Slaidburn Road. The Ordinary Watercourse enters a culvert beneath the B6478 and continues to flow south along the southern site boundary. Ordnance Survey maps show a small tributary of the Ordinary Watercourse issuing in the northwest of the site, which flows southwest and then 'sinks' beneath Slaidburn Road.

179) The hydrological catchment for the site extends some 415 m north, to the Slaidburn Road / Mill Lane road junction, where the ground reaches an elevation of 200 mAOD.

3.7.2 Soils and Geology

180) Soils at the site are described as slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage[38].

181) Geological mapping indicates that the site is underlain by superficial deposits of glacial till, comprising clay, sand and gravel[39]. Bedrock at the site is the Clitheroe Limestone Formation and Hodder Mudstone Formation (Undifferentiated), comprising interbedded limestone and mudstone.

182) One historical BGS borehole record is located 70 m south of the site, but no lithological information is provided[40]. At the time of writing, there were also no GI data available for the Marl Hill Section.

3.7.3 Groundwater

183) There are no EA or BGS groundwater monitoring locations close to the site. There were also no GI data available at the time of writing to provide an indication of groundwater seeps, strikes, or rest water levels. The historical BGS borehole record noted the presence of a spring and catch-pit located 70 m south and downgradient of the site.

184) The site was added to the assessment following an update to habitat mapping that took place after hydrogeological walkover surveys had been completed. Consequently, no hydrogeological survey was undertaken for this site.

[38] Cranfield Soil and Agrifood Institute (2020) *op. cit.*
[39] British Geological Survey (2020a) *op. cit.*

185) There are no springs shown on Ordnance Survey maps within the site or its immediate vicinity, but the small tributary of the Ordinary Watercourse is shown to issue in the northwest of the site, which could indicate shallow groundwater emergence in this area.

186) BGS data suggests that there is potential for groundwater flooding to occur at surface level across most of the site[40]. The only exception is the far northeast of the site, where there is potential for groundwater flooding to occur to property or infrastructure situated below ground level.

3.7.4 Habitats and Vegetation

187) Phase 1 Habitat, high-level NVC, and SNIFFER WFD95 Wetland Typology surveys[41], were carried out by Bowland Ecology Ltd. in April 2020[42]. A detailed description of the data collected, and methodologies used for the ecology surveys can be found in Chapter 9A: Terrestrial Ecology.

188) Habitat, vegetation, and wetland typology information recorded at the site is summarised in Table 11, along with groundwater dependencies assigned by the UKTAG guidance[43].

Table 11: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Thornbers

Phase 1 Habitat Type	Ecology Site ID / Location	WFD95 Wetland Type	High-level NVC Community	Groundwater Dependency [43]
B5 – marsh / marshy grassland	TR4.GW23	2a – marshy grassland	M23 / MG10	High to moderate / Moderate

189) Marsh / marshy grassland habitat was recorded throughout the site, comprising a mosaic of M23 *Juncus effuses / acutiflorus-Galium palustre* rush-pasture and MG10 *Holcus lanatus-Juncus effusus* rush-pasture vegetation. According to the UKTAG guidance, these plant communities have a high to moderate and moderate groundwater dependency, respectively[44].

190) There are no ecological designations present within the site.

3.7.5 Initial Conceptual Site Model

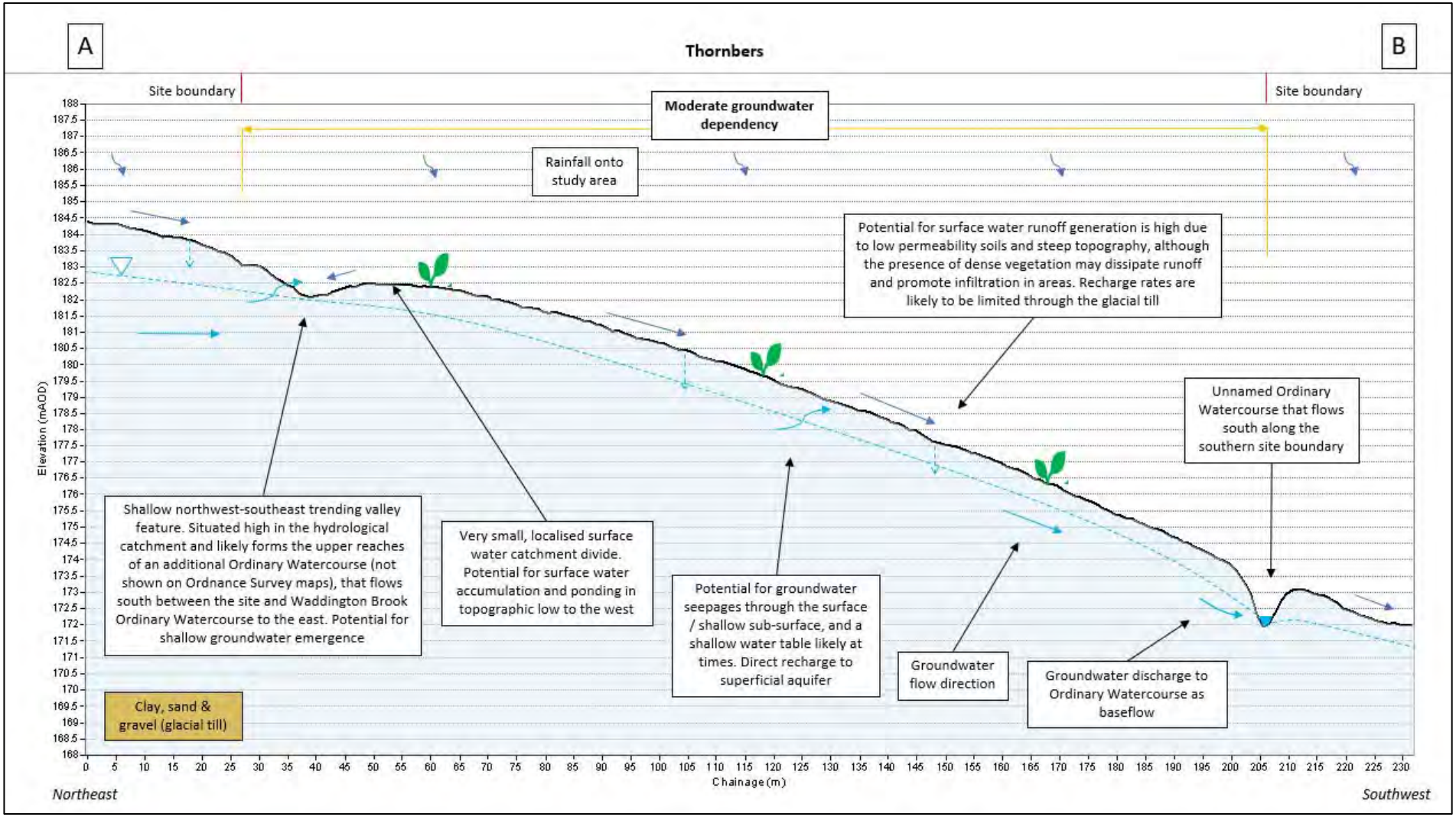
191) Illustration 7 shows a conceptualised cross-section running northeast to southwest through the centre of the site (Section A-B). The CSM highlights the indicative movement of groundwater and surface water through the site, and groundwater dependencies supporting vegetation and habitats present.

192) Shallow groundwater within the superficial aquifer is likely to be primarily recharged by incident rainfall within the wider catchment. Groundwater within the glacial till is expected to flow southwards, broadly following the topography, to provide baseflow inputs to the unnamed Ordinary Watercourse present along the southern site boundary. Groundwater levels may also be shallow throughout most of the site, with the slight drop in topography in the north promoting shallow groundwater emergence in the form of seepages. Given the nature of the topography in this area, there is potential for a flushing mechanism through the surface / shallow subsurface, which could sustain groundwater dependent vegetation at the site. However, surface water runoff generation is also likely to be high, with limited infiltration rates, and based on the likely combination of both surface water and shallow groundwater flows downslope, the site is considered to have moderate groundwater dependency.

193) Annexe 1 shows the distribution of groundwater dependency at the site. In accordance with Chapter 7: Water Environment, the sensitivity of the GWDTE is medium.

[40] British Geological Survey (2020b) *op. cit.*
[41] SNIFFER (2009) *op. cit.*
[42] Bowland Ecology Ltd. (2020b) *op. cit.*
[43] UKTAG (2009) *op. cit.*
[44] UKTAG (2009) op. cit.

Illustration 7: Conceptual Site Model for Thornbers



3.7.6 Assessment of Effects

195) The site lies 9 m east of the Braddup Compound access area and across-gradient in terms of groundwater flow. The B6478 (Slaidburn Road) and the unnamed watercourse 436 separate the site from the proposed new access track.

Enabling Works

196) The site lies outside of the estimated dewatering zone of influence for the attenuation pond and is not downgradient of the activity. Therefore, no impacts on groundwater flows or levels at the site due to dewatering are predicted (see Table 12).

197) Groundwater flow disturbance could occur due to compaction-related construction activities and earthworks that do not require dewatering, i.e. topsoil stripping and construction of the temporary access track. Topsoil stripping would involve excavation to a maximum depth of 0.5 m, at a distance of 9 m from the western site boundary. Given local groundwater flow directions in the area, and the site's location across-gradient from the direct works footprint and on the other side of the unnamed watercourse 436, no impacts on groundwater levels and flows are expected to the GWDTE.

198) Similarly, as the site is situated across-gradient from the compound access area, any changes to groundwater quality within the works footprint, for e.g. due to accidental leaks or spills of fuels and chemicals, and / or mobilisation of suspended solids, are not expected to impact groundwater quality at the site.

Construction

199) The site lies outside of the calculated dewatering zones of influence for the proposed shaft, open-cut connection and overflow structures. Therefore, no impacts on groundwater levels and flows at the site due to construction phase dewatering are predicted.

200) In addition, the proposed access road lies 9 m across-gradient from the western site boundary and on the other side of the unnamed watercourse 436, and no impacts on groundwater quality (i.e. from a release of suspended solids and / or leaks of fuels and chemicals) are therefore expected at the site.

Operation

201) There are no permanent below ground structures proposed within the vicinity of the site to locally alter groundwater levels and flows supporting GWDTEs. No impacts to the site are therefore predicted.

Summary

202) A summary of the potential impacts to the site is provided in Table 12.

Table 12: Summary of Effects to Thornbers

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
Moderate	None	Medium	Attenuation pond dewatering (groundwater levels / flows)	Enabling	No impact	N/A
			Shaft dewatering (groundwater levels / flows)	Construction	No impact	N/A

Groundwater Dependency	Ecological Designation	Sensitivity	Effect Type	Phase	Highest Magnitude of Impact	Highest Significance of Effect
			Open-cut connection dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Overflow dewatering (groundwater levels / flows)	Construction	No impact	N/A
			Intercept flows in short term, including ground compaction (groundwater levels / flows)	Enabling	No impact	N/A
			Accidental leaks / spills, of fuels and chemicals, including cement and sewage (groundwater quality)	Enabling / Construction	No impact	N/A
			Mobilisation of suspended solids (groundwater quality)	Enabling / Construction	No impact	N/A
			Intercept flows in long term, i.e. loss of aquifer storage, backfilling materials, and ground settlement in superficial deposits (groundwater levels / flows)	Operation	No impact	N/A

3.8 Other Potential GWDTEs

203) In addition to the GWDTEs assessed above, there are nine potential sites located in the overarching GWDTE assessment area (see Chapter 7: Water Environment). No CSMs have been developed for these additional sites because they are considered unlikely to experience direct or indirect significant effects as a result of the Proposed Marl Hill Section. Whilst these potential GWDTEs have not been assessed individually, they are listed in Table 13. Annexe 1 shows their locations.

Table 13: Potential Sites in the Overarching GWDTE Assessment Area

Phase 1 Habitat Type	Ecology Site ID / Location	Relation to Scheme / General Comments
B5 (Marsh / marshy grassland)	TR4.GW7	A small area of marsh located 150 m north of the access area for the Bonstone Compound and 85 m north of the Blue Gates site
B5 (Marsh / marshy grassland)	TR4.GW12 and TR4.GW14	Large area of marsh to the east of Braddup Farm, and situated 60 m west of the Braddup Compound at its closest point
B5 (Marsh / marshy grassland)	TR4.GW13	Small area of marsh southwest of TR4.GW14, and situated 180 m southwest of the Braddup Compound
B5 (Marsh / marshy grassland)	TR4.GW16	Area of marsh 100 m northeast of the Braddup Compound at its closest point
B5 (Marsh / marshy grassland)	TR4.GW18	Small area of marsh located 80 m east of the Braddup Compound at its closest point
B5 (Marsh / marshy grassland)	TR4.GW19	Small area of marsh to the south of TR4.GW18 and situated 80 m east of the Braddup Compound at its closest point
B5 (Marsh / marshy grassland)	TR4.GW21	Area of marsh located 35 m south of the access area for the Braddup Compound, and approximately 300m west of the B6478 (Slaidburn Road)
B5 (Marsh / marshy grassland)	TR4.GW22	Small area of marsh located 125 m west of the B6478 (Slaidburn Road), and 90m north of the access for Braddup Compound
B5 (Marsh / marshy grassland)	TR4.GW25 and TR4.GW26	Area of marsh located 160 m south of the access area for the Braddup Compound, and approximately 300 m west of the B6478 (Slaidburn Road)

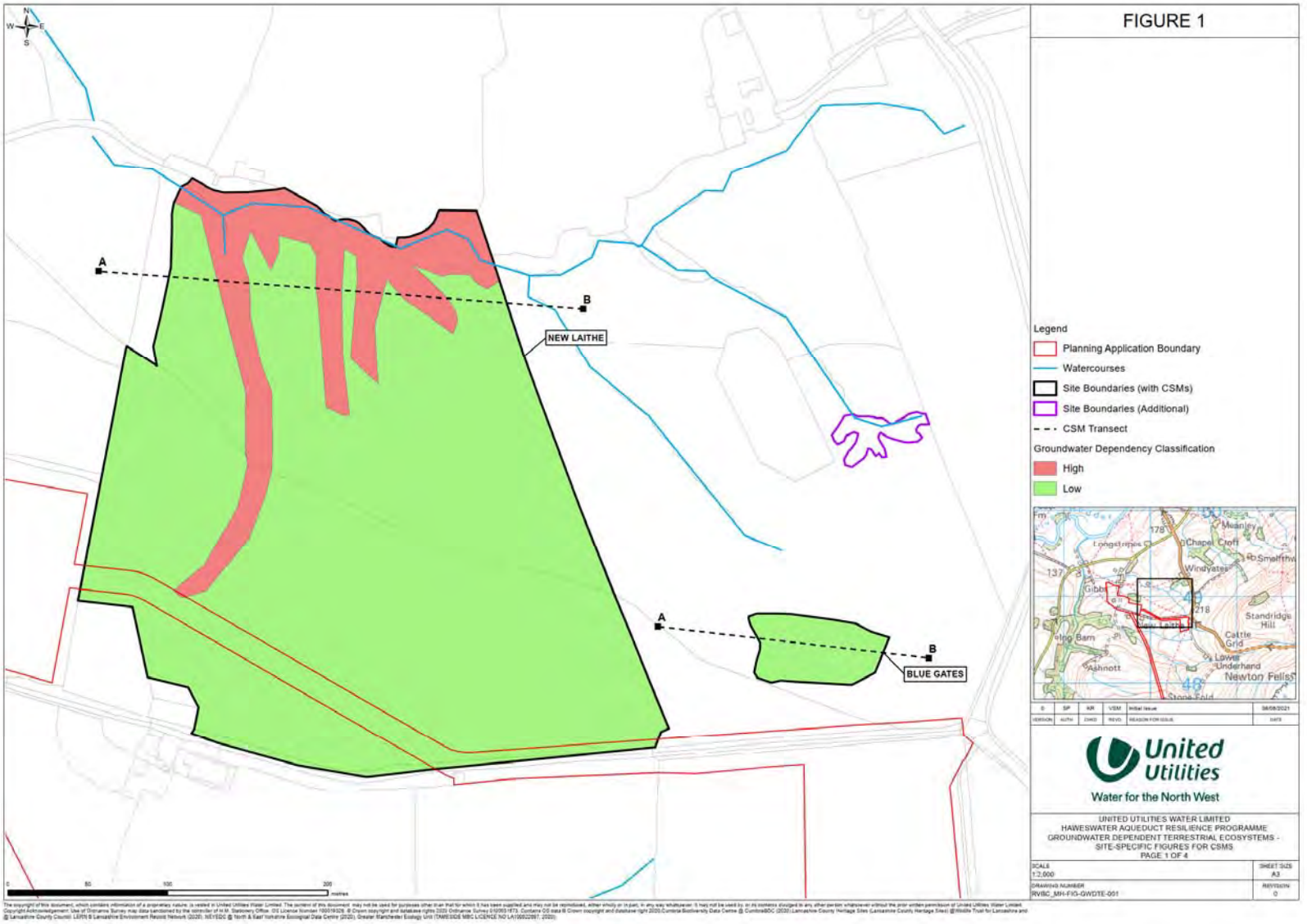
4. Summary of Effects

204) A summary of the initial assessment of groundwater dependency of each GWDTE and the associated magnitudes of impacts to existing groundwater levels, flows, and quality is provided in Table 14.

Table 14: Summary of Effects to GWDTEs for the Proposed Marl Hill Section

Site	Initial Assessment of Groundwater Dependency	Sensitivity	Highest Magnitude of Impact			Highest Significance of Effect		
			Enabling	Construction	Operation	Enabling	Construction	Operation
New Laithe	High to low	Medium to low	Major Adverse	Major Adverse	No impact	Large	Large	N/A
Blue Gates	Low	Low	Negligible	Negligible	No impact	Neutral	Neutral	N/A
Braddup House	Low	Low	Major Adverse	Major Adverse	Moderate Adverse	Large	Large	Slight
Whinny Lane West	Moderate	Medium	No impact	No impact	No impact	N/A	N/A	N/A
Whinny Lane East	Moderate to low	Medium to low	Major Adverse	Major Adverse	No impact	Large	Large	N/A
Slaidburn Road West	Moderate to low	Medium to low	Major Adverse	Major Adverse	No impact	Large	Large	N/A
Thornbers	Moderate	Medium	No impact	No impact	No impact	N/A	N/A	N/A

Annexe A: Site-specific Figures for CSMs



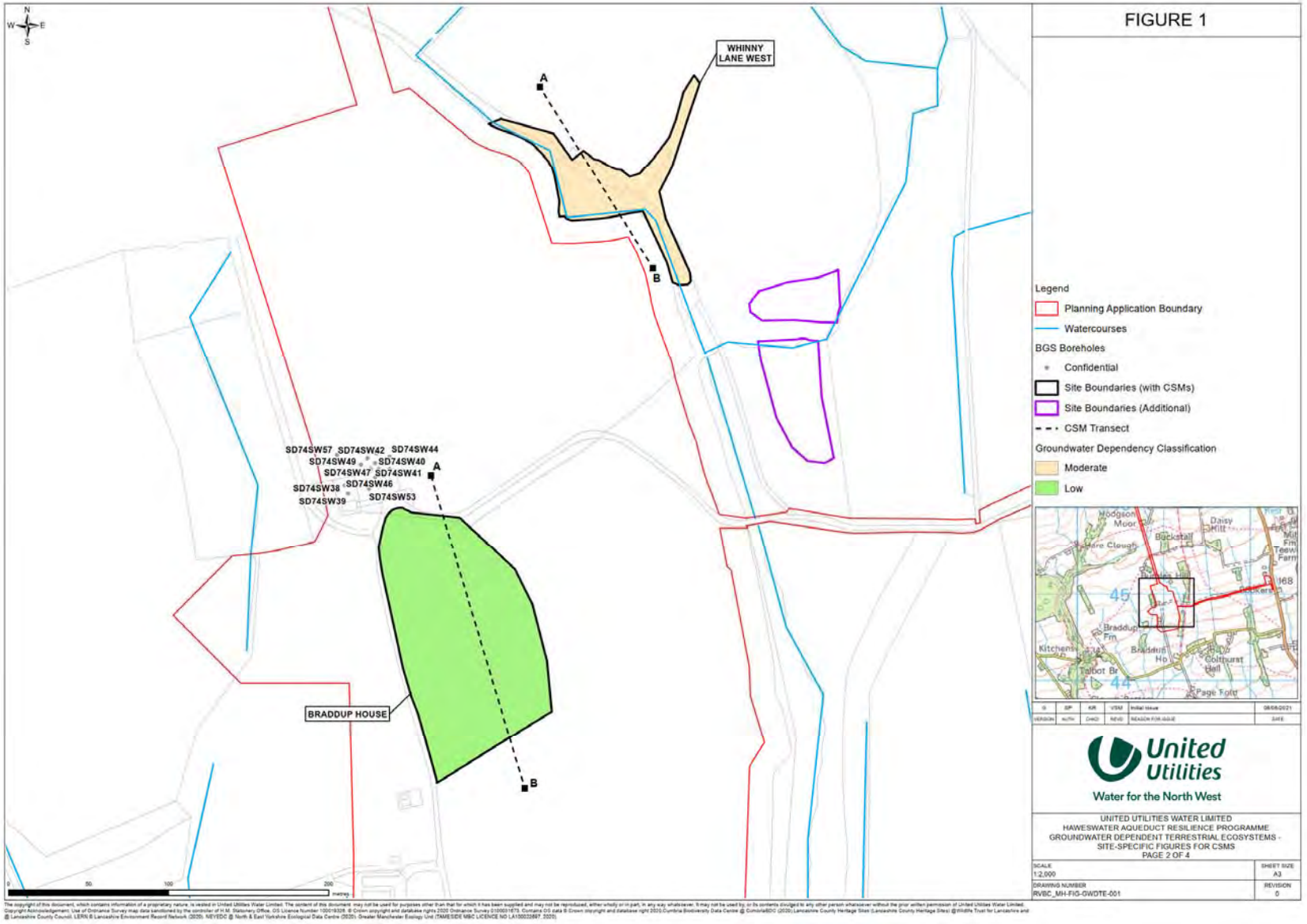


FIGURE 1
WHINNY LANE WEST
BRADDUP HOUSE
A
B
SD74SW57 SD74SW42 SD74SW44
SD74SW49 SD74SW40
SD74SW47 SD74SW41
SD74SW38 SD74SW46
SD74SW39 SD74SW53
Legend
Planning Application Boundary
Watercourses
BGS Boreholes
Confidential
Site Boundaries (with CSMs)
Site Boundaries (Additional)
CSM Transect
Groundwater Dependency Classification
Moderate
Low
United Utilities
Water for the North West
UNITED UTILITIES WATER LIMITED
HAWESWATER AQUEDUCT RESILIENCE PROGRAMME
GROUNDWATER DEPENDENT TERRESTRIAL ECOSYSTEMS -
SITE-SPECIFIC FIGURES FOR CSMS
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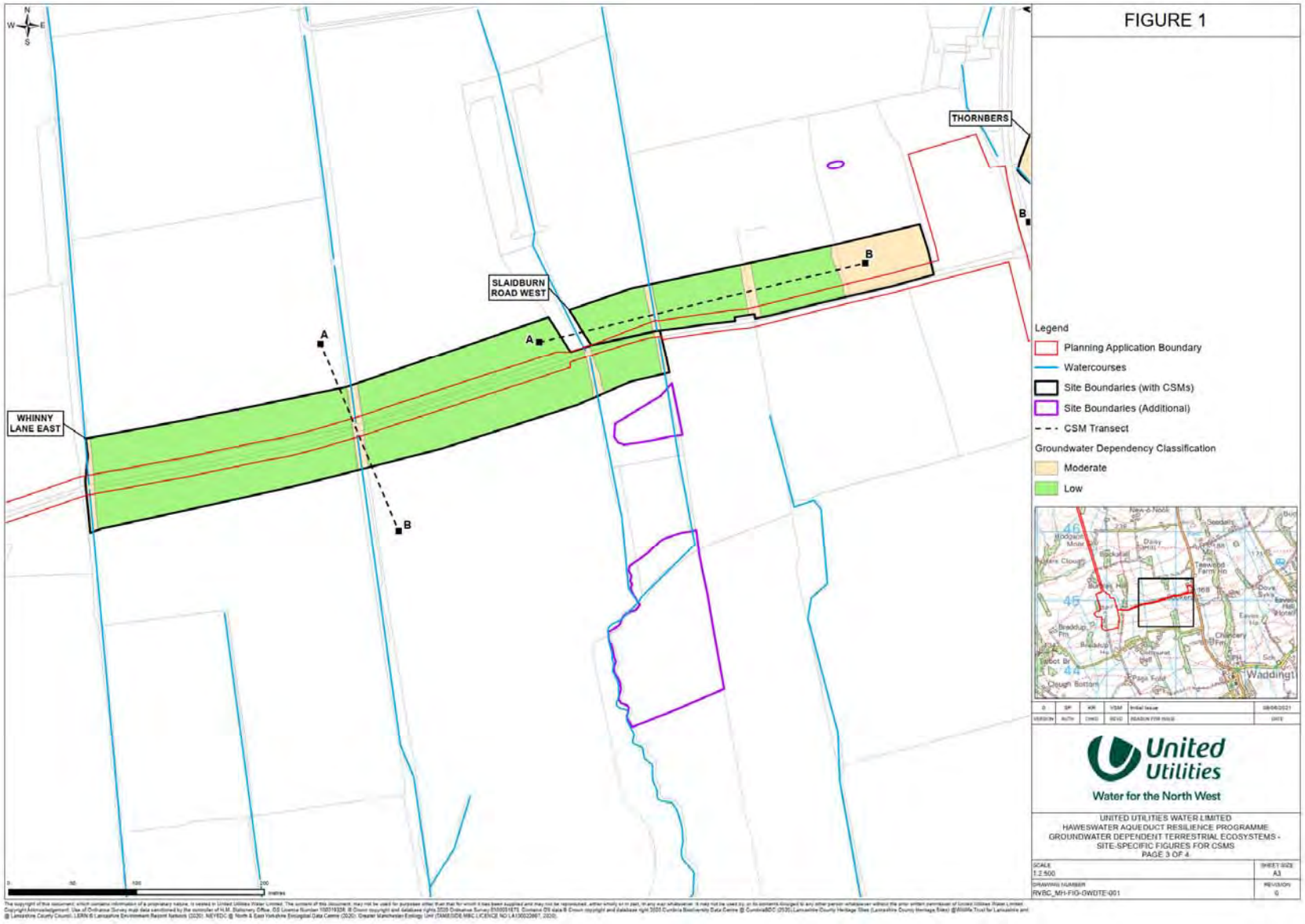
FIGURE 1
THORNBERS
SLAIDBURN ROAD WEST
WHINNY LANE EAST
A
B
Legend
Planning Application Boundary
Watercourses
Site Boundaries (with CSMs)
Site Boundaries (Additional)
CSM Transect
Groundwater Dependency Classification
Moderate
Low
United Utilities
Water for the North West
UNITED UTILITIES WATER LIMITED
HAWESWATER AQUEDUCT RESILIENCE PROGRAMME
GROUNDWATER DEPENDENT TERRESTRIAL ECOSYSTEMS - SITE-SPECIFIC FIGURES FOR CSMS
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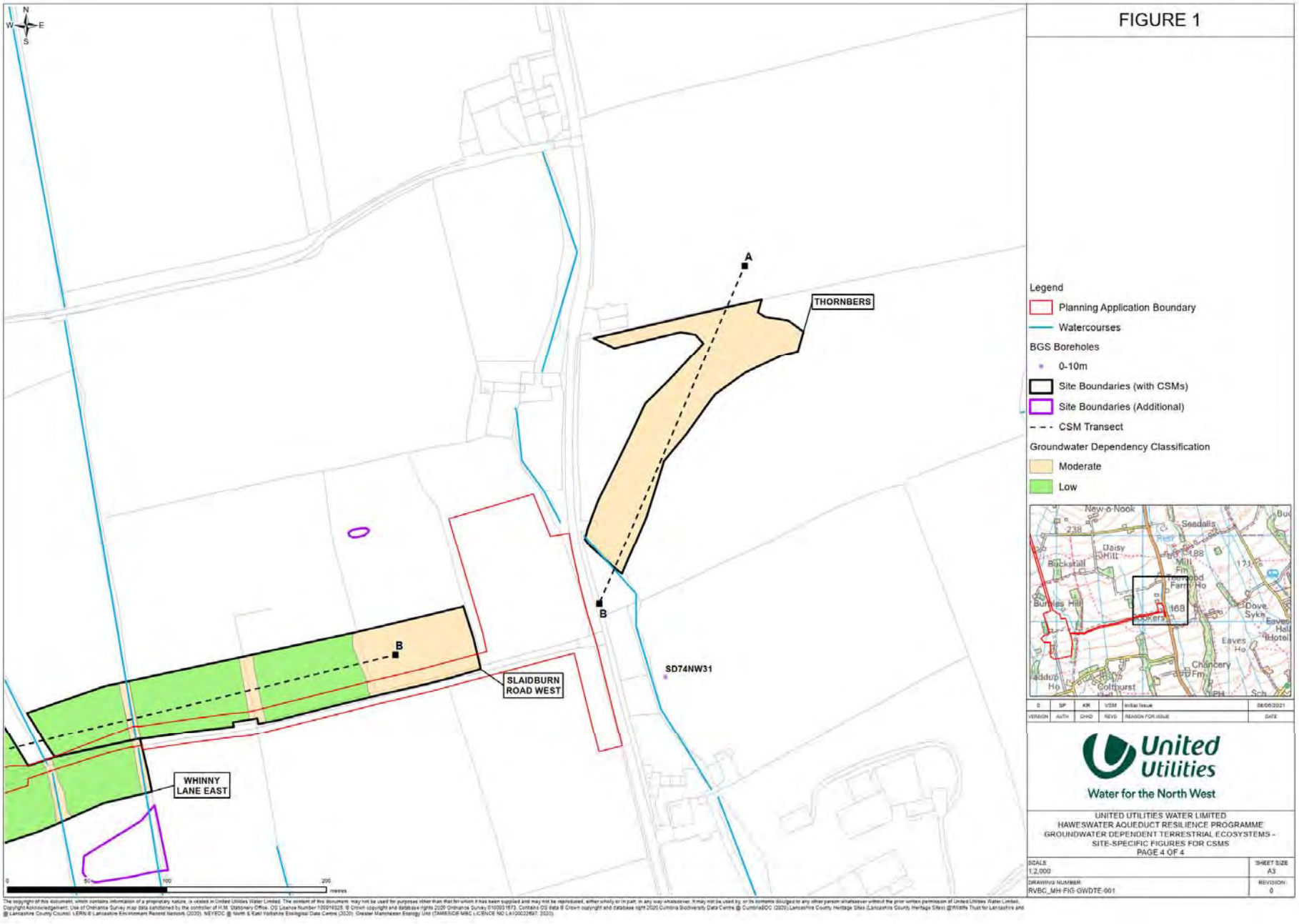
FIGURE 1
THORNBERS
SLAIDBURN ROAD WEST
WHINNY LANE EAST
SD74NW31
A
B
B
Legend
Planning Application Boundary
Watercourses
BGS Boreholes
0-10m
Site Boundaries (with CSMs)
Site Boundaries (Additional)
CSM Transect
Groundwater Dependency Classification
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Low
United Utilities
Water for the North West
UNITED UTILITIES WATER LIMITED
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PAGE 4 OF 4
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