



**Haweswater Aqueduct Resilience Programme - Proposed Bowland
Section**

Environmental Statement

Volume 4

Appendix 7.7: Shaft Dewatering Calculation

June 2021



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Shaft Calculations

General parameters		
Parameter	Value	Source
Sichardt constant (C)	3000	Preene <i>et al</i> (2016)
Drawdown factor	0.5	To account for limited time of open excavation in shafts

Shaft parameters	Lower Houses Compound Reception Shaft			Newton-in-Bowland Compound Portal			Units	Source
	Intermediate depth	Intermediate depth	Total depth	Intermediate depth	Intermediate depth	Total depth		
Depth	4	7.5	10.5	1.5	6	11	m BGL	T03/A depth taken from Costain (2020). Portal depth taken from construction drawings (ref)
	184.60	181.10	178.10	182.20	177.70	172.70	m AOD	
Shaft ground level	188.60	188.60	188.60	183.7	183.7	183.7	m AOD	Costain (2020)
Groundwater level	1.00	1.00	1.00	1.00	1.00	1.00	m BGL	No relevant GI available - assumed high rest levels (T03/A)
Open face height	2	2	2	0.50	5.00	10.00	m	Costain briefing
Shaft diameter/Face width	15	15	15	30	30	30	m	Costain (2020) for T03/A. Rough portal width taken from construction drawings (ref)
Horizontal hydraulic conductivity (Kh)	2.00E-06	2.00E-08	2.00E-08	2.00E-06	6.00E-06	6.00E-06	m/s	Preliminary GI data (2020) where possible, otherwise generic parameters
K data source	Superficials depth indicated by BH03 from Preliminary GI data (2020). Generic value for Till (clay with cobbles and boulders) provided by Domenico et al (1990) - higher end of the range used	Preliminary GI data (2020) - Mudstone (based on BH03). No relevant Packer test or Geophysics data. Generic value for Shale from Domenico et al (1990), increased one order magnitude as Secondary A aquifer.	Preliminary GI data (2020) - Mudstone (based on BH03). No relevant Packer test or Geophysics data. Generic value for Shale from Domenico et al (1990), increased one order magnitude as Secondary A aquifer.	Superficials depth indicated by BH021 Preliminary GI data (2020). Generic value for Till (clay with cobbles and boulders) provided by Domenico et al (1990) - higher end of the range used	Preliminary GI data (2020) - Limestone (based on BH021). No relevant Packer test or Geophysics data. Generic value for Limestone from Domenico et al (1990) - higher end of the range used	Preliminary GI data (2020) - Limestone (based on BH021). No relevant Packer test or Geophysics data. Generic value for Limestone from Domenico et al (1990) - higher end of the range used		
K anisotropy factor	10	10	10	10	10	10		Based on horizontal/sub-horizontal layered mudstone and siltstone.

Summary Table

Location	Shaft ID	Shaft diameter (m)	Shaft depth (m)	Original groundwater level (m BGL)	Construction stage	Depth (m BGL)	Radius of influence (Ro) (m)	Total groundwater inflow (horizontal + vertical) (m3/d)	Total groundwater inflow (horizontal + vertical) (l/s)
Lower House Compound	Reception Shaft	30	10.5	1	Intermediate depth (bedrock)	4.0	6.36	8.42	0.0974
				1	Intermediate depth (bedrock)	7.5	1.38	0.48	0.0056
				1	Total depth (bedrock)	10.5	2.02	0.53	0.0061
Newton-in-Bowland	Compound Portal	30	11	1	Intermediate depth (superficials)	1.5	2.12	0.61	0.0071
				1	Intermediate depth (bedrock)	6.0	36.74	10.58	0.1225
				1	Total depth (bedrock)	11.0	73.48	21.16	0.2449