Appendix A10.4: Surface Water Indirect Dewatering Assessment

1 Introduction

1.1.1 This appendix provides an assessment of the expected dewatering impacts on surface water features present within the study area, supporting Chapter 10 (Geology, Soils and Groundwater). Data were obtained from review of current maps and the Advanced and preliminary GI.

1.1.2 The assessment has been carried out in two stages. The initial screening considers the potential impacts on all surface water features within the potential zone of influence of dewatering at excavations (including cuttings, widenings and drainage detention basins) and is deemed conservative. A detailed assessment was then carried out for all potential impacts identified as of Moderate significance or larger in the initial conservative screening.

2 Initial Screening

2.1.1 The initial screening is based on simple estimates of the zone of influence of dewatering (Sichardt Method) around each excavation considered likely to intercept groundwater, consistent with the approach defined in Chapter 10 (paragraph 10.4.18). The magnitude of impact has been derived based on the expected groundwater drawdown at the location of the surface water feature. It was assumed that a degree of hydraulic conductivity exists between groundwater and the surface water receptor. The significance of impact was derived based on the methodology described in Chapter 10, Section 10.2 (Approach and Methods) The outcome of the initial assessment is presented in Table 1.

Table 1: Initial Screening of Cutting Impacts on Surface Water Features

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
CS21	86	low	negligible	Neutral
CS21	87	low	minor	Slight
CH16	88	low	minor	Neutral
W16	88	low	minor	Slight
CP19	88	low	negligible	Neutral
CP2	89	low	negligible	Neutral
CP2	90	low	negligible	Neutral
W3	92	low	negligible	Neutral
W3	93	low	negligible	Neutral
C3	97	low	minor	Neutral

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
C3	98	low	moderate	Slight
C7	98	low	minor	Neutral
C5	98	low	minor	Neutral
C6	99	low	Minor	Neutral
C8	98	low	negligible	Neutral
CP3	98	low	negligible	Neutral
CP4	98	low	negligible	Neutral
C6	99	low	negligible	Neutral
C8	99	low	negligible	Neutral
CS3	99	low	negligible	Neutral
W5	100	very high	negligible	Neutral
W6	100	very high	minor	**Moderate/Large**
W9	100	very high	negligible	Neutral
W12	100	very high	negligible	Neutral
W14	100	very high	negligible	Neutral
W15	100	very high	negligible	Neutral
W16	100	very high	negligible	Neutral
W19	100	very high	negligible	Neutral
W22	100	very high	major	**Very Large**
C3	100	very high	negligible	Neutral
C6	100	very high	minor	**Moderate/Large**
C8	100	very high	negligible	Neutral
CS1	100	very high	negligible	Neutral
CS2	100	very high	negligible	**Neutral**
CS3	100	very high	minor	**Moderate/Large**
CS5	100	very high	minor	**Moderate/Large**
CS7	100	very high	negligible	**Neutral**
CS12	100	very high	moderate	**Large/Very Large**
CS16	100	very high	major	**Very Large**
CS20	100	very high	negligible	Neutral

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
CS30	100	very high	negligible	Neutral
CP4	100	very high	negligible	Neutral
CP8	100	very high	major	**Very Large**
CP11	100	very high	negligible	Neutral
CP12	100	very high	negligible	Neutral
CP13	100	very high	negligible	Neutral
CP17	100	very high	negligible	Neutral
CP19	100	very high	negligible	Neutral
CP20	100	very high	negligible	Neutral
CH13	100	very high	negligible	Neutral
CH16	100	very high	negligible	Neutral
CS2	101	low	negligible	Neutral
CS3	101	low	moderate	Slight
W5	102	low	minor	Neutral
W22	102	low	minor	Neutral
CS2	102	low	negligible	Neutral
CS3	102	low	negligible	Neutral
CS4	102	low	negligible	Neutral
CS5	102	low	minor	Neutral
CS12	102	low	negligible	Neutral
CP8	102	low	negligible	Neutral
W5	103	low	minor	Neutral
W22	103	low	major	Slight/Moderate
CS3	103	low	negligible	Neutral
CS4	103	low	negligible	Neutral
CS7	103	low	negligible	Neutral
CS12	103	low	moderate	Slight
CP8	103	low	moderate	Slight
W5	104	low	negligible	Neutral
W22	104	low	major	Slight/Moderate

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
CS7	104	low	negligible	Neutral
CS12	104	low	moderate	Slight
CP8	104	low	major	Slight/Moderate
W22	105	low	major	Slight/Moderate
CS7	105	low	minor	Neutral
CS12	105	low	minor	Neutral
CP8	105	low	major	Slight/Moderate
W22	106	low	major	Slight/Moderate
CP8	106	low	major	Slight/Moderate
W6	107	low	negligible	Neutral
W22	107	low	major	Slight/Moderate
CP8	107	low	moderate	Slight
W6	108	low	moderate	Slight
W6	109	low	moderate	Slight
W6	110	low	moderate	Slight
W6	111	low	moderate	Slight
W6	112	low	moderate	Slight
W6	113	low	moderate	Slight
W6	114	low	moderate	Slight
CP10	115	low	negligible	Neutral
CS29	115	low	negligible	Neutral
W6	115	low	negligible	Neutral
W9	119	low	minor	Neutral
W9	120	low	minor	Neutral
CP11	120	low	negligible	Neutral
CS30	120	low	negligible	Neutral
W9	121	low	minor	Neutral
CP11	121	low	negligible	Neutral
CS30	121	low	negligible	Neutral
CP13	123	low	negligible	Neutral

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
W11	128	low	negligible	Neutral
CS14	128	low	negligible	Neutral
W11	129	low	negligible	Neutral
W12	131	low	negligible	Neutral
CS15	131	low	minor	Neutral
W12	132	low	minor	Neutral
CS15	132	low	minor	Neutral
CH9	132	low	negligible	Neutral
W12	133	low	moderate	Slight
CS15	133	low	minor	Neutral
CH9	133	low	negligible	Neutral
CH33	133	low	minor	Neutral
W12	134	low	moderate	Slight
CS15	134	low	minor	Neutral
CP15	134	low	negligible	Neutral
CH9	134	low	negligible	Neutral
CP15	135	low	negligible	Neutral
CS15	135	low	negligible	Neutral
W12	135	low	minor	Neutral
W12	136	low	moderate	Slight
CS15	136	low	minor	Neutral
CP15	136	low	minor	Neutral
W12	137	low	minor	Neutral
CP15	137	low	minor	Neutral
W12	138	low	moderate	Slight
CP15	138	low	minor	Neutral
CH33	138	low	negligible	Neutral
W12	139	low	moderate	Slight
CH27	140	low	negligible	Neutral

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
W12	140	low	moderate	Slight
W12	141	low	moderate	Slight
W12	142	low	minor	Neutral
CP17	143	low	negligible	Neutral
CS16	143	low	minor	Neutral
W14	143	low	negligible	Neutral
CH13	144	low	negligible	Neutral
CP17	144	low	negligible	Neutral
W14	144	low	minor	Neutral
CS16	144	low	major	Slight/Moderate
CH13	145	low	minor	Neutral
W14	145	low	minor	Neutral
CS16	145	low	major	Slight/Moderate
W14	146	low	negligible	Neutral
CS16	146	low	major	Slight/Moderate
CH13	146	low	moderate	Slight
W14	147	low	minor	Neutral
W21	147	low	minor	Neutral
CS16	147	low	major	Slight/Moderate
CH12	147	low	minor	Neutral
CH13	147	low	moderate	Slight
W14	148	low	negligible	Neutral
W21	148	low	minor	Neutral
CH11	148	low	minor	Neutral
CS16	148	low	major	Slight/Moderate
CH12	148	low	minor	Neutral
CH13	148	low	negligible	Neutral
W21	149	low	negligible	Neutral
CS16	149	low	major	Slight/Moderate

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
W15	150	low	minor	Neutral
CS16	150	low	moderate	Slight
W15	151	low	minor	Neutral
W15	152	low	negligible	Neutral
W16	153	low	negligible	Neutral
W16	154	low	moderate	Slight
CP19	154	low	negligible	Neutral
W16	155	low	moderate	Slight
W23	155	low	minor	Neutral
CS17	155	low	negligible	Neutral
CH16	155	low	minor	Neutral
W23	156	low	minor	Neutral
CS17	156	low	negligible	Neutral
W23	157	low	minor	Neutral
CP20	157	low	negligible	Neutral
W23	158	low	minor	Neutral
W18	158	low	negligible	Neutral
CS19	158	low	negligible	Neutral
CP20	158	low	negligible	Neutral
CP21	158	low	negligible	Neutral
W18	159	low	negligible	Neutral
W19	159	low	minor	Neutral
CS20	159	low	moderate	Slight
W18	160	low	minor	Neutral
CS20	160	low	moderate	Slight
CS39	160	low	negligible	Neutral
W18	161	low	negligible	Neutral
CS20	161	low	moderate	Slight
CS20	162	low	negligible	Neutral

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
W19	163	low	minor	Neutral
W19	164	low	minor	Neutral
W16	167	low	minor	Neutral
CP19	167	low	negligible	Neutral
CH16	167	low	minor	Neutral
W9	169	low	negligible	Neutral
W22	171	low	moderate	Slight
CP8	171	low	major	Slight/Moderate
W22	172	low	moderate	Slight
CS3	172	low	negligible	Neutral
CS12	172	low	minor	Neutral
CP8	172	low	moderate	Slight
W22	173	low	minor	Slight
CS2	173	low	negligible	Neutral
CS3	173	low	negligible	Neutral
CS5	173	low	minor	Neutral
CS12	173	low	negligible	Neutral
CP8	173	low	negligible	Neutral
CS2	174	low	negligible	Neutral
CS3	174	low	minor	Neutral
C8	176	low	negligible	Neutral
CS2	176	low	negligible	Neutral
CS3	176	low	negligible	Neutral
C6	178	low	negligible	Neutral
C8	178	low	minor	Neutral
CS1	178	low	negligible	Neutral
CP11	189	low	negligible	Neutral
W9	189	low	minor	Neutral
CH8	190	low	negligible	Neutral

Cutting ID	Water Feature ID	Sensitivity of Receptor	Initial screening magnitude of Impact	Initial screening significance of Impact
CP11	190	low	negligible	Neutral
CS30	190	low	negligible	Neutral
W9	190	low	minor	Neutral

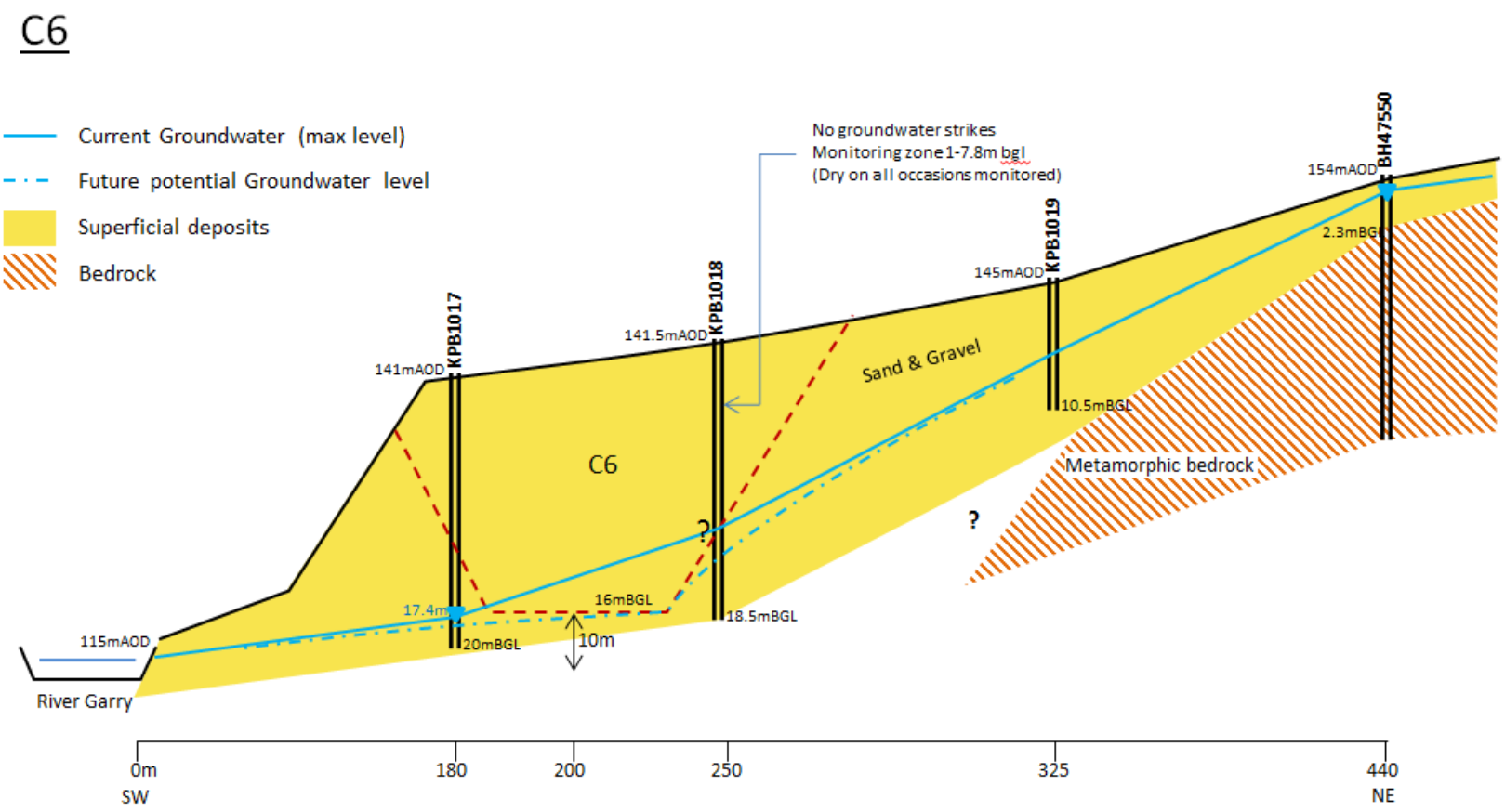
2.1.2 The initial conservative screening identified potential impacts of Moderate or greater significance onto one surface water feature (ID 100 - River Garry) which may be impacted as a result of dewatering at a number of cutting / widening locations: C6, W6, W22, CS3, CS5, CS12, CS16 and CP8.

3 Detailed Assessment

3.1.1 The detailed assessments for each of these cuttings are described below. The assessments aimed to identify whether a significant impact was likely considering the specific local circumstances and a more refined estimate of the potential magnitude of that impact. These detailed assessments were based on consideration of all available relevant information, primarily available GI, groundwater level monitoring data and the local topography. The significance of impact was then predicted based on the methodology described in Chapter 10, Section 10.2 (Approach and Methods).

Cutting C6 – River Garry (ch3840-3990, Figure 10.1b)

Diagram 1: Cross Section for C6 – River Garry



3.1.2 Cutting C6 is a 16m deep cut section to the south of the existing A9, at Aldclune junction. It will be excavated in permeable superficial sand and gravel deposits, which are underlain by metamorphic bedrock of anticipated low permeability.

3.1.3 The River Garry is located approximately 200m from the centre of C6 and at an elevation approximately 10m below it.

3.1.4 The GI information suggests that the cutting will only intercept groundwater to a limited degree, in particular in the southwestern part of the cutting, and very limited drawdown would be expected. Consequently, no impact is expected on the River Garry and groundwater baseflow contribution.

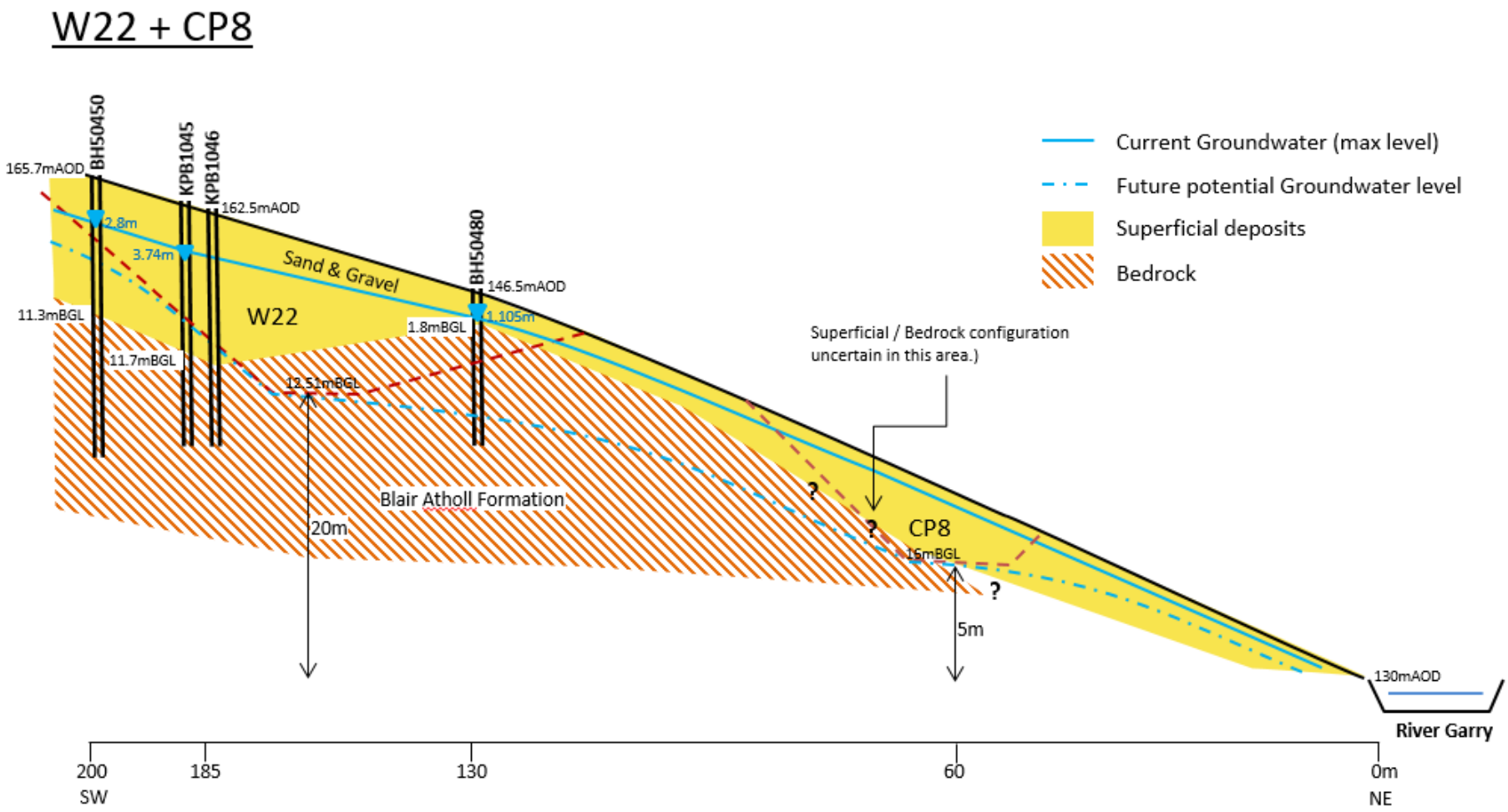
Widening W6 – River Garry (ch7200-8730, Figure 10.c-d)

3.1.5 Widening W6 is a 1.5km long widening section that will widen the road platform to the south of the existing A9. It will be excavated in permeable superficial sand and gravel deposits, which are underlain by metamorphic bedrock of anticipated low permeability and 'very limited to no' groundwater drawdown would be expected. Consequently, no impact is expected on the River Garry in this area.

3.1.6 There is a greater potential for impact towards the eastern end of W6, where the available GI information indicates that groundwater levels are closer to ground level. Around chainage ch7550 the River Garry is located approximately 130m from the edge of W6 and at an elevation approximately 27m below it. The widening is 4.5m deep in this area and groundwater levels are indicated to be between 1.8m bgl and ground level in the vicinity. A localised moderate degree of groundwater dewatering is expected. However considering the distance and elevation of the widening from the river and taking into account the volume / flow associated with the river, the potential magnitude of impact on the River Garry due to widening W6 is anticipated to be negligible, resulting in a neutral impact significance of impact.

Widening W22 and CP8 – River Garry (ch6470-700 and ch6670-6800, Figure 10.1c)

Diagram 2: Cross Section for W22 and CP8 – River Garry



3.1.7 Widening W22 is a 12.51m deep cut that will widen the road platform to the south of the existing A9. It will be excavated in permeable superficial sand and gravel deposits, which are underlain by metamorphic bedrock of anticipated low permeability. CP8 is a 16m deep drainage settlement pond, located opposite W22, on the north side of the existing A9. There is no GI information in the area of CP8 but it is assumed likely to be excavated in superficial sand and gravel deposits based on GI available in the wider area. CP08 will only affect groundwater levels during construction as the SuDS features will be lined and groundwater levels will be left to rebound.

3.1.8 The River Garry is located approximately 159m from the edge of W22 and at an elevation approximately 10m below it. It is located approximately 60m from the centre of CP8 and approximately 5m below its base.

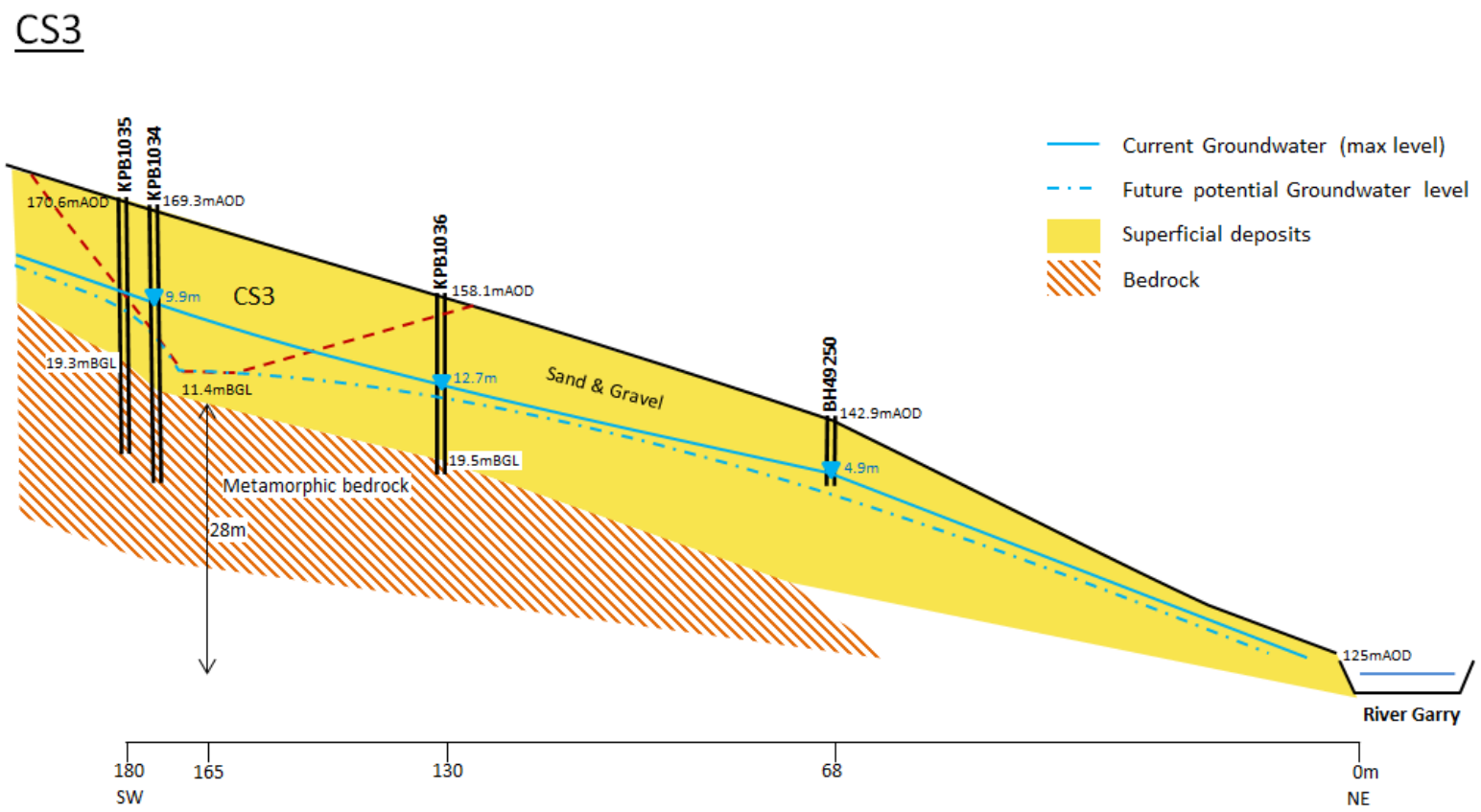
3.1.9 The available groundwater level information indicates that groundwater levels are close to the ground surface in this area and both excavations are expected to intercept groundwater. The main cut areas of W22 are excavating shoulders of elevated ground surrounded by lower lying areas. Similarly, CP8 is cut into an elevated shoulder of land above the river.

3.1.10 Considering the distance and elevation of W22 from the river and the small area of CP08, the potential for disruption of groundwater flows to the river is considered to be very limited during the construction phase.

3.1.11 No dewatering impact is expected from CP08 during the operation phase. Given the distance between W22 and the River Garry and taking into account that the drainage system will return run-off and intercepted groundwater to the River Garry at ch6800, no long term impact is expected on the River Garry as a result of W22 and CP08.

Cutting CS3 – River Garry (ch5550, Figure 10.1c)

Diagram 3: Cross Section for CS3 – River Garry



3.1.12

3.1.13 Cutting CS3 is 11.4m deep and forms a side road access on the south side of the existing A9. It will be excavated in permeable superficial sand and gravel deposits, which are underlain by metamorphic bedrock of anticipated low permeability.

3.1.14 The River Garry is located approximately 165m from the centre of CS3 and at an elevation approximately 22m below it.

3.1.15 The available GI information indicates that groundwater levels are around 10m to 12m below the ground surface in the area of the cutting. The cutting is therefore expected to slightly intercept groundwater. Considering the distance and elevation of the cutting from the river, the potential for disruption of groundwater flows to the river is considered to be negligible, in particular compared to the volume / flow associated with the river. Therefore the potential magnitude of impact on the surface water feature is anticipated to be negligible, resulting in a Neutral significance of impact.

Cutting CS5 – River Garry (ch6080-6160, Figure 10.1c)

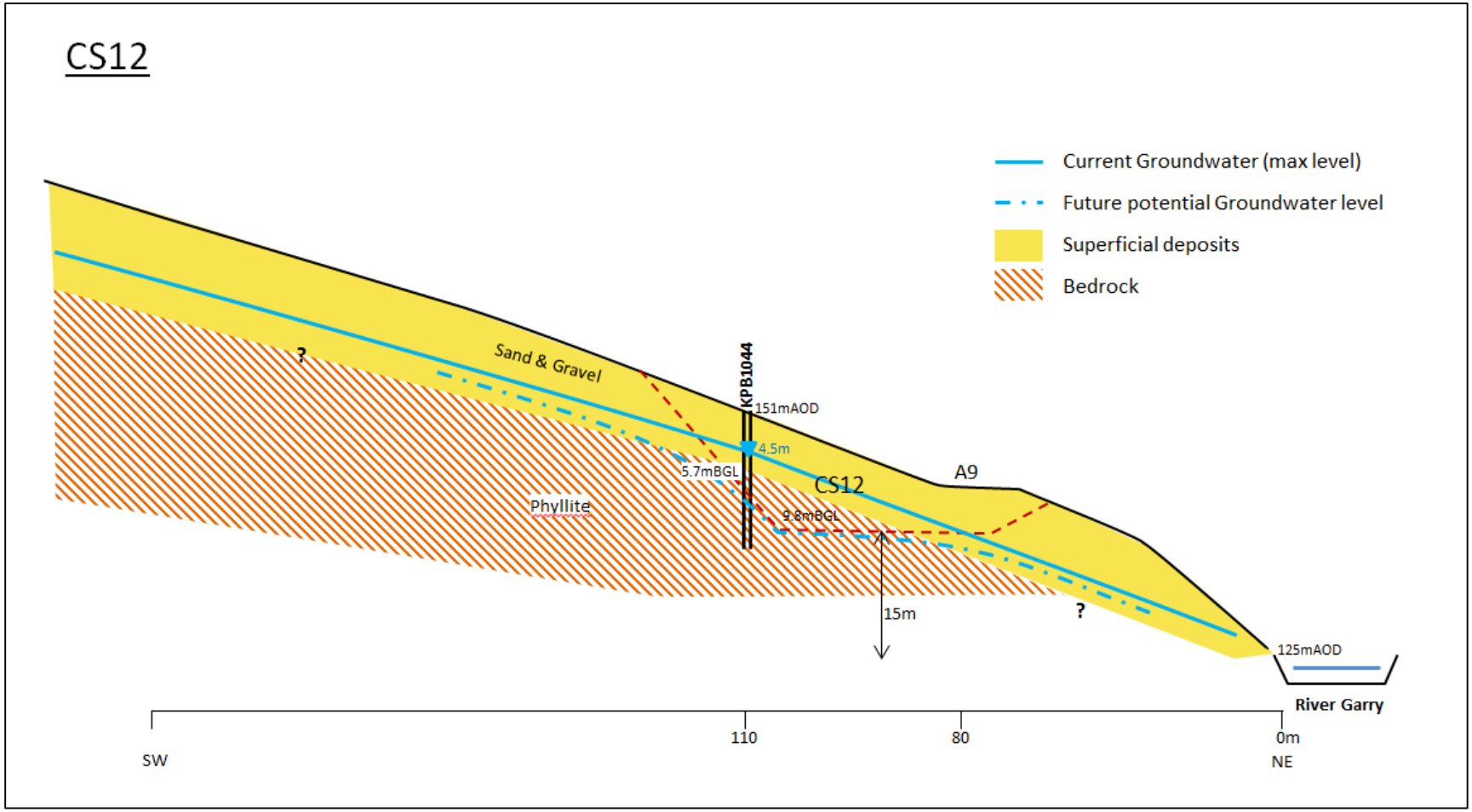
3.1.16 Cutting CS5 is a small, 6.7m deep cutting on a side road on the north side of the existing A9, between the A9 and the River Garry. There are limited GI boreholes available in this area and none within the footprint of the cutting. However, based on extrapolated ground conditions, it is expected to be excavated in permeable superficial sand and gravel deposits, possibly reaching the underlying metamorphic bedrock, which is of anticipated low permeability.

3.1.17 The River Garry is located approximately 60m from the centre of CS5 and at approximately the same elevation.

3.1.18 The available GI information (located up to 100m away from the cutting) indicates that groundwater levels are likely to be close to the ground surface in this area. However, the cutting will be partly excavated in a locally higher area of ground above the river. The cutting is expected to intercept groundwater and cause a local groundwater drawdown effect. However, considering the small size of the cutting any dewatering effect is likely to be very localised and the potential for disruption of groundwater flows to the river is considered to be small and negligible compared to the volume / flow associated with the river. The area of potential effect represents a small proportion of the local river system, therefore the magnitude of impact on the surface water feature is anticipated to be negligible, resulting in a Neutral significance of impact.

Cutting CS12 – River Garry (ch64440-6470, Figure 10.1c)

Diagram 4: Cross Section for CS12 – River Garry



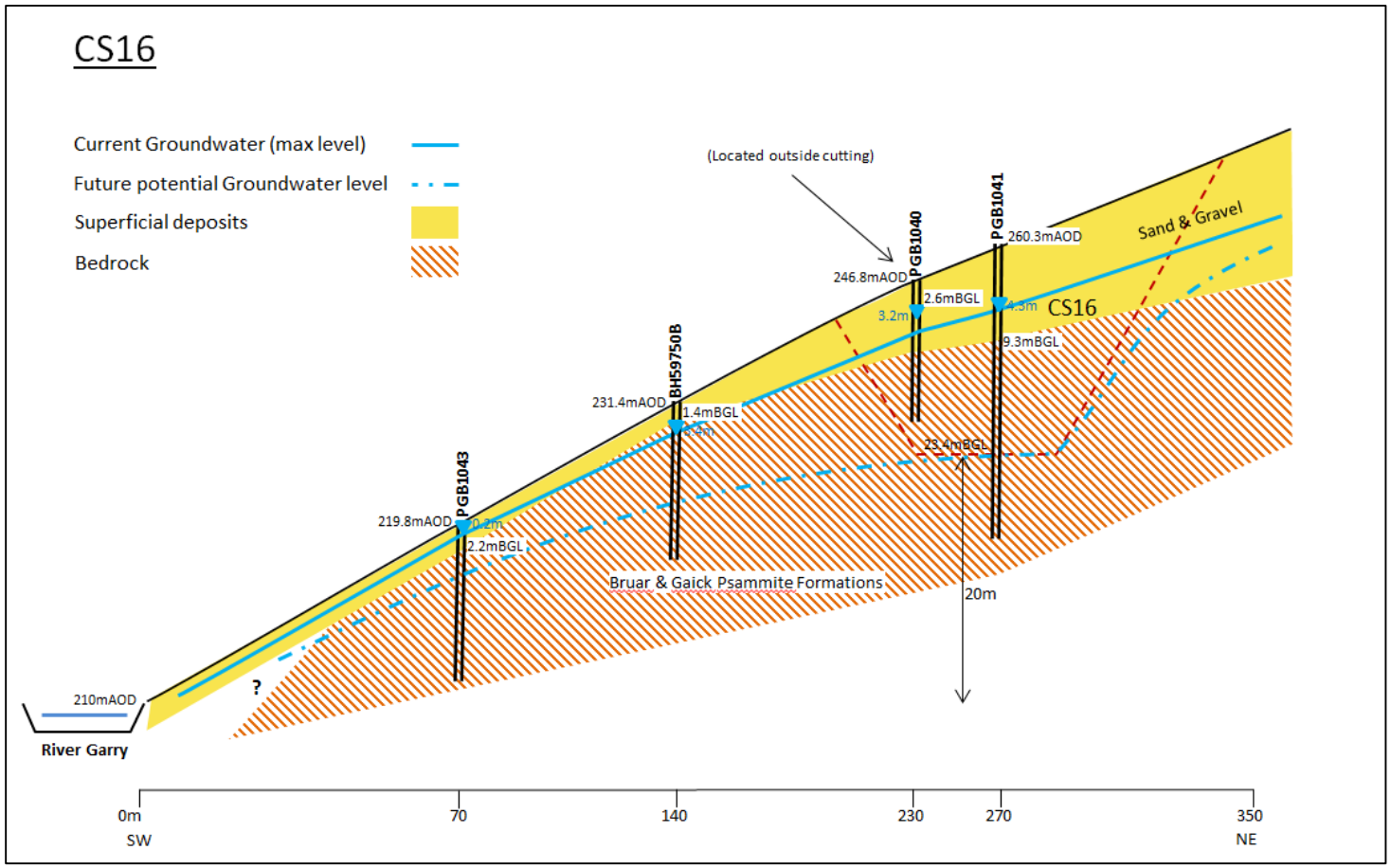
3.1.19 Cutting CS12 is a 9.8m deep cutting on a side road crossing from the south to the north side of the existing A9. There are limited GI boreholes available in this area as only one is located within the footprint of the cutting. The cutting is expected to be excavated in permeable superficial sand and gravel deposits and the underlying metamorphic bedrock, which is of anticipated low permeability.

3.1.20 The River Garry is located approximately 80m from CS12 where it crosses under the A9 and at an elevation approximately 15m below it. The deepest part of the cutting is approximately 110m away from the River Garry, on the opposite side of the A9.

3.1.21 The available GI information indicates that groundwater levels are likely to be around 4.5m below the ground surface within the main part of the cutting. The cutting is therefore expected to intercept groundwater and cause a local groundwater drawdown effect. There could potentially be a reduction in the groundwater gradient and consequently a small reduction in groundwater flows towards the river along the section opposite the cutting. However, the drainage system will return run-off and intercepted groundwater to the River Garry at ch6800 just upstream of the CS12 cutting. Considering all these conditions, the potential impact on groundwater baseflow to the River Garry is considered negligible compared to the volume / flow associated with the river. Therefore the magnitude of impact on the surface water feature is anticipated to be negligible, resulting in a Neutral significance of impact.

Cutting CS16 – River Garry (ch14780-17880, Figure 10.1f)

Diagram 5: Cross Section for CS16 – River Garry



3.1.22 CS16 is a 23.4m deep cutting on a side road on the north side of the existing A9. It will be excavated partly in permeable superficial sand and gravel deposits but is also expected to be excavated partly in the underlying metamorphic bedrock, of anticipated low permeability.

3.1.23 The River Garry is located approximately 270m from the centre of CS16 and at an elevation approximately 27m below it

3.1.24 The available GI indicates that groundwater levels are around 3m to 4m below the ground surface in the area of the cutting. The cutting is therefore expected to intercept groundwater however most of the groundwater is expected to be in bedrock. The low bedrock permeability will limit the drawdown effect and extend. In addition, the drainage system will return run-off and intercepted groundwater to the River Garry at ch16300 in the vicinity of the CS16 cutting. As a consequence, the reduction in groundwater flows towards the River is expected to be negligible compared to the volume/flow associated with the river. Therefore, the magnitude of impact on the surface water feature is anticipated to be negligible, resulting in a Neutral significance of impact.

Cumulative effects & conclusions – River Garry

3.1.25 There are a number of cuttings throughout the proposed route which may generate a groundwater drainage effect within the vicinity of the River Garry. Although all have been assessed as individually likely to create an effect of negligible magnitude, the potential for a cumulative impact of greater significance has been considered. In general, the proportion of the groundwater system likely to be in connection with the River Garry that could potentially be affected is small, with the majority of the cuttings being of limited extent. In addition, groundwater abstracted via the cuttings during the operational phase will be returned to the River Garry catchment, which will compensate for any groundwater baseflow losses at the catchment scale. Consequently, the potential cumulative impact is anticipated to be of negligible, magnitude, resulting in a Neutral significance of impact.

4 Conclusion

4.1.1 Following detailed assessment, no potential impacts of significance are expected on surface water receptors as a result of indirect dewatering effects.