Norwich Western Link Habitats Regulations Assessment Appendix 3: Screening Matrices

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Contents

1 Introduction

1.1.1 Appendix 3 is requested by Natural England and follows a specific template dictated by the Planning Inspectorate and therefore have not been subject to accessibility review.

1.1.2 We have included a summary of key information shown in this document in an accessible format in section 1.1.1. However, some users may not be able to access all technical details that are included in the rest of this document. If you require this document in a more accessible format, please contact norwichwesternlink@norfolk.gov.uk

1.1.3 This document provides the Habitats Regulations Assessment (HRA) screening matrices for the Norwich Western Link (NWL) Scheme. The matrices summarise information provided in the **Information to Inform a Habitats Regulations Assessment** (**Document Reference NCC/4.03.00**) (hereafter '**HRA report'**).

2 Potential Effects

2.1.1 Potential effects upon the European site(s) which are considered within the submitted **HRA report** (**Document reference: NCC/04.03.00**) are provided in the table (**Table 1**) below.

Table 1 - Effects considered within the screening matrices

Designation	Effects described in submission information	Presented in screening matrices as
River Wensum	*Temporary and permanent loss of supporting floodplain habitat due to land-take*	Temporary and permanent loss of supporting floodplain habitat due to land-take
River Wensum	*Changes in hydrological conditions – non-flood condition river flows and ground water levels*	Changes in hydrological conditions – non-flood condition river flows and ground water levels
River Wensum	*Changes in hydrological conditions – increased flood risk*	Changes in hydrological conditions – increased flood risk
River Wensum	*Shading of in-channel vegetation from the under-construction viaduct and temporary bailey bridge*	Shading of in-channel vegetation from new structures
River Wensum	*Fragmentation of the landscape by construction of the Scheme*	Fragmentation of the landscape by construction of the Proposed Scheme
River Wensum	*Localised changes in air quality due to emissions of construction vehicles*	Localised changes in air quality due to emissions of vehicles
River Wensum	*Sediment and chemical run-off*	Sediment and chemical run-off
River Wensum	*Noise and vibrational disturbance*	Noise and vibrational disturbance
River Wensum	*Introduction of invasive non-native plants (eg, Himalayan balsam) and animal (e.g., signal crayfish) species*	Introduction of invasive non-native plants (eg, Himalayan balsam) and animal (e.g., signal crayfish) species

Designation	Effects described in submission information	Presented in screening matrices as
Norfolk Valley Fens; Potter and Scarning Fen	*Wide-scale air quality changes within the ARN*	Wide-scale air quality changes within the ARN

3 Screening Matrices

3.1 European sites

3.1.1 The European sites included within the screening assessment are:

- River Wensum SAC; and
- Norfolk Valley Fens SAC.

3.1.2 Evidence for, or against, likely significant effects on the European site(s) and its qualifying feature(s) is detailed within the footnotes to the screening matrices below.

3.2 Matrix Key:

✓ Likely significant effect **cannot** be excluded

× Likely significant effect **can** be excluded

C = construction

O = operation

4 HRA Screening Matrix 1: River Wensum SAC

Name of European site and designation: River Wensum SAC																			
EU Code: UK0012647																			
Distance to Proposed Scheme: 0km																			
European site features	**Likely effects of Proposed Scheme**																		
Effect	*Temporary and permanent loss of supporting floodplain habitat due to land-take*		*Changes in hydrological conditions – non-flood condition river flows and ground water levels*		*Changes in hydrological conditions – increased flood risk*		*Shading of in-channel vegetation from new structures*		*Fragmentation of the landscape by construction of the Proposed Scheme*		*Localised changes in air quality due to emissions of vehicles*		*Dust, sediment and chemical run-off*		*Noise and vibrational disturbance*		*Introduction of invasive non-native plants (eg, Himalayan balsam) and animal (e.g., signal crayfish) species*		*In-combination effects*
Stage of Development	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	-
Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	✓1		✓2		✓3		✓4	✓4	✓5		×6	×7	✓8	✓8	×9	×9	✓10		✓52

Name of European site and designation: River Wensum SAC																			
EU Code: UK0012647																			
Distance to Proposed Scheme: 0km																			
European site features	**Likely effects of Proposed Scheme**																		
Effect	*Temporary and permanent loss of supporting floodplain habitat due to land-take*		*Changes in hydrological conditions – non-flood condition river flows and ground water levels*		*Changes in hydrological conditions – increased flood risk*		*Shading of in-channel vegetation from new structures*		*Fragmentation of the landscape by construction of the Proposed Scheme*		*Localised changes in air quality due to emissions of vehicles*		*Dust, sediment and chemical run-off*		*Noise and vibrational disturbance*		*Introduction of invasive non-native plants (eg, Himalayan balsam) and animal (e.g., signal crayfish) species*		*In-combination effects*
Stage of Development	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	*C*	*O*	-
White-clawed (or Atlantic stream) crayfish	×11		×12		×13		×14	✓15	×16		×17	×18	×19	✓20	×21	✓22	×23		✓52
Bullhead	✓24		✓25		✓26		✓27	✓27	×28		×29	×29	✓30	✓30	✓31	✓31	✓32		✓52
Brook lamprey	✓33		✓34		✓35		✓36	✓36	✓37		×38	×38	✓39	✓39	✓40	✓40	✓41		✓52
Desmoulin's whorl snail	✓42		✓43		✓44		×45	×45	×46		×47	✓48	✓49	✓49	×50	×50	✓51		✓52

Evidence supporting conclusions:

Water courses with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

1. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect processes on which the river and its vegetation community rely. **Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.**
2. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. **Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2**.
3. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Temporary works structures including the bailey bridge across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and increased water velocity through the confined works area. This could lead to scouring of riverbed sediments and associated *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation within the river channel and immediately downstream of the works area, with peak flood flows removing materials and uprooting plants. **Therefore, changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.**
4. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). In-channel vegetation is reliant on light and shading could cause dieback of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation stands and other in-channel and riparian vegetation, and the loss of this qualifying feature. In the construction phase, both the under-construction viaduct and temporary bailey bridge represent sources of shading. In the operational phase, the permanent viaduct represents a source of shading. **Therefore, shading of in-channel vegetation**

from the under-construction viaduct, temporary bailey bridge and then the permanent viaduct represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.

5. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the channel as a result of the Proposed Scheme. However, temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. **Thus, fragmentation of in-channel *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and fragmentation within the wider floodplain will be taken forward for further consideration at Stage 2.**
6. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Lowland rivers such as the River Wensum are typically nutrient poor, with the availability of phosphorus (rather than nitrogen) within the ecosystem limiting the growth of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation as well as other macrophyte species and algae (English Nature, 1999; Natural England, 2022). Analysis of nitrogen to phosphorus ratios within the River Wensum confirm phosphorus is the limiting nutrient (**Document Reference 3.10.34b**). Emissions from Proposed Scheme construction vehicles would lead to deposition of nitrogen compounds as a result of exhausts during the construction phase including nitrogen dioxide and nitrate (see **Environmental Statement Chapter 6: Air Quality** and **ES Appendix 10.34 Air Quality Ecological Impact Assessment**); phosphorus is not released by vehicle exhausts and would not become elevated in the River Wensum as a result of localised air quality changes. Levels of phosphorus in the River Wensum ecosystem would therefore not change as a result of the Proposed Scheme and would remain as a growth-limited factor for in-stream plants. Thus, the sensitivity of vegetation of the River Wensum to air quality changes during the construction phase is low. A far greater risk to the River Wensum is the input of nitrogen from agricultural run-off through pollution events which would see concentrations of nitrogen enter the river at orders of magnitude greater than from air quality changes due to the Proposed Scheme (Natural England, 2022). The overall area of the River Wensum exposed to air quality changes would be small due to the small overlap between the River Wensum and the Proposed Scheme construction footprint, and the relatively limited period of time required to construct the Proposed Scheme (i.e., construction phase air quality changes would be temporary). The Wensum is also sensitive to acidification (Natural England, 2022) and deposition of acids (e.g., NHx, SO2) from exhaust fumes of construction traffic would affect the water column. However, as with nitrogen deposition the small overlap between the River Wensum and the

Proposed Scheme construction footprint would restrict the potential for acidification, and the calcareous chemistry of the river water (Berrie, 1992) would buffer the resulting change in pH to non-perceptible levels. Thus, localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme.

7. See **Table 6-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Lowland rivers such as the River Wensum are typically nutrient poor, with the availability of phosphorus (rather than nitrogen) within the ecosystem limiting the growth of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation as well as other macrophyte species and algae (English Nature, 1999; Natural England, 2022). Analysis of nitrogen to phosphorus ratios within the River Wensum confirm phosphorus is the limiting nutrient (**Document Reference 3.10.34b**)). Emissions from vehicles using the Proposed Scheme during operation would lead to deposition of nitrogen compounds as a result of exhausts including nitrogen dioxide and nitrate (**Environmental Statement Chapter 6: Air Quality**); phosphorus is not released by vehicle exhausts and would not become elevated in the River Wensum as a result of localised air quality changes. Levels of phosphorus in the River Wensum ecosystem would therefore not change as a result of the Proposed Scheme and would remain as a growth-limiting factor for in-stream plants. Thus, the sensitivity of vegetation of the River Wensum to air quality changes during the operational phase is low. Input of nitrogen from agricultural run-off could lead to effects on the River Wensum, but such inputs would be pollution events with concentrations of nitrogen orders of magnitude greater than from air quality changes due to the Proposed Scheme (Natural England, 2022). In addition, floodplain grassland habitat surrounding the River Wensum in its floodplain show effects of agricultural improvement, and thus is not considered sensitive to the effects of enrichment through nitrogen deposition as it already receives significant nitrogen input from such sources, primarily manure from grazing animals (“Nitrogen deposition :: Improved Grassland”; APIS, 2023). Nitrogen deposition would not significantly raise the nutrient status of the river due to the small overlap between the River Wensum and the operational cross section of the viaduct, the Wensum only being 10-12m wide beneath it. The height of the viaduct would also reduce nitrogen compound deposition, with exhaust fumes dispersing before descending to the level of the River Wensum. In addition, given the surrounding land uses, nitrogen from existing background agricultural run-off into the Wensum is relatively high and that received by the water column from vehicles using the completed viaduct would not be perceptible above existing inputs to the river. The Wensum is also sensitive to acidification (Natural England, 2022) and deposition of acids (e.g. NHx, SO2) from exhaust fumes traffic would affect the water column. However, as with nitrogen deposition the small overlap between the River Wensum

and the Proposed Scheme construction footprint would restrict the potential for acidification, and the calcareous chemistry of the river water (Berrie, 1992) would buffer the resulting change in pH to non-perceptible levels. Thus, localised changes in air quality as a result of emissions from vehicles using the completed viaduct is not a likely effect of the Proposed Scheme during its operational phase.

8. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Chalk rivers are sensitive to sediment inputs which can smother stands of vegetation and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008), causing significant effects on in-channel vegetation. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream. **Therefore, construction and operational phase dust, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the construction and operational phase, and will be taken forward for further consideration at Stage 2.**
9. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation is not sensitive to noise and vibrational disturbance, and consequently it is not a likely effect of the Proposed Scheme during its construction and operational phases.
10. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation if established. **Therefore, introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase.**

White-clawed Crayfish

11. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (**Section 5.46**). Thus, white-clawed crayfish would not be affected by temporary and permanent loss of supporting floodplain habitat due to land-take.

12. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). White-clawed crayfish are absent from the stretch of the River Wensum crossed by the Proposed Scheme and an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (see **Section 5.46**). Thus, white-clawed crayfish would not be affected by changes in hydrological conditions – non-flood condition river flows and ground water levels.
13. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (**Section 5.46**). Thus, white-clawed crayfish would not be affected by changes in hydrological conditions e.g., increased flood risk.
14. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (**Section 5.46**). Thus, white-clawed crayfish would not be affected by shading of in-channel vegetation from the under-construction viaduct and temporary bailey bridge.
15. See **Table 6-2** of the **HRA report** (**Document Reference NCC/4.03.00**). In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which white-clawed crayfish would rely upon as a habitat upon recolonisation, for foraging areas and for shelter. The operational viaduct would represent a permanent source of shading. **Therefore, shading of in-channel vegetation by the completed viaduct represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.**
16. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (**Section 5.46**). Thus, white-clawed crayfish would not be affected by fragmentation of the landscape by construction of the Proposed Scheme.

17. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (see **Section 5.46**). Thus, white-clawed crayfish would not be affected by localised changes in air quality due to emissions of construction vehicles.
18. See **Table 6-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Localised changes in air quality due to emissions of vehicles using the operational viaduct is not a likely effect of the Proposed Scheme on recolonising white-clawed crayfish. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on white-clawed crayfish through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, neither nitrogen deposition nor water acidification would significantly alter habitat within the River Wensum, and thus localised changes in air quality due to emissions of vehicles using the operational viaduct is therefore not considered a likely effect of the Proposed Scheme upon this species.
19. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-clawed crayfish population through direct competition and introduction of crayfish plague (**Section 5.46**). Thus, white-clawed crayfish would not be affected by sediment and chemical run-off.
20. See **Table 6-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Chalk rivers are sensitive to sediment inputs which can smother stands of vegetation on which recolonising white-clawed crayfish relies, and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream, affecting recolonising white-clawed crayfish. Sediment and chemical run-off could also kill recolonising white-clawed crayfish directly. Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the operational phase and would be taken forward for further consideration at Stage 2.
21. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the stretch of the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**). In addition, an invasion of signal crayfish in 2015 has displaced the white-

clawed crayfish population through direct competition and introduction of crayfish plague (see **Section 5.46**). Thus, white-clawed crayfish would not be affected by noise and vibrational disturbance.

22. See **Table 6-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Operation of the Proposed Scheme would generate noise and vibrational adjacent to the River Wensum. Noise would not only be transmitted directly through the air, vibration and percussive energy would be transmitted through support piers to the ground and then onto the River Wensum. White-clawed crayfish are sensitive to such sources of disturbance which could prevent them from recolonising viable habitat in the vicinity of works, which may have effects on recolonising of white-clawed crayfish in the Wensum. **Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.**
23. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). This species has been shown to be absent from the River Wensum that is crossed by the Proposed Scheme (see **Section 5.46**), and a population of signal crayfish has already established itself in its place. Thus, white-clawed crayfish would not be affected by Introduction of invasive non-native plants (e.g., Himalayan balsam) and animal (e.g., signal crayfish) species.

Bullhead

24. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect processes within the river itself on which bullhead rely. **Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.**
25. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. **Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2**.

26. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Temporary works structures including the bailey bridge across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and increased water velocity through the confined works area. This could lead to scouring of in-channel vegetation stands within the river channel and immediately downstream of the works area which bullhead relies upon as a habitat, for foraging areas and for shelter. **Therefore, changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.**
27. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which bullhead relies upon as a habitat, for foraging areas and for shelter. In the construction phase, both the under-construction viaduct and temporary bailey bridge represent sources of shading. In the operational phase, the operational viaduct represents a permanent source of shading. **Therefore, shading of in-channel vegetation from the under-construction viaduct, temporary bailey bridge and then the permanent viaduct represents a likely effect of the Proposed Scheme during the construction and operational phases and will be taken forward for further consideration at Stage 2.**
28. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the main channel as a result of the Proposed Scheme. Although the main River Wensum channel provides suitable habitat for bullhead, due to the recorded absence of bullhead in WC5 and its poor suitability to support them (bullhead require coarse substrates with large stones (Tomlinson and Perrow, 2003)), the proposed temporary diversion and culverting on WC5 is not expected to cause fragmentation for bullhead populations. Thus, no fragmentation of habitat used by bullhead would occur and fragmentation is therefore not considered a likely effect of the Proposed Scheme upon this species.
29. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Localised changes in air quality due to emissions of vehicles in both construction and operational phases is not a likely effect of the Proposed Scheme on bullhead. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on bullhead through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, neither nitrogen

deposition nor water acidification would significantly alter bullhead habitat within the River Wensum, and thus localised changes in air quality due to emissions of vehicles in both construction and operational phases is therefore not considered a likely effect of the Proposed Scheme upon this species.

30. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Chalk rivers are sensitive to sediment inputs (including windblown dust) which can smother stands of vegetation on which bullhead relies, and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (eg, fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream, affecting bullhead. Sediment and chemical run-off could also kill bullhead directly. **Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during the construction and operational phases and will be taken forward for further consideration at Stage 2.**
31. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Construction of the Proposed Scheme would generate noise and vibrational disturbance adjacent to the River Wensum as a result of works to build the proposed viaduct. Operation of the Proposed Scheme would generate noise and vibrational disturbance adjacent to the River Wensum. Noise would not only be transmitted directly through the air, vibration and percussive energy would be transmitted through support piers to the ground and then onto the River Wensum. Fish such as bullhead are sensitive to such sources of disturbance which could displace them from viable habitat in the vicinity of works, which may have effects on the survival of individuals and consequently effects on the wider population of bullhead in the Wensum. **Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during both the construction and operational phases and will be taken forward for further consideration at Stage 2.**
32. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect bullhead if established. **Therefore, introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.**

Brook lamprey

33. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect processes within the river itself on which brook lamprey rely. **Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.**
34. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. **Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.**
35. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Temporary works structures including the bailey bridge across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and increased water velocity through the confined works area. This could lead to scouring of in-channel vegetation stands within the river channel and immediately downstream of the works area which brook lamprey relies upon as a habitat, as larval feeding areas and for shelter of both larvae and adults. **Therefore, changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.**
36. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). In-channel vegetation is reliant on light and shading could cause dieback of in-channel vegetation stands which brook lamprey relies upon as a habitat, as larval feeding areas and for shelter of both larvae and adults. During the construction phase, the under-construction viaduct and temporary bailey bridge represent sources of shading. During the operational phase, the operational viaduct represents a permanent source of shading. **Therefore, shading of in-channel vegetation from the under-construction viaduct, temporary bailey bridge and then operational viaduct represents a likely effect of the Proposed Scheme during the construction and operational phases and will be taken forward for further consideration at Stage 2.**

37. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). No realignment of the main River Wensum channel would occur, and also no obstacles (weirs, culverts etc) would be engineered into the channel as a result of the Proposed Scheme. However, temporary diversion and culverting (both permanent and temporary) would occur within the River Wensum floodplain on WC5. **Thus, fragmentation of in-channel habitats used by brook lamprey and fragmentation within the wider floodplain will be taken forward for further consideration at Stage 2.**
38. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme on brook lamprey. Localised changes in air quality due to emissions of vehicles using the operational viaduct is also not a likely effect of the Proposed Scheme on brook lamprey. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on brook lamprey through changes to its habitat, rather than through direct effects on individuals. However, as discussed above for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, neither nitrogen deposition nor water acidification would significantly alter brook lamprey habitat within the River Wensum, and thus localised changes in air quality due to emissions of construction vehicles and then vehicles using the operational viaduct is therefore not considered a likely effect of the Proposed Scheme upon this species.
39. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Chalk rivers are sensitive to sediment inputs (including windblown dust) which can smother stands of vegetation on which brook lamprey adults and larvae rely, and fill pore-spaces within the riverbed (the 'hyporheic zone') (Joyce and Wotton, 2008) which support its prey invertebrate species. In addition, accidental release of chemicals (e.g., fuels, lubricants) into the river channel could kill vegetation directly in the area surrounding the Proposed Scheme's River Wensum crossing, as well as downstream, affecting brook lamprey. Sediment and chemical run-off could also kill brook lamprey directly. **Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during both the construction and operational phases and will be taken forward for further consideration at Stage 2.**
40. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Construction of the Proposed Scheme would generate vibrational and percussive noise adjacent to the River Wensum as a result of works to build the proposed viaduct. Operation of the Proposed Scheme would generate noise and vibrational disturbance adjacent to the River Wensum. Noise would not only be transmitted directly

through the air, vibration and percussive energy would be transmitted through support piers to the ground and then onto the River Wensum. Fish such as brook lamprey are sensitive to such sources of disturbance which could displace them from viable habitat in the vicinity of works, which may have effects on the survival of individuals, their ability to breed, and consequently effects on the wider population of brook lamprey in the Wensum. **Therefore, noise and vibrational disturbance represents a likely effect of the Proposed Scheme during both the construction and operational phases and will be taken forward for further consideration at Stage 2.**

41. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect brook lamprey if established. **Therefore, introduction of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.**

Desmoulin's whorl snail

42. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Loss of habitat within the River Wensum flood plain, either temporary or permanent, could affect wider processes on which this species relies, including habitat fragmentation and links to habitat in the wider landscape. **Therefore, temporary and permanent loss of supporting floodplain habitat due to land-take represents a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2.**
43. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Non-flood condition changes to hydrological conditions (including groundwater levels and flows) could occur due to work (such as piling and excavations) in the adjacent floodplain. **Therefore, changes in hydrological conditions – non-flood condition river flows and ground water levels represent a likely effect of the Proposed Scheme on this feature during the construction phase and will be taken forward for further consideration at Stage 2**.
44. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Temporary works structures including the bailey bridge across the River Wensum would act to increase flood risk by acting to confine river discharge in the area upstream. Thus, under flood conditions there would be an increased tendency of upstream areas to flood, and these areas currently support a population of Desmoulin's whorl snail. **Increased flood risk could**

lead to consequent effects on the population's viability, and therefore changes in hydrological conditions – increased flood risk represents a potentially significant effect of the Proposed Scheme and will be taken forward for further consideration at Stage 2.

45. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). There would be no effect of shading on Desmoulin's whorl snail as it is not found within the Site Boundary and ditches and river margins within this area are not suitable to support Desmoulin's whorl snail (**Section 5.24**). Thus, no Desmoulin's whorl snail habitat would be lost, and shading of in-channel vegetation from the under-construction viaduct, temporary bailey bridge and then the operational viaduct (which crosses suitable habitat for this species in the River Wensum floodplain) is not considered a likely effect of the Proposed Scheme upon this species.
46. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Although the Proposed Scheme crosses the River Wensum floodplain, the use of a viaduct in its design would maintain a link between habitats either site of the Proposed Scheme alignment and avoid effects of fragmentation and the separation of the existing Desmoulin's whorl snail populations in WC3, WC4, and in the Wensum floodplain 1km to the south-east of the Site Boundary. The principal dispersal mechanism of Desmoulin's Whorl snail is waterborne transportation, and snails typically disperse across floodplains during periods of flooding (Killeen, 2003). The Proposed Scheme design would retain the majority of existing connective floodplain habitat within the Site Boundary, as the design of the viaduct structure minimises the number of piers required and therefore the amount of permanent habitat loss within the floodplain. This would allow for the potential future colonisation of Desmoulin's whorl snail in this area. The Proposed Scheme design also ensures the retention of up- and downstream connectivity of watercourses across the Wensum floodplain for the duration of the operation of the Proposed Scheme, and this would further reduce the risk of fragmentation. The culverting of WC5 to facilitate the construction of a temporary works platform would allow the passage of water and would be reduced to the minimum length required (approximately 22m) to support a permanent maintenance track for the Proposed Scheme operational period. It should be noted that the ditches and the river margins of the Wensum in the crossing area are either not suitable for Desmoulin's whorl snail (Section 5.24) or returned negative results for this species during surveys. Habitat beneath the viaduct would remain passable for the duration of the Proposed Scheme, and the fragmentation of the landscape and therefore the existing populations by construction of the Proposed Scheme is not considered a likely effect of the Proposed Scheme upon this species.

47. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Localised changes in air quality due to emissions of construction vehicles is not a likely effect of the Proposed Scheme on Desmoulin's whorl snail. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on Desmoulin's whorl snail through changes to its habitat, rather than through direct effects on individuals. The temporary nature of the construction works, alongside the distance of the population of this feature from the Site Boundary (~80m), would avoid effects of localised changes in air quality due to emissions of construction vehicles, which is not considered a likely effect of the Proposed Scheme upon this species.
48. See **Table 6-2** of the **HRA report** (**Document Reference NCC/4.03.00**). Localised changes in air quality as a result of emissions from vehicles using the completed viaduct would occur and could affect land adjacent to the Proposed Scheme. Site-specific supplementary advice for River Wensum SAC identifies air quality changes as a potential effect on Desmoulin's whorl snail through changes to its habitat, rather than through direct effects on individuals. **Changes in vegetation in the River Wensum floodplain due to air quality changes therefore represent a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.**
49. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Run-off from the Proposed Scheme could enter the ditch system on adjacent land that supports Desmoulin's whorl snail, altering and / or degrading habitat used by this species. Dust from construction may also have a similar effect. **Therefore, sediment and chemical run-off represents a likely effect of the Proposed Scheme during both the construction and operational phases and will be taken forward for further consideration at Stage 2.**
50. See **Table 6-1 (construction)** and **Table 6-2 (operation)** of the **HRA report** (**Document Reference NCC/4.03.00**). Desmoulin's whorl snail is not considered to be sensitive to noise and vibrational disturbance, as both these effects are not identified as attributes in site-specific supplementary advice on conserving and restoring site features for River Wensum SAC (Natural England, 2022), and thus this is not considered to be a likely effect upon this species.
51. See **Table 6-1** of the **HRA report** (**Document Reference NCC/4.03.00**). Movement of vehicles during the construction phase and importation of materials to site represents a potential vector for invasive species that could affect Desmoulin's whorl snail if established. **Therefore, the introduction**

of invasive non-native plant and animal species represents a likely effect of the Proposed Scheme during the construction phase and will be taken forward for further consideration at Stage 2.

In-combination effects

52. See **Table 6-4** of the **HRA report** (**Document Reference NCC/4.03.00**). In-combination LSE have been identified for Development S6 (**ES Appendix 10.36 ID**) during construction of the Proposed Scheme. The A47 meets the southern boundary of the Proposed Scheme where it is intended to provide a new route north between the A47 and A1067. Dualling of the A47 could therefore interact with the Proposed Scheme directly and in-directly. In-combination effects on River Wensum SAC are therefore possible and will be assessed through Stage 2 Appropriate Assessment. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within the HRA report inherently consider an in-combination assessment of movements associated with this development.

5 HRA Screening Matrix 2: Norfolk Valley Fens SAC; Potter and Scarning Fen

Name of European site and designation: Norfolk Valley Fens SAC: Potter and Scarning Fen			
EU Code: UK0012892			
Distance to Proposed Scheme: 11.2 km			
European site features	**Likely effects of Proposed Scheme**		
Effect	*Wide-scale air quality changes within the ARN*		*In-combination effects*
Stage of Development	*C*	*O*	-
Alkaline Fens		✓1	✓10
Northern Atlantic Wet Heaths with *Erica tetralix*		×2	×11
European dry heaths		×3	×11
Semi-natural dry grasslands and scrublands facies on calcarerous substrates (*Festuco-Brometalia*) (important orchid sites)		×4	×11

Name of European site and designation: Norfolk Valley Fens SAC: Potter and Scarning Fen			
EU Code: UK0012892			
Distance to Proposed Scheme: 11.2 km			
European site features	**Likely effects of Proposed Scheme**		
Effect	*Wide-scale air quality changes within the ARN*		*In-combination effects*
Stage of Development	*C*	*O*	-
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)		×5	×11
Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*		×6	×11
Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Anion incanae, Salicion albae*)		×7	×11
Narrow-mouthed whorl snail		×8	×11
Desmoulin's whorl snail		×9	×11

Evidence supporting conclusions:

Alkaline fens

1. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Perceptible effects of air quality changes are typically limited to within 200m of their source (Highways England, 2019), in this case adjacent roads included within the Proposed Scheme's ARN. This 200m zone overlaps with the boundary of Potter and Scarning Fen. As Alkaline Fen habitat is present at all three SAC areas, this and could lead to effects on this habitat through chemical changes to soil (e.g., nutrient status, soil pH) or direct contact between aerial pollutants and plants (e.g. soot). **Therefore, operational phase wide-scale air quality changes within the ARN represents a likely effect of the Proposed Scheme during the operational phase and will be taken forward for further consideration at Stage 2.**

Northern Atlantic Wet Heaths with *Erica tetralix*

2. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that northern Atlantic wet heath with Erica tetralix habitat is not present at Potter and Scarning Fen within 200m of the ARN. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

European dry heaths

3. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that European dry heaths habitat is not present at Potter and Scarning Fen within 200m of the ARN. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Semi-natural dry grasslands and scrublands facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites)

4. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that semi-natural dry grasslands and scrublands facies on calcareous substrate habitat is not present at Potter and Scarning Fen. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)

5. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that Molinia meadows on calcareous, peaty or clayey-silt-laden soils habitat is not present at Potter and Scarning Fen. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*

6. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* is not present at Potter and Scarning Fen. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Anion incanae, Salicion albae*)

7. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* habitat is not present at Potter and Scarning Fen. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Narrow-mouthed whorl snail

8. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that narrow-mouthed whorl snail is not present at Potter and Scarning Fen. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

Desmoulin's whorl snail

9. See **Table 6-3** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that Desmoulin's whorl snail is not present at Potter and Scarning Fen. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.

In-combination effects

10. See **Table 6-4** of the **HRA report** (**Document Reference NCC/4.03.00**). In-combination LSE have been identified for Development S6 (**ES Appendix 10.36 ID**) during construction of the Proposed Scheme. The A47 meets the southern boundary of the Proposed Scheme where it is intended to provide a new route north between the A47 and A1067. Dualling of the A47 could therefore interact with the Proposed Scheme directly and in-directly. In-combination effects are therefore possible and will be assessed through Stage 2 Appropriate Assessment. In-direct effects through air quality changes are already incorporated into existing ARN model assessed above and so the air quality-based assessments within the HRA report inherently consider an in-combination assessment of movements associated with this development.
11. See **Table 6-3** and **Table 6-4** of the **HRA report** (**Document Reference NCC/4.03.00**). Site-specific supplementary advice on conservation objectives indicates that northern Atlantic wet heath with *Erica tetralix*, European dry heaths, Semi-natural dry grasslands and scrublands facies on calcarerous substrates, *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils, Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* habitat, Narrow-mouthed whorl snail and Desmoulin's whorl snail are not

present at Potter and Scarning Fen within 200m of the ARN. Thus, wide-scale air quality changes within the ARN would not lead to adverse effects on this Qualifying Feature or the integrity of Norfolk Valley Fens SAC, either alone or in-combination with the other plans or projects.