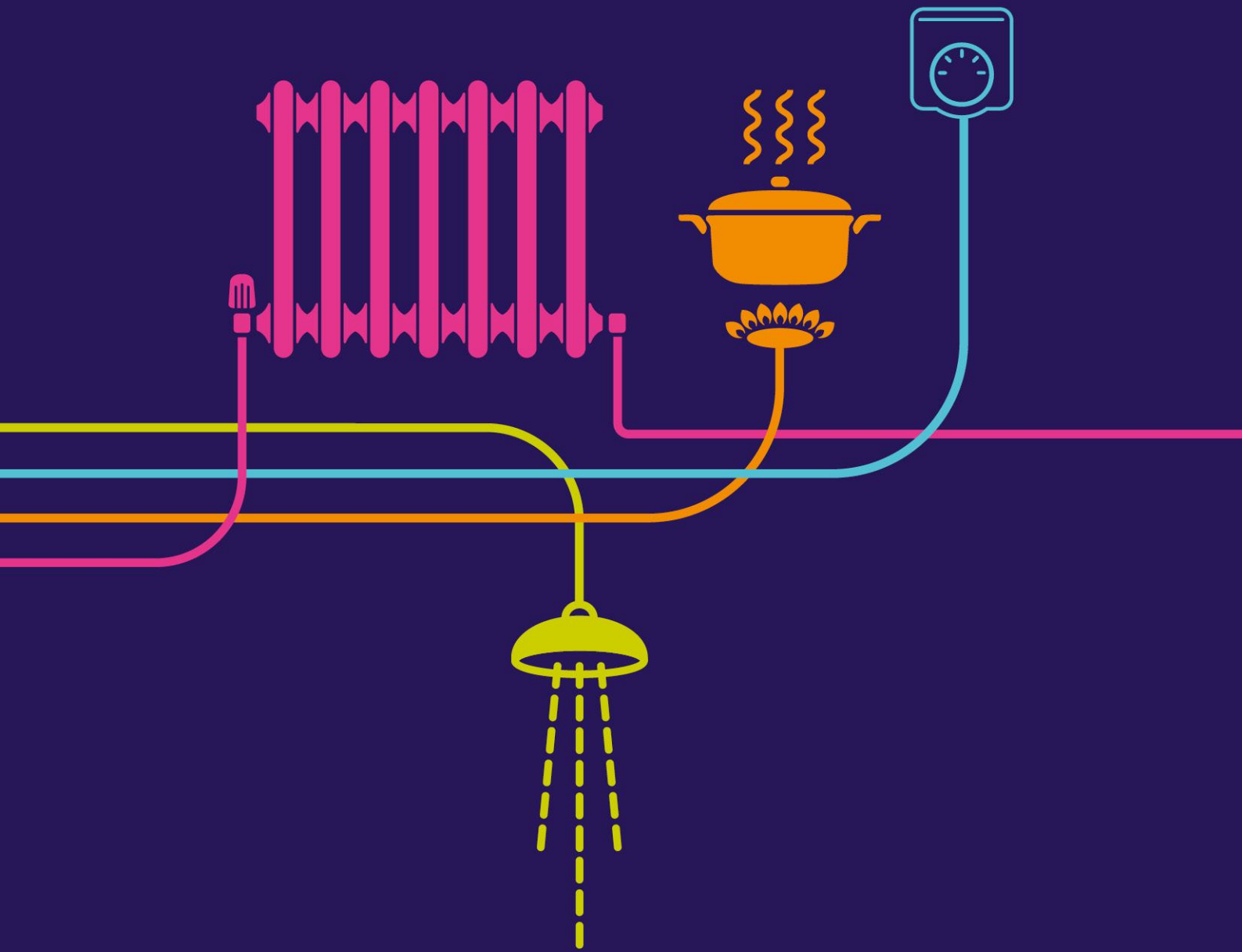
DOCUMENT

8.9.7

nationalgrid

Annexure 7 to Response to First Written Questions - Q4.7 Updated Risk Register

River Humber Gas Pipeline Replacement Project



Application Reference: EN060004

Deadline 3 Submission: 02 November 2015

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
1	Tunnelling	Inappropriate choice of TBM for encountered ground conditions	Variability of soils. Chalk and glacial deposits. Boreholes at Paull highlight variability of glacial deposits. Around one km of tunnel below mudflats has no GI at present	High	Delays and additional cost to project	Review of 1st and 2nd Phase GI highlights variability of glacial deposits. 2nd Phase GI suggests more continuous units of granular superficials between L17 and L16A/16 (off line). Consideration to additional GI to further define risk beneath mudflats.	Medium
2	Tunnelling	Settlement greater than predicted	Inaccurate ground model and volume loss estimation	Medium	May damage existing HP gas mains or other infrastructure when tunnelling close to	Designer to provide tunnel settlement predictions around infrastructure. Range of volume losses for typical tunnelling schemes to be considered. Does not account for catastrophic event. Horizontal alignment has avoided AGI on Paull side.	Low
3	Tunnelling	Loss of tunnel face	Tunnelling through untreated soft / loose alluvial deposits. Alluvial channel has been identified in GIR cross section	High	Unable to control face leading to settlement at surface. May be critical around existing infrastructure	Vertical alignment to avoid known buried alluvial channels. CPTs confirmed the variability in depth of alluvial deposits associated with buried channels. Current tunnel vertical alignment is such that it will be in chalk where the depth of alluvial deposits varies significantly with presence of buried alluvial channels.	Low
4	Tunnelling	Loss of tunnel face	Tunnelling through solution features in chalk that have been filled with soft deposits. Most critical on Goxhill side	Medium	Unable to control face leading to settlement at surface. May be critical around existing infrastructure	1st Phase GI (including CPTs) and 2nd Phase GI has not identified any solution features.	Low
5	Tunnelling	Blow out of tunnel	Inability of ground to withstand face pressure, especially with regard to slurry tunnelling machines. It is notable on Goxhill side poor recovery and observational evidence suggests heavily fractured	High	Ground unable to balance applied pressure at TBM face. Delays to programme	Variable head tests undertaken during 1st Phase GI suggest fairly impermeable material. Land access prevented 2nd Phase GI boreholes being drilled at Goxhill where the poor recovery was identified in 1st Phase GI. Consideration for additional GI to provide more information.	Medium to Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
			highly permeable chalk below superficial deposits.				
6	Tunnelling	Blow out of tunnel	Loose deposits above tunnel while crossing under deep channel in river.	Medium	Loss of tunnel beneath river with safety and programme implications	1st Phase GI suggests stiff to very stiff clay at Channel. Vertical alignment to be set with appropriate cover	Low
7	Tunnelling	Obstructions	Boulders in glacial deposits or very large flints (paramoudras) in chalk	Medium	Delays to programme. Possibility of man entry required to face (under compressed air) to facilitate removal / break up of obstruction	1st and 2nd Phase GI have not identified boulders or very large flints. Risk of boulders in glacial deposits should be highlighted to contractor. Geological markers have been identified in chalk and corresponding outcrops should be sought for visual examination for presence of very large flints.	Medium
8	Tunnelling	Pore water pressures vary significantly	Hydraulic conductivity leading to tidal variation in pore water pressures	Medium	Design values for TBM pressures incorrect	The TBM utilised will be designed to control pore water pressures greater than hydrostatic. The pore water pressures will be greatest beneath the River Humber and will be at least hydrostatic, due to the weight of the overlying water and the flow of groundwater upwards towards the estuary from the surrounding aquifer. A closed face TBM will be adopted which is designed to balance the ground and groundwater pressures.	Low
9	Goxhill Launch Structure	Ground water inflow	Excessive water entering structure / pit	High	Excavation instability / local collapse. Programme delays	The retaining wall is to be of low permeability to prevent significant groundwater inflow into the excavation through the walls. The retaining wall is to be of sufficient strength/stability to withstand a conservative design groundwater level which takes into consideration the ongoing monitoring undertaken to date since June	Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
						2014. A groundwater control system is to be implemented as outlined within the Hyder Hydrogeological Impact Assessment (HIA) and OGI HIA Addendum.	
10	Goxhill Launch Structure	Ground water inflow	Excessive seepage below walls.	High to medium	Instability of base / piping, risk of flooding, Programme delays	A groundwater control system is to be implemented as outlined within the Hyder HIA and OGI HIA Addendum.	Low
11	Goxhill Launch Structure	Obstructions to installation of walls	Boulders / flints	Medium	Programme delays	Identification of potential obstructions. Selection of applicable techniques for wall construction	Low
12	Goxhill Launch Structure	Ground gas entering excavations	Ground gas generation from the organic deposits within the alluvial soils entering the launch structure. CPTB14 encountered trapped ground gas.	High	Collapse/injury/death to site personnel working within excavations	Gas monitoring designed to target ground gas sources in organic alluvial deposits to be undertaken to better define ground gas types, concentrations, pressures and flows. Based on this a Confined Spaces Risk Assessment should be carried out to define any preventative measures e.g. ventilation and a Safe Method of Works for working within Confined Spaces.	Low
13	Paull reception pit	Ground water inflow	Excessive water entering structure / pit	High	Excavation instability / local collapse. Programme delays	Additional site investigation boreholes are currently being undertaken to better determine the geology at the location of the Reception Pit. Site works to be completed w/c 12/10/15) As with the Drive Pit, the retaining wall is to be low permeability to prevent groundwater inflow into the excavation through the walls. The retaining wall is also to be of sufficient strength/stability to withstand conservative	Medium to Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
						groundwater pressures which takes into consideration the ongoing monitoring since June 2014. A groundwater control system is to be implemented as outlined within the Hyder HIA and OGI HIA Addendum.	
14	Paull reception pit	Ground water inflow	Excessive seepage below walls.	High to medium	Instability of base / piping, risk of flooding, Programme delays	Additional Site investigation boreholes are currently being undertaken to better determine the geology at the location of the Reception Pit. Site works to be completed w/c 12/10/15) A groundwater control system is to be implemented as outlined within the Hyder HIA and OGI HIA Addendum.	Medium to low
15	Paull reception pit	Obstructions to installation of walls	Boulders	Medium	Programme delays	Identification of potential obstructions. Selection of applicable techniques for wall construction. Contractor to adopt an appropriate form of plant where boulders encountered.	Low
16	AGI Connections	Construction works	Variable soils	High	Collapse/injury to site personnel and programme delays	Selection of conservative design parameters. Appropriate ground investigation and temporary works to be adopted.	Low
17	AGI Connections	Construction works	High pore water pressure	Medium	Collapse/injury to site personnel and programme delays	2nd Phase GI completed (boreholes L09 & L10 at Paull). Conservative design parameters to be selected in the temporary and permanent works design based on ongoing groundwater monitoring. Continued inspection and monitoring prior to, during and post construction.	Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
18	AGI Connections	Construction works	Excessive water ingress	High	Collapse/injury to site personnel and programme delays	2nd Phase GI completed (boreholes L09 & L10 at Paull). Site Investigation has indicated predominantly low permeability cohesive ground at shallow depths with only limited permeable granular lenses observed which could produce large groundwater flows. Retaining walls will be installed to prevent shallow horizontal groundwater flow at the AGI Connections, where required. Mitigation measures to be considered for worst case scenarios. Conservative parameters to be selected for the design. Continued inspection and monitoring prior, during and post construction. Contingency measures for evacuation.	Low
19	AGI Connections	Construction works	Ground settlements	High	Collapse/injury to site personnel and programme delay Nearby assets and structures	2nd Phase GI completed (boreholes L09 & L10 at Paull). Selection of conservative design parameters. Settlement of ground due to dewatering to be mitigated by implementation of recharge system which will prevent drawdown at distance and subsequently prevent a reduction in pore water pressure which induces settlement. Ongoing groundwater monitoring and settlement monitoring to be undertaken throughout the construction works (as well as pre and post construction works).	Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
20	Use of dewatering measures to control groundwater regime	Effects of nearby structures and assets	Instability of existing structures and assets	Medium	Collapse/injury to site personnel and programme delays	Impact on the surrounding area has been assessed within the Hydrogeological Impact Assessment. A groundwater control system and mitigation measures (such as recharge) are documented within the Hyder HIA and OGI HIA Addendum. The mitigation measures will prevent drawdown at distance and over abstraction from the aquifer which could affect nearby structures and assets.	Low
21	Site wide Archaeological and Culture Heritage	Delay to construction programme	Encountering Archaeological and Culture Heritage	Medium	Delay to programme and cost	Consider effect of design on known sites. Contingency measures for possible presence of unidentified sites. Archaeological investigations ongoing in the area of proposed works.	Low
22	Ecology	Delay to construction programme	Encountering RAMSAR and SSSI sites	Medium	Delay to programme and cost	Avoidance of such areas during design	Low
23	Flooding	Health hazard to site personnel and potential delay to construction programme	Flooding of works during construction	Medium	Collapse/injury to site personnel and programme delays	Allow for mitigation measures during design to deal with flooding for worst possible flood event.	Medium to Low
24	Land Contamination	Health hazard to site personnel and potential delay to construction programme	Unexpected contamination encountered during ground works	High	Mitigation measures likely to be required, possible impact on groundwater resources	Desk Study and walkover identified potential sources of contamination. Investigation and testing of any potential sources has been carried out during 1st and 2nd Phase GI. A thin area of made ground containing asbestos contaminated materials around reception shaft at Goxhill has been identified and the risks assessed. Construction works in the vicinity of the reception shaft will be subject to an agreed programme of remediation/remedial works, prior to the commencement of site operations and prior to shaft excavation.	Medium to Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
25	Land Contamination	Health hazard to site personnel and potential delay to construction programme. Underlain Chalk aquifer	Piling and tunnelling	High	Mitigation measures may be required.	Ensure sufficient ground investigation data is available. Use of appropriate piling technique. Control on pile length. Piling risk assessment shall be prepared and agreed with the Environment Agency prior to commencement of piling operations.	Medium to Low
26	Buried concrete design and protection	Chemical attack	High sulphate levels,	High	Deterioration of concrete leading to serviceability problems	Phase 1 and 2 GI undertaken included testing to BRE SD1 (site works to be completed w/c 12/10/15 at Paull). Buried concrete classification and design in accordance with BRE Special Digest 1 and BS 8500	Low
27	Hydrogeology and Groundwater control measures	Lack of seasonal data and extreme data	Groundwater data collected over summer 2014; not over whole year.	High	Unable to substantiate the annual groundwater piezometric highs; limited understanding of the annual range of piezometric head. Underestimate inflow rates and volumes during dewatering and excavation.	Groundwater monitoring data has been continuously collected since June 2014, with monitoring still ongoing. Monitoring will continue up to, during and post construction of the pits and tunnel. The groundwater control system and associated mitigation measures will be designed for conservative groundwater pressures which takes into consideration the ongoing monitoring since June 2014. This allows additional dewatering/recharge during periods where the piezometric level is higher.	Low
28	Hydrogeology and Groundwater control measures	Weathered chalk surface – putty chalk and fractured chalk	Post-depositional weathering of Chalk prior to deposition of Glacial Deposits and Alluvium.	High	Collapse/injury to site personnel and programme delays	Ground Investigations, historic data and scientific literature along the tunnel line and within the region has indicated the depth of the weathered Chalk at the project location. The structural and groundwater control system design includes a secant pile retaining wall around the Drive and Reception Pits which will exclude the weathered Chalk. This wall will be	Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
						designed to withstand a conservative Groundwater pressures which takes into consideration the ongoing monitoring since June 2014. The TBM will be a closed system which excludes groundwater. The system will be designed to handle a variety of ground conditions including cohesive putty Chalk and highly permeable weathered or fractured Chalk. The groundwater control system is outlined within the Hyder HIA and OGI HIA Addendum.	
29	Hydrogeology and Groundwater control measures	Heave of bedrock with removal of over burden	Release of over burden leading to ground heave and groundwater movement from aquifer strata at depth.	High	Collapse/injury to site personnel, programme delays and potential damage to services/adjacent road	The groundwater control system is outlined within the Hyder HIA and OGI HIA Addendum. Pressure relief wells will allow the dissipation of pressure and prevent heave of the ground as excavation progresses.	Low
30	Hydrogeology and Groundwater control measures	Saline intrusion into aquifer and earthworks / construction; deterioration of groundwater quality in aquifer units.	Dewatering draws saline/brackish water towards construction, migration of the saline interface.	High	Deterioration of groundwater quality in aquifer units;	Saline intrusion has been assessed within the Hyder HIA and OGI HIA Addendum. The designed groundwater control system and recharge wells will prevent drawdown at distance and subsequently prevent reversal of the hydraulic gradient which could result in intrusion. Continued monitoring of groundwater levels, groundwater quality and the position of the saline interface will be undertaken prior to, during and post construction	Low

Ref	Activity, Design, Process and Material	Hazard	Cause	Qualitative assessment of Initial Risk	Consequence	Actions taken by the Designer to reduce risk rating or manage risk	Qualitative assessment of Residual Risk
31	Hydrogeology and Groundwater control measures	Groundwater quality deterioration in the aquifer units affecting future potential for aquifer use. Deterioration or no improvement to WFD status.	Movement of saline, brackish or poorer quality groundwater towards the construction and dewatering sites.	High	Reduced current and future potential for consumptive and non-consumptive groundwater use. No improvement to the WFD status.	Groundwater quality and quantity deterioration has been assessed within the Hyder HIA and OGI HIA Addendum. Recharge is to be implemented to prevent over abstraction from the aquifer, reduction in baseflow to surface systems and migration of contaminants which could lead to groundwater quality deterioration. Continued monitoring of groundwater levels, groundwater quality and the position of the saline interface to be undertaken prior to, during and post construction	Low