

Hampshire Water Transfer & Water Recycling Project Environmental Statement - Appendix 11.1 Response to Havant Borough Council Environmental Control Officer

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from
**Southern
Water.** 

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Hampshire Water Transfer and Water Recycling Project

Response to Havant Borough Council Environmental Control Officer

710166-SWS-XX-XX-CO-GE-00001 P01

1. Introduction

- 1.1. The aim of the note is to respond, where a response is within the remit of the “ground conditions” discipline, to the comments raised by the Environmental Control Officer (ECO) at Havant Borough Council (HBC) during earlier email correspondence on 31st August 2022 (email from Jonathan Driver to Gary Christie) and 18th February 2023 (email from Jonathan Driver to water.resources@defra.gov.uk). These comments relate to the proposed Water Recycling Plant (WRP) on land parcel WRP_72 also referred to as “the Broadmarsh site”.
- 1.2. It is recognised that the ECO’s comments were made prior to the issue of Southern Water’s (SW) Geo-Environmental Interpretative Report (GIR) (SSP, 2023, Geo-Environmental Interpretative Report, ref: 331101000-RP-GEO-100.00948-710060-002 Version 2). This report was made available to the ECO in January 2024 and re-issued at the ECO’s request in May 2024.
- 1.3. The GIR was prepared with the intention of addressing the ECO’s comments. This technical note provides ‘signposting’ of where responses to the ECO’s comments can be located.
- 1.4. The ECO made some additional comments on 2nd May 2024 (email from Jonathan Driver to Sophie Maloney). A request was made for technical details regarding the design and installation of the proposed underground pipelines. As such, this technical note includes tables in Appendix B and Appendix C to cover such details and how they relate to mitigation of the perceived environmental/health risks, where not already covered by the current GIR.
- 1.5. The GIR and the Outline Remediation Strategy therein is currently being updated to include details related to the proposed shafts and underground pipelines associated with the proposed Water Recycling Plant (WRP) on land parcel WRP_72, in line with the information presented in this technical note. The update of the GIR will also address comments made by the ECO as part of the summer 2024 consultation process, which are not covered in this technical note.
- 1.6. It should be noted that the information relating to the proposed WRP foundations and underground pipelines presented in Appendix B has been developed by Southern Water as part of the initial stages of design of the proposed development. A competitively appointed provider will be appointed through a direct procurement for customers process to undertake the design, construction, operation and maintenance of the proposed development, in line with the approved Development Consent Order (DCO). Precise details of technical design of the proposed development are therefore subject to refinement, as part of this process.



2. Level of Detail / Interaction with the Development Consent Order

- 2.1. At this stage of the project, SW has developed parameters and development zones for the proposed WRP and underground pipelines to allow for sufficient level of flexibility for further scheme design and development and any innovation once the contractor is on board. We have also developed a set of design opportunities that will evolve into the design principles for the WRP and associated infrastructure that will be included in the DCO application.
- 2.2. The final detailed design of the proposed WRP and underground pipelines will be determined by the contractor, following approval of the DCO. The detailed design will be developed in line with the parameters, limits of deviation and design principles that would be secured in the approved DCO.
- 2.3. The DCO application will also be supported by outline management plans, for example an Outline Construction Environment Management Plan which will control potential construction impacts. It is anticipated that preparation of a detailed Construction Environment Management Plan would form a requirement that would need to be discharged with approval by the relevant consent granting body following approval of the DCO application.

3. Site Selection Process

- 3.1. The site of the proposed WRP has been identified through a site selection process that has consisted of a number of stages which have been undertaken throughout the development of the project to ensure the site selection process reflects the latest information. The initial stages of the site selection process were as follows:
 - Definition of a 1.5 km search area from Budds Farm Wastewater Treatment Works. Areas at risk of future coastal flooding were excluded from the search area.
 - Identification of terrestrial parcels against a set of criteria which excluded residential areas, key infrastructure and existing employment development.
 - The identified terrestrial parcels were evaluated against environmental, planning and engineering criteria. The sites were scored according to their proximity to a range of environmental designations including international and national ecological sites, landscape designations and flood risk zones.
- 3.2. This process resulted in the identification of WRP_72 (located north of Harts Farm Way and west of the Hermitage Stream) as the preferred site for the water recycling plant, due to the limited environmental constraints.
- 3.3. As a result of feedback received at the Summer 2022 Consultation on the selection of WRP_72, we undertook a review of the site selection process with the aim of ensuring that all reasonable alternative sites for the water recycling plant had been considered and reviewed.

3.4. The review consisted of three key parts:

- All sites that had been identified through the site selection process previously were rereviewed. Sites that had the potential for significant adverse impacts were not progressed.
- As a result of feedback from stakeholders identifying that there was potential for developed employment sites in the proximity of Budds Farm Wastewater Treatment Works to become available, we considered new sites that hadn't been previously identified. Sites that had the potential for significant adverse impacts were not progressed.
- A land availability and cost review were undertaken on the sites where the risk of significant adverse impacts was not identified in the previous two stages.

3.5. Engagement with HBC was undertaken throughout this process to seek views on the proposed approach and outcomes.

3.6. The water recycling plant review process identified that WRP_72 remained the best performing site for the water recycling plant against the defined criteria set out in the water recycling plant site selection review. This site also was considered to perform the best in the land availability and best value review as the site was undeveloped. This was due to its lower environmental, planning and deliverability risks in comparison to alternative site models, which all had greater environmental constraints, or existing development and therefore greater deliverability implications, which is outlined within the Scheme Development Summary document submitted as part of the summer 2024 consultation ([2024 Scheme Development Summary.pdf | Powered by Box](#)).

4. 31st August 2022 Comments

4.1. **ECO comment.** *“Principle concerns for me are ensuring that the development is suitable for the characteristics of the proposed land – this is material to the development beyond the scope of the EIA, in that the development itself is also at risk from the ground conditions (e.g. the risk of accumulation of combustible or asphyxiant mixtures of gas in below ground voids within the development itself; the aggressive chemical environment for buried materials - pipes, seals, concrete etc.; the risk to the pipeline from differential settlement, and the risk that any significant resultant leakage could alter the materially alter the leachate regime at the site and adversely affect the integrity of its containment structure).”*

4.2. **SW response.** As described in Section 1.2 of the GIR, the GIR has been prepared in a planning context and recognises the need for planning decisions to ensure that a site is suitable for its proposed use. In relation to the specific points raised:

- Gas risk: A landfill gas risk assessment is presented in Section 8 of the GIR which concludes that the site should be classified as Characteristic Situation (CS) 3 and that gas protection measures would be required. Contaminant Linkages 1 and 4 recognise the landfill gas hazard and require the use of landfill gas protection measures.
- Aggressive Ground Conditions: Contaminant Linkages 5 and 6 recognise the potential for aggressive ground conditions to be present and require the appropriate specification of concrete mixes and selection of in-ground materials. Sections 11.3 and 11.5 of the Outline Remediation Strategy provide further detail in this regard.

- **Differential Settlement:** The proposed WRP structure will rest upon piled foundations bearing upon competent natural strata. Deep shafts and tunnels will also be founded within competent natural strata. The detailed design of the WRP and associated shafts, tunnels and pipelines will be required to mitigate risks associated with differential settlement including provision of suitably stable foundations and connections designed with additional tolerances to accommodate differential movement without the risk of leakage e.g., through flexible joints in pipework etc.
- **Alteration of the leachate regime:** It is intended that the construction of the proposed development will alter the leachate regime for the better. The construction of the proposed development will result in a reduction in infiltration through the cover soils of the landfill via the introduction of new areas of impermeable development. Infiltration drainage is not proposed. A reduction in infiltration will correspond to a reduction in leachate generation and therefore a corresponding reduction in contaminant load being released to controlled waters (groundwater and surface water).
- **Landfill containment structure:** The landfill is an unlined 'dilute and disperse' type. The wider landfill is retained by a bund which rests upon a sheet-piled wall, the sheet-piles appear to vary along different points in the bund, with various lengths of between approximately 1.8 m to 6.0 m. The proposed development includes a pipeline from the Budds Farm Wastewater Treatment Works (WTW). This tunnel will extend laterally at depth within the natural strata between shafts sunk within the site and at Budds Farm WTW. The design of the proposed WRP foundations and underground pipelines is presented in Appendix B. Responses relating to the environment / health risk mitigation of the pipeline are contained in Appendix B and Appendix C.

4.3. **ECO comment:** *"the potential to create a preferential pathway [between Langstone Harbour and] an actively decomposing landfill (which represents a source of organic nitrogen in various forms) risks undermining this aspect of the sustainability case. Similarly, the landfill waste body is a potential source of compounds that are currently causing occasional WFD failures at harbour monitoring locations, so again, any material increase in the rate of leachate flux, or any shortening of leachate transport pathways, also risks environmental harm"*.

4.4. **SW response:** The potential for the creation of preferential pathways for contamination to enter Langstone Harbour is recognised within Contaminant Linkage 7 which requires the selection of an appropriate piling methodology, a surface water management plan, surface water quality monitoring, agreement of threshold concentrations and actions to be undertaken should agreed threshold concentrations be exceeded, a foundation works risk assessment etc, all of which will be included within the Construction Environmental Management Plan. These measures are designed to ensure the Proposed Development does not lead to an increase in the rate of leachate generation, leachate flux or the shortening of leachate transport pathways which would increase the risk of environmental harm. At present, a period of baseline monitoring of the surface water upgradient and downgradient of the site, as well as the leachate within the landfill and the underlying groundwater within the natural strata is being undertaken. The proposed structures, with the exception of the tunnel from Budds Farm to WRP_72 are all located within the west of the Site, at distance from the existing sea defences (landfill bund). The current design of the tunnel is such that the tunnel passes beneath the landfill bund and the toe of the associated sheet pile wall at a depth, avoiding any adverse impact on the integrity and lifespan of the sea defences and landfill bund. The impact of the proposed tunnelling on the sea defences and landfill bund would be subject to detailed assessment as subsequent stages in the design.

4.5. **ECO comment:** *"The risks are principally related to buried & below ground infrastructure, and whilst engineering solutions probably exist, the simplest solution (with the greatest certainty) would be to avoid the very challenging ground conditions altogether (e.g. by choosing a different site)"*.

- 4.6. **SW response:** A robust site-selection process has been undertaken (see Section 3 above), concluding that the site offers the best solution. SW have acquired the site and will be continuing with proposals. Further comments relating to site selection on 18th February 2023 should refer to this response. Additional details on how the risks posed by the WRP_72 site's ground conditions have been addressed in the current design are set out in Appendices B and C.
- 4.7. **ECO comment:** *"The next most certain solution would be robustly engineered passive venting of pipelines routing N/NW, and bringing the SE pipeline (which connects to Budds Farm) above-ground outside of the Landfill bund, and then routing it to the recycling plant above-ground...I have reservations about the bored, direct pipeline linking Budds to the recycling plant which would appear to be proposed; this option would ultimately be heavily reliant on the aggregate efficacy of the engineering, materials and construction-quality in order to be effective (maintain risk status-quo) in the long term"*.
- 4.8. **SW response:** At the time this comment was issued, the proposed design used a horizontally directionally drilled pipe, running at a shallower level between entry and reception pits at Budds Farm WWTW and the WRP site respectively. With consideration of the environmental risks and feasibility of this technique, the design has been revised (as stated above) to a 'tunnels and shafts' methodology. Similar shafts will be created on the northern side of the site for the onward pipelines to Otterbourne and the proposed Havant Thicket reservoir.
- 4.9. The proposed construction methodology for the shafts comprises primary shaft linings using reinforced concrete diaphragm walls and base slabs. The diaphragm walls would be constructed by forming a series of adjoining reinforced concrete panels, constructed in deep trenches excavated by vertical grabs, extending down to the natural strata. Shafts would be excavated within the primary diaphragm wall linings and reinforced concrete based slabs formed at the base of the shafts. The tunnel will then be pipe-jacked between the shafts with the tunnel lining grouted in place once tunnelling is complete. Through this methodology 'intimate contact' will be maintained between the waste and the external face of the shaft and tunnel lining, such that a preferential pathway for leachate migration will not be created. Further detail on the proposed shaft and pipe-jack construction methodology is provided in Appendix B.
- 4.10. Gas protection measures will be included within the proposed development and will be subject to design by a specialist designer (see Section 8.3 of the GIR).
- 4.11. Responses relating specifically to design and environmental / health risk mitigation of the proposed WRP foundations and underground shafts and pipelines are contained in Appendix B and Appendix C. The design presented in Appendix B is for outline design / planning stage only.

5. 18th February 2023 Comments

- 5.1. **ECO comment:** *"Incoming pipework from Budds Farm represents a risk of increasing leachate egress from the landfill, and by extension exacerbating the risk of related environmental harms"*.
- 5.2. **SW response:** See above relating to tunnels and shaft construction, piling method selection and foundation works risk assessment.
- 5.3. **ECO comment:** *"Delivery & transfer pipework also represents a risk of acting as a conduit for migration of landfill gas to reach sensitive receptors – with a subsequent risk to both health & property (e.g. through ignition)"*.

- 5.4. **SW response:** This risk is recognised and whilst Contaminant Linkage 1 identifies landfill gases as a hazard to on-site human health receptors, and requires landfill gas protection measures to be included, the hazard of gas migration via the proposed shafts to off-site human health receptors has not been explicitly included. Within the final Remediation Strategy to be prepared following the detailed design of the Proposed Development (to be secured by Requirement) completion of the design of the proposals, Contaminant Linkage 1 can be expanded to include the proposed shafts as a pathway, and require gas protection measures (e.g., venting at the shafts).
- 5.5. **ECO comment:** *“Risks to the plant/pumping station, and staff working at it would also be elevated as a direct result of the presence of un-degraded landfill waste, relative to those that would exist at an alternative site”.*
- 5.6. **SW response:** A landfill gas risk assessment is presented in Section 8 of the GIR. Contaminant Linkages 1 and 4 recognise the landfill gas hazard and require the use of landfill gas protection measures.
- 5.7. **ECO comment:** *“The active degradation of waste poses a risk to infrastructure through movement, carrying a relatively high risk of failures of features designed to contain fluids and gasses. Inherently ‘safe’ routing solutions exist (e.g. over-sail containment bund, utilise above-ground-only pipework routing, and to ‘underground’ pipes outside the northern boundary of the landfill basin), but these options would carry significantly increased visual impact. As the site is regarded locally as contributing to the character & beauty of the harbour landscape, and due to it’s position relative to the Chichester Harbour AONB, planning policy challenges may arise”.*
- 5.8. **SW response:** The potential impact of an above-ground pipeline was considered, and for the reasons outlined in the above comment, as well as the requirement to maintain a navigable channel, a below ground pipeline was opted for. Note that the supports of an above ground pipeline would also be subject to movement due to degradation of waste, meaning this risk isn’t unique to underground pipework. As discussed above, pipelines, shafts and tunnels will be designed to address risks associated with ground movement. As part of our site selection process outline in Section 3, landscape character along with other environmental considerations were assessed.
- 5.9. **ECO comment:** *“...the permitting system represents a risk to the scheme (at this location), as (insofar as my understanding of the current form of the proposals) it would require substantial excavation and off-site disposal of formerly deposited municipal black-bag waste, possible treatment of that waste (under permit), and the modification of the containment of a closed landfill site (permitting requirements unclear). All of this seems to me to represent unnecessary complexities, and unnecessary risk”.*

- 5.10. **SW response:** The proposed development has been sited on the western side of the site where the ground levels are more level and where any required cut/fill earthworks can be minimised. It is also intended to keep as much as possible of the proposed development above ground level, such that the requirements for excavation and off-site disposal can be minimised. SW will engage with the EA as necessary regarding permitting, noting that in absence of any historical environmental permit, waste management licence or similar permit / permission relating to the original landfilling of the site it is not anticipated that significant permitting hurdles will be present. The EA have also stated that *“During the last redevelopment we took a local viewpoint that top material at the site (and 1.5m of inert material) was capping material not landfilled waste. As such it could be reused under DoWCoP At the time this was a bit a grey area, and we did not get that much of a steer from any national waste teams. The reuse of this material resulted in far less of a requirement to dispose of material and bring fresh material onto site (and associated large savings both in terms of carbon and cost to the developer). From an environmental and practical perspective, I cannot see any gain in removing and disposing of perfectly good structural soil material, that poses little risk to the environment, and replacing it with virgin aggregate”*.
- 5.11. Responses relating specifically to design and environmental / health risk mitigation of the proposed WRP foundations and underground shafts and pipelines are contained in Appendix B and Appendix C. The design presented in Appendix B is for outline design / planning stage only.

6. 4th August 2023: Havant Borough Council Bilateral Meeting

- 6.1. A meeting was held on 4 August 2023 between the SW project team and HBC. An overview of the context and outcomes of ground conditions investigations and monitoring at the proposed WRP site with regard to human health and controlled waters was presented. Some details of mitigation works and outline remediation strategy were also presented.
- 6.2. During this meeting HBC's concerns relating to land contamination and the selection of an historical landfill site as the site of the proposed WRP were discussed. The GIR and the Outline Remediation Strategy included therein demonstrate how the WRP can be safely constructed and both human and environmental health can be protected. Following completion of the design process by SW's design and build contractor (presumed to be post-DCO consent) a Detailed Remediation Strategy will be prepared which will finalise the mitigation measures that will be included/undertaken.

7. Email Correspondence from Jonathan Driver on 2nd May 2024

- 7.1. **ECO comment:** "... I suspect that the report has a broad scope and likely covers the entire pipeline route, however to my mind (from HBC's perspective-), the principle focus at this stage should be the interaction between the geo-environmental investigation/assessment and the Pipeline & WRP design details; I would like to maintain a fairly tight focus on the Broadmarsh site at this stage. Risks arising in the vicinity of the pipeline route are likely to be routine and easily managed, or to be associated with the landfill source".
- 7.2. **SW Response:** As detailed in paragraph 1.3, the GIR (SSP, 2023, Geo-Environmental Interpretative Report, ref: 331101000-RP-GEO-100.00948-710060-002 Version 2) covers the proposed WRP site. A conceptual site model (CSM) for the proposed WRP site is presented in Appendix A.
- 7.3. **ECO comment:** "it would also be helpful if you could outline some of the technical details relating to the pipeline specification, the absolute design constraints, installation process details (especially depth, jointing, precautions against settlement, and grouting-), and the requirements for- and general construction details of- any below ground voids associated with WRP (alongside any related design precautions)".
- 7.4. **SW Response:** The current design and construction details of proposed WRP foundations and underground shafts and pipelines are presented in Appendix B, this includes the current proposed depths and dimensions, possible construction methods (e.g. diaphragm walling, pipe jacking etc.) as well as relevant performance and technical requirements. Appendix C then specifically addresses each environment/health risk and concern highlighted by the ECO to date, by suggesting how the design and construction of each design element could mitigate them. It should be noted that the design of the proposed WRP foundations and underground shafts and pipelines presented in Appendix B is for outline design / planning stage only.

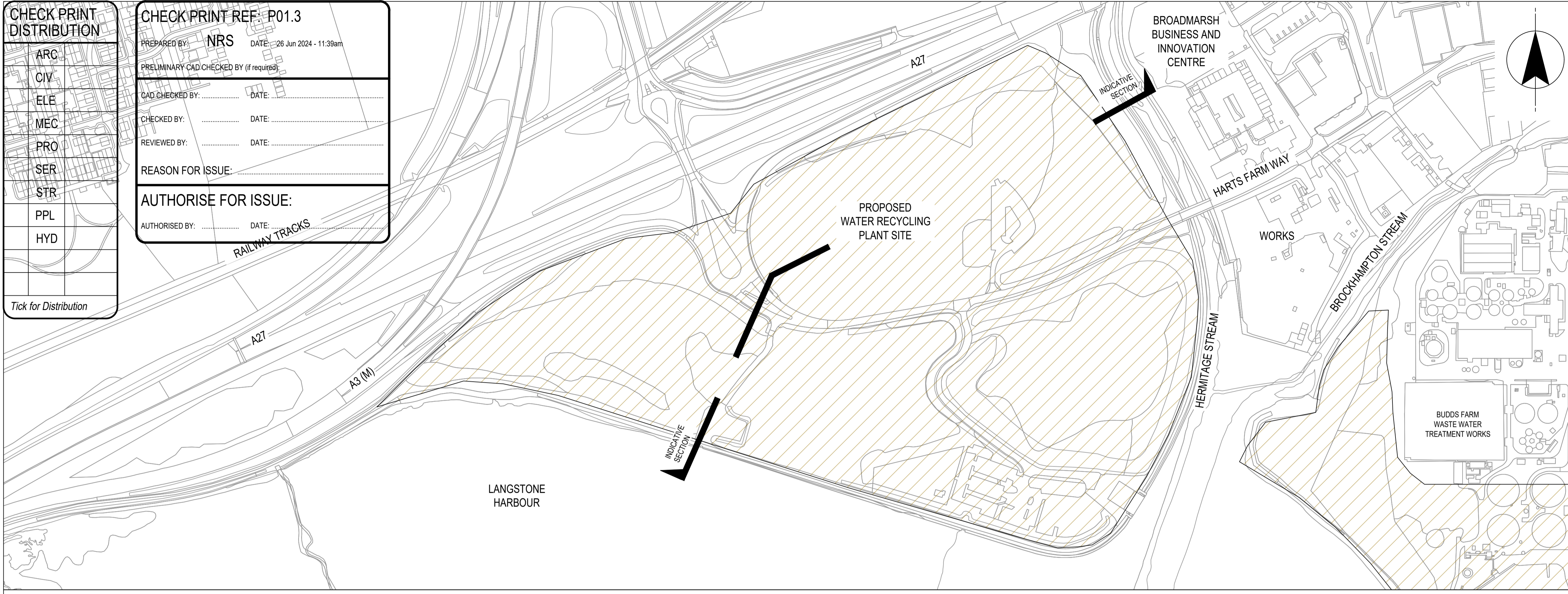
Appendix A: Figures

A1 – Conceptual Site Model

A2 – Shaft and Tunnel Sections

A1 – Conceptual Site Model

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ARC		PREPARED BY: NRS	DATE: 26 Jun 2024 - 11:39am
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MEC		CHECKED BY:	DATE:
PRO		REVIEWED BY:	DATE:
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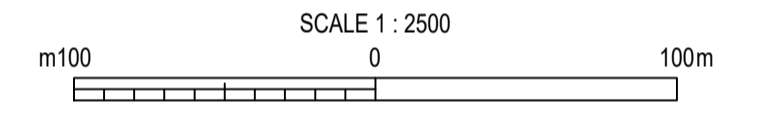


LOCATION PLAN
SCALE 1:2500

NOTES
1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES UNLESS SHOWN OTHERWISE.

LEGEND

	INDICATIVE WATER / LEACHATE LEVEL (NOTE: WATER / LEACHATE LEVEL IN LANDFILL IS TIDALLY INFLUENCED - 1.0 TO 1.3m RANGE)
	LANDFILL COVER SOILS (VARIABLY SANDY AND GRAVELLY CLAY)
	LANDFILL WASTE (DOMESTIC, COMMERCIAL AND INDUSTRIAL)
	LANDFILL GAS
	ALLUVIUM - SOFT SLIGHTLY GRAVELLY SOIL
	RIVER TERRACE DEPOSITS - SLIGHTLY CLAYEY SANDY GRAVEL
	CHALK - Dm TO Dc BECOMING C2 TO B2 WITH DEPTH



CURRENT VERSION INFORMATION

DATE	ORIG	CHKD	REVD	APPR	REV	STS	REASON FOR ISSUE
26/06/24	---	---	---	---	P01.3	S0	Initial Status or WIP

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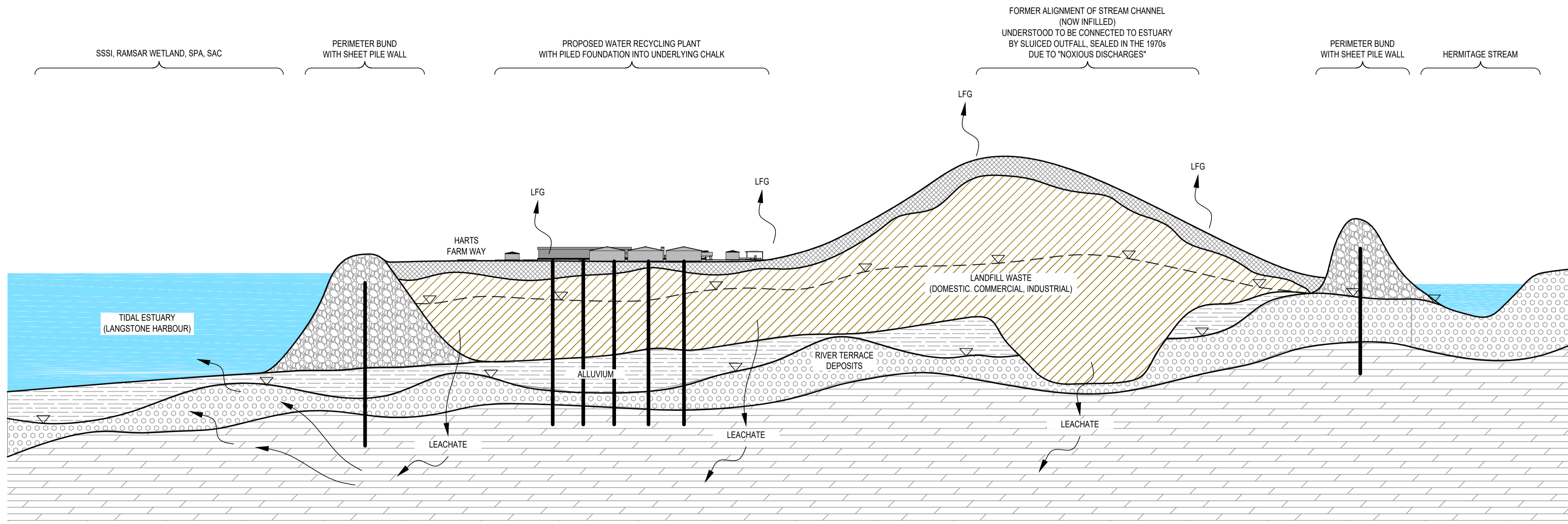
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Southern House, Yeoman Road, Worthing, West Sussex, BN11 1NY
Tel: 01903 264444 Fax: 01903 691435

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DRAWING TITLE
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PROPOSED WATER RECYCLING PLANT

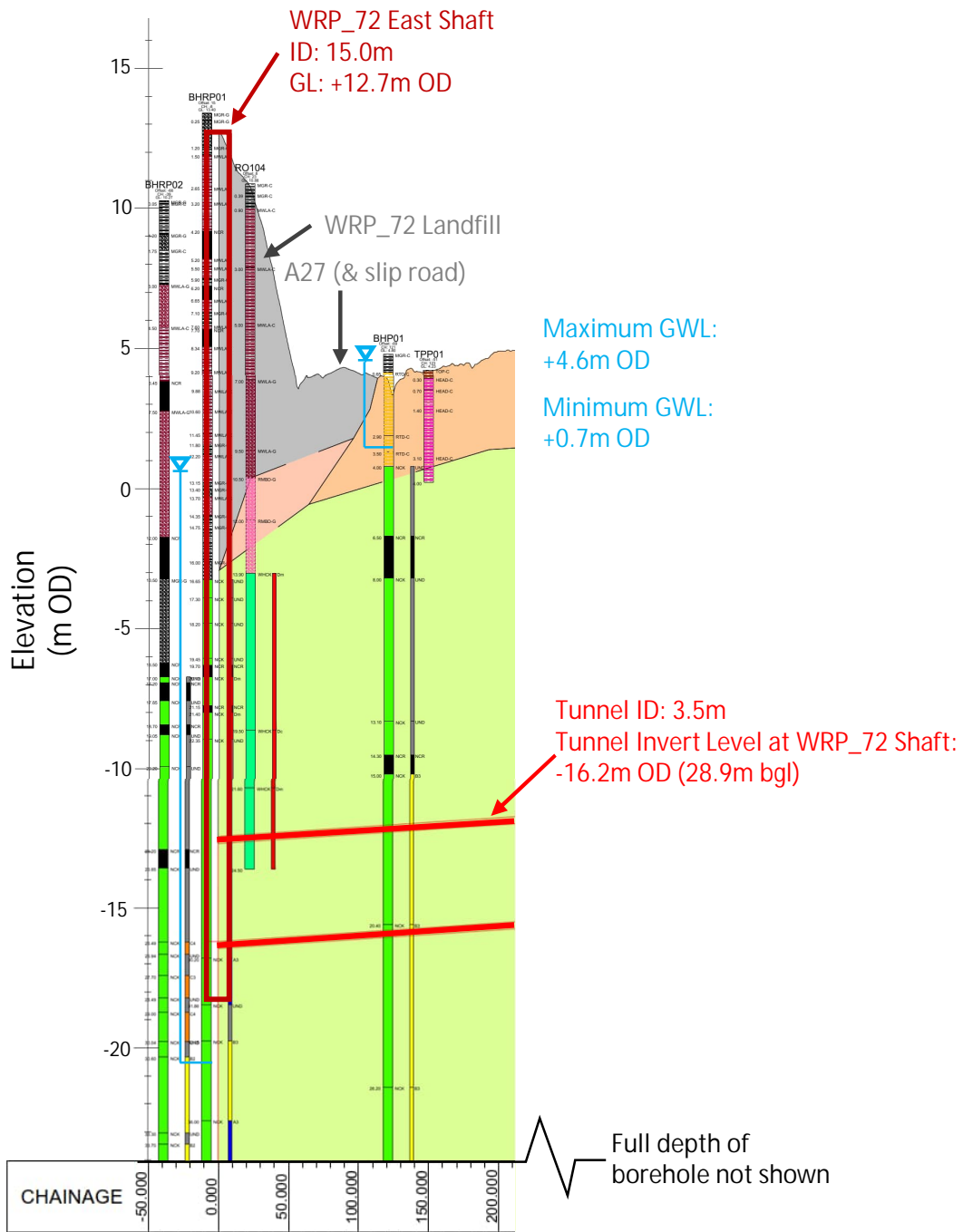
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INDICATIVE SECTION
SCALE NTS

A1 – Shaft and Tunnel Sections



Notes

1. Do not scale from this drawing.
2. All dimensions in metres (m) including the internal diameters (ID), all elevations/levels in metres relative to ordnance datum (m OD) and depths presented in meters below ground level (m bgl).
3. Borehole offset distance from alignment is shown as -ve to west and +ve to east.
4. The existing ground level (GL) line shown on the long section is from DEFRA national lidar programme.
5. The exploratory hole information presented is based on the WfLH Phase 0, 1 and 3A and historical Delta-Simons ground investigations (GIs). The range of ground water level (GWL) is based on groundwater monitoring data from installations in BHRP01, BHRP02 and BHP01 obtained between November 2022 and March 2024.
6. The geological units and indicative boundaries shown on the long section have been assessed based on the GI information available to date. Due to the offset of the exploratory holes from the alignment, the geological boundaries shown will not always correlate to the borehole sticks projected onto the long section.
7. This figure focuses on the shaft and tunnel proposed at land parcel WRP_72 therefore, the full extent of boreholes may not be shown.
8. The design presented herein is for outline design / planning stage only. The responsibility for the design, execution and performance of the proposed development will sit with a party who is yet to be appointed.

Legend

Indicative geological boundary

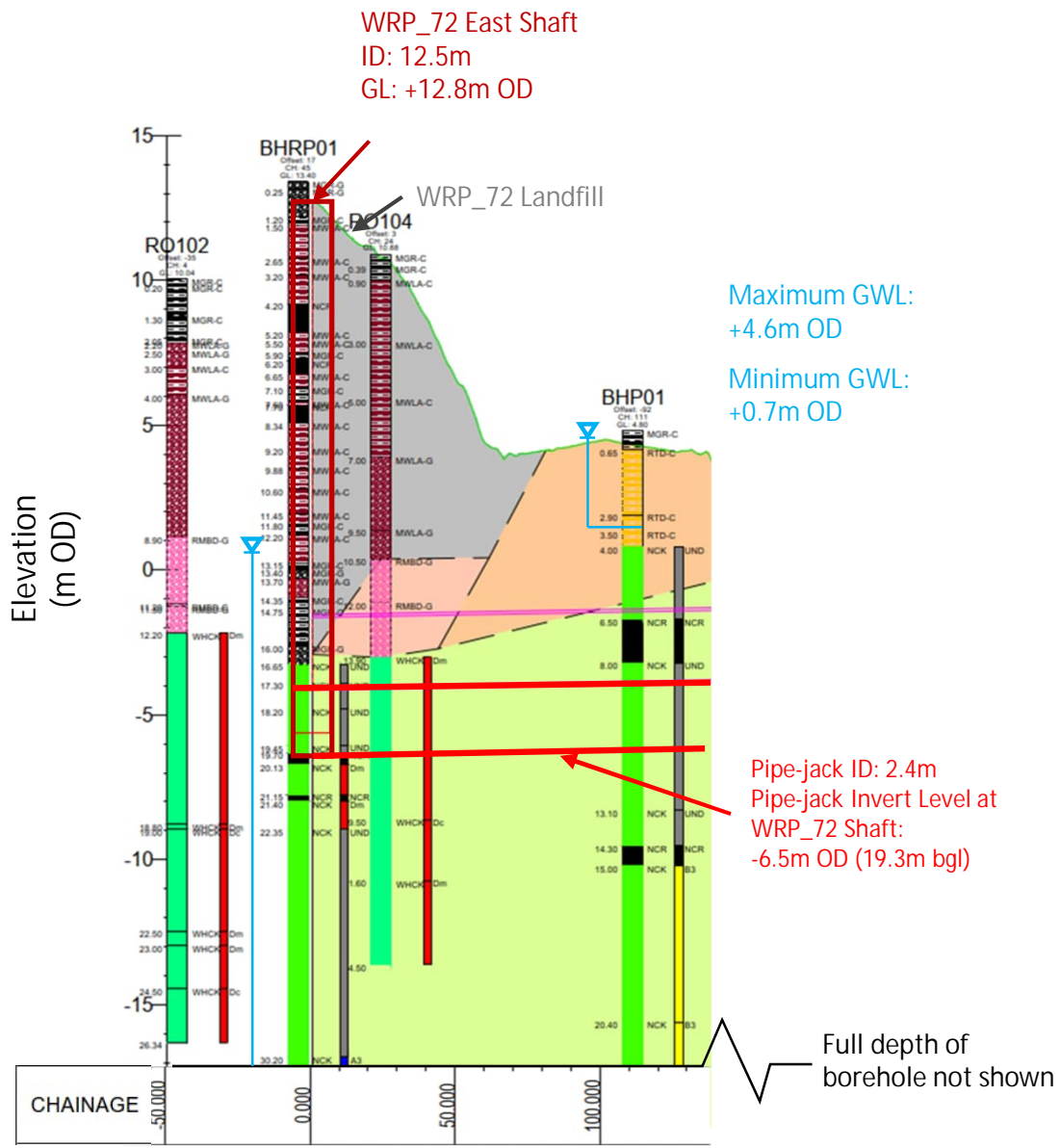
GEOLOGICAL UNIT LEGEND			
BOREHOLE HATCH		GEOLOGY HATCH	
	TOP-C TOPSOIL (COHESIVE)		TOP / MGR / MWLA
	TOP-G TOPSOIL (GRANULAR)		
	MGR-C MADE GROUND (COHESIVE)		TOPSOIL / MADE GROUND / LANDFILL
	MGR-G MADE GROUND (GRANULAR)		
	MWLA-C LANDFILL (COHESIVE)		ALLUVIUM
	MWLA-G LANDFILL (GRANULAR)		
	ALV-C ALLUVIUM (COHESIVE)		ALV
	ALV-G ALLUVIUM (GRANULAR)		
	RTD-C RIVER TERRACE DEPOSITS (COHESIVE)		RTD
	RTD-G RIVER TERRACE DEPOSITS (GRANULAR)		
	HEAD-C HEAD DEPOSITS (COHESIVE)		HEAD
	HEAD-G HEAD DEPOSITS (GRANULAR)		
	RMBD-G RAISED MARINE DEPOSITS (GRANULAR)		RMBD
	LC-C LONDON CLAY FORMATION (COHESIVE)		
	LC-G LONDON CLAY FORMATION (GRANULAR)		LC-G
	BOSA BOGNOR SAND FORMATION		
	LMBE-C LAMBETH GROUP (COHESIVE)		LMBE
	LMBE-G LAMBETH GROUP (GRANULAR)		
	RB-C READING FORMATION (COHESIVE)		LMBE
	UPR-C UPNOR FORMATION (COHESIVE)		
	UPR-G UPNOR FORMATION (GRANULAR)		WHCK
	CUCK CULVER CHALK FORMATION		
	NCK NEWHAVEN CHALK FORMATION		WHCK
	WHCK WHITE CHALK SUBGROUP		
	NCR NO CORE RECOVERY	N/A	

CIRIA CHALK GRADE LEGEND	
BOREHOLE HATCH	
	A1 - A5
	B1 - B5
	C1 - C5
	Dc
	Dm
	UND

Bottom of response zone & monitored GWL

Proposed shaft

Proposed tunnel or pipe-jack



Notes

1. Do not scale from this drawing.
2. All dimensions in metres (m) including the internal diameters (ID), all elevations/levels in metres relative to ordnance datum (m OD) and depths presented in meters below ground level (m bgl).
3. Borehole offset distance from alignment is shown as -ve to west and +ve to east.
4. The existing ground level ground level (GL) line shown on the long section is from DEFRA national lidar programme.
5. The exploratory hole information presented is based on the WFLH Phase 0, 1 and 3A, historical Delta-Simons ground investigations (GIs). The range of ground water level (GWL) is based on groundwater monitoring data from installations in BHRP01 and BHP01 obtained between November 2022 and March 2024.
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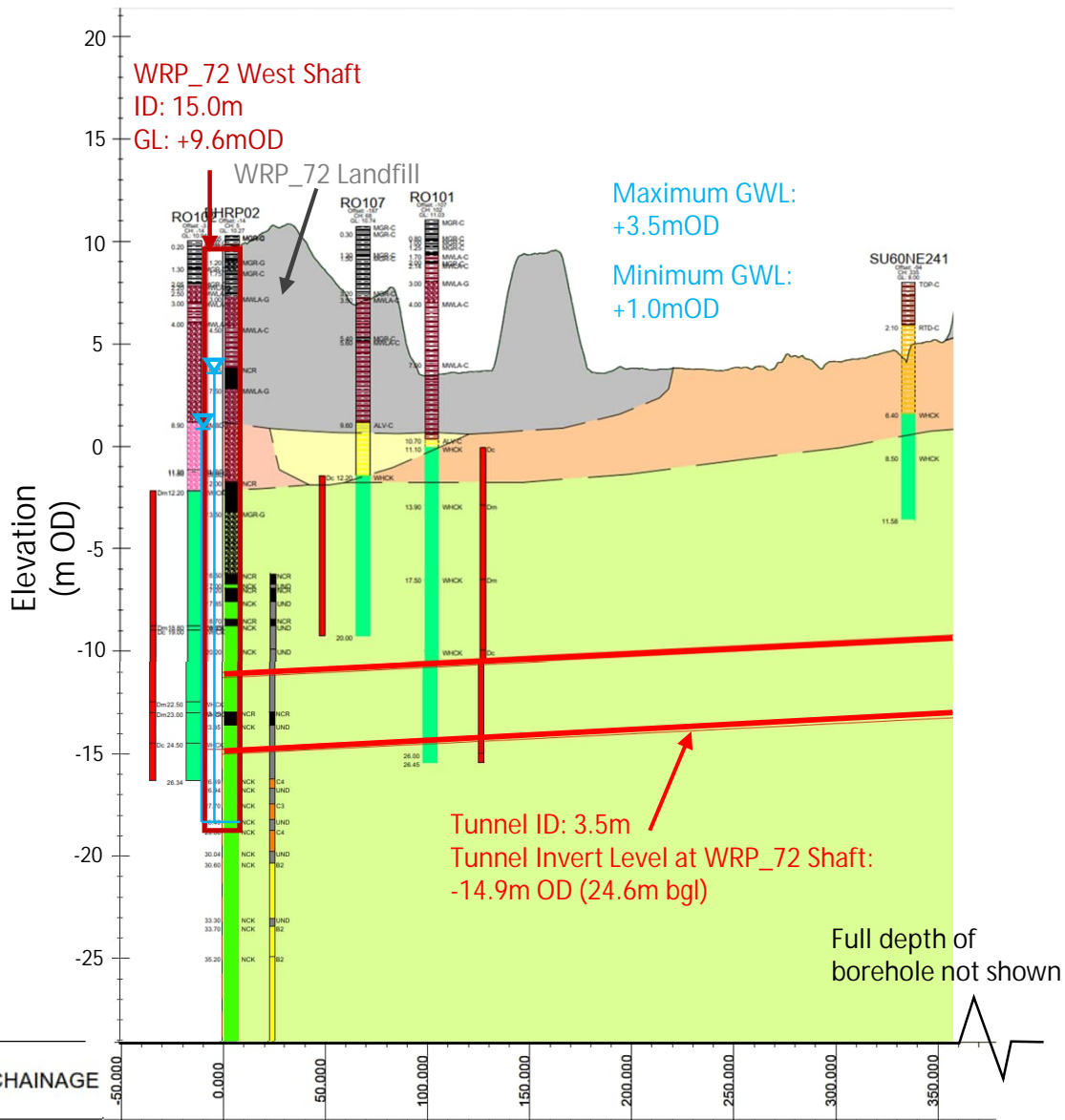
Legend

— Indicative geological boundary

GEOLOGICAL UNIT LEGEND				
BOREHOLE HATCH		GEOLOGY HATCH		
	TOP-G	TOPSOIL (GRANULAR)	TOP / MGR / MWLA	TOPSOIL / MADE GROUND / LANDFILL
	MGR-C	MADE GROUND (COHESIVE)		
	MGR-G	MADE GROUND (GRANULAR)		
	MWLA-C	LANDFILL (COHESIVE)		
	MWLA-G	LANDFILL (GRANULAR)	ALV	ALLUVIUM
	ALV-C	ALLUVIUM (COHESIVE)		
	ALV-G	ALLUVIUM (GRANULAR)	RTD	RIVER TERRACE DEPOSITS
	RTD-C	RIVER TERRACE DEPOSITS (COHESIVE)		
	RTD-G	RIVER TERRACE DEPOSITS (GRANULAR)	HEAD	HEAD DEPOSITS
	HEAD-C	HEAD DEPOSITS (COHESIVE)		
	RMBD-G	RAISED MARINE DEPOSITS (GRANULAR)	RMBD	RAISED MARINE DEPOSITS
	NCK	NEWHAVEN CHALK FORMATION		
	WHCK	WHITE CHALK SUBGROUP	WHCK	WHITE CHALK SUBGROUP
	NCR	NO CORE RECOVERY		

CIRIA CHALK GRADE LEGEND		
BOREHOLE HATCH		
	A1 - A5	Structured Chalk
	B1 - B5	
	C1 - C5	
	Dc	STRUCTURELESS CHALK (CLAST-DOMINATED)
	Dm	STRUCTURELESS CHALK (MATRIX-DOMINATED)
	UND	UNDEFINED

- Bottom of response Zone & monitored GWL
- Proposed shaft
- Proposed tunnel or pipe-jack



Notes

1. Do not scale from this drawing.
2. All dimensions in metres (m) including the internal diameters (ID), all elevations/levels in metres relative to ordnance datum (m OD) and depths presented in meters below ground level (m bgl).
3. Borehole offset distance from alignment is shown as -ve to west and +ve to east.
4. The existing ground level (GL) line shown on the long section is from DEFRA national lidar programme.
5. The exploratory hole information presented is based on the WfLH Phase 0 and 1, historical Delta-Simons ground investigations (GIs) and historical BGS exploratory holes. The range of ground water level (GWL) is based on groundwater monitoring data from the installation in BHRP02 obtained between November 2022 and January 2024.
6. The geological units and indicative boundaries shown on the long section have been assessed based on the GI information available to date. Due to the offset of the exploratory holes from the alignment, the geological boundaries shown will not always correlate to the borehole sticks projected onto the long section.
7. This figure focuses on the shaft and tunnel proposed at land parcel WRP_72 therefore, the full extent of boreholes may not be shown.
8. The design presented herein is for outline design / planning stage only. The responsibility for the design, execution and performance of the proposed development will sit with a party who is yet to be appointed.

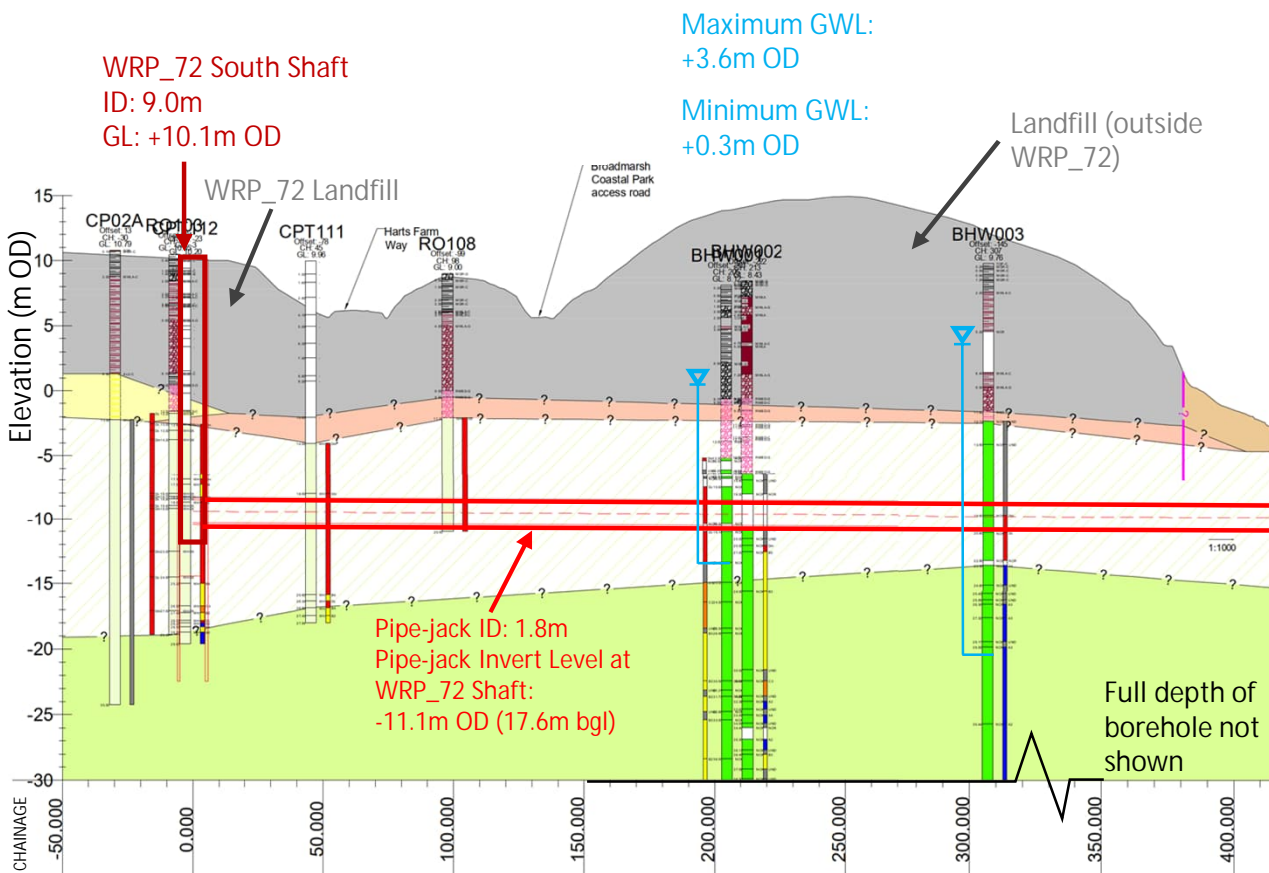
Legend

— Indicative geological boundary

GEOLOGICAL UNIT LEGEND				
BOREHOLE HATCH		GEOLOGY HATCH		
	TOP-C	TOPSOIL (COHESIVE)	TOP / MGR / MWLA	TOPSOIL / MADE GROUND / LANDFILL
	MGR-C	MADE GROUND (COHESIVE)		
	MGR-G	MADE GROUND (GRANULAR)	ALV	ALLUVIUM
	MWLA-C	LANDFILL (COHESIVE)		
	MWLA-G	LANDFILL (GRANULAR)	RTD	RIVER TERRACE DEPOSITS
	ALV-C	ALLUVIUM (COHESIVE)		
	RTD-C	RIVER TERRACE DEPOSITS (COHESIVE)	HEAD	HEAD DEPOSITS
	HEAD-C	HEAD DEPOSITS (COHESIVE)		
	HEAD-G	HEAD DEPOSITS (GRANULAR)	RMBD	RAISED MARINE DEPOSITS
	RMBD-G	RAISED MARINE DEPOSITS (GRANULAR)		
	PCK/CUCK	PORTSDOWN / CULVER CHALK FORMATION	WHCK	WHITE CHALK SUBGROUP
	CUCK	CULVER CHALK FORMATION		
	NCK	NEWHAVEN CHALK FORMATION		
	SECK	SEAFORD CHALK FORMATION		
	WHCK	WHITE CHALK SUBGROUP		
	NCR	NO CORE RECOVERY	N/A	

CIRIA CHALK GRADE LEGEND		
BOREHOLE HATCH		
	A1 - A5	Structured Chalk
	B1 - B5	
	C1 - C5	STRUCTURELESS CHALK (CLAST-DOMINATED)
	Dc	
	Dm	STRUCTURELESS CHALK (MATRIX-DOMINATED)
	UND	UNDEFINED

- Bottom of response zone & monitored GWL
- Proposed shaft
- Proposed tunnel or pipe-jack



Notes

1. Do not scale from this drawing.
2. All dimensions in metres (m) including the internal diameters (ID), all elevations/levels in metres relative to ordnance datum (m OD) and depths presented in meters below ground level (m bgl).
3. Borehole offset distance from alignment is shown as -ve to west and +ve to east.
4. The existing ground level (GL) line shown on the long section is from DEFRA national lidar programme.
5. The exploratory hole information presented is based on the WfLH Phase 0 and historical Delta Simons ground investigations (GIs). The range of ground water level (GWL) is based on groundwater monitoring data from installations in BHW001, BHW002 and BHW003 obtained between November 2022 and January 2024.
6. The geological units and indicative boundaries shown on the long section have been assessed based on the GI information available to date. Due to the offset of the exploratory holes from the alignment, the geological boundaries shown will not always correlate to the borehole sticks projected onto the long section.
7. This figure focuses on the shaft and tunnel proposed at land parcel WRP_72 therefore, the full extent of boreholes may not be shown.
8. The design presented herein is for outline design / planning stage only. The responsibility for the design, execution and performance of the proposed development will sit with a party who is yet to be appointed.

Legend

GEOLOGICAL UNIT LEGEND					
BOREHOLE HATCH		GEOLOGY HATCH			
[Hatch]	TOP-C	TOP SOIL (COHESIVE)	TOP / MGR / MWLA	TOP SOIL / MADE GROUND / LANDFILL	
[Hatch]	TOP-G	TOP SOIL (GRANULAR)			
[Hatch]	MGR-C	MADE GROUND (COHESIVE)	TOP / MGR / MWLA	TOP SOIL / MADE GROUND / LANDFILL	
[Hatch]	MGR-G	MADE GROUND (GRANULAR)			
[Hatch]	MWLA-C	LANDFILL (COHESIVE)	TOP / MGR / MWLA	TOP SOIL / MADE GROUND / LANDFILL	
[Hatch]	MWLA-G	LANDFILL (GRANULAR)			
[Hatch]	ALV-C	ALLUVIUM (COHESIVE)	ALV	ALLUVIUM	
[Hatch]	ALV-G	ALLUVIUM (GRANULAR)			
[Hatch]	BTFU	BEACH AND TIDAL FLAT DEPOSITS	BTFU	BEACH AND TIDAL FLAT DEPOSITS	
[Hatch]	RTD-C	RIVER TERRACE DEPOSITS (COHESIVE)	RTD	RIVER TERRACE DEPOSITS	
[Hatch]	RTD-G	RIVER TERRACE DEPOSITS (GRANULAR)			
[Hatch]	HEAD-C	HEAD DEPOSITS (COHESIVE)	HEAD	HEAD DEPOSITS	
[Hatch]	HEAD-G	HEAD DEPOSITS (GRANULAR)			
[Hatch]	RMBD-C	RAISED MARINE DEPOSITS (COHESIVE)	RMBD	RAISED MARINE DEPOSITS	
[Hatch]	RMBD-G	RAISED MARINE DEPOSITS (GRANULAR)			
[Hatch]	NCK	NEWHAVEN CHALK FORMATION	WHCK	STRUCTURELESS CHALK / WHITE CHALK SUB GROUP	
[Hatch]	WHCK	WHITE CHALK SUB GROUP			
[Hatch]	NCR / -	NO CORE RECOVERY / -	N/A		

CIRIA CHALK GRADE LEGEND		
BOREHOLE HATCH		
[Hatch]	A1 - A5	Structured Chalk
[Hatch]	B1 - B5	
[Hatch]	C1 - C5	
[Hatch]	Dc	STRUCTURELESS CHALK (CLAST-DOMINATED)
[Hatch]	Dm	STRUCTURELESS CHALK (MATRIX-DOMINATED)
[Hatch]	UND	UNDEFINED

- ? - Indicative geological boundary
- Blue triangle symbol: Bottom of response zone & monitored GWL
- Red line: Proposed shaft
- Red line with hatch: Proposed tunnel or pipe-jack
- Pink dashed line: Anticipated sheet pile wall

Appendix B: Design and Construction Details for Shafts, Tunnels & Foundations

Design and Construction Details for Shafts, Tunnels & Foundations Currently Proposed

	Proposed Development Components	General Description of Proposed Development Components ^[2]	Proposed Construction Method ^[2]	Relevant Performance and Technical Requirements ^[2]
Shafts	WRP to HTR Shaft^[1] 'WRP_72 East Shaft' (See Appendix A2, Figure 1) Purpose: TBM launch and accommodates pipeline between tunnel and WRP	The proposed arrangements of the shafts are shown in Appendix A2 (Figure 1 and Figure 3). The shafts located on the WRP_72 site will be constructed through the Landfill / Made Ground and other superficial deposits and will be founded below the landfill. Shaft for TBM launch or pipe jacking to comprise: Shaft cover slab: precast concrete.	<ol style="list-style-type: none"> 1) Working platform prepared at ground surface. 2) Deep soil mixing to stabilise the Landfill either side of the diaphragm wall to ensure excavation stability. 3) Excavate diaphragm wall panels to depth below shaft excavation level, install reinforcement and pour concrete. Then construct concrete capping beam. 5) Dewatering: Dewatering/depressurisation of groundwater within the diaphragm walling using dewatering wells within the shaft lining to allow excavation of the shaft in the dry. Preceded by fissure grouting of Chalk below base slab formation level (if needed) to provide further restriction of groundwater inflow. 6) Excavation within the shaft carried out to base slab formation level, then cast base slab. 7) Portal around tunnel eye opening to be constructed and secondary shaft lining to be cast. 8) Following tunnel construction, the portal opening and chamber for the pipe will be installed. 9) Mass concrete infill from the top of the base slab up to tunnel invert levels. 10) Construction of shaft cover slab. 	Design life: shafts shall be designed to 100 years in accordance with CED 4002 Issue No.10 Cl. 3.5 "Design Life". Pressure: All shafts designed to withstand water mains within the shafts, earth pressures and groundwater pressures during design life. Water tightness: shafts shall be designed to be 'substantially watertight' with no water flow penetrating the primary or secondary lining, per CESWI Cl. 11.11. Concrete: durability and tolerances must meet BS 8500-1:2015, CED4023 Issue No.4, Cl.4.25, and BS-EN 13670 requirements. Concrete mix to be appropriately designed for the aggressivity class of the Landfill / Made Ground and natural strata.
	WRP to BHS Shaft^[1] 'WRP_72 East Shaft' (See Appendix A2, Figure 2) Purpose: Pipe jacking launch and accommodates pipeline between tunnel and WRP	Diaphragm wall (primary lining): reinforced diaphragm wall with overlapping panels. Diaphragm wall to be cut/removed as required for the construction of tunnel portal. Diaphragm walls extend below shaft excavation level to provide cut-off and reduce inflow of water into shaft during excavation. Secondary lining: cast in situ reinforced concrete lining within the diaphragm wall for watertightness. Tunnel-to-Shaft portal: reinforced concrete portal integrated into the secondary lining. Base slab: cast in situ circular reinforced concrete slab.		
	WRP to Purbrook Shaft 'WRP_72 West Shaft' (See Appendix A2, Figure 3) Purpose: TBM launch and accommodates pipeline between tunnel and WRP	Mass concrete infill: to raise the shaft invert levels above the base slab to the required finished level. Sump: integrated into the mass concrete infill.		
	WRP to Budds Farm Shaft 'WRP_72 South Shaft' (See Appendix A2, Figure 4) Purpose: Pipe jacking launch and accommodates pipeline between tunnel and WRP			
TBM Tunnels	WRP to HTR Tunnel^[1] 'Havant Thicket Route' (See Appendix A2, Figure 1) Purpose: Accommodates pipelines between WRP and HTR	The proposed arrangements for the tunnels are shown in Appendix A2 (Figure 1 and Figure 3). The tunnels will be constructed below the Landfill / Made Ground and other superficial deposits, through natural strata. Tunnel to be constructed using Earth Pressure Balance (EPB) TBM or Slurry TBM. EPB TBM utilises a pressurised plug to counteract the external earth and hydrostatic pressures, advantage is limiting mobilisation of Chalk 'flour' from TBM operation. Slurry TBM utilises a compressed air cushion / bubble to fine tune the slurry support pressure, advantage is better resilience against flint wear and reduced need of intervention for maintenance.	<ol style="list-style-type: none"> 1) TBM assembled within launch shaft. 2) TBM excavates the tunnel using its rotating cutter head to break through the soil/ rock. 3) Spoil management: EPB TBM: spoil to be transported from cutting face through a screw conveyor and guillotine valve for onward transfer out of tunnel by conveyor/wagons. Slurry TBM: slurry of excavated material, water and drilling fluids transported through discharge pipe to treatment plant at surface for segregation. Cleaned slurry returned to TBM vial slurry feed pipe. 4) Pre-cast concrete segments transported into tunnel and assembled to form complete rings with grouting behind the tunnel lining to create seal between the soil and segments. 5) TBM advances with excavation, spoil removal and construction of tunnel lining in a cyclical process and constant monitoring/ adjustments to ensure alignment and face pressure. 6) TBM breakthrough at reception shaft followed by disassembly. 7) Installation of water pipeline(s) into tunnel. 	Design life: tunnels shall be designed to 100 years in accordance with CED 4002 Issue No.10 Cl. 3.5 "Design Life". Pressure: All tunnels designed to withstand water mains within the tunnels, earth pressures and groundwater pressures during design life. Water tightness: tunnels shall be designed to be 'substantially watertight' with no water flow penetrating the primary or secondary lining, per CESWI Cl. 11.11. Concrete: durability and tolerances must meet BS 8500-1:2015, CED4023 Issue No.4, Cl.4.25, and BS-EN 13670 requirements. Concrete mix to be appropriately designed for the aggressivity class of the Landfill / Made Ground and natural strata.
	WRP to Purbrook Tunnel 'Purbrook Route' (See Appendix A2, Figure 3) Purpose: Accommodates pipeline between WRP and Purbrook	Tunnel lining to comprise: Pre-cast concrete segments typically 1m length incorporating elastomeric gaskets to provide a watertight connection. Tail-skin grouting to provide grouted annulus around tunnel lining and prevents creation of preferential flow path along tunnel during construction and in the permanent case.		
Pipe Jack Tunnels	WRP to BHS Pipe Jack^[1] 'Bedhampton Springs Route' (See Appendix A2, Figure 2) Purpose: Accommodates pipelines between WRP and BHS	The proposed arrangements for the pipe-jack tunnels are shown in Appendix A2 (Figure 2 and Figure 4). The pipe-jack tunnels will be constructed below the Landfill. Tunnel for water pipelines to be constructed by pipe jacking. The pipe jacking method is a widely used trenchless technique for installing small-diameter utility tunnels by hydraulically pushing a series of jacking pipes behind a tunnelling shield undertaking a controlled excavation at the advancing face. The tunnelling shield and jacking pipes are pushed/jacked from a launch shaft to a reception shaft.	<ol style="list-style-type: none"> 1) Jacking frame installed at the base of the launch shaft. 2) Pre-cast concrete jacking pipe is positioned in the launch shaft. 3) Mechanical excavation tool (likely to be EPB or Slurry TBM) to break through the soil/ rock in front of jacking pipe and excavated soil removed from the pipe using conveyor belts/slurry pipeline. 4) Hydraulic jacks used to push pipe forward into the soil. 5) As each pipe is pushed forward, the next pipe is added and jacked into place, continuing the process until the pipes reach the reception shaft. 6) Bentonite pumped into annulus to reduce friction while pipe jacking. 7) Annulus grouting upon completion of pipe jacked tunnel to fill any voids and stabilise the tunnel. 8) Installation of water pipeline(s) into tunnel. 	
	WRP to Budds Farm Pipe Jack 'Budds Farm Route' (See Appendix A2, Figure 4) Purpose: Accommodates pipelines between WRP and Budds Farm WTW	Tunnel lining to comprise: Pre-cast concrete jacking pipes typically 2-2.5m length with joints incorporating elastomeric gaskets to provide a watertight connection. A low permeability lubricant (for example, bentonite) can be injected into the annulus around the jacking pipes during installation to aid advancement of the pipe jack and prevent the formation of a preferential flow path around the pipe during installation. Grouting at the end of pipe jacking around the pipe annulus can be applied to prevent creation of preferential flow path along tunnel in the permanent case.		
Other Permanent Structures Foundations	Proposed WRP Foundations (See Appendix A1 for indicative WRP development) Purpose: To support structures associated with the proposed WRP. Structures e.g. tanks, pumping station, storage and prep areas, silos, office facilities etc.	Deep foundations i.e., piles are assumed to be required to transmit loads below the Landfill / Made Ground for all permanent structures due to potential non-uniform surface settlements. CFA method is preferred for pile construction, other methods may be used such as bored piling.	CFA option is preferred for outline design stage but method is subject to further assessment. Pile length to be confirmed after detailed assessment. Other methods may be used such as bored piling. <ol style="list-style-type: none"> 1) CFA rig positioned over designated pile location. 2) Continuous flight auger drilled into the ground to required depth (extending beyond Landfill). 3) Once the required depth is reached, concrete is pumped through the hollow stem of the auger as the auger is withdrawn along with excavated material carried to the surface by the auger flights. 4) After the auger is fully withdrawn, a reinforcement cage is inserted into the fresh concrete. The cage is typically pre-fabricated and is lowered into the pile using a crane or other lifting equipment. 5) Concrete to cure and gain strength for pile to achieve its designed load-bearing capacity. 	Design life: Foundations shall have a design life commensurate with the design life of the structure they support. Loading and displacement: Foundations will be designed to support the required loads at tolerable displacements in accordance with BS EN 1997-1 and BS 8004. Where relevant, this will include resisting downdrag actions from negative skin friction due to ongoing displacement / settlement of landfill. Concrete: Concrete mix to be appropriately designed for the aggressivity class of the Landfill / Made Ground and natural strata.

Abbreviations
 WRP: Water Recycling Plant, WTW: Wastewater Treatment Works, HTR: Havant Thicket Reservoir, BHS: Bedhampton Springs, TBM: Tunnel Boring Machine, CFA: Continuous Flight Auger

Notes
 [1] Either deep tunnel (and associated WRP shaft) option linking WRP to HTR **OR** pipe jack (and associated WRP shaft) option linking WRP to BHS will be progressed. Only one of these options will form part of the scheme.
 [2] The design presented herein is for outline design / planning stage only. Performance and technical requirements listed are not exhaustive. The responsibility for the design, execution and performance of the works will sit with a party who is yet to be appointed.

Appendix C: Environment and Health Risks and Mitigation Table for Shafts, Tunnels & Foundations

Environment and Health Risks and Mitigation Table for Shafts and Tunnels Currently Proposed

	Risks/concerns of ECO	Response: Risk mitigation by each proposed development component			
		Shafts	TBM Tunnels	Pipejack Tunnels	Other Permanent Structures Foundations
Engineering-related	High rates of settlement in landfill material and negative skin friction poses risk of failure/breach and leakage.	Shafts designed to accommodate downdrag from negative skin friction and will be founded below the Landfill.	Tunnels located within the Chalk below landfill at WRP_72 site and therefore not subject to downdrag.	Tunnels located within the Chalk below landfill at WRP_72 site and therefore not subject to downdrag.	Downdrag due to Negative skin friction (NSF) will be investigated and taken into account during foundation (e.g. pile) design.
	Construction material faults or installation errors poses risk of failure/breach and therefore leakage.	1) Shaft construction must adhere to technical requirements/standards which ensure quality, as set out in Appendix B. Shafts will be inspected on completion. 2) Watertightness required and achieved for diaphragm walls by means of an internal secondary lining (cast in situ continuous concrete barrier).	1) Tunnel construction must adhere to technical requirements/standards which ensure quality, as set out in Appendix B. Tunnels will be inspected on completion. 2) A gasket system provides a watertight seal for these segmentally-lined tunnels as well as annulus grouting which fills the gap between segments and the surrounding ground.	See 'TBM tunnel' response.	Construction of piles to be monitored and controlled, trial piles may be considered. With appropriate design and construction which ensures quality, likelihood of failure is low.
	General leak risks	1) Sumps located within the shafts collect leaked water and transmit it to the surface. 2) Proposed shafts accommodate pipework (not pressurised) and are accessible for maintenance/repair works.	1) Tunnels are constructed at a gradient leading to the shaft, where sumps are located to collect any water leaking from pipelines. 2) See 'Shafts' response.	See 'TBM tunnel' response.	Not applicable.
Environment, health and property risks DURING construction	Contamination to the Chalk aquifer due to advancement through Landfill into aquifer (shafts and foundation piles only).	1) Landfill either side of the diaphragm wall excavation trench stabilised by support fluid and deep soil mixing (if required) prior to casting diaphragm wall. 2) Non-displacement method of construction for the diaphragm wall minimises the downwards displacement of the Landfill.	Not applicable. Tunnels advanced from within Chalk.	Not applicable. Tunnels advanced from within Chalk.	Continuous Flight Auger (CFA) is preferred for pile construction, other methods may be used such as bored piling. CFA is a replacement piling method, not displacement, meaning landfill is not driven down with the pile into the underlying chalk. Casing of pipe concrete in-situ ensures intimate contact between the pile and the surrounding landfill waste, minimising the risk of creating contamination pathways.
	Contamination to surrounding sensitive receptors during construction works.	1) Below ground: - Landfill either side of the diaphragm wall excavation trench stabilised by support fluid and deep soil mixing (if required) prior to casting diaphragm wall, limiting potential for trench instability which could cause landfill migration into surrounding ground. Appropriate selection of additives and conditioning agents for construction and the exclusion of hazardous substances. EA to be consulted on requirement for Joint Agencies Groundwater Directive Advisory Group (JAGDAG) assessment. - In-situ casting of reinforced concrete diaphragm walls and shaft base slabs creates intimate contact with surrounding ground minimising the risk of creating contamination pathways. - A Groundwater Monitoring Plan could identify significant changes in groundwater levels/contamination levels in key locations during construction, and a contingency action plan established. 2) Above ground: - Suitable storage of chemicals/oils; and suitable storage (containment), chemical testing and disposal of potentially contaminated, excavated soils. A Pollution Incident Protocol to be developed by the Contractor as part of Emergency Plan. Abstraction and discharge licences obtained from the Environment Agency for any dewatering, and treatment of contaminated waters pumped from the excavation.	1) Below ground: - Pressure control at tunnel face to limit excess fluids being pushed into surrounding ground and tail-skin grouting to prevent flow path formation along outside of tunnel. Thixotropic grout to be used which sets quickly to prevent wide dispersal into ground and appropriate selection of additives and conditioning agents, including the exclusion of hazardous substances and consultation with EA to agree on whether JAGDAG assessment is required prior to use of some chemicals. - A Groundwater Monitoring Plan could identify significant changes in groundwater levels/contamination levels in key locations during construction, and a Contingency Action Plan (CAP) established. 2) Above ground: - See 'Shafts' response.	See 'TBM tunnel' response.	1) Below ground: - CFA is preferred for pile construction which is unlikely to require any form of dewatering. Any perched groundwater encountered would be controllable by sump pumping. The pumped water would likely need containing for removal off-site, possibly with specialist treatment required prior to transport - further advice to be sought on any treatment / disposal required. 2) Above ground: - See 'Shafts' response.
	Contaminated ground, groundwater and ground gas pose a health risk to construction workers.	- Workers limited from entering shaft during construction and proximity of workers to spoils should be kept to a minimum. - Construction methodology designed to limit airborne dust from arising from the excavation, and excess disturbance to the ground. - Contamination/health hazard monitoring through appropriate testing and monitoring of arisings, continuous air quality monitoring, as well as appropriate exposure limits and PPE (including gas masks) where required.	- Workers may be required at the tunnel face and may be exposed to slightly contaminated ground/ground gas within the Chalk aquifer (subject to further ground investigation/testing). A ventilation system would provide some protection from contaminated ground gas. Monitoring should be carried out to ensure potentially harmful gases are identified and the necessary exposure limits/PPE including gas masks are implemented. - Arisings may be contaminated (although this is expected to be minimal) and contaminated leachate and ground gas may also be present. Therefore the proximity of workers to these spoils should be kept to a minimum. - Construction methodology should be designed to limit air borne dust and excess disturbance to the ground. Appropriate testing and monitoring of arisings, continuous air quality monitoring, dust control, as well as appropriate PPE could be deployed to ensure the safety of those exposed where contaminated soils are deemed a risk.	See 'TBM tunnel' response.	- Arisings may be contaminated and contaminated leachate and ground gas may also be present. Continuous monitoring could be carried out to ensure potentially harmful gases are identified and the necessary exposure limits/PPE including gas masks are implemented. Proximity of workers to these spoils should be kept to a minimum. - A decontamination unit should be provided on site. - Construction methodology should be designed to limit air borne dust and excess disturbance to the ground.
Environment, health and property risks AFTER construction	Shaft/tunnel creates a potential contamination pathway: a) from the landfill to the strata below (including Chalk aquifer) in the shaft case or b) through the Chalk aquifer in the tunnel case.	Diaphragm wall is cast in situ which ensures better contact between the wall and surrounding materials thus reducing the potential for contamination pathways. Secondary lining and sump/fluid removal system inhibits leachate migration inside the shaft.	Annulus grouting around the tunnel and grouting at the shaft will provide intimate contact with the natural strata, reducing the potential for the creation of additional pathways by which contamination could migrate.	Bentonite lubrication system and annulus grouting around the tunnel and grouting at the shaft will provide intimate contact with the natural strata, reducing the potential for the creation of additional pathways by which contamination could migrate.	See 'Contamination to the Chalk aquifer due to advancement through Landfill into aquifer' response above.
	Leaks from shaft/tunnel or creation of preferential pathways cause adverse changes to the site's leachate regime, which may include increasing the flux rate to Langstone Harbour and other sensitive environmental receptors.	Leak risk is negligible. If construction is completed according to technical requirements/standards, significant preferential pathways are unlikely to form.	Leak risk is negligible. If construction is completed according to technical requirements/standards, significant preferential pathways are unlikely to form.	See 'TBM tunnel' response.	See 'Contamination to the Chalk aquifer due to advancement through Landfill into aquifer' response above.
	Shaft/tunnel acts as conduit for landfill gas migration to sensitive receptors, with a risk to human health and property.	Secondary lining to provide a watertight seal around the shaft, limiting incoming gas. Regular gas monitoring/fitting of sensors could provide second line of defence, detecting ground gas accumulation early to protect workers entering shaft, remove any explosive risk, and remove risk of gas unknowingly migrating to other sensitive receptors. Workers can wear gas masks/breathing protection if required.	A grout/gasket system surrounding the tunnels provides a watertight seal around the tunnels, limiting incoming gas. Tunnels are located below groundwater which also minimises the possibility of gas migration into the tunnel. Nonetheless gas monitoring/sensors could be utilised to ensure any ground gas accumulation is detected, to protect any workers who might enter the shaft, remove any explosive risk, and remove the risk of gas migration to other sensitive receptors. Maintenance workers may be required to wear gas masks/breathing protection.	See 'TBM tunnel' response.	Not applicable.
	Combustible and/or asphyxiant gases accumulate in shaft/tunnel - risk to human health and the structures in the event of explosion.				
Notes: - Construction activities to follow the Outline Construction Environmental Management Plan (OCEMP) and the recommendations of available contaminated land risk assessments. - Design to avoid risk of exposure to potentially contaminated land (e.g. remove the requirement of person entry into excavations wherever possible). - The design presented herein is for outline design / planning stage only. Performance and technical requirements listed are not exhaustive. The responsibility for the design, execution and performance of the works will sit with a party who is yet to be appointed.					