
Environmental Statement

Appendix 11.2: Nutrient Neutrality Assessment

Land at Ruthin Road, Wrexham

On behalf of Redrow Homes Ltd

August 2023





TECHNICAL NOTE

DATE:	15 August 2023	CONFIDENTIALITY:	Public
SUBJECT:	Ruthin Road Nutrient Neutrality Assessment & Mitigation Strategy		
PROJECT:	70098269	AUTHOR:	Aidan Wilks Daly
CHECKED:	James Ellaway	APPROVED:	James Ellaway

INTRODUCTION

Redrow North-West (Redrow) is proposing a development at Ruthin Road in Wrexham consisting of 1,430 to 1,520 homes. Two options have been considered in this nutrient neutrality assessment:

- Option 1 – 1,430 homes with foul flows discharged to a new on-site wastewater treatment works (WWTW) with a total phosphorus (TP) discharge consent limit of 0.20mg/l.
- Option 2 – 1,520 homes with foul flows discharged off-site to Welsh Water's Five Fords WWTW, which has a current total phosphorus (TP) discharge consent limit of 1.0mg/l that is being upgraded to 0.7mg/l. The additional homes would be constructed on the land that would no longer be required for the on-site WWTW.

The masterplan is provided in **Appendix A**.

The proposed development is located in the River Dee catchment.

PHOSPHORUS NEUTRALITY

In 2021 Natural Resources Wales (NRW) published a review of waterbody compliance against phosphorus standards and found that over 60% of river Special Areas of Conservation (SAC), including the River Dee, failed to comply.

Wrexham County Borough Council and Flintshire County Council took advice from NRW that reliance on the existing total phosphorus (TP) permit limits at WWTWs in the Dee catchment could not ensure that there would be no adverse effect to the integrity of the River Dee SAC from new development proposed in the Wrexham and Flintshire LDPs.

The Councils subsequently developed the Dee Catchment Phosphorus Reduction Strategy (DCPRS) to outline how new development could be delivered whilst achieving no net increase in phosphorus impacts to the River Dee. The DCPRS requires that new developments must achieve phosphorus neutrality before planning approval can be granted.

As the Ruthin Road development is located in the Dee catchment, the phosphorus neutrality requirements apply to the site, and it must achieve phosphorus neutrality.

The DCPRS sets out a phosphorus neutrality assessment method and this approach has been adopted for the Ruthin Road phosphorus neutrality assessment detailed in this technical note.

WASTEWATER TREATMENT WORKS

Option 1 – 1,430 Homes

Option 1 will entail the construction of an on-site WWTW that can achieve a total phosphorus discharge consent limit of 0.20mg/l, which is the discharge concentration calculated to deliver neutrality for the development. The WWTW would discharge treated effluent to the River Clywedog and would be secured in perpetuity, defined as the 80 – 125-year design life of the development. This would be achieved by engaging an experienced WWTW operator to design, install, maintain and operate the system, acting as a



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sewerage only New Appointee approved by Ofwat through the New Appointments and Variations (NAV) process. Ongoing operational, maintenance and upgrade costs would be recovered through an annual sewerage charge levied on each new property.

Severn Trent Connect (STC) is an experienced WWTW operator. Redrow is in discussions with STC for the design, construction and operation of a WWTW using the NUTREM treatment process designed by Plantworks Systems (PWS). This cutting-edge WWTW technology can achieve the required TP discharge consent limit of 0.20mg/l. A letter of support has been provided by STC and is presented in **Appendix B**.

Option 2 – 1,520 Homes

Option 2 will entail the discharge of foul flows to Welsh Water's Five Fords WWTW, which has a current TP discharge consent limit of 1.0mg/l that is being upgraded to 0.7mg/l. The load calculations have been based on the upgraded TP consent limit of 0.7mg/l. As the discharge consent limit is higher than that achievable by Option 1, this will generate a residual TP load that will require mitigation to deliver neutrality for the development. Mitigation will be delivered by using the phosphorus 'headroom' generated by DCWW upgrading Five Fords WWTW (subject to NRW agreement) or through the development or purchase of phosphorus mitigation credits from a mitigation scheme in the Dee catchment.

NUTRIENT NEUTRALITY ASSESSMENT

The nutrient neutrality assessment consists of calculation of the TP loads for the two development options using the DCPRS assessment method. This method specifies key input values including:

- The number of residents per unit – 2.4 (paragraph 4.3.3 of the DCPRS).
- Per capita water usage of 110 litres/person/day (paragraph 4.3.3 of the DCPRS).
- The use of 90% of the WWTW discharge consent limit (paragraph 4.3.3 of the DCPRS).
- A sustainable urban drainage system (SUDS) phosphorus removal efficiency of 50% (paragraph 4.4.31 of the DCPRS, this is applied to the TP load generated in runoff from the whole development).
- Existing and future land use TP export rates (mid values) as specified in Table 4.3 of the DCPRS.

The detailed calculations and supporting information are presented in **Appendix A**, which also contains ten years of Google Earth Pro historical aerial imagery that confirms the existing land uses. The existing and proposed land use areas are detailed in Table 1.

The land parcel identified for the option 1 onsite WWTW totals 2.55ha. The WWTW footprint will be 25% of this (classified as 'urban development') while the remaining 75% will be a vegetated cordon sanitaire (classified as 'SANG / green space'). In contrast, for option 2, this parcel will be used for housing and so is all classified as 'urban development'. This generates a small difference in the proposed land use areas between the 1,430 and 1,520 home options.

Table 1 – Existing and Proposed Land Use Areas (ha)

Land Use	Existing (ha)	Proposed (ha)	
		Option 1	Option 2
Arable	58.17	0.00	
Lowland Grazing	5.81	0.00	
Hedgerow / Woodland	7.85	Included in SANG / Open Space	
Urban Development	1.02	44.30	46.21
SANG / Open Space	0.00	28.55	26.64
Total Site Area	72.85	72.85	72.85

The results of the phosphorus neutrality calculations are detailed in Tables 2 – 3, with full calculations in Appendix A.

Table 2: Total Phosphorus Loads (kg/year) Option 1 – 1,430 homes with an on-site WWTW

Load Component	TP Load (kg/year)
Wastewater load (A)	24.82
Future landuse load (B)	40.76
Existing landuse load (C)	47.83
Future landuse urban load SUDS reduction (D)	20.38
Future nutrient load (= A + (B - C) - D)	-2.62
Precautionary buffer (20%)	0.00
Total nutrient load for the proposed development	-2.62

Table 3: Total Phosphorus Loads (kg/year) Option 2 – 1,520 homes with no on-site WWTW

Load Component	TP Load (kg/year)
Wastewater load (A)	92.34
Future landuse load (B)	42.08
Existing landuse load (C)	47.83
Future landuse urban load SUDS reduction (D)	21.04
Future nutrient load (= A + (B - C) - D)	65.55
Precautionary buffer (20%)	13.11
Total nutrient load for the proposed development	78.66

The results confirm that:

- Option 1 for 1,430 homes with an on-site WWTW will achieve phosphorus neutrality with no further mitigation required.
- Option 2 for 1,520 homes with foul flows treated at Five Fords WWTW will generate a residual TP load of 78.66kg/year. This load must be mitigated to achieve phosphorus neutrality. Redrow will mitigate this residual load by using the phosphorus ‘headroom’ generated by DCWW upgrading Five Fords WWTW (subject to NRW agreement) or by developing or purchasing phosphorus credits from a phosphorus



mitigation scheme in the Dee catchment, once such a scheme become available prior to determination of the planning application. This would deliver phosphorus neutrality for Option 2.

CONCLUSIONS

The proposed development will achieve phosphorus neutrality by:

- Option 1 for 1,430 homes – treating foul flows through a new on-site WWTW achieving a TP discharge consent limit of 0.20mg/l.
- Option 2 for 1,520 homes – using the phosphorus ‘headroom’ generated by DCWW upgrading Five Fords WWTW (subject to NRW agreement) or by developing or purchasing phosphorus credits from a phosphorus mitigation scheme in the Dee catchment.



APPENDIX A – NUTRIENT LOAD CALCULATIONS

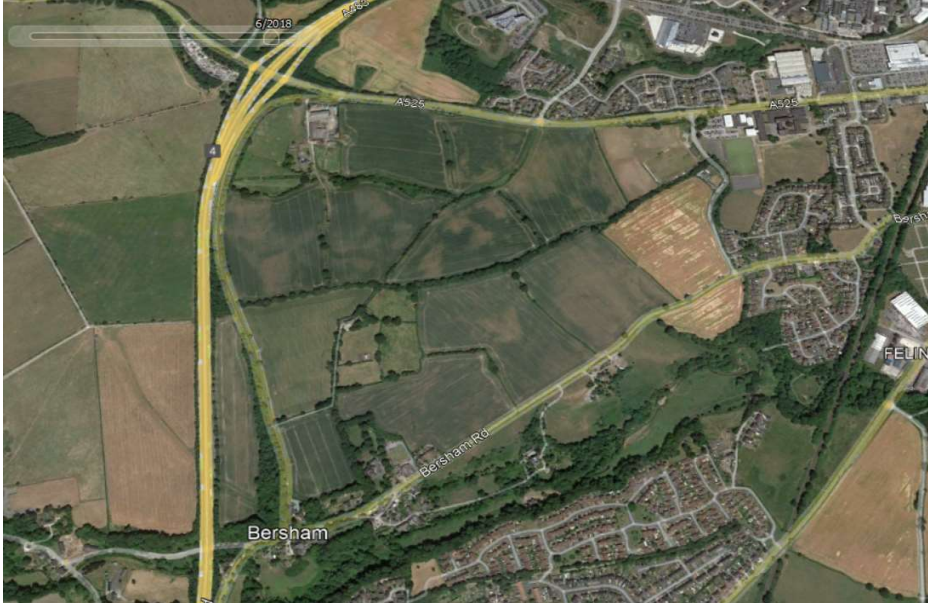
Existing Landuse

Google Earth Pro historical aerial imagery spanning 2010 to 2021 (provided below) establishes that there has been stability in the land usage over at least a decade, with most in arable plus lowland grazing, woodland/hedgerow and existing development.

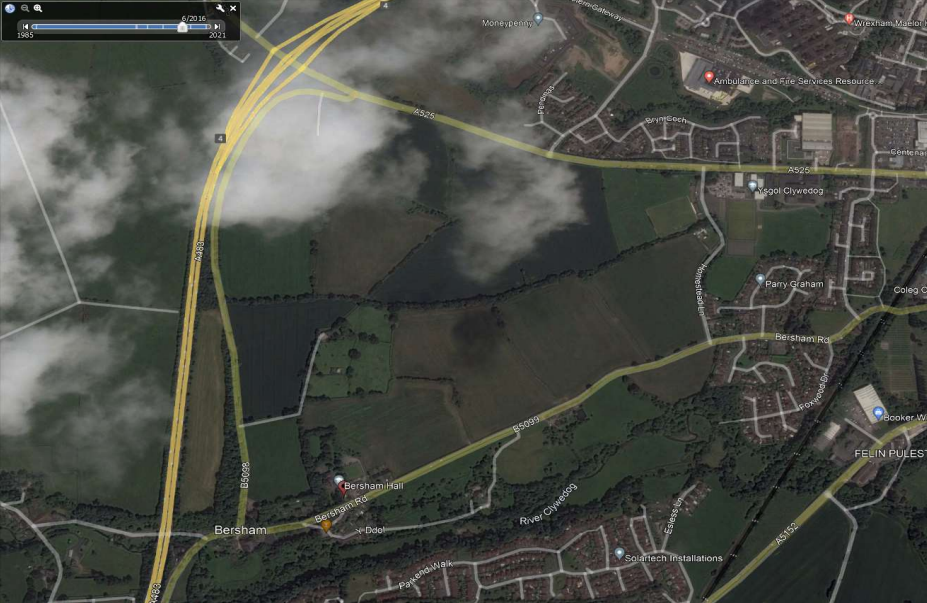
2021



2018



2016



2012



2010



Aerial imagery has been used to estimate the existing land use areas as:

Land Use	Area (ha)
Arable	58.17
Lowland Grazing	5.81
Hedgerow / Woodland	7.85
Urban Development	1.02
Total Area	72.85



Land Use Classification	Option 1 - 1430 Homes with Onsite WWTW	Option 2 - 1520 Homes & Five Fords WWTW
	Area (ha)	Area (ha)
Urban Development	44.30	46.21
SANG / Open Space	28.55	26.64
Total	72.85	72.85

Development Parcel	Area (Hectares)	Option 1 - 1430 Homes with Onsite WWTW	Option 2 - 1520 Homes & Five Fords WWTW
		Land Use Classification	Land Use Classification
A	2.57	Urban Development	Urban Development
B	0.78	Urban Development	Urban Development
C	3.12	Urban Development	Urban Development
D	5.52	Urban Development	Urban Development
E	2.58	Urban Development	Urban Development
F	2.91	Urban Development	Urban Development
G	1.41	Urban Development	Urban Development
H	1.52	Urban Development	Urban Development
I	2.91	Urban Development	Urban Development
J	3.52	Urban Development	Urban Development
K	3.75	Urban Development	Urban Development
L	2.15	Urban Development	Urban Development
M	2.94	Urban Development	Urban Development
N	1.89	Urban Development	Urban Development
O (Option 1 WWTW / Greenspace; Option 2 Residential)	2.55	25% Urban Development, 75% SANG / Open Space	Urban Development
School Site	1.62	50% Urban Development, 50% SANG / Open Space	50% Urban Development, 50% SANG / Open Space
Local Centre	1.46	Urban Development	Urban Development
Roads & footpaths outside development parcels	3.82	Urban Development	Urban Development
Public Open Space	15.98	SANG / Open Space	SANG / Open Space
Strategic Open Space	7.89	SANG / Open Space	SANG / Open Space
Drainage attenuation	1.96	SANG / Open Space	SANG / Open Space
Total	72.85		



Ruthin Road, Wrexham - Phosphorus Neutrality Calculations

Notes

1. This calculation uses the method detailed in the Dee Catchment Phosphorus Reduction Strategy (DCPRS).
2. The proposed numbers of units are: Option 1 - 1,430 homes with an on-site WWTW; Option 2 - 1,520 homes with no on-site wastewater treatment works.
3. Foul flows from Option 1 would be treated at an on-site WWTW which would have a total phosphorus (TP) discharge limit of 0.20mg/l.
4. Foul flows from Option 2 would be treated at Five Fords WWTWW which will be upgraded to have a TP discharge limit of 0.70mg/l.
5. The nutrient neutrality calculation method specifies the use of 90% of a WWTW permit consent limit.
6. A SUDS TP removal efficiency of 50% is adopted as per paragraph 4.4.31 of the DCPRS.

LOAD CALCULATION

Site Characteristics

	Option 1 - 1430 Homes with Onsite WWTW	Option 2 - 1520 Homes & Five Fords WWTW
Total site area (ha)	72.85	72.85
Number of homes	1430	1520
Number of residents per unit	2.40	2.40
Wastewater volume (litres/person/day)	110	110
Wastewater generated (litres/day)	377520	401280
SUDS Nutrient Removal Efficiency (%)	50%	50%

Wastewater Load

	Option 1 - 1430 Homes with Onsite WWTW	Option 2 - 1520 Homes & Five Fords WWTW
WWTW consent limit (mg/l)	0.20	0.70
90% of WWTW consent limit (mg/l)	0.18	0.63
Total nutrient load from wastewater (mg/day)	67954	252806
Total nutrient load from wastewater (mg/yr)	24820052	92337538
Total nutrient load from wastewater (kg/yr)	24.82	92.34

Existing Landuse Load

Existing Landuse	Area (ha)	Total Phosphorus Export Rate (kg/ha/year)	Total Phosphorus Load (kg/year)
Arable / cereal	58.17	0.75	43.63
Lowland Grazing	5.81	0.55	3.19
Hedgerow / Woodland	7.85	0.02	0.16
Urban Development	1.02	0.83	0.85
Total	72.85	-	47.83

Future Landuse Load - Option 1

Future Landuse	Area (ha)	Total Phosphorus Export Rate (kg/ha/year)	Total Phosphorus Load (kg/year)
Urban Development	44.30	0.83	36.77
SANG / Open Space	28.55	0.14	4.00
Total	72.85	-	40.76

Future Landuse Load - Option 2

Future Landuse	Area (ha)	Total Phosphorus Export Rate (kg/ha/year)	Total Phosphorus Load (kg/year)
Urban Development	46.21	0.83	38.35
SANG / Open Space	26.64	0.14	3.73
Total	72.85	-	42.08

SUDS Mitigation

	Option 1 - 1430 Homes with Onsite WWTW	Option 2 - 1520 Homes & Five Fords WWTW
Total nutrient load from surface water (kg/year)	40.76	42.08
SUDS TP removal efficiency (%)	50.0%	50.0%
Total SUDS TP reduction (kg/year)	20.38	21.04

Mitigated Future Nutrient Load

Load Contribution	Option 1 - 1430 Homes with Onsite WWTW	Option 2 - 1520 Homes & Five Fords WWTW
Wastewater load (A)	24.82	92.34
Future landuse load (B)	40.76	42.08
Existing landuse load (C)	47.83	47.83
Future landuse urban load SUDS reduction (D)	20.38	21.04
Future nutrient load (= A + (B - C) - D)	-2.62	65.55
Precautionary buffer (20%)	0.00	13.11
Mitigated future nutrient load	-2.62	78.66

Conclusions

1. Option 1 would deliver phosphorus neutrality for the development and would not require any further mitigation.
2. Option 2 would result in a residual TP load that would require additional mitigation. Redrow has confirmed that this would be mitigated either by the headroom created by DCWW upgrading Five Fords WWTW to a TP consent limit of 0.7mg/l (subject to NRW approval) or by developing or purchasing phosphorus mitigation credits from a mitigation scheme in the Dee catchment once such a scheme becomes available.



APPENDIX B – SEVERN TRENT CONNECT LETTER OF SUPPORT

Letter of support

Wastewater strategy

Ruthin Road, Wrexham

Author: William Mackveley

Date: June 2023

Letter of support: Wastewater strategy

ONSITE WASTEWATER STRATEGY FOR RUTHIN ROAD, WREXHAM.

ST Connect have been appointed by Redrow Homes to work alongside their technical advisors to develop a feasible foul water drainage and treatment strategy, at their proposed development known as Ruthin Road near Wrexham. It is expected that the development will be in the region of 1,500 homes.

ST Connect

ST Connect are an Ofwat-regulated water company appointed by the Secretary of State to provide wastewater and surface water management services in England and Wales. We have a strong track record for designing, building, owning and operating wastewater treatment assets (including foul and surface sewerage infrastructure) and are part of the wider Severn Trent Group, which in its portfolio has one of the UK's largest water and sewerage companies.

We are familiar with the environmental challenges to developments resulting from both a chronic lack of available sewerage capacity, and nutrient pollution; as a result, we are helping our clients to develop effective wastewater management strategies. The company is well placed to do this, given our experience and effective relationships with the statutory environmental regulators.

Proposed wastewater treatment and disposal strategy summary

Foul sewage from all properties will be collected and conveyed through a separate foul-only sewerage system to the onsite wastewater treatment works (WwTW). Following treatment to the required standards, final effluent will be discharged into a drainage system out falling into the River Clywedog.

Having assessed all relevant site constraints and considering the scale of the development we are confident that a WwTW can be delivered and adopted on this site.

Our treatment strategy will comprise of an ST Connect designed and built onsite WwTW; which shall be adopted, maintained, and operated in the long-term by ST Connect in our capacity as the local statutory wastewater undertaker.

ST Connect would operate the WwTW complying with a Natural Resources Wales (NRW) discharge permit for Phosphorous removal level(s) in-line with the Nutrient Neutrality requirements of 0.2 mg/l Total Phosphorous (and any other parameters set by the NRW).

Asset and treatment process resilience

Detailed designs of the WwTW have not yet been commissioned, however ST Connect, will propose to construct a state-of-the-art facility, based on an advanced form of activated sludge treatment, see Design Statement below.

The system is particularly resilient to catchment contamination events or natural variation of inbound wastewater concentration, due to the significant dilution factors provided by the large balancing tank at the head of the works. The treatment processes will be configured to allow for bolt-on technologies to meet more stringent permits; should they become required in the future.

The design will include inherent capacity and asset redundancy which shall all but remove the risk of permit compliance failure. In a worst-case scenario of significant system failure, raw and/or part-treated sewage shall be isolated and tankered to a suitable off-site facility for safe treatment and disposal.

Sludge management

Organic sludges generated during the treatment process which cannot be treated onsite will be periodically removed by tanker for further processing at a nearby sludge treatment centre to generate sustainable energy from biogas. The remaining by-product, sludge cake is sold as an organic fertiliser. It should be noted that, were farmers within the River Clywedog catchment to use this source of fertiliser, it would act as a direct replacement of other sources of fertilisers (such as inorganic chemical fertilisers).

Long-term asset performance

The onsite treatment system will be designed and built to our adoptable standards, and therefore be owned and operated by ST Connect in its capacity as the local wastewater undertaker; subject to a licence variation being granted by Ofwat. The assets will therefore be considered “public” assets by NRW, which the company shall have a duty to maintain and operate effectively in perpetuity in line with its licence obligations.

The treatment system shall have in place both planned and reactive operations and maintenance arrangements to ensure the good upkeep of assets and effective wastewater treatment. In addition, the facility will benefit from remote telemetry and sensors to monitor site condition and treatment processes effectiveness.

Natural Resources Wales wastewater discharge permit

A wastewater discharge permit from NRW will be required to operate the onsite WwTW. ST Connect will apply to NRW for the required permit having undertaken the necessary studies (including a water quality and quantity study). It is important to note that as a statutory wastewater undertaker, ST Connect is able to obtain discharge permits within sewerage areas (within the geographic areas of appointment of other wastewater

undertakers, such as Welsh Water DCWW) – NRW don't distinguish between licence applications / variations made by ST Connect and those made by incumbent water companies.

Conclusion

ST Connect in its capacity as a competent sewerage undertaker, experienced in the construction and long-term operations of sewage treatment assets is satisfied that a public onsite wastewater treatment system can be designed, built, adopted, operated, and maintained within the Ruthin Road development.

We look forward to continuing to develop the wastewater treatment strategy for this development site and are happy to be able to contribute to Wrexham County Borough Council's housing delivery plans in a sustainable way.

Yours sincerely



William Mackveley
General Manager
Severn Trent Connect

Design statement

Onsite wastewater treatment works

Wastewater treatment works overview

This design statement provides an overview of the required wastewater treatment works (WwTW) at the proposed development known as Ruthin Road near Wrexham – which is to be designed in accordance with the site-specific Nutrient Neutrality requirements, where treated final effluent shall contain not more than 0.2 mg/l Total Phosphorous.

Wastewater treatment processes

Inlet flows

Wastewater arriving at the WwTW passes through the inlet works, where a series of screens remove wipes, grit, and other matter not suitable for onward treatment.

Balance tank / fermenter

The screened wastewater is transferred to the covered balance tank / fermenter (BTF). The BTF serves two distinct purposes in the treatment cycle. Firstly, it is used to balance the incoming flows prior to being passed forward for processing in the Reactors. Its second function is to act as an anaerobic fermenter; crucial to enable the Phosphorus Accumulating Organisms present in the Reactors to super absorb Phosphorus.

Reactors

The Reactors use simultaneous fill and decant, whereby the treated water is discharged using a piston effect created by the introduction of the fermented, raw, screened sewage. This influent is introduced at the bottom of the tank where it is gently mixed with the settled biomass using the hyperboloid mixer. The sludge blanket remains undisturbed, whilst the clean effluent in the top of the tank is discharged.

Once the fill/decant stage is complete, and the influent has had appropriate contact time with the biomass, the aerobic and anoxic treatment stages are carried out. The duration and timing of these phases are varied dependent on specific site conditions and permit requirements.

Sludge thickening

The sludge generated by the process can be thickened using sludge thickening equipment. Thickened sludge is held in the aerated sludge storage tank, whilst supernatant is returned to the head of works.

Aerated sludge storage

Thickened sludge is stored within this tank and periodically aerated using a coarse bubble aeration grid to prevent the sludge thickening too much at the bottom of the tank and to prevent the sludge becoming septic and causing odour issues.

Final effluent discharge

The final effluent discharged from the reactors, flows through a sample chamber prior to discharging to the River Clywedog. Should there be a restriction on the permitted discharge flow rate, then an attenuation tank can be included.

STC4000

A detailed design of the proposed Ruthin Road WwTW, designated “STC4000” has not yet been undertaken, however, the design will be based on ST Connect’s standard designs for facilities of this scale; the closest of which is the “STC3000”, which utilises the above-described treatment processes.

The rendered images below are of an STC3000 which has been proposed to serve a residential development of ca. 1,200 homes near Tonbridge, Kent.



Figure 1 STC3000 Tonbridge – overhead view



Figure 2 STC3000 Tonbridge – entrance view

Dimensions

The table below displays the dimensions of the STC3000, these can be used as a proxy for the required STC4000 facility at Ruthin Road development.

Item	Dimensions
Compound width	33m
Compound length	70m
Compound area	2,310m ²
Maximum building height (exc. access gantries)	6.4m
Maximum building height (inc. access gantries)	7.5m

Noise

A site-specific noise impact assessment (NIA) for Ruthin Road has not been undertaken with reference to an onsite WwTW. However, a NIA was undertaken in January 2022 at a demonstrator WwTW utilising the proposed treatment process to inform stakeholders on the minimum stand-off distances from these facilities. A full copy of the report can be found in Appendix 03.

There are various assets on the WwTW which generate noise; the air blowers are responsible for generating the most powerful noise emissions on the plant – accordingly they shall be housed within acoustic enclosures to provide attenuation. The risk of adverse impact to Noise

Sensitive Receptors (NSRs) is low, and subject to an appropriate level of mitigation, principally to any blower units, then it should be possible to site any properties within 50 metres of the WwTW.

Odour

A site-specific odour impact assessment (OIA) for the Ruthin Road has not been undertaken with reference to an onsite WwTW. However, an OIA was undertaken in January 2022 at a demonstrator WwTW utilising the proposed treatment process to inform stakeholders on the minimum stand-off distances from these facilities.

The study was undertaken by a competent consultant in accordance with published guidance from the Department for Environment, Food & Rural Affairs, the Environment Agency, the Institute of Air Quality Management, and statements from bodies such as the Chartered Institution of Water and Environmental Management, and UK Water Industry Research to determine the potential odour impact of the sewage treatment works on proposed developments. A full copy of the report can be found in Appendix 04.

The assets with the greatest potential for nuisance odour emissions are the inlet works, balance tank / fermenter and sludge holding tanks. These assets shall be designed and configured in a way which minimises their odour emissions. For example, the inlet works shall be covered, the balance tank / fermenter shall be sealed to the environment, and the sludge holding tanks will be aerated to prevent sludge becoming septic. As such, it is not considered that the WwTW would cause a loss of amenity, annoyance, nuisance, or complaints for future occupiers of the development in close proximity (30-50m) to the WwTW.

Performance certificates: Nutrient removal

A twelve-month trial of maximum nutrient removal (without additional tertiary treatment) at the Petersfield demonstrator WwTW was undertaken between February 2021 and February 2022. The demonstrator plant takes raw, screened sewage from Southern Water's main Petersfield WwTW, for treatment at the demonstrator facility, before treated effluent is discharged back into Southern Water's main works. The table below shows the average results throughout the study (full sample data can be found in Appendix 01). Current trials of the process with additional tertiary treatment are consistently performing below the proposed limit of 0.2 mg/l Total Phosphorus.

Table 1 Final effluent sampling averages

Determinand	Average	Units
BOD	2.45	mg/l
TSS	5.77	mg/l
Ammoniacal Nitrogen as N	0.157	mg/l
Phosphorous, Total	251.4	µg/l
Phosphate, Orthophosphate as P	0.04	mg/l
Nitrogen, Total	3.96	mg/l

Sample collection was carried out by Plantworks Systems and sent to ALS Environmental for accredited analysis. Example certificates can be found in Appendix 02

Appendix 01: Full sample data

	Date	17/02/2021	18/02/2021	22/02/2021	05/03/2021	08/03/2021	12/03/2021	15/03/2021	19/03/2021	22/03/2021	15/04/2021	05/05/2021	07/05/2021	02/06/2021	04/06/2021	11/06/2021	19/06/2021
	Time	16:30:00	16:20:00	09:20:00	16:30:00	09:30:00	16:30:00	09:15:00	16:30:00	09:30:00	09:30:00	14:30:00	14:30:00	14:30:00	14:30:00	14:30:00	14:30:00
BOD	mg/l	<10	<10	1.92		4.85	<1	3.22	<10	5.48	3.32	5.28	6.66	6.88	2.3		
TSS	mg/l	7.3	3.15	3.05	4.85	13	5.1	5.65	5.1	4.7	17.8	10.8	9.7	6.85	9.25	7.7	3.6
Amm. N	mg/l	0.271	0.039	0.047	0.06	0.177	0.05	0.031	0.057	0.103	<0.01	0.054	0.237	0.098	0.035		
TP	µg/l	301	147	133	161	521	231	272	230	156	645	398	299			215	123
Ortho-P	mg/l	<0.02	<0.02	<0.02	<0.02	0.0989	0.0656	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.0326	<0.02	<0.02	<0.02
TN	mg/l	2.14	1.4	2.18	1.44	2.54	1.62	1.9	2.22	3.35	3.24	4.19			4.1		
	Date	24/06/2021	01/07/2021	05/07/2021	06/07/2021	09/07/2021	09/07/2021	14/07/2021	19/07/2021	22/07/2021	29/07/2021	02/08/2021	09/08/2021	23/08/2021	26/08/2021	31/08/2021	01/09/2021
	Time	14:30:00	13:30:00	13:30:00	09:30:00	10:15:00	13:30:00	13:30:00	13:30:00	17:30:00	13:30:00	13:30:00	13:30:00	13:45:00	13:30:00	13:30:00	09:30:00
BOD	mg/l		6.82	<1	<1	<1	<1	<1	2.02	2.32	2.02	<1	<1	3.65	2.33	2.27	2.52
TSS	mg/l	9.15	10	8.7	7.95	<2	3.2	5.3	7.95	5.63	3.65	3.65	6.85	5.1	5.75	3.6	8.2
Amm. N	mg/l		0.205						0.032	0.059	0.014	0.023	0.012	3.17	0.049	0.018	0.013
TP	µg/l	200	379	184	198	97.1	157	187	199	262	160	156	181	239	244	190	472
Ortho-P	mg/l	<0.02	0.12						0.0232	0.0313	<0.02	<0.02	<0.02	0.0268	<0.02	<0.02	0.187
TN	mg/l		4.74	3.44	5.37	4.4	2.47	3.11	5.24	6.96	3.5	3.06	2.74	5.62	2.82	4.43	7.76
	Date	11/09/2021	13/09/2021	21/09/2021	06/10/2021	12/10/2021	15/10/2021	19/10/2021	22/10/2021	22/10/2021	29/10/2021	29/10/2021	03/11/2021	03/11/2021	03/11/2021	15/11/2021	17/11/2021
	Time	13:30:00	13:30:00	13:30:00	13:00:00	13:00:00	12:50:00	12:57:00	11:15:00	13:00:00	11:55:00	14:15:00	09:30:00	13:30:00	13:35:00	14:30:00	10:33:00
BOD	mg/l	2.04	2.37		<1	<1	2.07	<1	2.2	<1	2.77	<1	<1	<1	<1	2.16	2.16
TSS	mg/l	5.15	5.35	8.25	2.65	3.05	6.15	9.25	3.25	2.05	4.3	5.55	<2	3.1	<2	4.3	2.05
Amm. N	mg/l	0.029	0.024	0.022		0.03	0.071	0.031	0.132	0.086	0.209	0.037	0.158	0.026	0.1	0.198	0.398
TP	µg/l	180	187	116	212	116	211	260	191	132	248	207	148	148	130	255	380
Ortho-P	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.0238	<0.02	0.0721	<0.02	0.0578	<0.02	0.0457	0.0747	0.272
TN	mg/l	2.29		3.6	2.45	3.61	2.2	4.37	2.46	3.02	2.74	2.07	3.16	1.94	3.17	4.02	4.87
	Date	17/11/2021	22/11/2021	22/11/2021	25/11/2021	25/11/2021	30/11/2021	30/11/2021	04/12/2021	04/12/2021	05/12/2021	06/12/2021	05/01/2022	05/01/2022	10/01/2022	11/01/2022	12/01/2022
	Time	14:45:00	09:45:00	13:45:00	10:15:00	10:45:00	09:40:00	13:34:00	07:30:00	13:45:00	09:40:00	13:35:00	12:15:00	12:20:00	18:45:00	13:30:00	09:30:00
BOD	mg/l	2.64	2.23	2.75	<1	<1	1.87	2.4	3.58	4.8	12.7	2.99	<1		4.14	2.36	3.3
TSS	mg/l	8.2	4.8	7.35	<2	5.45	4.05	8	6.75	7.65	7.35	3.8	4.55	<2	12.3	4.05	5.15
Amm. N	mg/l	0.037	0.315	0.028	0.041	0.061	0.05	0.034	0.145	0.172	0.111	0.055	0.089		0.036	0.036	1.18
TP	µg/l	270	331	273			275	329	327	318	380	235	199	365	434	219	245
Ortho-P	mg/l	<0.02	0.137	<0.02			<0.02	<0.02	0.0483	<0.02	0.0287	<0.02	<0.02	0.206	<0.02	<0.02	<0.02
TN	mg/l	5.56	5.12	5.4			6.59	6.78	9.03	3.44	4.75	3.34	6.21			3.97	7.75
	Date	14/01/2022	14/01/2022	17/01/2022	17/01/2022	27/01/2022	27/01/2022	09/02/2022	14/02/2022	14/02/2022	17/02/2022						
	Time	09:30:00	09:35:00	09:30:00	12:30:00	09:30:00	09:30:00	13:30:00	13:55:00	14:05:00	09:30:00						
BOD	mg/l	2.44	2.4	2.48	<1	3.99		2.81	2.31		2.48						
TSS	mg/l	3.2	3.35	9.45	7.05	9.05	5.15	3.15	4.1	2.4	8.85						
Amm. N	mg/l	0.032	0.32	0.095	0.051	0.055		0.059	0.243		0.055						
TP	µg/l	137	251	315	206	470	352	229	358	277	344						
Ortho-P	mg/l	<0.02	0.0702	0.0375	<0.02	0.0421	0.138	<0.02	0.095	0.0702	<0.02						
TN	mg/l	5.31			3.88	8.28		3.39	2.94	3.52	4.52						

Appendix 02: Example certificates



Validated

CERTIFICATE OF ANALYSIS

SDG: 210316-39 Client Reference: EBNet-NUTREM Sample Analysis Report Number: 591650
 Location: NUTREM Demo Site Order Number: 1291 Superseded Report:

Results Legend		Customer Sample Ref. Depth (m) Sample Type Date Sampled Sample Time Date Received SDG Ref Lab Sample No.(s) AGS Reference	SAMPLE 01	SAMPLE 02	SAMPLE 03	SAMPLE 03F		
A	ISO17025 accredited.		Treated Sewage (TS)	Untreated Sewage (US)	Treated Sewage (TS)	Treated Sewage (TS)		
M	mCERTE accredited.							
AS	Aqueous / solid sample.							
disoln	Dissolved / filtered sample.							
totunfil	Total / unfiltered sample.							
-	Subcontracted - refer to subcontractor report for accreditation status.							
-	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within a sample aren't checked for the recovery.							
FI	Trigger breach confirmed.							
1-9999	Sample deviation (see appendix)							
Component	LOD/Units	Method						
Suspended solids, Total	<2 mg/l	TM022	5.1	344	5.65	2.7		
			#	#	#	#		
BOD, unfiltered	<1 mg/l	TM045	<1	227	3.22	2.3		
			@ #	#	#	#		
Ammoniacal Nitrogen as N (low level)	<0.01 mg/l	TM099	0.05	61	0.031	0.03		
			2	2	2	2		
Phosphorus (totunfil)	<20 µg/l	TM152	231	9750	272	111		
			2 #	2 #	2 #	2 #		
Phosphate (Ortho as P)	<0.02 mg/l	TM184	0.0656	5.03	<0.02	<0.02		
			#	#	#	#		
Nitrogen, Total	<1 mg/l	TM212	1.62		1.9	1.9		
			#		#	#		



Validated

CERTIFICATE OF ANALYSIS

SDG:	210715-42	Client Reference:	NBIC Project	Report Number:	606704
Location:	NUTREM DEMO Plant	Order Number:	PO-0097	Superseded Report:	

Results Legend			Customer Sample Ref.	SAMPLE 01	SAMPLE 02	SAMPLE 03	SAMPLE 04	SAMPLE 05	
A	ISO17025 accredited.								
M	mCERTS accredited.								
AS	Aqueous / solid sample.								
dis.filt	Decanted / filtered sample.								
tot.unfilt	Total / unfiltered sample.								
-	Subcontracted - refer to subcontractor report for accreditation status.								
^	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within a sample are not corrected for the recovery.								
FI	Trigger breach confirmed.								
1-deg@	Sample deviation (see appendix)								
Component	LOD/Units	Method	Depth (m) Sample Type Date Sampled Sample Time Date Received SDG Ref Lab Sample No.(s) AGS Reference	Treated Sewage (TS) 06/07/2021 13:30:00 16/07/2021 210715-42 24632963	Treated Sewage (TS) 06/07/2021 09:30:00 15/07/2021 210715-42 24632964	Treated Sewage (TS) 09/07/2021 10:15:00 15/07/2021 210715-42 24632968	Treated Sewage (TS) 09/07/2021 13:30:00 15/07/2021 210715-42 24632969	Treated Sewage (TS) 14/07/2021 13:30:00 15/07/2021 210715-42 24632970	
Suspended solids, Total	<2 mg/l	TM022		8.7 #	7.95 #	<2 #	3.2 #	5.3 #	
BOD, unfiltered	<1 mg/l	TM045		<1 @ #	<1 @ #	<1 @ #	<1 @ #	<1 #	
Phosphorus (tot.unfilt)	<20 µg/l	TM152		184 2 #	198 2 #	97.1 2 #	157 2 #	187 2 #	
Nitrogen, Total	<1 mg/l	TM212		3.44 #	5.37 #	4.4 #	2.47 #	3.11 #	



Validated

CERTIFICATE OF ANALYSIS

SDG: 220115-70

Report Number: 630420

Superseded Report:

Client Ref.: Not Specified

Location: NUTREM DEMO Plant

Results Legend			Customer Sample Ref.	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5	SAMPLE 6
A ISO17025 accredited. M mCERIS accredited. aq Aqueous / filtered sample. disl. H Dissolved / filtered sample. tot. L (H) Total / unfiltered sample. - Subcontracted - refer to subcontractor report for accreditation status. - % recovery of the surrogate standard to check the efficiency of the method. The results of individual components within samples are all corrected for the recovery. FI - Filter or leach confirmed. 1-5000 Sample deviation (see appendix).			Depth (m)	Treated Sewage (TS)	Treated Sewage (TS)	Treated Sewage (TS)	Treated Sewage (TS)	Treated Sewage (TS)	Treated Sewage (TS)
			Sample Type	05/01/2022	05/01/2022	10/01/2022	11/01/2022	12/01/2022	14/01/2022
			Date Sampled	12:15:00	12:20:00	19:45:00	19:30:00	09:30:00	09:30:00
			Sample Time	15/01/2022	15/01/2022	15/01/2022	16/01/2022	16/01/2022	16/01/2022
			Date Received	220115-70	220116-70	220116-70	220116-70	220116-70	220116-70
			SDG Ref	25051754	25051755	25051757	25051758	25051760	25051761
			Lab Sample No. (s)						
			AGS Reference						
Component	LOD/Units	Method							
Suspended solids, Total	<2 mg/l	TM022	4.55	<2	12.3	4.05	5.15	3.2	
			#	#	#	#	#	#	#
BOD, unfiltered	<1 mg/l	TM045	<1		4.14	2.36	3.3	2.44	
			@ #	@ #	@ #	@ #	#	#	#
Ammoniacal Nitrogen as N (low level)	<0.01 mg/l	TM099	0.089		0.036	0.036	1.18	0.032	
			2	2	2	2	2	2	2
Phosphorus (tot.unfil)	<20 µg/l	TM152	199	365	434	219	245	137	
			2 #	2 #	2 #	2 #	2 #	2 #	2 #
Phosphate (Ortho as P)	<0.02 mg/l	TM184	<0.02	0.206	<0.02	<0.02	<0.02	<0.02	
			#	#	#	#	#	#	#
Nitrogen, Total	<1 mg/l	TM212	6.21			3.97	7.75	5.31	
			#	#	#	#	#	#	#

Report for:

Severn Trent Connect

Petersfield Demonstrator Wastewater Treatment
Works

Noise Impact Assessment

Status: Final

Date: 26.01.2022

Author	 Paul Sneddon Acoustic Consultant
Reviewed and Approved By	 Graham Parry Managing Director
Report For	Severn Trent Connect
Date	26.01.2021
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Status	Final

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1. INTRODUCTION

ACCON UK Limited (ACCON) has been commissioned by Severn Trent Connect to provide a Noise Impact Assessment to support planning applications where the Wastewater Treatment Works (WwTW) may be in close proximity to existing or proposed residential developments.

In order to assess the noise impacts from the WwTW, ACCON personnel carried out noise measurements at the Petersfield Demonstrator WwTW, as identified in **Figure 1.1**.

Figure 1.1 - Aerial view of the existing Petersfield site



A Glossary of Acoustic Terminology is provided in **Appendix 1**.

2. THE NATURE, MEASUREMENT AND EFFECT OF NOISE

Noise is often defined as sound that is undesired by the recipient. Whilst it is impossible to measure nuisance caused by noise directly, it is possible to characterise the loudness of that noise. 'Loudness' is related to both sound pressure and frequency, both of which can be measured. The human ear is sensitive to a wide range of sound levels. The sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitudes of the numbers involved, a logarithmic scale of decibels (dB) is normally used, based on a reference level of the lowest audible sound.

The response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequencies to approximate the human response. The resulting 'A' weighted decibel, dB (A), has been shown to correlate closely to the subjective human response.

When related to changes in noise, a change of ten decibels, for example, from 60 dB (A) to 70 dB (A), would represent a doubling in 'loudness'. Similarly, a decrease in noise, for example, from 70 dB (A) to 60 dB (A), would represent a halving in 'loudness'. A change of 3 dB (A) is generally considered to be just perceptible¹. **Table 2.1** details typical noise levels.

Table 2.1: Typical Noise Levels

Approximate Noise Level (dB(A))	Example
0	Limit of hearing
30	Rural area at night
40	Library
50	Quiet office
60	Normal conversation at 1 m
70	In car noise without radio
80	Household vacuum cleaner at 1 m
100	Pneumatic drill at 1 m
120	Threshold of pain

¹ Institute of Environmental Management and Assessment (2014). Guidelines for environmental noise impact assessment.

3. LEGISLATIVE/POLICY BACKGROUND

3.1. National Planning Policy Framework

The revised National Planning Policy Framework (NPPF as amended in July 2021) supersedes the 2012, 2018 and 2019 versions of the NPPF. The purpose of the planning system is to contribute to the achievement of sustainable development. There are three dimensions to sustainable development: economic, social and environmental. The environmental role is to contribute to protecting and enhancing our natural, built and historic environment; and as part of this, make effective use of land, help to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate to adapt to climate change including moving to a low carbon economy.

One of the core planning principles is to contribute to conserving and enhancing the natural environment and reducing pollution. Allocations of land for development should prefer land of lesser value, where consistent with other policies in the Framework. The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.

Paragraph 185 of the NPPF states:

“Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- a) Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life (see Explanatory Note to the Noise Policy Statement for England (Department for Environment, Food and Rural Affairs, 2010));*
- b) Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.”*

Additionally, Paragraph 187 states:

“Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or ‘agent of change’) should be required to provide suitable mitigation before the development has been completed.”

3.2. Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) was developed by DEFRA and published in March 2010. The vision of the NPSE is to *'Promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development'*.

The Noise Policy Statement for England (NPSE) aims to *'through the effective management and control of environmental neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life.'*

Based on concepts from toxicology, it introduces three 'Effect Levels' relevant to the assessment of noise. These are:

- NOEL: No Observed Effect Level: This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise;
- LOAEL: Lowest Observed Adverse Effect Level: This is the level above which adverse effects on health and quality of life can be detected; and
- SOAEL: Significant Observed Adverse Effect Level: This is the level above which significant adverse effects on health and quality of life occur.

3.3. Planning Practice Guidance

The Planning Practice Guidance for Noise (PPG-N) was published in March 2014 and most recently updated in July 2019. The PPG-N suggests that the most appropriate and cost-effective solutions to potential noise issues are best identified when good acoustic design is considered early in the planning process.

The PPG-N provides the following advice on how to determine the noise impact on development:

"Plan-making and decision making need to take account of the acoustic environment and in doing so consider:

- *Whether or not a significant adverse effect is occurring or likely to occur;*
- *Whether or not an adverse effect is occurring or likely to occur; and*
- *Whether or not a good standard of amenity can be achieved.*

In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation. As noise is a complex technical issue, it may be appropriate to seek

experienced specialist assistance when applying this policy.” (Paragraph 003 Reference ID 30-003-20190722)

The document goes on to acknowledge the levels of noise exposure at which an effect may occur as provided in the NPSE and introduces a fourth effect level:

- UAE: Unacceptable Adverse Effect: Extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise lead to psychological stress or physical effects.

Where residential development is proposed in the vicinity of existing businesses, community facilities or other activities that produce noise, the PPG-N advises that the applicant (or ‘agent of change’) will need to clearly identify the effects of the existing businesses that may cause a nuisance (including noise) and clearly define the mitigation measures being proposed to address any potential significant adverse effects that are identified. The agent of change needs to not only consider the current activities of the business, but the permitted activities too, even if they are not occurring at the time of the application being made. The PPG-N acknowledges that *“It can be helpful for developers to provide information to prospective purchasers or occupants about mitigation measures that have been put in place, to raise awareness and reduce the risk of post-purchase/occupancy complaints.”* (Paragraph 009 Reference ID 30-009-20190722).

It is important to understand that as the PPG-N does not specifically provide any advice with respect to noise levels/limits for different sources of noise, it is appropriate to consider other sources of advice and guidance documents when considering whether new developments would be sensitive to the prevailing acoustic environment and the PPG-N signposts a number of appropriate guidance documents.

3.4. British Standard BS 4142:2014

BS 4142:2014 *Methods for rating and assessing industrial and commercial sound* provides a method for the measurement and rating of industrial or commercial type noise sources and background noise levels outside dwellings. The ‘rating level’ (defined in the BS) is used to rate the noise level of the source (this is defined as the ‘specific sound level’) outside residential dwellings.

The rating level is determined by assessing the character of the noise and applying an acoustic feature correction, if appropriate, to the specific sound level. Corrections are applied for the tonality, impulsivity, intermittency or other distinctive characteristics of the noise source which can all increase the impact of noise.

The initial assessment described in BS 4142 to determine whether an adverse impact is likely is based on establishing the difference between the rating level and the background noise level outside the residential property of interest. The British Standard states that the following points should be considered:

- *“Typically, the greater this difference, the greater the magnitude of the impact.*
- *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*

- *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
- *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

Where it is considered that the initial assessment of the impact needs to be modified due to the context in which the noise is occurring, BS 4142 suggests that all pertinent factors are taken into consideration, including:

- i. *"The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.*

Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.

Where residual sound² levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

- ii. *The character and level of the residual sound compared to the character and level of the specific sound. Consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound, to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/or commercial nature is likely to be perceived and how people react to it.*
- iii. *The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:*
 - i. *facade insulation treatment;*
 - ii. *ventilation and/or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation; and*
 - iii. *acoustic screening."*

² The residual sound is defined as the ambient sound level at the assessment location in the absence of the specific sound source.

There is also a requirement within BS 4142:2014 to consider the uncertainty in the measurement and assessment procedure and it is stated that: *"The level of uncertainty associated with a measurement of sound level depends upon a number of factors, including:*

- a. the complexity of the sound source and the level of variability in sound emission from the source;*
- b. the complexity and level of variability of the residual acoustic environment;*
- c. the level of residual sound in the presence of the specific sound at the measurement location;*
- d. the location(s) selected for taking the measurements;*
- e. the distance between sources of sound and the measurement location and intervening ground conditions;*
- f. the number of measurements taken;*
- g. the measurement time intervals;*
- h. the range of times when the measurements have been taken;*
- i. the range of suitable weather conditions during which measurements have been taken;*
- j. the measurement method and variability between different practitioners in the way the method is applied;*
- k. the level of rounding of each measurement recorded; and*
- l. the instrumentation used."*

4. NOISE MEASUREMENT SURVEY

Noise measurements were carried out between 1315 hrs and 1356 hrs on Wednesday 12th January 2022 to determine the noise levels in close proximity to the existing plant at Petersfield WwTW. The purpose of the noise measurement survey was to obtain source noise levels for inclusion in a detailed noise model.

At the start of the noise measurement period the weather was dry with approximately 10% cloud cover with a daytime temperature of 12°C and wind travelling in a south-easterly direction at 1 m/s. At the end of the measurement period the weather was dry with approximately 10% cloud cover with a temperature of 12 °C with wind travelling in a south-easterly direction at 1 m/s.

4.1. Noise Monitoring

The noise measurements utilised a Rion NL-52 Sound Level Meter which holds a current certificate of calibration. Before and after the measurement period, the equipment was calibrated in order to ensure that the equipment had remained within reasonable calibration limits (+/- 0.5 dB).

Measurement Positions 1 - 7 were at the locations illustrated in **Figure 4.1** at a height of 1.2 – 1.5 m. Photographs of the measurement positions can be found in **Appendix 2** and specific source details can be found in **Table 5.1**.

Figure 4.1: Noise Measurement Locations



The ambient noise climate in close proximity to the WwTW was dominated by the various plant.

5. NOISE SOURCES

Plant on the site consists of several compressors. Each item of plant has been measured and is shown below **Table 5.1**.

Table 5.1: Source Noise Levels

Noise measurement locations	Noise Source	Distance from Source (m)	Noise Level @ 1 m (SPL) (dBA)
1	SBC Blower	1	86
2	Pump Z17B	1	66
3	Hyperclassic HMCA	1	59
4	SEW Geared Motor	1	67
5	Gamak AGM 80 8a	1	59
6	Z14A	1	57

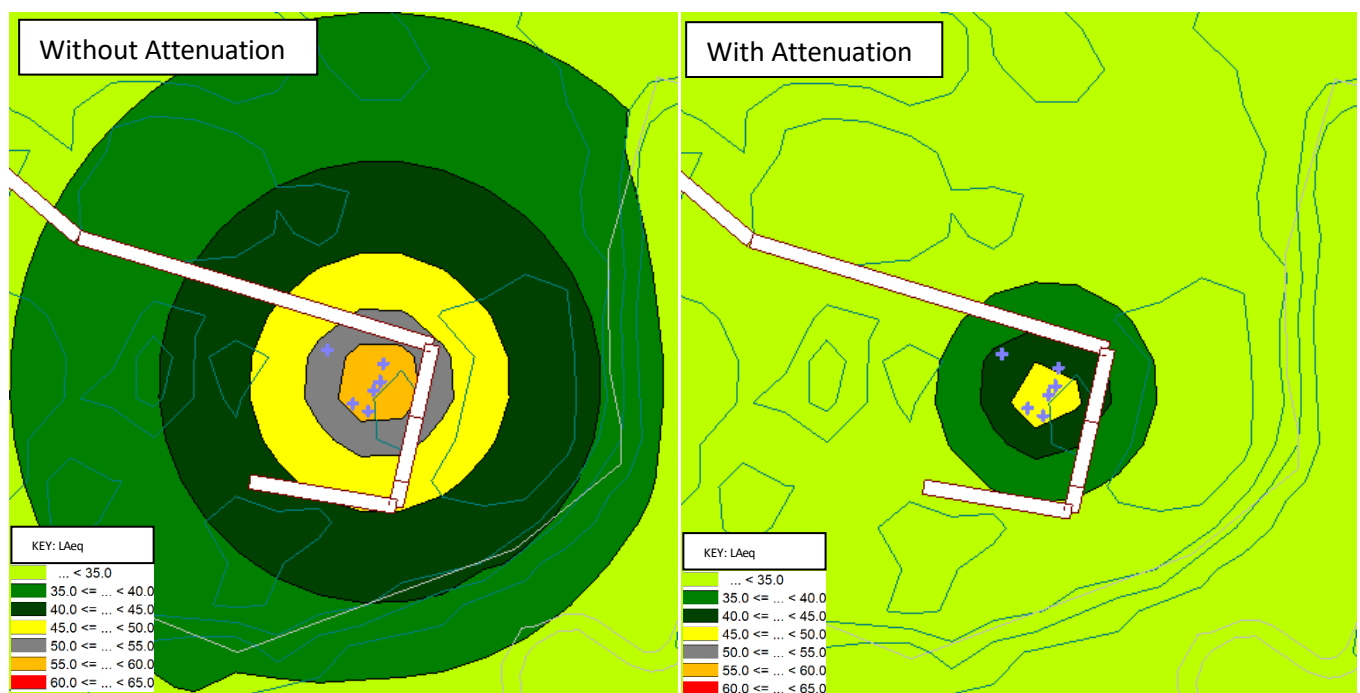
It was noted that noise generated by operational motors was the significant noise source at each of the six measurement positions.

6. NOISE MODELLING

6.1. Methodology

The CadnaA noise modelling software has been utilised to calculate the external noise levels from the WwTW. CadnaA is a three-dimensional noise model developed by DataKustik and has been extensively used by ACCON and others to develop noise models for a wide variety of situations and noise sources. CadnaA utilises ISO 9613 to predict noise from point, line and area sources.

Figure 6.1 – CadnaA noise model contour



The CadnaA image on the left of **Figure 6.1** identifies the predicted noise levels from the WwTW at Petersfield in its current operational mode, assuming that all noise generating machinery (measured on site) is active simultaneously. The significant noise source on site was the SBC Blower unit. It can be determined that noise from the site currently falls below a typical background sound level (35 dB LA₉₀) at a distance of 85 - 90 metres.

The CadnaA image on the right of **Figure 6.1** illustrates the reduction in noise egress if the SBC Blower was within an attenuating enclosure with a performance of Rw 15 dB. This would reduce the noise of the SBC Blower to a similar level to that of other motor related noise sources on the site. In the attenuated scenario, it can be determined that noise from the motors would not exceed the typical rural daytime background sound level (35 dB LA₉₀) at a distance of 30 - 35 metres

7. PLANT NOISE ASSESSMENT

7.1. BS 4142 Assessment

Subject to confirmation from an LPA, ACCON have determined that a BS4142 assessment would be an appropriate method for determining the acceptability of a WwTW.

Table 7.1 provides a notional BS 4142 assessment of noise from the WwTW.

Table 7.1: Noise Assessment of WwTW - Unattenuated

Results	LAeq (10 metres)	LAeq (20 metres)	LAeq (40 metres)	LAeq (80 metres)
Typical Background Sound Level L _{A90, 5min} (dB)	35	35	35	35
Specific Sound Level L _{Aeq, Tr} (dB)	55	49	43	36
Acoustic Feature Correction (dB)	2	2	2	2
Rating Level L _{Ar, Tr} (dB)	57	51	45	38
Difference between Rating Level and Background Sound Level (dB)	22	16	10	3
Initial Estimate of Impact	Significant adverse impact	Significant adverse impact	Significant adverse impact	Low risk of adverse impact

It can be identified from **Table 7.1** above that if the SBC blower unit remains unattenuated, the rating noise level from the WwTW meets the criteria for low risk of adverse impact at a distance of 80m.

It can be identified from **Table 7.2** that when the significant noise source on site is attenuated with an acoustic enclosure, the rating noise level from the WwTW meets the criteria for low risk of adverse impact at a distance of 30 m.

Table 7.2: Noise Assessment of WwTW – Attenuated Blower Unit

Results	LAeq (10 metres)	LAeq (20 metres)	LAeq (30 metres)
Typical Background Sound Level $L_{A90, 5min}$ (dB)	35	35	35
Specific Sound Level $L_{Aeq, Tr}$ (dB)	45	39	34
Acoustic Feature Correction (dB)	2	2	2
Rating Level $L_{Ar, Tr}$ (dB)	47	41	36
Difference between Rating Level and Background Sound Level (dB)	12	6	1
Initial Estimate of Impact	Significant risk of adverse impact	Adverse impact	Low risk of adverse impact

7.2. Uncertainty

The analysis has utilised a notional background noise level and it will therefore be important to ensure that for any specific location for a WwTW the background noise level is measured for inclusion in any subsequent BS 4142 assessment.

8. CONCLUSION

A CadnaA noise model has been prepared to predict noise emanating from the WwTW.

A BS 4142 assessment of the noise has concluded that if the significant noise sources on site are attenuated with a suitable acoustic enclosure, the risk of adverse impact to Noise Sensitive Receptors (NSRs) at a distance greater than 30 metres is low.

Where a larger WwTW installation than the demonstrator WwTW is planned and subject to an appropriate level of mitigation, principally to any blower units, then it should be possible to site any residential properties within 50 metres of the WwTW.

Appendix 1

Glossary of Acoustic Terminology

Term	Description
'A'-Weighting	This is the main way of adjusting measured sound pressure levels to take into account human hearing, and our uneven frequency response.
Decibel (dB)	This is a tenth (deci) of a bel. A decibel can be a measure of the magnitude of sound, changes in sound level and a measure of sound insulation. Decibels are not an absolute unit of measurement but are an expression of ratio between two quantities expressed in logarithmic form.
Frequency	Frequency is related to sound pitch; frequency equals the ratio between velocity of sound and wavelength.
$L_{Aeq, T}$ (Ambient /Period Sound Level)	The equivalent steady sound level in dB containing the same acoustic energy as the actual fluctuating sound level over the given period, T. T may be as short as 1 second when used to describe a single event, or as long as 24 hours when used to describe the noise climate at a specified location. $L_{Aeq, T}$ can be measured directly with an integrating sound level meter.
$L_{A90, T}$ (Background Sound Level)	The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 90 per cent of a given time. The $L_{A90, T}$ is used to describe the background noise levels at a particular location.
Sound Power Level	The total sound energy radiated by a sound source in all directions. In decibels with a reference level of 1×10^{-12} Watts
Rating Level, $L_{Ar, Tr}$	The specific sound level plus any adjustment for the characteristic features of the sound.
Residual Sound Level, $L_r = L_{Aeq, T}$	Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound.
Specific Sound Level, $L_s = L_{Aeq, Tr}$	The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr .
T	Sometimes denoted RT, this is the reverberation time. The reverberation time is defined as the time in seconds taken for the sound pressure level to decay by 60 dB. This is measured within rooms to allow the determination of the level of acoustic absorption present.

Appendix 2

Photographs of Measurement Positions

Figure 1 - Measurement Position 1



Figure 2 - Measurement Position 2



Figure 3 - Measurement Position 3



Figure 4 - Measurement Position 4

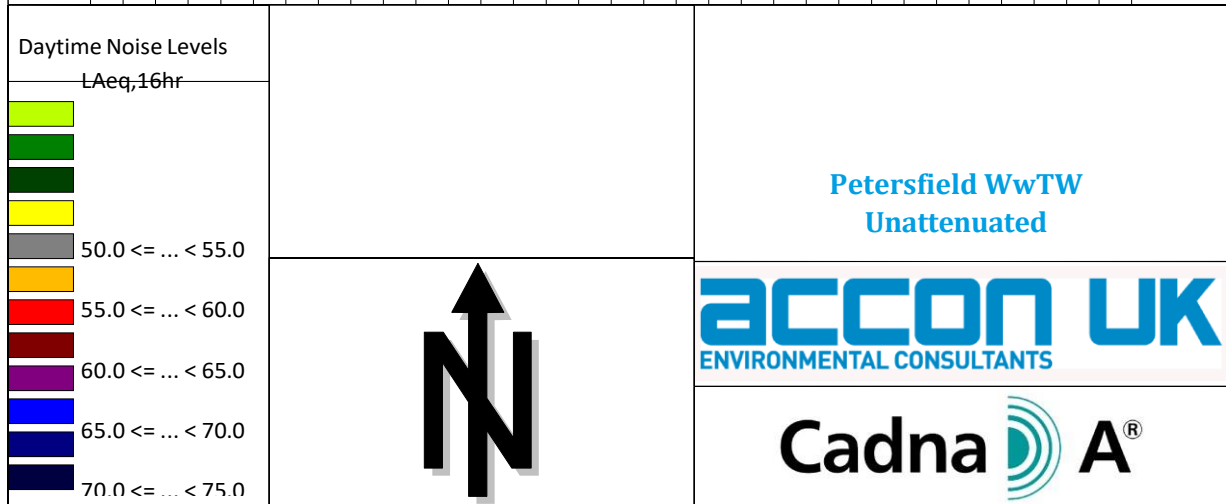


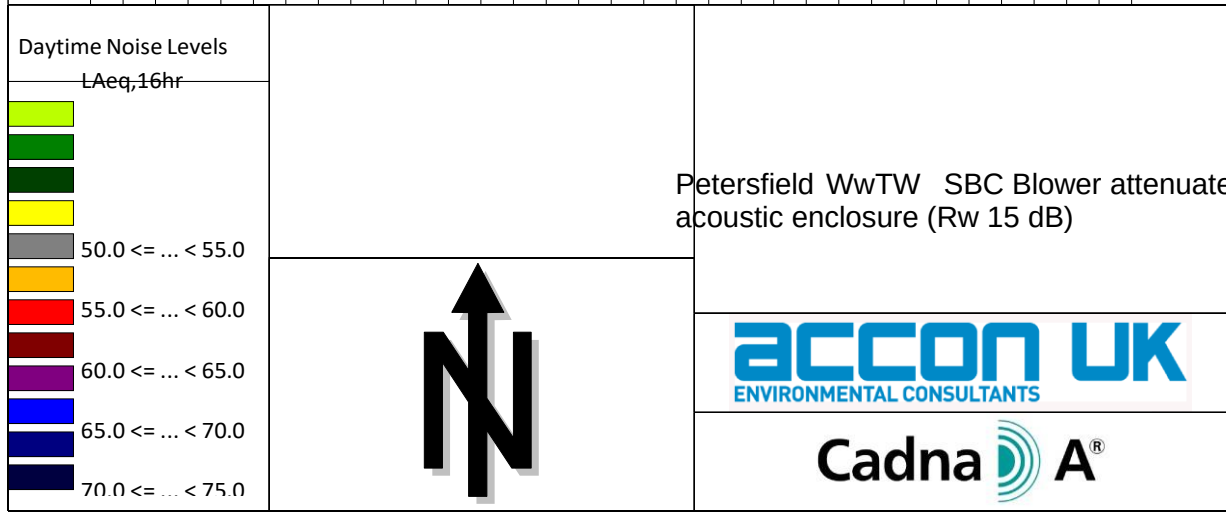
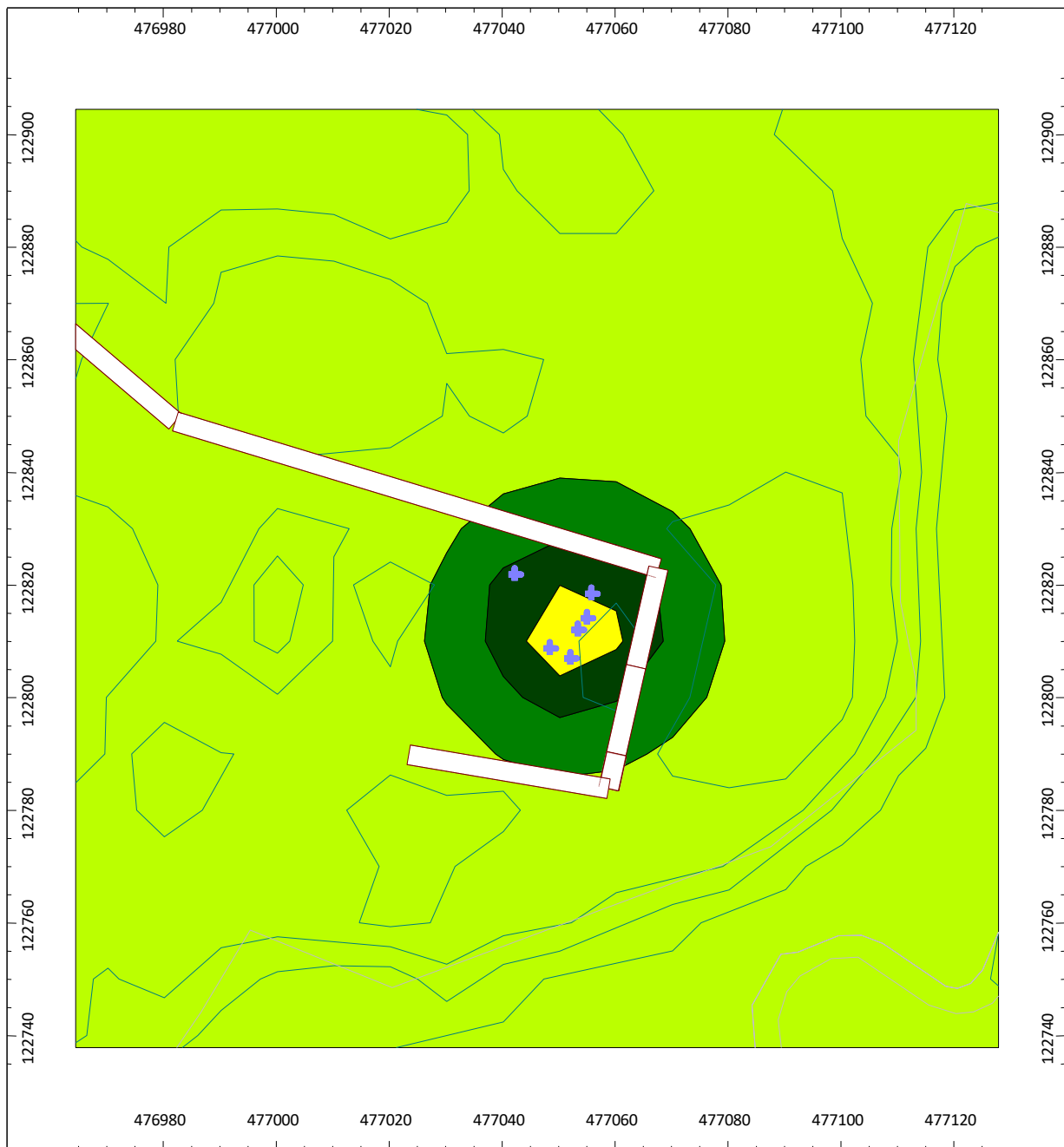
Figure 5 - Measurement Position 5



Figure 6 - Measurement Position 6







476980

477000

477020

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477120



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50.0 <= ... < 55.0

55.0 <= ... < 60.0

60.0 <= ... < 65.0

65.0 <= ... < 70.0

70.0 <= ... < 75.0

Report for: 476980 477000 477020 477040 477060 477080 477100 477120

Severn Trent Connect

Petersfield demonstrator wastewater
treatment works

Odour Assessment

Status: Final

Date: 25.01.2022

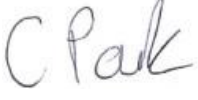
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476980	477000	477020	477040	477060	477080	477100	477120
Author		 Christine Park Senior Air Quality Consultant					
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1. INTRODUCTION

ACCON UK Limited (ACCON) have been commissioned by Severn Trent Connect to carry out an odour assessment to support planning applications where the waste water treatment works (WwTW) may be in close proximity to existing or proposed residential development.

In order to assess the odour impacts from the WwTW ACCON personnel have visited the Petersfield Demonstrator WwTW, the location of which site is identified in **Figure 1.1**.

Figure 1.1: Site Location Plan



- Carried out qualitative odour assessments at and in the vicinity of the WwTW;
- Carried out an odour impact assessment in accordance with published guidance from the Department for Environment, Food & Rural Affairs (DEFRA)¹, the Environment Agency (EA)², the Institute of Air Quality Management (IAQM)³ and statements from bodies such as the Chartered Institution of Water and Environmental Management (CIWEM) and the UK Water

¹ 'Odour Guidance for Local Authorities', DEFRA (2010)

² IPPC H4 'Odour Management', Environment Agency (2011)

³ 'Guidance on the assessment of odour for planning' IAQM (2014)

Industry Research (UKWIR) to determine the potential odour impact of the sewage treatment works on the proposed development.

2. ODOUR BACKGROUND, POLICY, LEGISLATION AND GUIDANCE

Odour Legislation and Guidance considered in this Assessment

The following legislation and guidance were utilised as part of this assessment:

- Odour Guidance for Local Authorities', DEFRA (2010);
- IPPC H4 'Odour Management', Environment Agency (2011);
- 'Guidance on the assessment of odour for planning' IAQM (2014);
- Chartered Institute for Water and Environmental Management (CIWEM) Policy Statement (2011);
- Odour Control in Sewage Treatment (Technical Reference Document 01/WW/13/3) UK Water Industry Research (UKWIR) (2001); and
- Planning Precedent Decisions

Odour Background

2.1.1. Odour Definition

The DEFRA guidance defines odour as:

"An odour is the organoleptic attribute perceptible by the olfactory organ on sniffing certain volatile substances. It is a property of odorous substances that make them perceptible to our sense of smell. The term odour refers to the stimuli from a chemical compound that is volatilised in air. Odour is our perception of that sensation and we interpret what the odour means. Odours may be perceived as pleasant or unpleasant. The main concern with odour is its ability to cause a response in individuals that is considered to be objectionable or offensive.

Odours have the potential to trigger strong reactions for good reason. Pleasant odours can provide enjoyment and prompt responses such as those associated with appetite. Equally, unpleasant odours can be useful indicators to protect us from harm such as the ingestion of rotten food. These protective mechanisms are learnt throughout our lives. Whilst there is often agreement about what constitutes pleasant and unpleasant odours, there is a wide variation between individuals as to what is deemed unacceptable and what affects our quality of life."

Odour is perceived by our brains in response to chemicals present in the air we breathe. Odour is the effect that those chemicals have upon us. Humans have a particularly developed sense of smell and they can detect odour even when chemicals are present in very low concentrations. Most odours are a mixture of many chemicals that interact to produce what we detect as an odour.

Different life experiences and natural variation in the population can result in different sensations and emotional responses by individuals to the same odorous compounds. Because the response to odour is synthesised in our brains, other senses such as sight and taste, and even our upbringing, can influence our perception of odour and whether we find it acceptable, objectionable or offensive

2.1.2. Odour Units

The concentration at which an odour is just detectable to a 'typical' human nose is referred to as the 'threshold' concentration. At the detectability threshold, the concentration of an odour is so low that it is not recognisable as any specific odour at all, but the presence of some very faint, odour can be sensed when the 'sample' odour is compared to a clean, odour-free sample of air.

Odours are a complex mixture of compounds and the concentration of the mixture is expressed in European odour units per cubic metre ($\text{ou}_\text{E}\text{m}^{-3}$ or $\text{ou}_\text{E}/\text{m}^3$) as defined by European standard BSEN 13725:2003 'Air quality. Determination of odour concentration by dynamic olfactometry'.

An odour at strength of $1 \text{ ou}_\text{E} \text{ m}^{-3}$ would only be detectable within the confines of an odour laboratory by the majority of the population. As odour concentrations increase, they become more noticeable. The following published guideline values⁴ provide context to odour concentrations;

- $1 \text{ ou}_\text{E}\text{m}^{-3}$ = the point of detection;
- $5 \text{ ou}_\text{E}\text{m}^{-3}$ = is a faint odour;
- $10 \text{ ou}_\text{E}\text{m}^{-3}$ = is a distinct odour.

In the general environment however, the population are exposed to levels of 'background' odours from road traffic, vegetation and numerous other activities which can produce background odour concentrations between 5 to $60 \text{ ou}_\text{E}\text{m}^{-3}$.

The units for exposure to odour is given in terms of a percentile of averages over the course of a year. The current accepted method of assessing the impact of odour concentration in the UK at present is a 98th percentile (C_{98}) of hourly averages. This allows for 2% (175 hours) of the year to be above the limit criterion.

2.1.3. Odour Exposure

Before an adverse effect (such as disamenity, annoyance, nuisance or complaints) can occur, there must be odour exposure. For odour exposure to occur all three links in the source-pathway-receptor chain must be present:

- i. An emission source - a means for the odour to get into the atmosphere.
- ii. a pathway - for the odour to travel through the air to locations off site, noting that:
 - anything that increases dilution and dispersion of an odorous pollutant plume as it travels from source to receptor will reduce the concentration at the receptor, and hence reduce exposure.
 - increasing the length of the pathway (e.g. by releasing the emissions from a high stack or at a distance) will – all other things being equal – increase the dilution and dispersion.
- iii. The presence of receptors (people) that could experience an adverse effect, noting that people vary in their sensitivities to odour.

⁴ IPPC H4 'Odour Management', Environment Agency (2011)

The scale of exposure (the impact) is determined by the parameters collectively known as the FIDO factors (Frequency, Intensity, Duration and Offensiveness; these are described in **Table 3.1**. The magnitude of the effect experienced is determined by the scale of exposure (**FIDOL**) and the sensitivity of the receptor (**L**, denoting the location, which is often taken to be a surrogate for the sensitivity and incorporates the social and psychological factors that can be expected for a given community.) **Figure 2.1** depicts how the human appraisal of the **FIDOL** factors and social and psychological factors determines whether an odour has an adverse odour impact and an objectionable effect. Different combinations of the **FIDO** factors can result in different exposures at a location. For example, odours may occur as a one-off, as frequent short bursts, or for longer, less- frequent periods, and may be said to give ‘acute’ or ‘chronic’ exposures respectively.

Table 2.1: Description of the FIDOL factors

Frequency	How often an individual is exposed to odour
Intensity	The individual’s perception of the strength of the odour
Duration	The overall duration that individuals are exposed to an odour over time.
Odour unpleasantness	Odour unpleasantness describes the character of an odour as it relates to the ‘hedonic tone’ (which may be pleasant, neutral or unpleasant) at a given odour concentration/intensity. This can be measured in the laboratory as the hedonic tone, and when measured by the standard method and expressed on a standard nine-point scale it is termed the hedonic score.
Location	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The ‘Location’ factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

Source: IAQM, 2014

2.1.4. Adverse Effects of Odour

The odour effect to be concerned with is the negative appraisal by a human receptor of the odour exposure. This appraisal, occurring over a matter of seconds or minutes, involves many complex psychological and socio-economic factors. Once exposure to odour has occurred, the process can lead to adverse effects such as loss of amenity, annoyance, nuisance and possibly complaints. It is important to emphasise the technical differences between annoyance and nuisance:

- Annoyance – the adverse effect occurring from an immediate exposure; and
- Nuisance – the adverse effect caused cumulatively, by repeated events of annoyance.

Accordingly, in determining whether a site is suitable for development where a WWTW may be installed it is important to understand the scale of the potential odour, over what period it may occur and importantly whether it will migrate from the source to the sensitive receptors on a regular basis such as to cause a loss of amenity or nuisance. Additionally, it is also important to understand the extent to which any exposure at a sensitive receptor, i.e. a proposed residential development, would occur.

Table 2.2: Receptor sensitivity to odours

High sensitivity receptor	Surrounding land where: • Users can reasonably expect enjoyment of a high level of amenity; and • People would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium sensitivity receptor	Surrounding land where: • Users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or • People wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Low sensitivity receptor	Surrounding land where: • The enjoyment of amenity would not reasonably be expected; or • There is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial use, farms, footpaths and roads.

Source: IAQM, 2014

2.1.5. Odour from Wastewater Treatment Works

There are many chemical species that have been detected in sewage treatment works odours. In addition to hydrogen sulphide and other pollutants such as ammonia, there are a wide variety of organic sulphides and organic nitrogen-based compounds along with some oxygenated organic compounds and organic acids.

In addition to these compounds, there are many potential substances which may be released depending upon the quality of the influent, for example if it includes industrial effluent. The range of contaminants potentially present in industrial effluent is extensive but those which are likely to be of concern are already odorous liquids (such as sewage from food production), warm effluent which may accelerate anaerobic conditions and volatile organic compounds such as solvents and petroleum derivatives. The primary odours from sewage treatment works are biogenic due to the degradation of organic matter by microorganisms under anaerobic conditions. The development of anaerobic conditions in sewage is often referred to as 'septicity'. Septicity can be onset by elevated temperature, high biological oxygen demand, high sulphate levels and the presence of reducing chemicals. Anaerobic activity leads to the production of methane, hydrogen sulphide (H₂S), ammonia (NH₃), organic sulphur, thiols (mercaptans), amines, indole and skatole. During the fermentation phase of anaerobicity, volatile fatty acids, alcohols, aldehydes and ketones can be produced.

However, odour which is not typical of anaerobic conditions can also be generated by other mechanisms in a treatment works including:

- Volatile substances in the influent such as petroleum derivatives, solvents;

- Air stripping of volatile compounds and odours particularly from industrial effluent often at inlet works or during aeration;
- Aerobic odours – which are often described as a ‘musty’ odour; and
- Ammonia odour from reactions after liming of sludges or when sludges become re-wetted.

Hydrogen sulphide is often referred to as the cause of odour from sewage treatment works. Whilst hydrogen sulphide may be a principal component of the odour cocktail, there are other compounds which cannot be ignored. Because it is relatively easy to measure, H₂S is often used as a target indicator for odour but there are important limitations to this technique.

Odour Standards and Benchmarks

There are a number of sources of ‘standards’ for odour unit concentrations and the assessment of impacts. Malodours from WWTW (particularly where sludge is used and processed) are considered to be potentially highly offensive and therefore careful consideration should be given to the placement of potential receptors.

2.1.6. Planning Precedents

There are a number of planning precedents that are able to inform this assessment. The first of these is the Newbiggin-by-the-Sea⁵ Planning Inspectorate decision in 1993. The appeal addressed what was an appropriate odour exposure limit at a sensitive receptor and the appeal concluded that: “Whilst a particularly sensitive person could detect an emission level as low as 20u_Em⁻³, it seems to be that adoption of a level of 50u_Em⁻³ for the appeal site is both reasonable and cautious.”

The decision in this Planning Inspectorate case was the origin of the now well-established empirical standard of 50u_Em⁻³ (98th percentile - C₉₈, 1-hour), which has been widely used in the sewage sectors in the UK to assess the likelihood of community annoyance. This impact criteria has been successfully applied within similar assessments, where odour from WWTW has been assessed at adjacent residential receptors^{6,7,8}.

At a WWTW managed by Southern Water, ACCON received the following comment from the EHO at the Local Planning Authority for that site:

“Further to the Technical Note produced in response to concerns expressed about odour, it is my view that the site is not ideal for residential development, however the developer has provided an assessment that predicts that odour will be within acceptable limits (C98, 1-hour <30u_E/m³). On this basis I am unable to object to the development on the grounds of odour.”

⁵ Department of the Environment (July 1993) Appeal by Northumbrian Water Ltd: *Land Adjacent to Spital Burn, Newbiggin-by-the-sea, Northumberland*. Case ref: APP/F2930/A/92 206240.

⁶ Planning Inspectorate – Appeal Reference: APP/P0240/A/09/2110667

⁷ Planning Inspectorate – Appeal Reference: APP/E3525/A/11/2145235.

⁸ High Court of Justice (2011). EWHC 3253 (TCC).

2.1.7. IAQM Guidance (2014, updated July 2018)

The IAQM document provides guidance on the odour impacts for planning purposes. As such, it gives details of relevant descriptors of effects and impacts, so that modelled odour concentrations can be quantified. **Table 2.3** compares the receptor sensitivity and relative odour exposure and provides a magnitude of effect.

Table 2.3: IAQM suggested descriptors for magnitudes of odour effects

		Receptor Sensitivity		
Relative Odour Exposure (Impact)		Low	Medium	High
	Very Large	Moderate adverse	Substantial adverse	Substantial adverse
	Large	Slight adverse	Moderate adverse	Substantial adverse
	Medium	Negligible	Slight adverse	Moderate adverse
	Small	Negligible	Negligible	Slight adverse
	Negligible	Negligible	Negligible	Negligible

Applicable to odours at the "most offensive" end of the relative-unpleasantness spectrum

2.1.8. Assessment of Community Response to Odorous Emissions

Environment Agency (EA) Research and Development Technical Report P4-095/TR (2002) provides a scientific background to assist in identifying defensible numerical limits for regulating exposure to odours in the UK. This report recognises that the $C_{98, 1\text{-hour}} < 5 \text{ ou}_{\text{EM}}^{-3}$ exposure level is currently applied in the UK with the legal objective of avoiding nuisance. Not all aspects of sewage treatment have the potential to generate odour which is likely to be offensive and therefore have the potential to generate complaints.

2.1.9. UKWIR Research⁹

The UK Water Industry Research (UKWIR) organisation undertook research into the correlation between modelled odour impacts and the spatial distribution of odour complaints in the areas surrounding nine STW in the UK. The report includes the likely amount of complaints for a given odour concentration and concludes:

"The main source of research into odour impacts in the UK has been the sewage industry and the most in-depth study published study in the UK of the correlation between modelled odour impacts and human response (dose-effect) was published by UK Water Industry Research (UKWIR) in 2001. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to 9 sewage treatment works in the UK with ongoing odour complaints. The findings of this research (and subsequent UKWIR research) indicated the following:

- *At modelled exposures of below $C_{98, 1\text{-hour}} 5 \text{ ou}_{\text{EM}}^{-3}$, complaints are relatively rare, at only 3% of the total registered;*

⁹ Odour Control in Sewage Treatment (Technical Reference Document 01/WW/13/3) UK Water Industry Research (UKWIR) (2001)

- *At modelled exposures between $C_{98, 1\text{-hour}} 50\text{ou}_E\text{m}^{-3}$ and $C_{98, 1\text{-hour}} 100\text{ou}_E\text{m}^{-3}$, a significant proportion of total registered complaints occur; 38% of the total;*
- *The majority of complaints occur in areas of modelled exposure greater than $C_{98, 1\text{-hour}} 100\text{ou}_E\text{m}^{-3}$, 59% of the total."*

Therefore, the UKWIR research findings are consistent with the 'Newbiggin' standard and other planning precedents (**Section 2.1.6**) as any potential odour impact and annoyance is effectively controlled for the vast majority of the population at a 98th percentile hourly mean odour impacts of $50\text{ou}_E\text{m}^{-3}$ or less.

2.1.10. Environment Agency H4 Odour Guidance

The EA published guidelines on odour regulation, assessment and control (H4: Odour Management) in March 2011. In Appendix 3 (of H4), modelled odour concentration benchmark levels are presented for odours of varying degrees of offensiveness.

The guidance recommends that preferably five years of meteorological data (and a minimum of three), should be used to calculate the 98th percentile of the hourly mean odour concentrations, to assess varying meteorological conditions.

2.1.11. Chartered Institute for Water and Environmental Management (CIWEM)

CIWEM released a Policy Position Statement regarding odour in February 2011. The statement provides appropriate assessment criteria and benchmarks to determine the potential for odour nuisance and was as follows:

"Given the differing odour impact criteria available, the selection of the most appropriate criterion should be determined by the objective of the assessment (whether this be against a standard of avoidance of nuisance or 'significant pollution') and the nature of the odour under assessment. It is, therefore, the view of CIWEM that these and other odour impact criteria should be regarded as indicative guidelines and cannot be applied as over-arching statutory numerical standards. CIWEM considers that the following framework is the most reliable that can be defined on the basis of the limited research undertaken in the UK at the time of writing:

- *$C_{98, 1\text{-hour}} > 100\text{ou}_E\text{m}^{-3}$ – complaints are highly likely and odour exposure at these levels represents an actionable nuisance;*
- *$C_{98, 1\text{-hour}} > 50\text{ou}_E\text{m}^{-3}$, – complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance; and*
- *$C_{98, 1\text{-hour}} < 30\text{ou}_E\text{m}^{-3}$, – complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature."*

3. ASSESSMENT METHODOLOGY

Sniff Testing Methodology

The odours from the WwTW were assessed against a fixed framework, which covers weather conditions, odour intensity, strength, frequency and characteristics. A number of locations were identified on and around the Petersfield Demonstrator WwTW for assessment to account for typical odour exposure depending on the wind speed and direction. Each location was assessed for a fixed period of time (10 minutes) to enable the assessment of frequency.

3.1.1. Assessment Quality Assurance

To ensure that the odour assessment was carried out to a satisfactory standard the following quality assurance steps were taken:

- A suitably qualified and trained odour assessor (assessed against EN13725);
- An objective method of describing and measuring odours
- A standardised monitoring process and data reporting

In addition, the quality of the assessment was managed by utilising the following guidelines as detailed in 'Guidance on the assessment of odour for planning' IAQM, (2014):

- *The odour assessor should not carry out the assessment if they have a cold, sore throat, sinus trouble, etc;*
- *The odour assessor should not be hungry or thirsty;*
- *The odour assessor should not work within half an hour of the end of their last meal;*
- *The odour assessor should not smoke or consume strongly flavoured food or drink, including coffee, for at least half an hour before the field odour survey is carried out, or during the survey;*
- *The odour assessor should not consume confectionery or soft drinks for at least half an hour before the field odour survey is carried out, or during the survey;*
- *Scented toiletries, such as perfume/aftershave should not be used on the day of the field odour survey;*
- *The vehicle used during the field odour survey should not contain any deodorisers;*
- *If the odour assessor has had to travel a long distance, then a rest period should be taken before starting the survey; and*
- *To reduce the likelihood of odour fatigue, assessors should always carry out the field odour survey before making any works site visit, inspection or walk-through survey.*

Odour Benchmarks

As outlined in **Section 2.1.4**, receptor sensitivity and possible exposure to potential odours will vary depending on the land-use of the site. The land use will change the expectation of users of the land depending on the level of amenity and the time spent at the location.

As such, this assessment has considered the following criteria when assessing the impacts of the WwTW on any proposed development. This enables the quantification of a 'stand-off' distance from the WwTW depending on the land-use and sensitivity of the proposed receptor. The criteria have been determined from the recommendations of the CIWEM, IAQM guidance and planning precedents outlined in **Section 2.1**.

- High sensitivity receptors – considered suitable for any development, including residential: Applied benchmark of less than $C_{98, 1\text{-hour}} 30u_E/m^3$;
- Medium sensitivity receptors – considered suitable for places of work, commercial/retail premises and playing/recreation fields: Applied benchmark of greater than $C_{98, 1\text{-hour}} 30u_E/m^3$ but less than $C_{98, 1\text{-hour}} 50u_E/m^3$; and
- Low sensitivity receptors – considered suitable for non-sensitive uses where exposure would be only transient, e.g. industrial use, farms, footpaths, car-parks and roads: Applied benchmark of greater than $C_{98, 1\text{-hour}} 50u_E/m^3$.

Accordingly, where a WwTW is proposed near occupiers of existing or proposed residential property the use is considered to be "high sensitivity receptors".

IAQM – Significance Criteria

Based upon the IAQM matrix and descriptors as presented within **Table 3.1**. **Table 3.1** outlines the relationship between modelled odour exposure level and the relevant receptor sensitivity. It should be noted that **Table 3.1** below is a conservative estimate of the impacts based on highly offensive odours. Therefore, less offensive odours would in all likelihood require a higher level of exposure to elicit the same response.

Table 3.1: IAQM odour effect descriptors for impacts predicted by modelling

Odour Exposure Level ou_E/m^3	Receptor Sensitivity		
	Low	Medium	High
>10	Moderate	Substantial	Substantial
5 - <10	Moderate	Moderate	Substantial
3 - <5	Slight	Moderate	Moderate
1.5 - <3	Negligible	Slight	Moderate
0.5 - <1.5	Negligible	Negligible	Slight
<0.5	Negligible	Negligible	Negligible

4. QUANTIFICATION OF ODOUR EMISSIONS

WwTW Process Overview

The advanced activated sludge treatment process is distinctly different to other waste water treatment works in that odour emissions from the principal sources appears to be relatively low. Whilst, odour at other times of the year may be slightly elevated, for example when temperatures are elevated, it seems highly unlikely based on ACCON's experience that a WwTW of the size and configuration of the Petersfield Demonstrator WwTW could result in offensive odour likely to result in a loss of amenity or a nuisance beyond 10 – 15 metres from the site boundary.

Where the size of the WwTW will be larger than the demonstrator WwTW, as a precautionary measure based on a professional judgement, a maximum offset distance from the site boundary of 30 - 50 metres should be adopted for sensitive receptors.

5. RESULTS

Qualitative Assessment

A qualitative odour assessment was carried out on the 12th January 2022. Whilst any qualitative assessment can only ever represent a 'snapshot in time' of the operational and meteorological conditions on the day, it does provide very useful observations in respect of how odorous the WwTW is and the extent to which odour could migrate offsite.

The two people carrying out the sniff testing on the site have previously had their detection threshold tested by Spectrum Environmental Limited and Silsoe Odours Limited. Their detection threshold was determined at 36.5ppb and 29.9ppb respectively for n-butanol (EN13725). What this means in practice is that both assessors have a range of odour sensitivity that covers the general population. Therefore, their judgements can be relied upon to determine the extent to which odour might be considered offensive such as to result in a nuisance or a loss of amenity to potential occupiers of the proposed property.

Full access to the WwTW was made available and therefore it was possible to carry out sniff testing around the WwTW and immediately above the various sources of odour. The principal identified sources of odour were the reactors and to a much lesser extent the balance tank.

Appendix 2 outlines each of the locations where sniff testing was carried out. **Table 5.1** outlines meteorological conditions on the day of the site visit.

Table 5.1: Meteorological Conditions on Assessment Days

Date	Average Temperature	Average Wind Speed	Average Wind Direction
12 th January 2022	12°C	1m/s	South westerly

Odour was detectable immediately adjacent the reactors and specifically when aeration was occurring. Additionally, odour was easily detectable above the reactors. At the balance tank odour was only just detectable.

Offsite depending on location odour was not detectable beyond a distance of 10 metres regardless of being upwind or downwind of the odour sources.

It is ACCON's consideration that the worst-case odour intensity value of 3, would be equivalent to a modelled odour level of 3ouE/m³.

6. CONCLUSIONS

ACCON have carried out an odour assessment of the Demonstrator WwTW at Petersfield. Sniff testing was carried out by qualified personnel in order to determine the odour intensity of the existing WwTW operation.

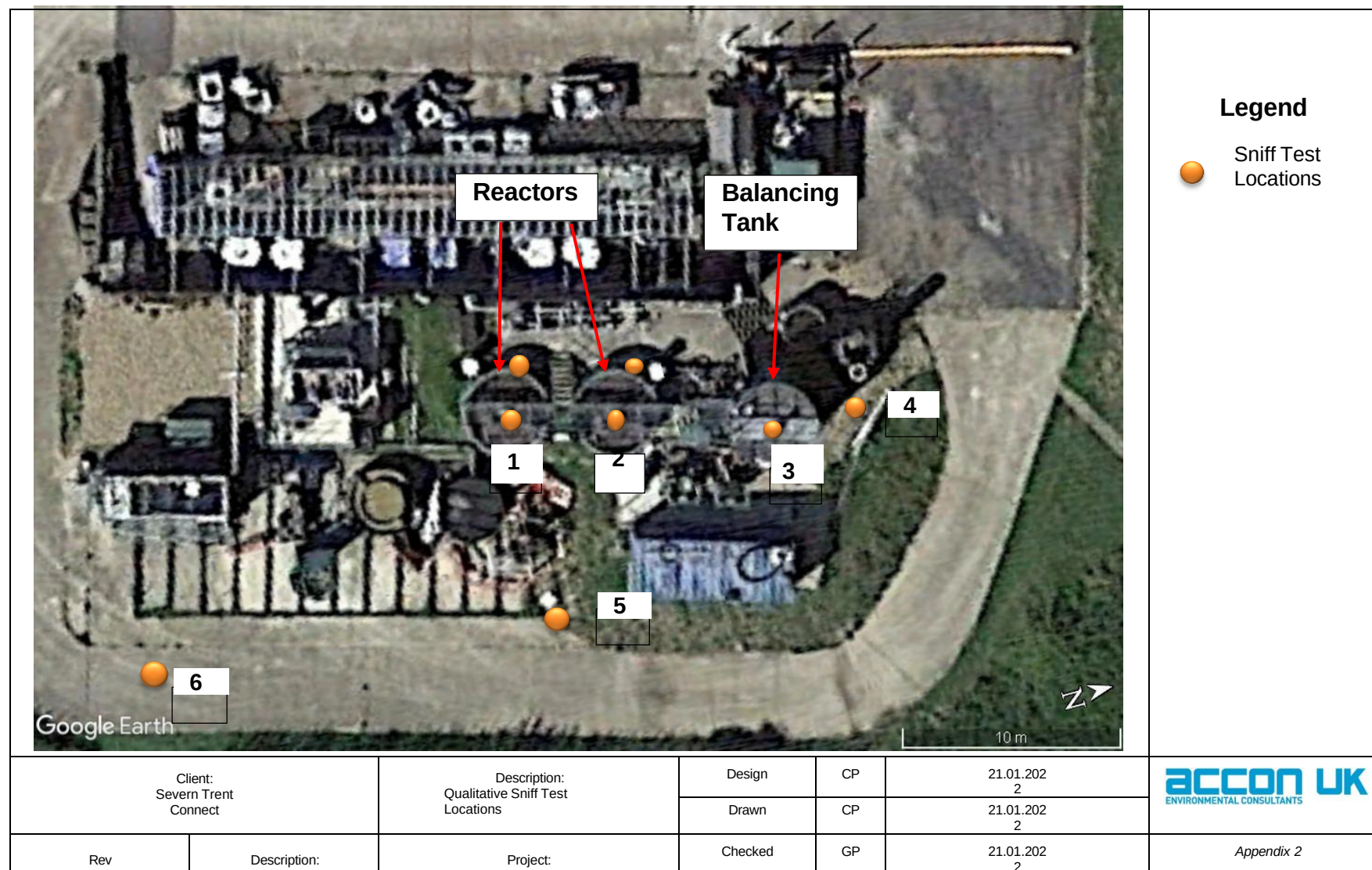
It is ACCON's view that beyond the boundary of the plant odour would be highly unlikely to result in a loss of amenity at sensitive receptors e.g. occupiers of residential property.

Assuming that the emission rates remained typical for the WwTW process it is very unlikely, that even when air temperatures are elevated during the summer months, that odour from the process would be at a level as to exceed $30 \mu\text{g}/\text{m}^3$ and would in all likelihood be lower still.

The combination of sniff testing and professional judgement has created a broad assessment of the potential odour from the WwTW process and the potential impact on any proposed residential development in close proximity to a WwTW. As such, it is not considered that the WwTW would cause a loss of amenity, annoyance, nuisance or complaints for future occupiers of residential development in close proximity to a WwTW process, where it operates in a similar mode to the WwTW at Petersfield. Additionally, where the WwTW is designed to a larger capacity then an offset distance of 30-50 metres is recommended.

APPENDICES

Appendix 2: Qualitative Sniff Testing Locations



: A	FINAL	Petersfield WwTW	Approved	GP	21.01.2022	Scale Not to Scale
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Appendix 5: Odour Report Forms – ‘Qualitative Sniff Tests’

Odour Report Form – Adapted from IPPC H4 ‘Odour Management’, Environment Agency (2011)

Odour Report Form	Date: 12.01.2022	Project: Petersfield WwTW		
Test Location	1. Immediately adjacent reactor	2. Immediately adjacent Reactor	3. Above balancing tank	4. At ground level
Commencement Time (Hrs)	1310	1315	1320	1330
Weather Conditions	Sunny with SW low wind			
Temperature	12°C			
Wind Speed/Direction	0.5m/s, occasional gusts up to 1m/s			
Distance to Source	0.5m	0.5m	1.5m	2.5m to closest source, 9m to closest reactor
Plant Operational?	Yes			
Intensity (VDI 3882, Part 14)	1 - 2	3	0 - 1	0
Duration	Constant – no aeration	Constant with aeration occurring	Constant	Constant
Notes and Odour Characteristics	None	Sweet sewage smell	Just detectable. Tank has lid.	No detectable odour

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour, **4** Strong odour, **5** Very strong odour,
6 Extremely strong odour

Odour Report Form	Date: 12.01.2021	Project: Petersfield WWTW		
Test Location	5. At ground level approximately 7.5m from reactors	1. 1.5m above reactor	2. 1.5m above reactor	5. At ground level approximately 7.5m from reactors
Commencement Time (Hrs)	1335	1340	1345	1350
Weather Conditions	Sunny with SW low wind			
Temperature	12°C			
Wind Speed/Direction	0.5m/s, occasional gusts up to 1m/s			
Distance to Source	7.5m	1.5m	1.5m	7.5m
Plant Operational?	Yes			
Intensity (VDI 3882, Part 14)	0	2	2	3 - 4
Duration	Constant	Constant	Constant not aerating	Constant
Notes and Odour Characteristics	No odour detectable	Very faint odour detectable – not offensive	Not offensive	None detectable

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour, **4** Strong odour, **5** Very strong odour,
6 Extremely strong odour

Status: Final

Odour Report Form	Date: 12.01.2021	Project: Petersfield WWTW		
Test Location	2. Immediately adjacent Reactor			
Time	1325			
Weather Conditions	Sunny with SW low wind			
Temperature	12°C			
Wind Speed/Direction	0.5m/s, occasional gusts up to 1m/s			
Distance to Source	0.5m			
Plant Operational?	Yes			
Intensity (VDI 3882, Part 14)	2 - 3			
Duration	Constant – no aeration			
Notes and Odour Characteristics	Distinct sewage smell			

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour, **4** Strong odour, **5** Very strong odour,
6 Extremely strong odour

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