kPa Consulting
Engineers Ltd.

Sant Ffraed House, Abergavenny
NP7 9BA

Wastewater Assessment for Proposed Wedding Function Room and Expansion

Client: SNACO Ltd

Prepared by:	Kevin Painter BEng, CEng, MIStructE
Checked by:	Gillian Painter BEng, CEng, MICE
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Reason for issue:	Information

Content

1. EXECUTIVE SUMMARY

It is proposed that the existing prestigious house is re-furbished & developed with a new wedding function room building constructed to provide a more current wedding venue offering. There will be an increase to the guest numbers from 120 to 150 persons.

The existing Sant Ffraed House foul drainage currently discharges off site via an existing treatment plant to a watercourse tributary to the River Usk. The additional guests and rooms will increase the foul water loading from the site. Mitigation measures are required to reduce the effect of additional foul water loading on the environment and ideally provide betterment.

The site is remote from any public drainage sewer, and so it is not viable to make a connection to the public drainage system.

Previously a basic treatment plant and large drainage field was envisaged for the site but has been discounted following additional percolation testing which gave varied results beyond the narrow criteria for BS6297 drainage field design. However, infiltration to ground is still viable for linear infiltration trenches.

A new high grade sewerage treatment plant and linear soakaway is proposed for all foul water from the existing and new buildings on the site.

By investing in and utilising a multistage treatment plant with recirculating sand bed filter, the effluent can be robustly treated to a very high standard (circa 20 times better than a septic tank and 10 times better than standard modern treatment plant), thereby eliminating the need for a drainage field providing additional secondary treatment. A ground water risk assessment shows that this highly treated effluent will be acceptable to groundwater without the need for a large drainage field.

This report should be read in conjunction with the comprehensive 'Hydrogeological Risk Assessment' by Hydrogeo Ltd. dated January 2022.

On site treatment and disposal to ground is regarded as the best solution for the environment. Minimising pollutants and phosphate levels to distant offsite receptors including watercourses, ground water and consequently Special Areas of Conservation such as the River Usk (As per NRW – Advice to Planning Authorities).

This report also estimates that the betterment to the USK (SAC) of the new proposed facility discharging to ground compared to the existing treatment plant facility discharging to watercourse is in the order of 3billion percent for Ammonia and more than 4000% for Phosphates.

2. INTRODUCTION

The Client proposes to enhance the existing provisions for weddings at Sant Ffraed House. The Client has appointed kPa Consulting Engineers Ltd to calculate the expected volume of wastewater for the proposed new function room at the Sant Ffraed House located in Llanvihangel Gobion, Abergavenny, Monmouthshire.

The Client wishes to construct a new more prestigious function room building with bar and kitchen on the site. It is understood that only weddings are to be held at this venue with some guests staying overnight at the hotel.

In line with Natural Resources Wales (NRW) interim advice for planning applications that have the potential to increase phosphate levels in river Special Areas of Conservation (SACs), it needs to be demonstrated that the development will not increase phosphate inputs into the River Usk SAC. This report assesses the likely wastewater volume changes and effluent quality from the proposed development.

The proposal within this report also seeks to consolidate existing discharge permits and deficiencies to a more sustainable arrangement.

3. SITE CONDITIONS AND CONSTRAINTS

The following site conditions and constraints have been identified for the site:

Item	Data
Grid Reference	SO356101
Latitude: longitude	51°47'12"N , 002°56'02"W
Elevation	60m AoD
Distance to river Usk	720m
Existing packaged sewerage treatment plant	Klargester Biodisc 9 (Older version of current BL Model)
Existing packaged sewerage treatment plant capacity	30 m^3/day
Proximity to nearest public drainage (See appendix B)	Llanarth 2km away
BRE 365 Site Infiltration Values (from GibbsGeo Technical Report)	1.44x10-6 m/s Lower bound value
Nearest Special Area of Conservation and Sites of Special Scientific Interest (see appendix C)	Usk 720m away
Nearest Source Protection Zone (SPZ)	7.3km away
Nearest Water Abstraction Point	None within 2km

The existing drainage from Sant Ffraed House discharges the treated effluent to a packaged sewerage treatment plant near the western boundary of the site. From there it is pumped off site to a discharge point at The Ffrwd Brook under existing permit ref AN0165601.

An existing permit reference NRW-WQE046147 is also registered for the 2-bedroom cabin/lodge on the site for which has a septic tank was installed with discharge to ground.

4. METHODOLOGY

This report considers the existing and proposed wastewater volume and quality generated by the site. If these existing wastewater loadings are exceeded by the proposed development additional mitigation measures will be implemented to prevent off site discharges causing any additional environmental risk.

The estimated wastewater volumes and quality will be based upon the effluent rates provided in the 2014 British Water Code of Practice. This Code of Practice provides typical wastewater loadings for sewage treatment systems for different occupants and building types. These values are recommended for use by NRW when applying for an environmental permit to determine the daily volume of effluent.

Sant Ffraed House does not operate as a traditional hotel but is used for weddings and provides accommodation to the wedding venue guests only. As such the best estimate of loadings has been calculated from the guest activities in addition to room only loadings. It is therefore regarded that these values are appropriate for use in determining the daily wastewater discharges.

5. EXISTING WASTEWATER DATA (Sant Ffraed House)

Based on the information provided by the Client the wastewater loading for Sant Ffraed House has been estimated and is shown in table 1 below.

The following assumptions are made:

- Hotel is used exclusively as a wedding venue for 120 guests (44 residential and 76 daytime).
- Hotel has 22 rooms with occupancy of 2 per room.
- Hotel wedding guests will have a full breakfast and luxury wedding banquet meal, drinks and evening buffet meal. These are added to the bedroom only loading.
- Day time wedding guests will have a full luxury wedding banquet meal, drinks and evening buffet meal.
- Laundry facilities are off site.
- Staffing levels are full time (there are no residential staff).
- Approximately 200 weddings per annum.
- 2 number let cottages (1x 2 bed and 1x 4 bed) drain to the hotel drainage system.
- An existing 2-bedroom cabin on the site drains to an existing septic tank and small drainage field.

	Source of Waste		Flow (Litre/day)		BOD (grams/day)		Ammonia as N (mg/L)	
	Description	Population	Per Head	Total	Per Head	Total	Per Head	Total
44 no. Overnight Guests	22 Rooms (bedroom only - no meals x 2 person occupancy)	44	80	3,520	50	2,200	6	264
	Full meals - luxury catering	44	30	1,320	38	1,672	4	176
	Drinkers	44	12	528	15	660	5	220
	Function Rooms incl Buffets	44	15	660	19	836	2.5	110
	Full Meals - breakfast (pre-prepared catering)	44	25	1,100	30	1,320	2.5	110
76 no. Day time Guests	Function Rooms incl Buffets	76	15	1,140	19	1,444	2.5	190
	Drinkers	76	12	912	15	1,140	5	380
	Full Meals - Luxury Catering	76	30	2,280	38	2,888	4	304
Staff	Full time Staff	12	90	1,080	38	456	5	60
	Part Time Staff	0	45	0	25	0	3	0
	1x 2 bed and 1x 4 bed cottage (5+6 PE)	11	150	1,650	60	660	8	88
	2 Bedroom Cabin	0	150	0	60	0	8	0
	Total			**14,190**		**13,276**		**1,902**

Table 1 – Existing Wastewater Loading - Existing Hotel Wedding Venue Wastewater Load to Existing Sewage Treatment Plant

Biodisc treatment values (from Klargester) for a comparable BL model are listed as follows:

Effluent Discharge Standard:	95%ile	
BOD5:	20	mg/L
Suspended solids:	30	mg/L
Ammoniacal nitrogen:	10	mg/L

Phosphates from untreated domestic sewage are typically in concentrations of 10mg/l (Metcalf & Eddy 2014). Biodisc treatment plants are only reported to provide a reduction in phosphate levels with chemical dosing which we do not believe is present.

With no dilution prior to entering a waterbody at the discharge point the daily discharge to waterbody of phosphates is estimated at 141g/day and Ammoniacal nitrogen at 141g/day.

6. PROPOSED WASTEWATER DATA (Sant Ffraed House and New Wedding Building)

Based on the information provided by the Client the proposed number of guests will only add additional wastewater load to the existing system. Therefore, it is proposed to deal with the whole site holistically and provide a new treatment plant for the entire site. The calculated wastewater loading is shown in table 2 below. The following assumptions are made:

- Hotel will be used exclusively as a wedding venue for 150 guests (66 residential and 84 daytime).
- Loading is based on occupancy of 2 persons per room for 33 rooms:
  - Main Hotel Building (20 bedrooms)
  - Mews Blocks (9 bedrooms)
  - Coach House (4 bedrooms)
- Hotel wedding guests will have a full breakfast and luxury wedding banquet meal, drinks and evening buffet meal. These are added to the bedroom only loading.
- Day time wedding guests will have a full luxury wedding banquet meal, drinks and evening buffet meal.
- Laundry facilities are off site.
- Staffing levels are 12 full time and 5 part time (there are no residential staff).
- Approximately 200 weddings per annum (No marquees will be added)
- 2 number let cottages (1x 2 bed and 1x 4 bed) will continue to drain to the hotel drainage system.
- An existing 2-bedroom cabin on the site will be connected to the new foul drainage system and the septic tank permit surrendered.

	Source of Waste		Flow (Litre/day)		BOD (grams/day)		Ammonia as N (mg/L)	
	Description	Population	Per Head	Total	Per Head	Total	Per Head	Total
66 no. Overnight Guests	33 Rooms (bedroom only - no meals x 2 person occupancy)	66	80	5,280	50	3,300	6	396
	Full meals - luxury catering	66	30	1,980	38	2,508	4	264
	Drinkers	66	12	792	15	990	5	330
	Function Rooms incl Buffets	66	15	990	19	1,254	2.5	165
	Full Meals - breakfast (pre-prepared catering)	66	25	1,650	30	1,980	2.5	165
84 no. Day time Guests	Function Rooms incl Buffets	84	15	1,260	19	1,596	2.5	210
	Drinkers	84	12	1,008	15	1,260	5	420
	Full Meals - Luxury Catering	84	30	2,520	38	3,192	4	336
Staff	Full time Staff	12	90	1,080	38	456	5	60
	Part Time Staff	5	45	225	25	125	3	15
	1x 2 bed and 1x 4 bed cottage (5+6 PE)	11	150	1,650	60	660	8	88
	2 Bedroom Cabin	5	150	750	60	300	8	40
	Total			**19,185**		**17,621**		**2,489**

Table 2 – Proposed Wastewater Loading - Existing Hotel and Function Room Wastewater Load to NEW Sewage Treatment Plant

It should be noted that whilst the above identifies maximum volumes per day at full occupancy, the actual number of weddings is circa 200 per year held typically on Wednesday, Thursday, Friday, and Saturdays. Therefore, per week the loading would average circa 60% of the full occupancy load noted above.

7. INVESTIGATION SUMMARY

The following site investigation works have been commissioned and are summarised below:

Hydrogeological Risk Assessment
A hydrogeological water risk assessment has been carried out by Hydrogeo Ltd. The risk assessments include the following:

- Desk Study
- Conceptual Model
- H1 Risk Assessment for ammoniacal nitrogen and phosphate

The findings assess the Ammoniacal nitrogen and Phosphates impact on ground water and receptors thereof.

The appendices to this report include the following investigation reports which have also been commissioned for the site.

Geotechnical Investigation
A geotechnical investigation has been carried out by Ground Investigation (South West) limited. On 4th November 2021. A summary is as follows:

- 6 number window sampler boreholes driven to refusal.
- Geotechnical testing
- Ground conditions encountered:
    - 0–0.2m Topsoil
    - 0.2–0.7m Subsoil
    - 0.7–5m Glacial Till
    - 5m+ Suspected Raglan Mudstone formation
- Ground water – Wet soils at 2–3m depth

Infiltration Testing to BRE365
Infiltration testing has been carried out to BRE365 by Gibbs GeoTechnical across the entire site on 24th August 2021. The results are as follows:

Test Pit 1: $1.60–1.44x10^{-6}$ m/s
Test Pit 2: $2.14–2.08x10^{-6}$ m/s
Test Pit 3: $1.89–1.55x10^{-6}$ m/s
Test Pit 4: $4.23–2.64x10^{-6}$ m/s

Test pit 1 and 2 are near the vicinity of the proposed soakaway.

Percolation Testing

Percolation testing has been carried out to BS6297 in the area of the proposed drainage field during the winter months, on 20th November 2021. 5 number tests were carried out. The results are as follows:

Round 1

- Test Pit 1 Vp= 36.6 s/mm
- Test Pit 2 Vp= 142.8 s/mm
- Test Pit 3 Vp= 6.0 s/mm
- Test Pit 4 Vp= 39.7 s/mm
- Test Pit 5 Vp= 63.6 s/mm

With concerns over variability of ground, a further round of 9 tests were carried out with one fill cycle. Indicative infiltration values are as follows:

Round 2

- Test pit 6 – Vp= 24s/mm ($4.21x10^{-5}$m/s)
- Test pit 7 – Vp= 155s/mm ($6.43x10^{-6}$m/s)
- Test pit 8 – Vp= 219s/mm ($4.55x10^{-6}$m/s)
- Test pit 9 – Vp= 173s/mm ($5.75x10^{-6}$m/s)
- Test pit 10 – Vp= 99s/mm ($99.43x10^{-6}$m/s)
- Test pit 11 – Vp= 89s/mm ($1.12x10^{-5}$m/s)
- Test pit 12 – Vp= 178s/mm ($5.61x10^{-6}$m/s)
- Test pit 13 – Vp= 104s/mm ($9.58x10^{-6}$m/s)
- Test pit 14 – Vp= 72s/mm ($1.39x10^{-5}$m/s)

NOTE: The variability and higher Vp values outside the area first considered are deemed unsuitable for a drainage field design.

Wastewater Packaged Treatment Plant Design

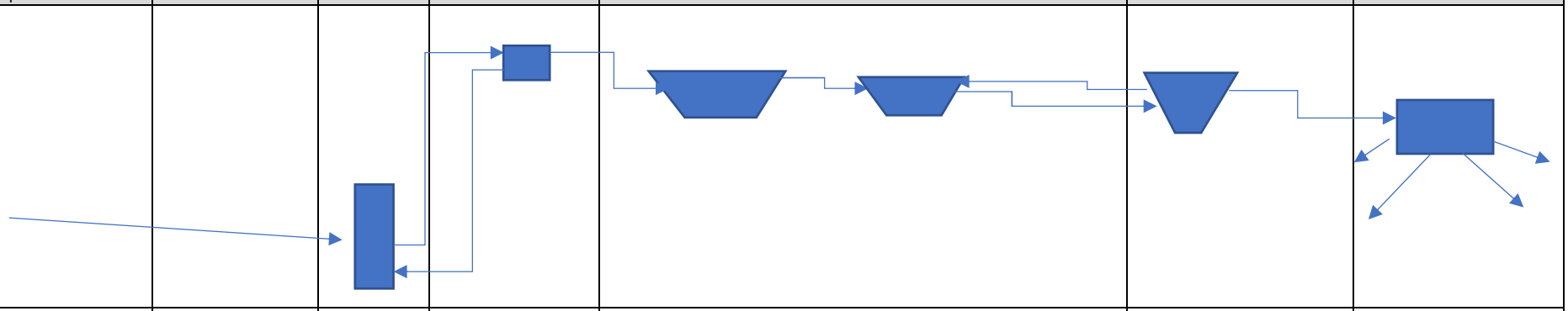
WPL Ltd. have provided a design for the proposed treatment plant. This has been upgraded to lower BOD, Suspended Solids and the Ammonical nitrogen quality to 2mg/L.

8. PROPOSED NEW INFRASTRUCTURE

A new sewerage treatment plant is proposed for the wastewater from both the existing hotel and proposed function room. The existing treatment plant although well maintained and recently refurbished will be decommissioned. The new more reliable treatment plant using a submerged aerated filtration process with minimal mechanical parts and lower energy consumption, is to discharge to a series of linear soakaways within the site. See the proposed site plan in appendix 4.

The proposed treatment chain is shown on the following schematic:

Treatment Chain Schematic with Output Effluent Quality

Chemical/Volume Component	Influent	Pump chamber	Flow calmer and return chamber	Multiple Tank HiPAF utilising Submerged Aerated Filtration treatment tank	Sand Filter	Conventional Infiltration Trench
						
Volume	20,000 (L/Day)	20,000 (L/Day)		20,000 (L/Day)	20,000 (L/Day)	20,000 (L/Day)
BOD	18,000 g/day	900 mg/L		20 mg/L	10 mg/L	10 mg/L
SS				30 mg/L	15 mg/L	15 mg/L
NH3	2,489 g/day	124mg/L		2 mg/L	2 mg/L	2 mg/L
Phosphate	10mg/L (reduce further through management)	10 mg/L		6mg/L 40% reduction	6 mg/L	6 mg/L

New Treatment Plant

The new treatment plant shall be a proprietary sewerage treatment plant to the following specification:

- Design and tested to EN12566 and CE marked
- Proposed to use HiPaf multi-unit filter which uses a Submerged Aerated Filtration treatment process with sand filter by WPL Environmental Engineering Ltd.
- To accommodate:
  - Maximum daily flow of 20m^3/day
  - Maximum daily BOD of 18kg/day
  - Maximum NH3 of 124g/day
  - Maximum Phosphates 10mg/L
- Telemonitoring to be provided
- Standby blower with auto changeover

The proposed treatment plant has been tested to give the following effluent discharge standards:

Effluent Discharge Standard:	95%ile	
BOD5:	10	mg/L
Suspended solids:	15	mg/L
Ammoniacal nitrogen:	2	mg/L

Although beyond the scope of EN12566 phosphate levels are reported to reduce by circa 40%

In addition to the treatment plant, Phosphates entering the drainage system will be minimised using low phosphate cleaning products via the site best practice management plan.

Linear Infiltration Trench

The new drainage shall be designed to the following specification:

- Designed to BRE365
- To accommodate a 4 day continuous daily flow of 20m^3 per day
- Hydrograph of inflow:
    - 1L/s for 5 hours
    - 0.5L/S for 2 hours
    - 0.2L/s for 3hours
- 7m from any habitable building
- 2m from any site boundary
- 50m from any surface water feature
- Protect from surface water runoff from higher ground with an uphill drainage ditch.
- To the infiltration value of **1.44x10^{-6} m/s**

For the above discharge to ground a new 'bespoke permit for water discharges' will be required from NRW. The information within this report demonstrates the criteria for this permit can be met. An application is currently underway.

General

An Environmental Management System has been provided the operation of the plant to deal with all eventualities of the treatment plan operation which could have an environmental impact.

Daily concentrations ammoniacal nitrogen with degradation at the nearest waterbody from the groundwater risk assessment are estimated as follows:

Ammoniacal nitrogen	2.18x10^{-7}mg/L	4.36x10^{-3}mg/day

Daily concentrations of phosphates at the nearest waterbody from the groundwater risk assessment are very difficult to estimate as the time taken to reach the USK is in the order of 260years. Practical evidence would suggest that the level of phosphates in the ground at circa 10m from the linear soakaway is as below:

Phosphates	0.18mg/L**	3.6g/day

** It should be noted that this calculated level of phosphates is purely a notional maximum as in reality it is expected that the majority of the phosphates will be retained within the ground local to the soakaways.

9. CONCLUSION

Because of the development the total usage and wastewater load generated across the site will increase. To mitigate this increase, the existing treatment plant will be decommissioned, and a new treatment plant and linear infiltration trench will be provided. The new modern treatment plant will be more reliable, with lower power and maintenance costs.

By discharging the treated effluent to ground there is a significant reduction to pollutant levels to the River Usk SAC and surrounding watercourses (600m away) as demonstrated in table 3 below.

Chemical	Existing (14.1m3/day)	Proposed (19.1m3/day)	Betterment
Ammoniacal nitrogen	141g/day	$4.36x10^{-6}$g/day	$3x10^{9}$%
Phosphates	141g/day	<<3.6g/day **	>>4000%

Table 3 – Comparison of existing and proposed discharge concentrations of ammoniacal nitrogen and phosphates to River USK SAC

The groundwater risk assessments undertaken demonstrates there is minimal risk to the ground water at 50 compliance point and watercourse receptors from the high level of treatment plant and linear soakaway and considerable betterment to the environment and USK compared to the existing system.

The existing discharge permits and treatment plant for the site are to be surrendered and a new bespoke permit applied for.

10. MANAGEMENT NOTES FOR NEW FUNCTION ROOM DRAINAGE SYSTEM

All sewage treatment system should be maintained according to the manufacturer's instructions by a certified engineer trained in accordance with the British Water Maintenance and Service Code of Practice.

The biological unit must be protected from grease and fats. Modern cooking uses light oils, which may not separate. The collection, containment, and separation of all forms of grease prior to the biological equipment is vital. Operate any grease system in full accordance with the manufacturer's instructions.

Individual kitchen practices affect loads, i.e., leftovers on plates may be scraped into bins, or wet rinsed into system, the former to be encouraged, the latter should be discouraged or factored into the treatment plant design. It is assumed that waste disposal systems are not used.

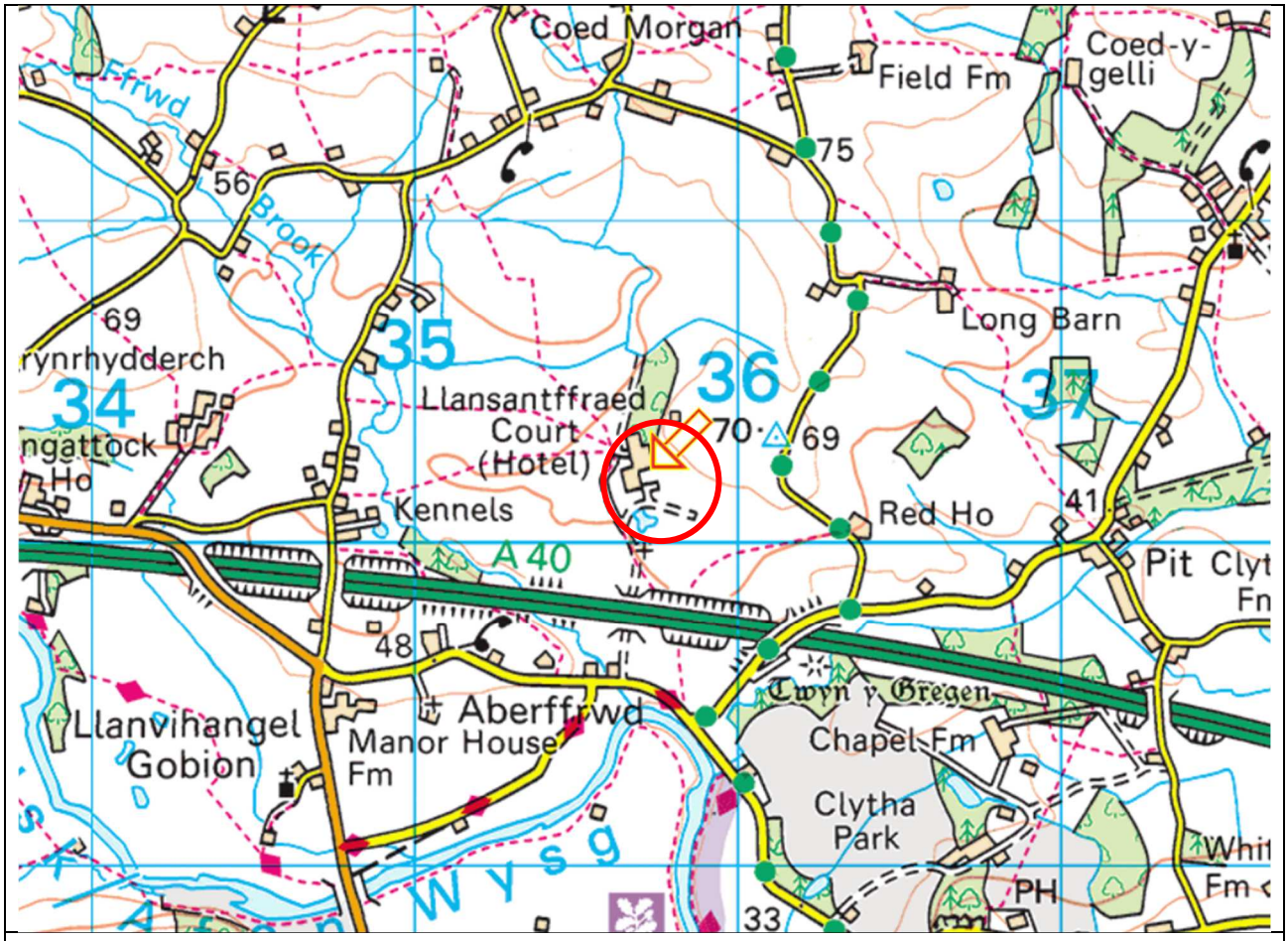
Some water treatment equipment effluents e.g. softeners, chlorinated backwashes may not be acceptable; system designers should specifically accept or exclude their use. Many treatment system designs will accept regenerants into their units, however this must be checked and agreed.

A policy of using detergents with low phosphates is to be provided by the Client.

REFERENCES

- British Waterways Code of practice - Sizing Criteria, Treatment Capacity for Sewage Treatment Systems
- NRW - Advice to planning authorities for planning applications affecting phosphorus sensitive river Special Areas of Conservation
- Lle Interactive Map – Nearest Special Area of Conservation and Sites of Special Scientific Interest (see appendix C)
- Welsh Water Drainage Maps
- EN12566 – Wastewater treatment plant systems
- BS6297:2007 - Code of practice for the design and installation of drainage fields for use in wastewater treatment
- GibbsGeoTechnical Report – Site infiltration values
- Metcalf & Eddy 2014 – Wastewater Engineering

APPENDIX 1 – Site Location Plan



Site Location Plan

APPENDIX 2 – Welsh Water Map

Dŵr Cymru
Welsh Water

1 sant ffrae Llanover Monmouthshire NP7 9BA

N
W E
S

LEGEND(Representative of most common features)

Waste network:

	Foul chamber		Outfall
	Surface water chamber	LH	Lamphole
	Combined chamber		Storm Overflow
	Combined sewer overflow		Rising main
	Special purpose chamber		Gravity sewer
	Treatment works		Private sewer
	Pumping station	S 104	Private sewer subject to Sect. 104 adoption agreement
			Private Sewer Transfer
			Lateral Drain
			Inspection Chamber

NB: Sewer symbol colour indicates the type.

RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former S24 sewers (for indicative purposes only)

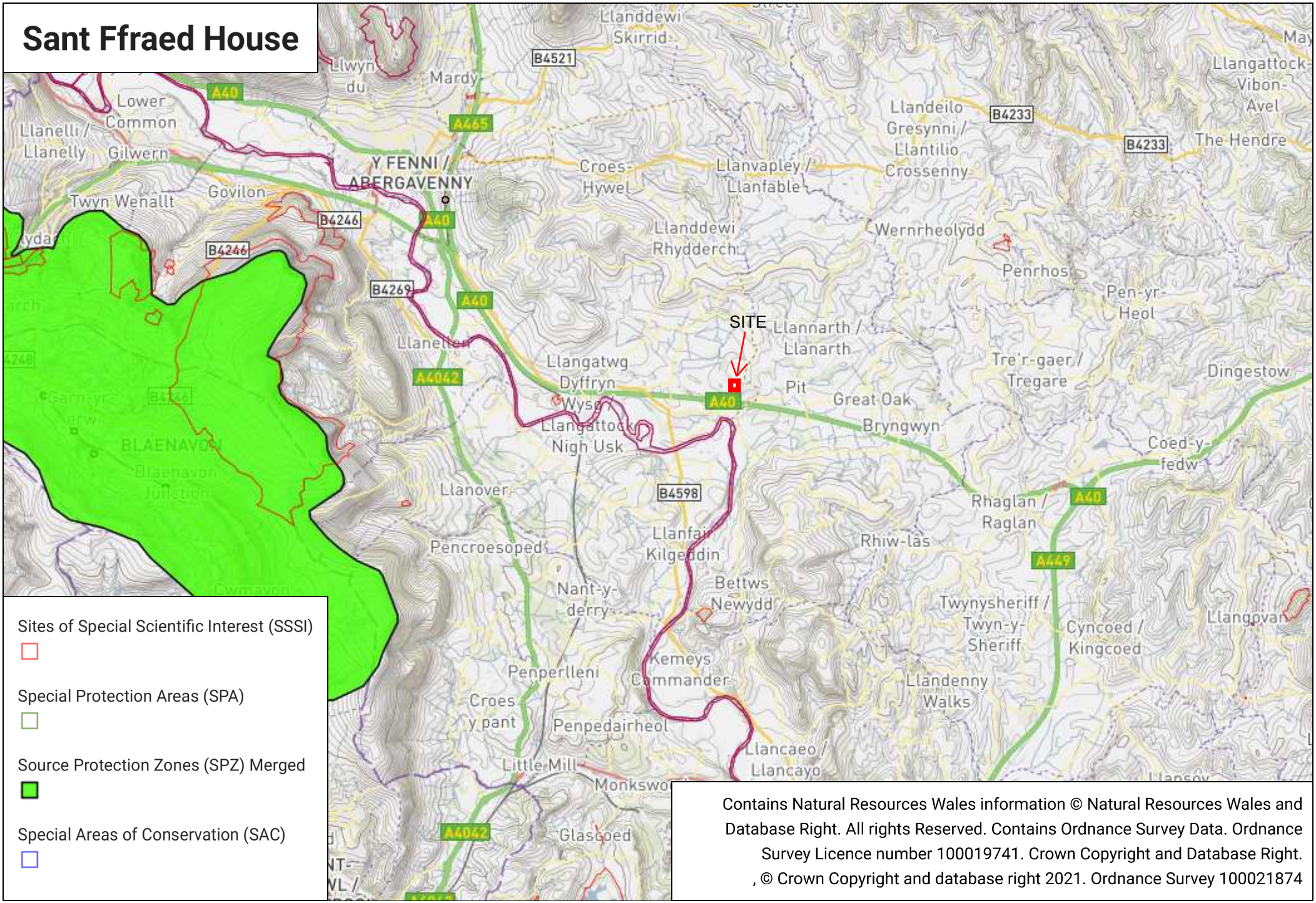
Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases, pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF) . It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Map Ref:	335865,210795
Map scale:	1:4950
Printed by:	Zara Howells
Printed on:	19 Oct 2021

APPENDIX 3 – Lle Environmental Map SPZ, SSSI and SAC Plan

Sant Ffraed House



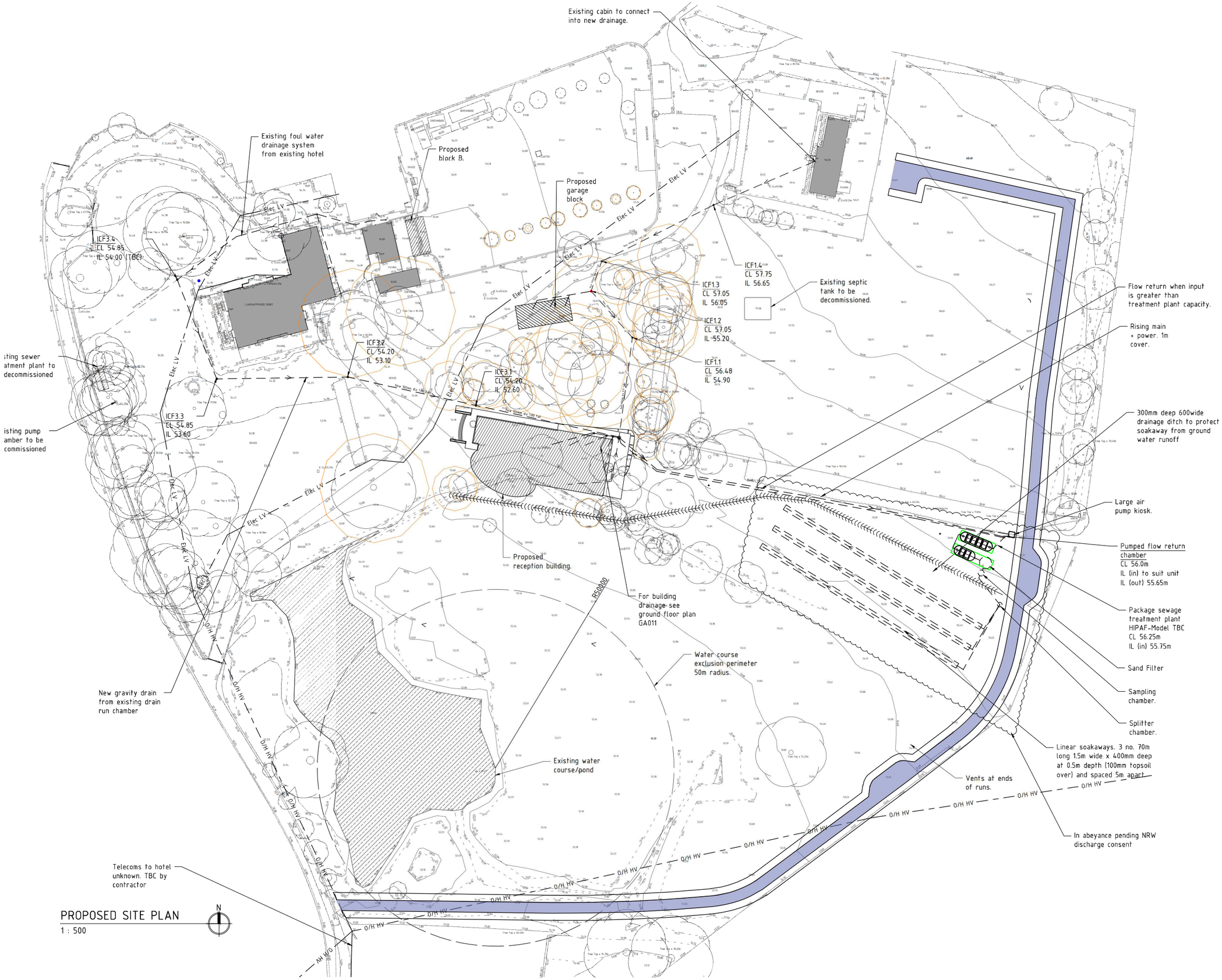
Sites of Special Scientific Interest (SSSI)

Special Protection Areas (SPA)

Source Protection Zones (SPZ) Merged

Special Areas of Conservation (SAC)

APPENDIX 4 – Proposed Site Plan



PROPOSED SITE PLAN

1 : 500

Notes:

This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification. This drawing should not be scaled. All dimensions are to be verified by the contractor on site. All discrepancies should be reported to the C.A. prior to the commencement of the works. Only drawings with 'CONSTRUCTION' status are to be used for construction.

DRAINAGE KEY:

SEWERS		
Private Foul Water Sewer		
Private Surface Water Sewer		
Private Combined Water Sewer		
Rising main		
Non-operational (To be abandoned)		
CONNECTION POINTS	**Foul**	**Surface**
Rainwater pipe		RWP
Soil & Vent Pipe	SVP	
Stub Stack	SS	
Soil pipe+air admittance valve	AAV	
Back Drop	BD	RD
Back inlet gully	BIG	
Gully		G
Roddable Gully		RG
Channel drain		Ch
ACCESS POINTS	**Foul**	**Combined**	**Surface**
Rodding Eye	RE	RE	RE
IC-Type 4 - 225x100mm / 180Ø	F	C	S
IC-Type 3 - 450x450mm / 450Ø	F	C	S
MH-Type 1 / 2 - PCC ring Manhole	F	C	S
IC-Type 3 - Slit Trap			S
Others			
Outfall			
Pumping Station			
Package Treatment Plant			
Radon sump and pipe		PS	
Cellular Storage (non-filtration)			
Soakaway (filtration)			
Water Butt		WB	

03/02/22	C03	Drainage general updates	CS	KP
27/01/22	C02	General updates	CS	KP
14/01/22	C01	Issued for construction	CS	KP
10/01/22	T04	Hotel drainage taken to new drainage treatment plant	CS	KP
10/01/22	T03	Drainage field amended	CS	KP
05/01/22	T02	Drawing number amended	CS	KP
21/12/21	T01	Levels Added	CS	KP
14/12/21	P02	Drainage field edged in green	CS	KP
04/11/21	P01	Issue for Information	CS	KP
DATE:	REV.	DESCRIPTION:	DRWN:	CHKD.

kPa Consulting Engineers Ltd

ADDRESS: Henbury Cottage, Southgate Road, Southgate Swansea SA3 2BT
TELEPHONE: 01792 456 577
ONLINE: www.kpaconsulting.co.uk

PROJECT:

SNACO UK LIMITED
Sant Ffraed House,
Abergavenny.
NP7 9BA

TITLE:

Proposed Site Plan

STATUS:

CONSTRUCTION

SCALE:	DATE:	DRAWN:	CHECKED:
1:500@A1	DEC'21	CS	KP

JOB No:	DRG No:	REV:
477-07	GA002	C03

APPENDIX 5 – Proposed Packaged Treatment Plant

A WCS Group Company

WPL HiPAF®

High performance aerated filter packaged wastewater treatment plants

Commercial wastewater treatment for demanding applications

Over 2,000 WPL HiPAF packaged sewage treatment plants have been installed where mains drainage is unavailable. Models are available to suit levels of pollution for 1 person up to 2,000 population equivalent (PE).

WPL HiPAF Range

Regularly specified by the highly regulated UK water utilities, the WPL HiPAF range meets stringent European environmental discharge consent standards. This makes our products the preferred choice for sensitive locations such as Sites of Special Scientific Interest (SSSI).

With biological treatment, stricter standards can be achieved, meeting Biological Oxygen Demand (BOD^5) 10mg/l; Suspended Solids (SS) 10mg/l; Ammoniacal Nitrogen (NH_4-N) 2mg/l (with tertiary treatment). Higher standards are achievable.

Our packaged plants can be design engineered to operate efficiently based on seasonal variations in loadings often experienced by hotels, caravan parks and cafés. Higher pollution loads and site expansion can be accommodated by adding WPL HiPAF modules.

The WPL HiPAF options depending on application parameters and population size:

- **Compact – 1 to 60 PE**
- **Midi – up to 300 PE**
- **Modular – up to 2,000 PE**
- **Larger bespoke systems available on request**

Each wastewater treatment plant includes primary settlement, biological treatment and final settlement processes, with custom design options available for larger applications. All models are manufactured in glass-reinforced plastic (GRP) which is UV stabilised with an external gel coat finish which extends asset life to 25 years.

The WPL HiPAF systems are installed below-ground, however WPL offer alternative above-ground equipment if required.

WPL Support

All WPL HiPAF solutions are backed by our continued support for the life of the project. With unrivalled specialist capabilities, we supply technical information and drawings; offering any additional assistance if required. This is to ensure a wastewater treatment solution that works effectively and efficiently, with minimal impact on the day to day running of businesses.

Optimum wastewater treatment performance

Features and Benefits:

Ease of installation

- Modular plants enable access and installation at space restricted sites
- Overall compact design minimises excavation required offering small footprint and lower installation costs

Low maintenance

- No internal mechanical or electrical moving parts
- Optional low energy compressors with adjustable timers
- Midi and modular plants have the option of isolating and removing air distribution within the biological section for ease of maintenance
- Tankering made easier because primary sludge and humus are stored together

Ease of access for maintenance

- Midi and modular plants have the option of large access lids for safe, clean, accessible air diffuser system maintenance

Robust process

- Proven WPL technology based on over 25 years empirical data
- Rectangular shape of the midi and modular plants reduces dead zones
- Use of high quality blowers and pumps underpins reliability of the plant

Energy efficiency

- Optional duty-standby blower arrangement is designed to provide process air; additional scour is provided by the secondary blower when required, reducing energy use
- Variable speed drives can be used to optimise power use

Variable flows and loads

- The unique design of the flow balancing in the primary tank means it can cope with variable flows and loads making it ideal for caravan sites and other seasonal venues

Minimal visual impact

- Below ground installation means the plant does not impede views of the landscape
- Discreet for use in tourist and leisure applications

Compliant

- Fully compliant with UK Building Regulations and Environment Agency guidelines
- WPL uses British Water's Code of Practice - Flows & Loads
- The compact plant is designed and manufactured to BS EN 12566-3. The midi and modular plants are designed in accordance with BS EN 12255 – 1/15 and manufactured using BS 4994 as a guide. WPL HiPAF treatment plants are CE marked where applicable

Three-stage system for safer processing

Each WPL HiPAF treatment plant includes a three-stage process - primary settlement, biological treatment (biozone) and final settlement. The segmented biozone process chambers in stage two eliminate the risk of process short-cuts and mitigates risks associated with variable loads.

Stage 1

Primary settlement

- Incoming wastewater enters the primary settlement stage where organic and inorganic matter settles
- The sludge is held in this section until it requires de-sludging
- A unique forward-feed arrangement uses an airlift to deposit wastewater into the biological treatment stage (biozone), which keeps peak flows from entering the system and prevents hydraulic surges

Stage 2

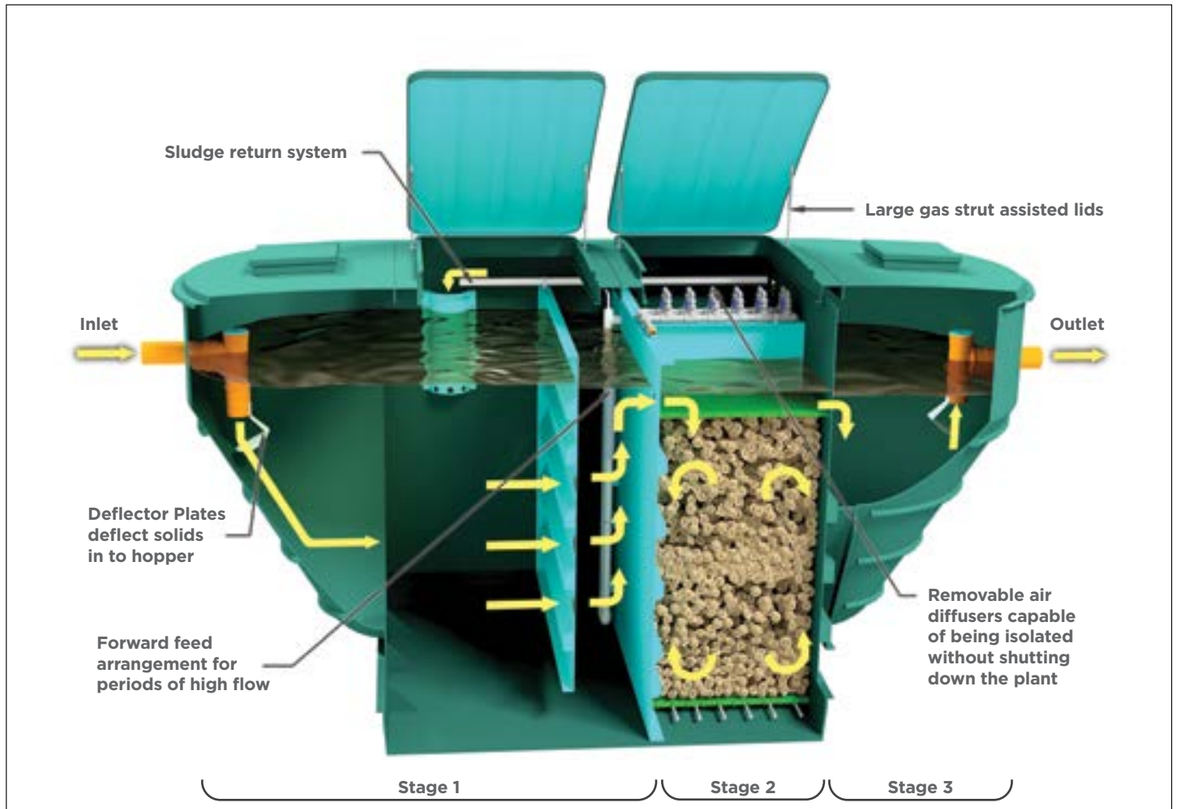
Biological treatment

- Settled liquor enters the biological section either by displacement or via the airlift
- High-voidage plastic media, contained between two floors within the biozone, encourages the growth of bacteria and other organisms which treat the wastewater
- Air required for the treatment process is delivered by air-blowers housed in a weatherproof kiosk
- The air also helps to scour the media bed, preventing the filter from blocking
- A series of diffusers installed beneath the media bed ensure an even distribution of air

Stage 3

Final settlement

- The treated wastewater (final effluent) enters the final settlement section
- Dead biomass (humus sludge) from the process settles out
- An airlift automatically transfers settled humus sludge back to the primary settlement section for co-settlement
- The final effluent is discharged through gravity displacement to either a watercourse or a sub-surface irrigation field



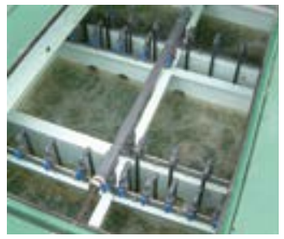
WPL HiPAF midi packaged sewage treatment plant illustration (above)

Internal Configuration

The internal sections of the plant can be accessed from the top of the unit to make servicing, maintenance and de-sludging easier. Plants are fitted-as-standard with large, stainless steel, gas strut assisted lids to give full access to the relevant parts of the plant.

Air is introduced to the WPL HiPAF unit by a series of air diffusers. Each diffuser is capable of being isolated and removed individually without the need to shut down the plant or affect air supply to the rest of the unit.

The complete absence of mechanical and electrical components within the hostile environment provides safe and clean working conditions on site.



Internal air diffusers (left) and large gas strut lids (right)

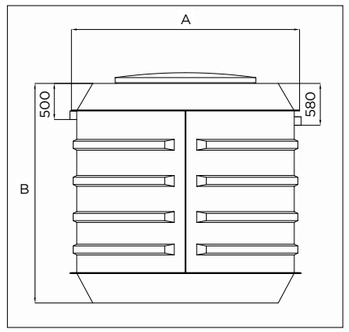
Technical Specification

Use the tables below as an indicative guide to selecting the right packaged treatment plant for your site. For advice on the modular system or more information on the range please contact WPL or a qualified contractor.

WPL HiPAF compact system 1 to 60 PE

Model PE	Standard Consent*	A Diameter (m)	B Height (m)	Inlet Invert (mm)	Outlet Invert (mm)
10	20:30:20	2.32	2.64	500	580
20	20:30:20	2.32	2.80	500	580
30	20:30:20	2.61	2.70	500	580
40	20:30:20	2.86	2.70	500	580
50	20:30:20	3.20	3.00	500	580
60	20:30:20	3.20	3.20	500	580

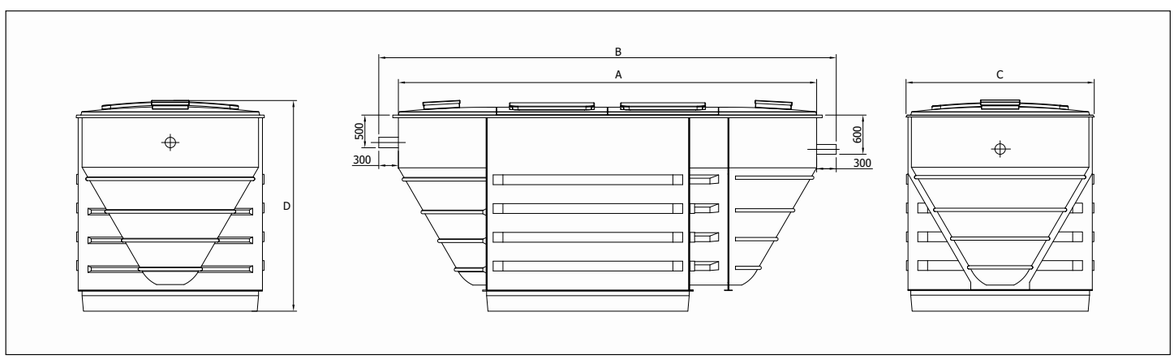
*Typical consent standards shown, tighter consent standards available to meet all requirements specified by the EA



WPL HiPAF midi system 60 to 300 PE

Model PE	Standard Consent**	A Length (m)	B Length w/pipes (m)	C Width (m)	D Height (m)	Inlet Invert (mm)	Outlet Invert (mm)	Weight (Tonne)
70	20:30:20	4.30	4.90	2.88	3.20	500	600	1.60
90	20:30:20	4.80	5.40	2.88	3.20	500	600	1.90
110	20:30:20	5.20	5.80	2.88	3.20	500	600	2.25
130	20:30:20	5.80	6.40	2.88	3.20	500	600	2.50
150	20:30:20	6.40	7.00	2.88	3.20	500	600	2.90
175	20:30:20	7.00	7.60	2.88	3.20	500	600	3.40
200	20:30:20	7.60	8.20	2.88	3.20	500	600	3.90

** Typical consent standards shown – tighter consent standards available to meet all requirements specified by the EA. For options above 200PE please contact WPL.



The tables are an indicative guide only. All applications are specified to comply with the British Water Code of Practice for Flows and Loads. Further technical information can be found on the WPL website, visit www.wplinternational.com.

WPL offers a complete in-house design and specification service. Each packaged treatment plant can be designed to site-specific requirements.

Each system is supplied with an installation manual and an operation and maintenance manual. Civil installation of the units can be arranged through a WPL recommended contractor.

WPL suggests that maintenance should only be undertaken by a reputable service company with British Water accredited service engineers.

Design parameters

Design Criteria	British Water's Flows and Loads 4
Peak flow treatment	Generally 3 dry weather flow
Invert depth	0.5m as standard, other invert depths available up to 1.5m
Discharge standards	The WPL HiPAF will typically attain BOD^5 20mg/l; SS 30mg/l; NH_4-N 20mg/l as standard. With biological treatment, stricter standards can be achieved, meeting BOD^5 10mg/l; SS 10mg/l; NH_4-N 2mg/l (with tertiary treatment). Higher standards are achievable. With the use of additional equipment WPL can produce effluent to meet phosphate standards when required.

Design options

- Inverts up to 1.5m with turret extensions
- Pumped inlet flow control
- Control panels are available to cater for single and three phase electrical supplies
- Alarm beacon for mechanical failure and loss of air pressure
- Duty/standby blowers with automatic changeover to ensure an uninterrupted air supply
- Energy-saving options such as variable speed drive blowers
- GSM telemetry for remote monitoring of the plant
- WPL Sand Filters/WPL Micro-screens can improve final effluent for strict consent requirements

Kiosk Options

Each WPL HiPAF treatment plant comes with a weatherproof kiosk to house the control panel and air blowers on site. The standard issue kiosk, which is acoustically-lined, houses a control panel, which automatically manages the operation of the plant; the air distribution manifold and one or more air blowers as required.

Features include thermostatic cut-off controls and air filtering monitoring which can alert the operator to loss of air pressure. Ten metres of high temperature resistant airline hose is supplied to connect blowers to the treatment plant – extra lengths can be supplied if the kiosk is sited further than 10m from the treatment unit.

Case Studies

Holiday Park treatment tackles seasonal flows

An existing sewage treatment plant located at the foot of the Quantock Hills in Somerset needed replacing. It was important to find a robust and reliable treatment for the static caravans and chalets on-site.

The Environment Agency stipulated the treated effluent quality, which is released into the historic bay of St Audries, should achieve a maximum of 40mg/l biochemical oxygen demand (BOD) and 60mg/l suspended solids (SS).

WPL HiPAF tanks were installed below ground. A two way flow splitter, installed between the HiPAFs and the primary tank separates the effluent into parallel streams, allowing the operators to switch between the two HiPAF systems or to use both at once, subject to load.

As the treatment site was close to a number of static caravans, it was important to create a replacement plant which was low on noise and odour. The Nethercott family, who own the Home Farm Holiday Centre, wanted the installation to take place with as little disruption to the natural environment as possible.

Dibby Nethercott, one of the owners said:

"The new treatment plant fulfils our requirement in that it is quiet when in operation and treats effluent to a high environmental standard."

Population equivalent: 1000
Consent: 40mg/l BOD^5 and 60mg/l SS
Design flow rate: 155.4m^3/day and 5.4l/sec peak flow

Discreet package treatment installed at English whisky distillery

When it came to choosing a package sewage treatment plant for The Lakes Distillery on the banks of Lake Bassenthwaite, it was important to find a model which could blend into the stunning rural setting and also treat wastewater to the highest environmental standards.

WPL HiPAF midi was chosen and fitted as the new distillery was taking shape. Treated water from the plant will be discharged into the River Derwent, which is a site of special scientific interest (SSSI), meaning pollutants have to be thoroughly removed from wastewater to meet statutory regulations.

The below ground WPL HiPAF midi can be controlled in such a way to guarantee removal of organic pollutants and total nitrification to meet surface water discharge consents even in SSSI's.

Managing director of The Lakes Distillery Paul Currie said:

"Our distillery is building a reputation as one of the greenest in the world, so it was important for every part of our renovation and building work to be carried out to the highest possible environmental standards."

The lakes which is at the heart of the Lake District National Park will produce a million bottles of English malt a year and expects to welcome 55,000 visitors annually.

Population equivalent: 177
Consent: 20mg/l BOD^5; 30mg/l SS; 20mg/l NH_4-N
Design flow rate: 10.2m^3/day flow and 0.35 l/sec peak flow

Northumberland National Park visitor centre selects WPL package treatment

A prestigious new visitor centre in the heart of Northumberland National Park has benefitted from a specially designed package plant from WPL. The Sill National Landscape Discovery Centre, a ₸14.2m joint project between the National Park and the Youth Hostel Association, has been built with the help of ₸8m from the Heritage Lottery Fund.

The treated effluent at the site is released into a natural stream while sludge is periodically tankered to an offsite wastewater treatment works. It was very important to supply back-up blowers and to enable the facility to connect a generator in the event of a power failure. The package plant comprises of two modular high performance aerated filter – HiPAF – units, a primary settlement tank to separate solids and a submerged aerated filter (SAF) tank for biological treatment. WPL have also supplied an extra-large, glass-reinforced plastic control kiosk.

Stuart Evans, Sill Project Director of Northumberland National Park said:

"The Sill will be much more than a visitor attraction – it will enable us to reconnect with our landscapes and our heritage. It is important that we seek the highest environmental standards in all our construction and operational activity to minimise disruption to the natural beauty of the area."

Population equivalent: 500
Consent: 20mg/l BOD^5; 30mg/l SS; 10mg/l NH_4-N
Design flow rate: 40m^3/day flow and 1.39 l/sec peak flow

Sewage treatment upgrade at remote historic site

A celebrated historic site on an island in the Orkney archipelago needed to upgrade its wastewater treatment plant; ensuring its replacement was able to cope with wildly fluctuating flows and extreme weather conditions. Whether coping with the impact of thousands of visitors during the summer or surviving the vagaries of the Orkney winter, the new compact treatment plant would be serving visitors to the Neolithic treasure for years to come.

A huge increase in the numbers of cruise ship visitors was one of the main reasons that the original WPL HiPAF system needed to be replaced. The previous plant was installed in 1997 when the Visitor Centre was first built and over the sixteen year time period, gave very few problems - which is why its engineers were happy to install a new WPL system to replace it.

The original plant was re-purposed to create an overflow tank by removing the internal equipment. This tank can now be used for storage should effluent pass a certain level in the event of prolonged power failure in extreme winter weather conditions.

Despite the technical challenges, the compact nature of the plant meant it could be transported and installed with minimum disruption to the daily running of the visitor centre.

Population equivalent: 500
Consent: 20mg/l BOD^5; 30mg/l SS; 20mg/l NH_4-N
Design flow rate: 19.4m^3/day flow and 0.67l/sec peak flow

Case Studies

Premier treatment for Swansea City's New Training Centre

The success of Premier League football team Swansea City on the pitch has been matched by the remarkable transformation of the club's new Fairwood training centre. Modernisation of the facility, which is leased from the University of Swansea, included building eight full-size pitches, changing facilities, offices, seminar rooms, a canteen and specialist medical and physiotherapy rooms.

Importantly, to accommodate the impressive new buildings and a significant increase in activity at the site, extra sewage treatment processing was also required. In view of the prestigious, public nature of the site, the installation needed to be wholly reliable, and discreet. The existing gravity-fed trickling filter plant, while meeting discharge consents, was too basic to accommodate the new demands. Further, the location of the legacy plant, in a wooded area 150m from the facility, also made it difficult to service and maintain.

The WPL HiPAF midi plant suits a usage of 60-300 people and can easily handle the variable pattern of usage to be expected at a state of the art premier league training facility.

Population equivalent: 300
Consent: 20mg/l BOD^5; 30mg/l SS; 20mg/l NH_4-N
Design flow rate: 11.1m^3/day flow and 0.39l/sec peak flow

Yorkshire Water installed WPL HiPAF® in rural village

Yorkshire Water installed a customised sewage treatment plant produced by WPL in the scenic, rural village of Appletreewick, in the Yorkshire Dales. The WPL HiPAF modular packaged treatment plant was used to replace the current system. The customised wastewater treatment system is designed to meet site specific requirements for up to 300 population equivalent and adheres to the Yorkshire Water assets standards.

Due to the aesthetics of both the village and the surroundings, minimal visual impact of the product was required. The WPL HiPAF modular is completely below ground, meaning that it does not impede the scenic views of the Yorkshire Dales and requires only a small excavation. A factor that had to be considered was the site's highly variable flow rate increases due to surface water ingress. At the Appletreewick site, the peak flow can reach levels over 20 times that of the dry weather flow. Flow retention within the primary, SAF (biozone) and humus tanks means that the WPL HiPAF modular "Off-site built" plant can cope with variable flows and loads, a key benefit of this particular system.

Population equivalent: 300
Consent: 40mg/l BOD^5 and 60mg/l SS
Design flow rate: 671m^3/day flow and 7.76l/sec peak flow

About WPL

WPL have been at the forefront of wastewater treatment technology for over 30 years, with international experience of technical design, quality of manufacture and supply of environmental wastewater solutions. Our high level of expertise means that we offer all of our customers, from the individual homeowner to large municipal communities and industrial markets, robust wastewater treatment process solutions that are environmentally compliant.

In January 2021, WPL joined the WCS Environmental Engineering Division that forms part of Marlowe's grouping of water and air industry. Marlowe is a UK leader in specialist services that ensure safety and regulatory compliance.

WPL
Unit 1 Aston Road
Waterlooville
Hampshire
PO7 7UX
United Kingdom

Tel: +44 (0)23 9224 2600
Email: enquiries@wpl.co.uk
Web: wpldiamond.com

Disclaimer

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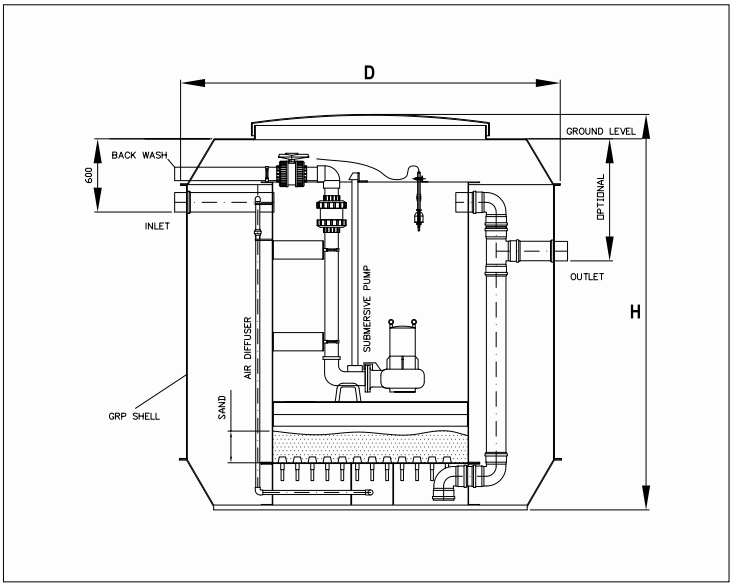
WPL SAND FILTER

TECHNICAL DATASHEET

Designed to remove excess suspended solids (SS) and biological oxygen demand (BOD) from wastewater treatment plants. The WPL sand filter meets stringent discharge consent standards above what is normally expected from a biological process or an industry standard clarifier.

KEY FEATURES:

- **Dependent on particle size, a minimum removal of 60%SS and 40%BOD**
- **Timed backwash sequence combines air scour and backwash**
- **Influent can flow by gravity or pumped into the filter**
- **No need to inhibit inflow to filter during backwash cycle**
- **Above and below ground installations**



Model	Population Equivalent (PE)	Max. flow (m3/day)	Filter area (m2)	Tank diameter "D" (m)	Tank height "H" (m)	Backwash flow required (m3/h)	Pumps flow (m3/h)	Air volume (m3/h) (backwash)
VSF01	93	42	0.28	1.740	3.150	10.2	18	20.4
VSF02	266	120	0.79	2.610	3.150	28.3	36	56
VSF03	400	180	1.33	2.860	3.150	47.8	42	95
VSF04	800	360	2.01	3.110	3.150	72.4	81	145

APPENDIX 6 – Linear Infiltration Trench Design

Flood Routing through Storage Facility

Event: Input Hydrograph

Time (mins)	Level (m)	Depth (m)	Σ Inflow (l/s)	Filtration (l/s)	Volume (m³)
60	0.018	0.018	1.0	0.1	1.6
120	0.052	0.052	1.0	0.2	4.7
180	0.083	0.083	1.0	0.2	7.4
240	0.113	0.113	1.0	0.2	10.1
300	0.143	0.143	1.0	0.3	12.8
360	0.162	0.162	0.5	0.3	14.6
420	0.172	0.172	0.5	0.3	15.4
480	0.175	0.175	0.2	0.3	15.7
540	0.172	0.172	0.2	0.3	15.5
600	0.170	0.170	0.2	0.3	15.3
660	0.163	0.163	0.0	0.3	14.7
720	0.152	0.152	0.0	0.3	13.7
780	0.142	0.142	0.0	0.3	12.8
840	0.132	0.132	0.0	0.3	11.9
900	0.122	0.122	0.0	0.3	10.9
960	0.112	0.112	0.0	0.2	10.0
1020	0.102	0.102	0.0	0.2	9.2
1080	0.092	0.092	0.0	0.2	8.3
1140	0.082	0.082	0.0	0.2	7.4
1200	0.073	0.073	0.0	0.2	6.5
1260	0.063	0.063	0.0	0.2	5.7
1320	0.054	0.054	0.0	0.2	4.8
1380	0.045	0.045	0.0	0.2	4.0
1440	0.037	0.037	0.0	0.2	3.4
1500	0.031	0.031	0.0	0.1	2.8
1560	0.044	0.044	1.0	0.2	4.0
1620	0.075	0.075	1.0	0.2	6.8
1680	0.105	0.105	1.0	0.2	9.5
1740	0.135	0.135	1.0	0.3	12.2
1800	0.165	0.165	1.0	0.3	14.8
1860	0.184	0.184	0.5	0.3	16.6
1920	0.193	0.193	0.5	0.3	17.4
1980	0.196	0.196	0.2	0.3	17.7
2040	0.194	0.194	0.2	0.3	17.4
2100	0.191	0.191	0.2	0.3	17.2
2160	0.184	0.184	0.0	0.3	16.5
2220	0.173	0.173	0.0	0.3	15.6
2280	0.162	0.162	0.0	0.3	14.6
2340	0.152	0.152	0.0	0.3	13.7
2400	0.142	0.142	0.0	0.3	12.7
2460	0.131	0.131	0.0	0.3	11.8
2520	0.121	0.121	0.0	0.3	10.9
2580	0.111	0.111	0.0	0.2	10.0
2640	0.101	0.101	0.0	0.2	9.1
2700	0.091	0.091	0.0	0.2	8.2
2760	0.082	0.082	0.0	0.2	7.4
2820	0.072	0.072	0.0	0.2	6.5
2880	0.063	0.063	0.0	0.2	5.7

Flood Routing through Storage Facility

Event: Input Hydrograph

Time (mins)	Level (m)	Depth (m)	Σ Inflow (l/s)	Filtration (l/s)	Volume (m³)
2940	0.073	0.073	1.0	0.2	6.6
3000	0.104	0.104	1.0	0.2	9.3
3060	0.134	0.134	1.0	0.3	12.0
3120	0.163	0.163	1.0	0.3	14.7
3180	0.192	0.192	1.0	0.3	17.3
3240	0.211	0.211	0.5	0.3	19.0
3300	0.220	0.220	0.5	0.3	19.8
3360	0.223	0.223	0.2	0.3	20.1
3420	0.220	0.220	0.2	0.3	19.8
3480	0.217	0.217	0.2	0.3	19.5
3540	0.209	0.209	0.0	0.3	18.8
3600	0.198	0.198	0.0	0.3	17.9
3660	0.187	0.187	0.0	0.3	16.9
3720	0.177	0.177	0.0	0.3	15.9
3780	0.166	0.166	0.0	0.3	14.9
3840	0.155	0.155	0.0	0.3	14.0
3900	0.145	0.145	0.0	0.3	13.1
3960	0.135	0.135	0.0	0.3	12.1
4020	0.125	0.125	0.0	0.3	11.2
4080	0.115	0.115	0.0	0.3	10.3
4140	0.105	0.105	0.0	0.2	9.4
4200	0.095	0.095	0.0	0.2	8.5
4260	0.085	0.085	0.0	0.2	7.7
4320	0.075	0.075	0.0	0.2	6.8
4380	0.066	0.066	0.0	0.2	5.9
4440	0.076	0.076	1.0	0.2	6.9
4500	0.107	0.107	1.0	0.2	9.6
4560	0.137	0.137	1.0	0.3	12.3
4620	0.166	0.166	1.0	0.3	15.0
4680	0.195	0.195	1.0	0.3	17.6
4740	0.214	0.214	0.5	0.3	19.3
4800	0.223	0.223	0.5	0.3	20.1
4860	0.226	0.226	0.2	0.3	20.3
4920	0.223	0.223	0.2	0.3	20.0
4980	0.219	0.219	0.2	0.3	19.7
5040	0.212	0.212	0.0	0.3	19.1
5100	0.201	0.201	0.0	0.3	18.1
5160	0.190	0.190	0.0	0.3	17.1
5220	0.179	0.179	0.0	0.3	16.1
5280	0.169	0.169	0.0	0.3	15.2
5340	0.158	0.158	0.0	0.3	14.2
5400	0.148	0.148	0.0	0.3	13.3
5460	0.137	0.137	0.0	0.3	12.4
5520	0.127	0.127	0.0	0.3	11.4
5580	0.117	0.117	0.0	0.3	10.5
5640	0.107	0.107	0.0	0.2	9.6
5700	0.097	0.097	0.0	0.2	8.7
5760	0.087	0.087	0.0	0.2	7.9

Flood Routing through Storage Facility

Event: Input Hydrograph

Time (mins)	Level (m)	Depth (m)	Σ Inflow (l/s)	Filtration (l/s)	Volume (m³)
5820	0.078	0.078	0.0	0.2	7.0
5880	0.068	0.068	0.0	0.2	6.1
5940	0.059	0.059	0.0	0.2	5.3
6000	0.050	0.050	0.0	0.2	4.5
6060	0.041	0.041	0.0	0.2	3.7
6120	0.034	0.034	0.0	0.2	3.1
6180	0.028	0.028	0.0	0.1	2.6
6240	0.024	0.024	0.0	0.1	2.1
6300	0.020	0.020	0.0	0.1	1.8
6360	0.016	0.016	0.0	0.1	1.5
6420	0.014	0.014	0.0	0.1	1.2
6480	0.011	0.011	0.0	0.1	1.0
6540	0.009	0.009	0.0	0.0	0.8
6600	0.008	0.008	0.0	0.0	0.7
6660	0.006	0.006	0.0	0.0	0.6
6720	0.005	0.005	0.0	0.0	0.5
6780	0.004	0.004	0.0	0.0	0.4
6840	0.004	0.004	0.0	0.0	0.3
6900	0.003	0.003	0.0	0.0	0.3
6960	0.003	0.003	0.0	0.0	0.2
7020	0.002	0.002	0.0	0.0	0.2
7080	0.002	0.002	0.0	0.0	0.2
7140	0.001	0.001	0.0	0.0	0.1
7200	0.001	0.001	0.0	0.0	0.1

Summary of Results for Input Hydrograph

Half Drain Time : 638 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
Input Hydrograph	0.226	0.226	0.3	20.3	O K

Storm Event	Flooded Volume (m³)	Time-Peak (mins)
Input Hydrograph	0.0	4860

Input Hydrograph

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
60	1.0	1020	0.0	1980	0.2	2940	1.0	3900	0.0	4860	0.2
120	1.0	1080	0.0	2040	0.2	3000	1.0	3960	0.0	4920	0.2
180	1.0	1140	0.0	2100	0.2	3060	1.0	4020	0.0	4980	0.2
240	1.0	1200	0.0	2160	0.0	3120	1.0	4080	0.0	5040	0.0
300	1.0	1260	0.0	2220	0.0	3180	1.0	4140	0.0	5100	0.0
360	0.5	1320	0.0	2280	0.0	3240	0.5	4200	0.0	5160	0.0
420	0.5	1380	0.0	2340	0.0	3300	0.5	4260	0.0	5220	0.0
480	0.2	1440	0.0	2400	0.0	3360	0.2	4320	0.0	5280	0.0
540	0.2	1500	0.0	2460	0.0	3420	0.2	4380	0.0	5340	0.0
600	0.2	1560	1.0	2520	0.0	3480	0.2	4440	1.0	5400	0.0
660	0.0	1620	1.0	2580	0.0	3540	0.0	4500	1.0	5460	0.0
720	0.0	1680	1.0	2640	0.0	3600	0.0	4560	1.0	5520	0.0
780	0.0	1740	1.0	2700	0.0	3660	0.0	4620	1.0	5580	0.0
840	0.0	1800	1.0	2760	0.0	3720	0.0	4680	1.0	5640	0.0
900	0.0	1860	0.5	2820	0.0	3780	0.0	4740	0.5	5700	0.0
960	0.0	1920	0.5	2880	0.0	3840	0.0	4800	0.5	5760	0.0

Model Details

Storage is Online Cover Level (m) 0.400

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00520	Trench Width (m)	1.5
Infiltration Coefficient Side (m/hr)	0.00520	Trench Length (m)	200.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000

Event: Input Hydrograph