

Whitehouse Farm Discharge

Treated Dairy Effluent Discharge – Environmental Risk Assessment

Wyke Farm Limited

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Contents

1 Introduction 1

1.1 Report Objectives 1

1.2 Existing Permit Conditions 1

2 Effluent Type and Treatment..... 2

2.1 Treatment Process 2

2.2 Effluent Quality..... 3

3 Discharge Route and Site Setting 6

4 River Brue 9

4.1 River Flow Rate..... 9

4.2 Water Quality..... 10

5 Effects of Mixing 12

5.1 Introduction..... 12

5.2 Step 1 Comparison with EQS 13

5.3 Process Contribution and Predicted Environmental Concentration Calculations..... 13

5.4 River Mixing Sensitivity Analysis 14

5.5 Predicted Environmental Concentration 16

6 Summary and Conclusion..... 19

Appendix A Process Flow DiagramA

1 Introduction

1.1 Report Objectives

This report has been prepared by Byrne Looby Partners (UK) Ltd (formerly TerraConsult) on behalf of Wykes Farms Ltd as part of a variation application to support the continued development of the Wyke Farmhouse Cheese creamery at Whitehouse Farm, Wyke Champflower, Bruton, Somerset, BA10 0PU. Specifically this assessment has been prepared to describe and discuss the effluent being treated and discharged from the activities permitted under Environmental Permit EPR/BQ1824IV/V003, dated 02/12/2013.

The existing facility is permitted for the discharge of up to 750m³/day of effluent. The variation being applied for is to increase this volume to 1,500m³/day, which would be discharged at the same location as the existing consent into the stretch of the River Brue between the confluence with the River Pitt at Cole (approximately 1km upstream) and the confluence with the River Alham 5km downstream of the discharge (Figure 1).

Figure 1 Permitted Facility and Discharge to River Brue Location



The effluent being produced is from food production and therefore harmful / hazardous chemicals are prohibited from the production process. However, as a milk-based product there is a high organic content to the effluent which must be treated prior to discharge. It is the treated effluent which is being discharged. This effluent has previously been determined as suitable for discharge by the Environment Agency when issuing the original permit. The permitted effluent volume at that time was proportional to the throughput of the facility, and therefore an increased discharge volume is required in proportion to the increased production at the site.

1.2 Existing Permit Conditions

Emission limits to water are set in Table 2.2.5 and Table 2.2.6 of the permit as summarised in Table 1 below.

Table 1 Permit BQ1824IV Tables 2.2.5 and 2.2.6 Emission Limit Conditions

Parameter	Limit	Frequency	Proposed Change
Flow	750m ³ /day 32.35m ³ /hr	Continuous Continuous	1,500m ³ /day 65m ³ /hr
pH	6.0 – 9.0 (between)	Daily	
Suspended Solids	30mg/l	Monthly	
BOD	10mg/l	Monthly	
Ammoniacal-N	5mg/l	Monthly	
Phosphate		Daily Monthly	5mg/l
Fats, Oil & Grease (FOG)	None Visible	Daily	
Mercury	1µg/l & 0.0125kg	Annual Annual	
Cadmium	0.01mg/l & 0.875kg	Annual Annual	

2 Effluent Type and Treatment

2.1 Treatment Process

The dairy effluent follows a multi-stage aerobic process which is followed in series of:

- 1) Dairy Effluent
- 2) Turbidity Tank
- 3) Fat Settlement Tank
- 4) Balance Tank (aerated and mixed)
- 5) DAF (Dissolved Air Flotation) Stage (promoted by flocculation agents)
 - a. Feed Tank
 - b. DAF Plant
 - c. DAF Effluent Tank
- 6) Paired Aerated Bioreactors operating in parallel
- 7) Ultrafiltration
- 8) Discharge via piped conduit to feeder channel into the River Brue

The specific purpose of this process layout is firstly to remove milk solids, including Fats, Oil & Grease (FOG), prior to removing the residual dissolved biodegradable organic content by aerobic microbial treatment.

The microbial and other solids are separated from the effluent by an ultrafiltration membrane, which are designed to remove microbial phases and sediments prior to discharge, and allow for the continuous operation of the plant and enable a stead-steady discharge from the site.

The removed milk fats and other solids are also degradable and form the feedstock to an Anaerobic Digestion (AD) plant as a renewable non-fossil fuel energy source.

2.2 Effluent Quality

The key component to the treatment process is the aeration units used in the DAF plant and the bioreactors, as otherwise it is a physical and biological process respectively which adjusts itself to the incoming load.

The aeration tank capacity has been doubled as part of the system upgrade, therefore, so long as sufficient air is supplied, there is no expectation for a change in the final effluent quality, whilst the increased tank capacity will also provide greater operational flexibility. The final effluent quality is therefore not expected to materially change for the increase in throughput as proposed from 750m³/day to 1,500m³/day.

The daily monitoring data for the period Jan 2020 – September 2021 is summarised as Table 2 and illustrated on Figure 2 and Figure 3.

The treated effluent is consistently within a narrow concentration range as illustrated by the consistency in average and median concentrations, although, where there is a discernible difference, this is due to outlier skewing the average concentration.

The Ultrafiltration (UF) membrane and the DAF stage also ensure that neither suspended solids nor visible milk fats (*i.e.* FOG) can ever be at significant concentrations within the effluent, in both cases, the higher the influent load, the more efficient will be the treatment.

Table 2 Treated Effluent Daily Quality Data (2020 – Sep 2021)

	Discharge	pH	COD	Phosphate	Ammonium	Solids	Visible FOG
	m ³ /day		mg/l	mg/l	mg/l	mg/l	
Typical Discharge Conditions							
Average	559	8.0	80	1.1	0.7	3	None
Median	585	8.0	78	0.6	0.3	2	None
General Boundary Conditions (<i>i.e.</i> excludes outliers)							
95 th %ile	724	8.3	126	3.27	2.30	6	None
90 th %ile	714	8.2	111	2.60	1.51	5	None
10 th %ile	380	7.7	47	0.04	0.01	1	None
Outlier Data Range							
Max	760	8.6	218	4.63	36.7	24	None
Min	0	7.2	30	0.00	<0.01	1	None

In accordance with current operational procedures, any permit limit exceedances are reported to the Environment Agency and the operational contingency plan¹ is enacted as appropriate.

¹ Wyke Farms Bruton Site Contingency Plan for Storing and Managing Liquid Waste (Doc ref EN3.30)

Figure 2 Daily Treated Effluent Quality Monitoring Major Components

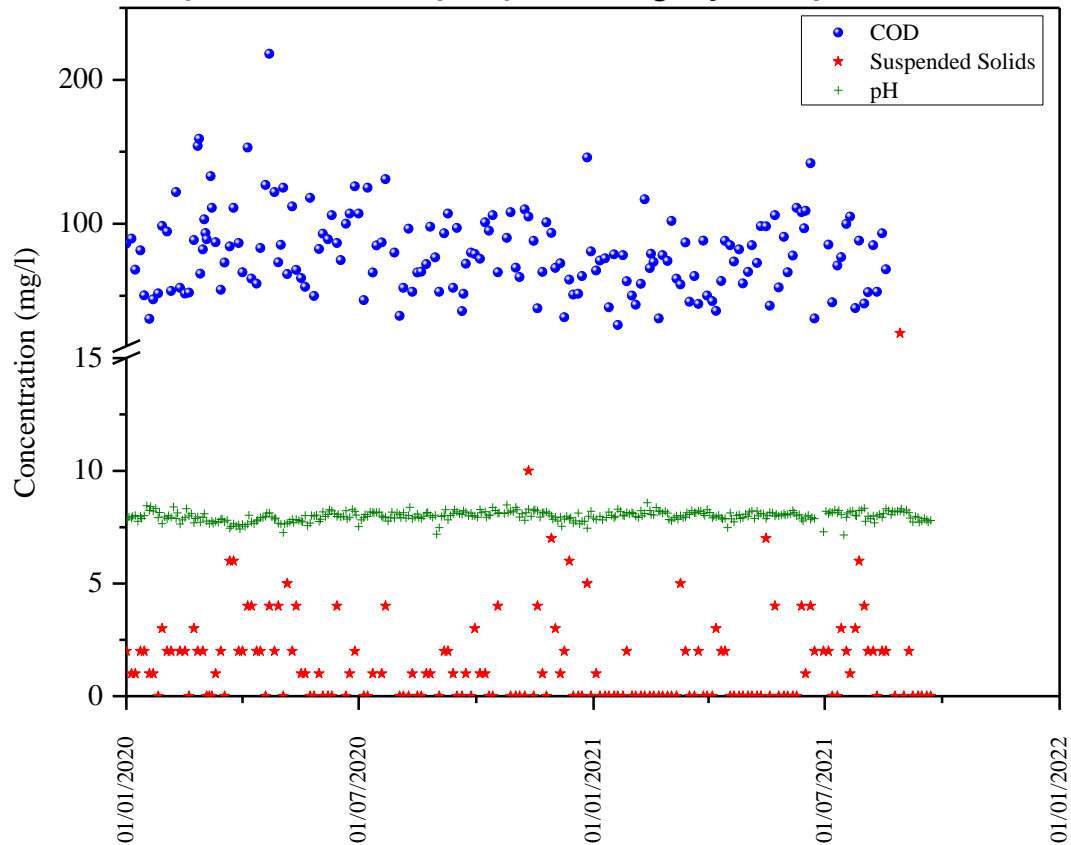


Figure 3 Daily Treated Effluent Ammonium and Phosphate Content

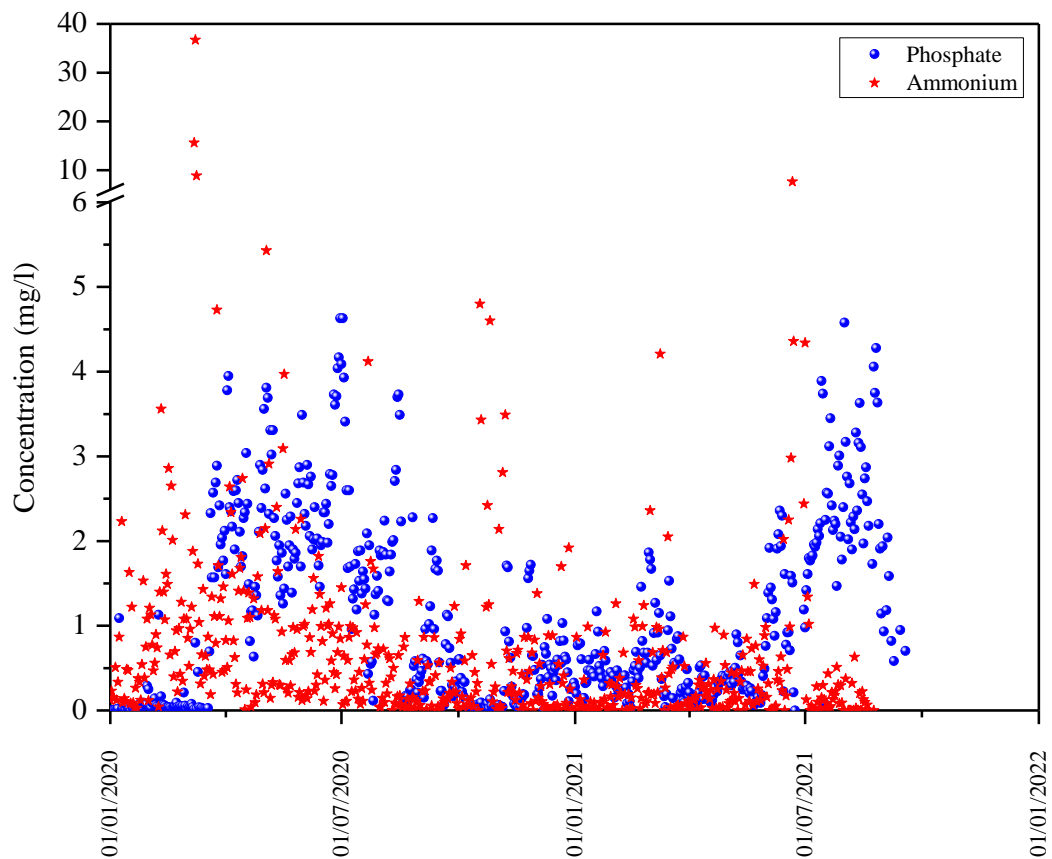


Figure 4 Effluent Discharge Rate

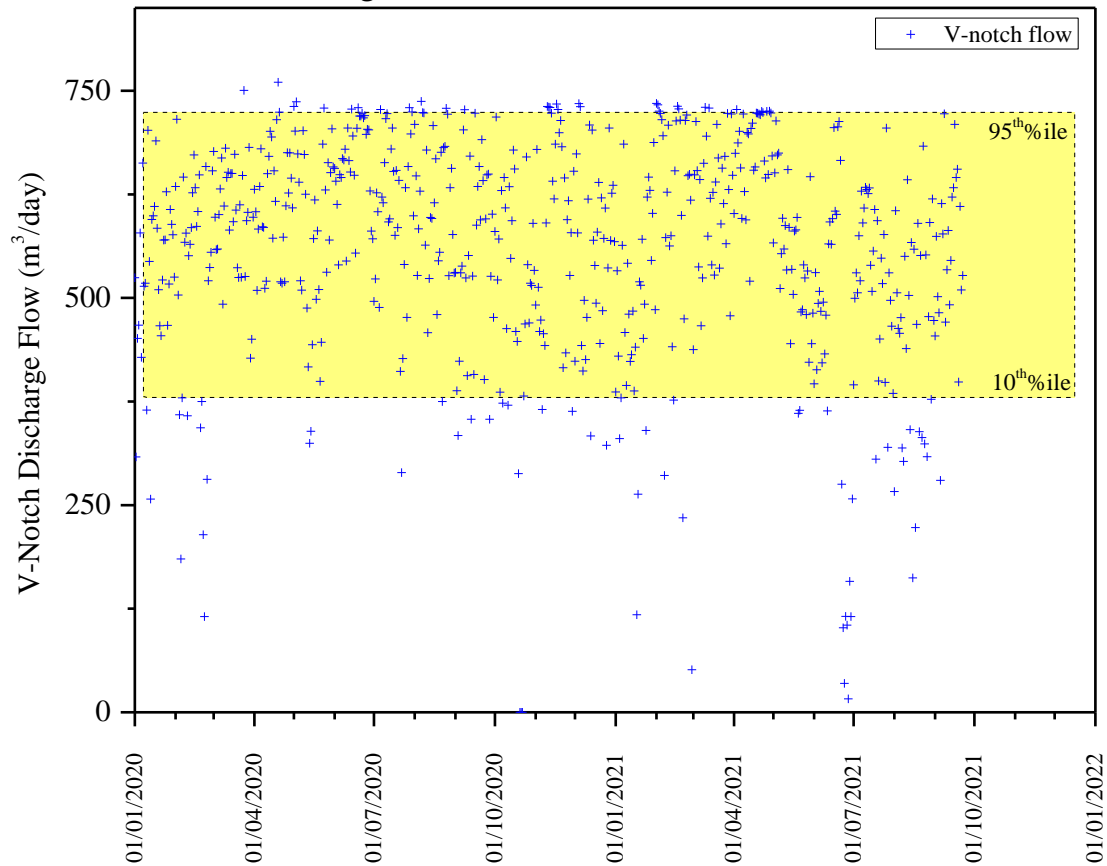
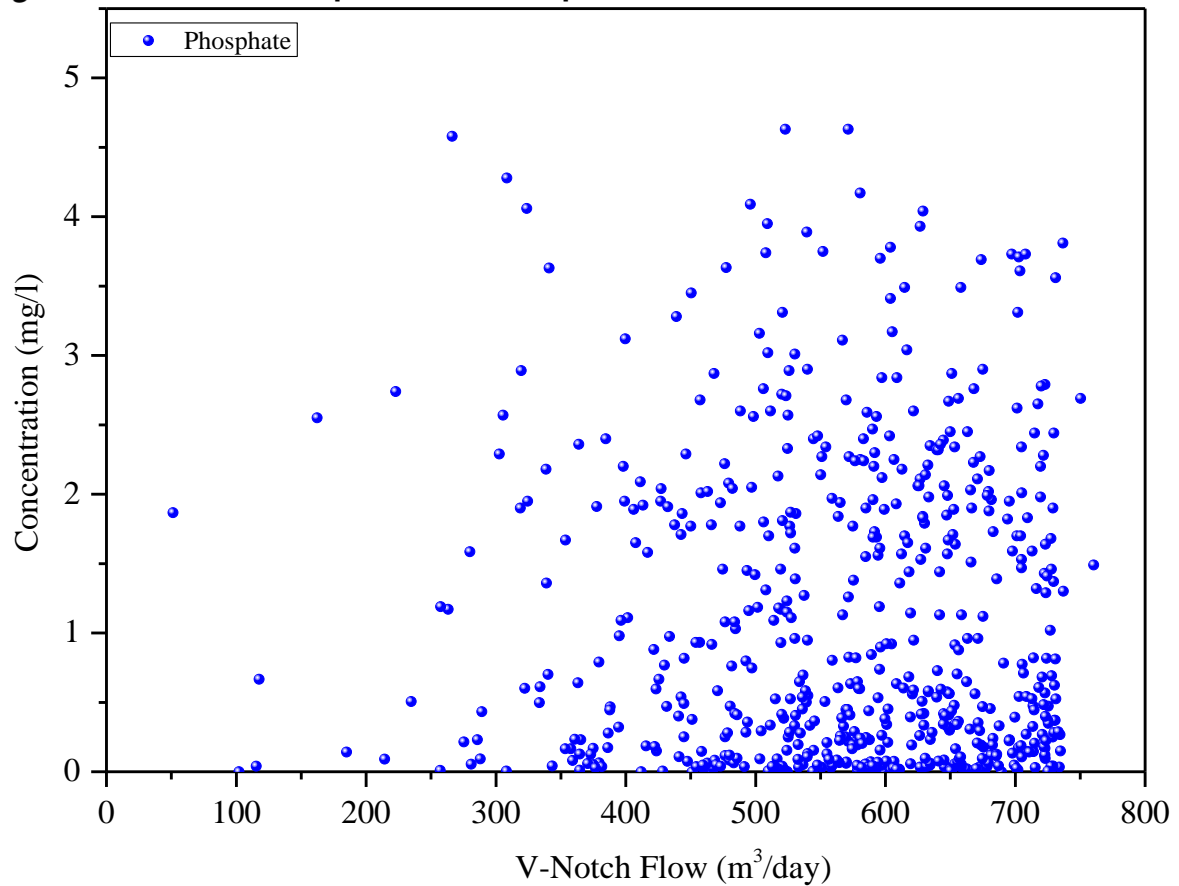


Figure 5 Flow - Phosphate Relationship



3 Discharge Route and Site Setting

The treated effluent is discharged via an identified monitoring point with V-notch weir gauging system, which is then culverted to the westerly flowing River Brue (Figure 6). The culvert route follows the reduction in topography afforded by a “dry-valley feature” to the south of the site as illustrated by Figure 7 to Wyke Lane, before following a field drain channel to the river.

Figure 6 a) Point of Entry to River Brue



b) V-Notch Weir at the Site



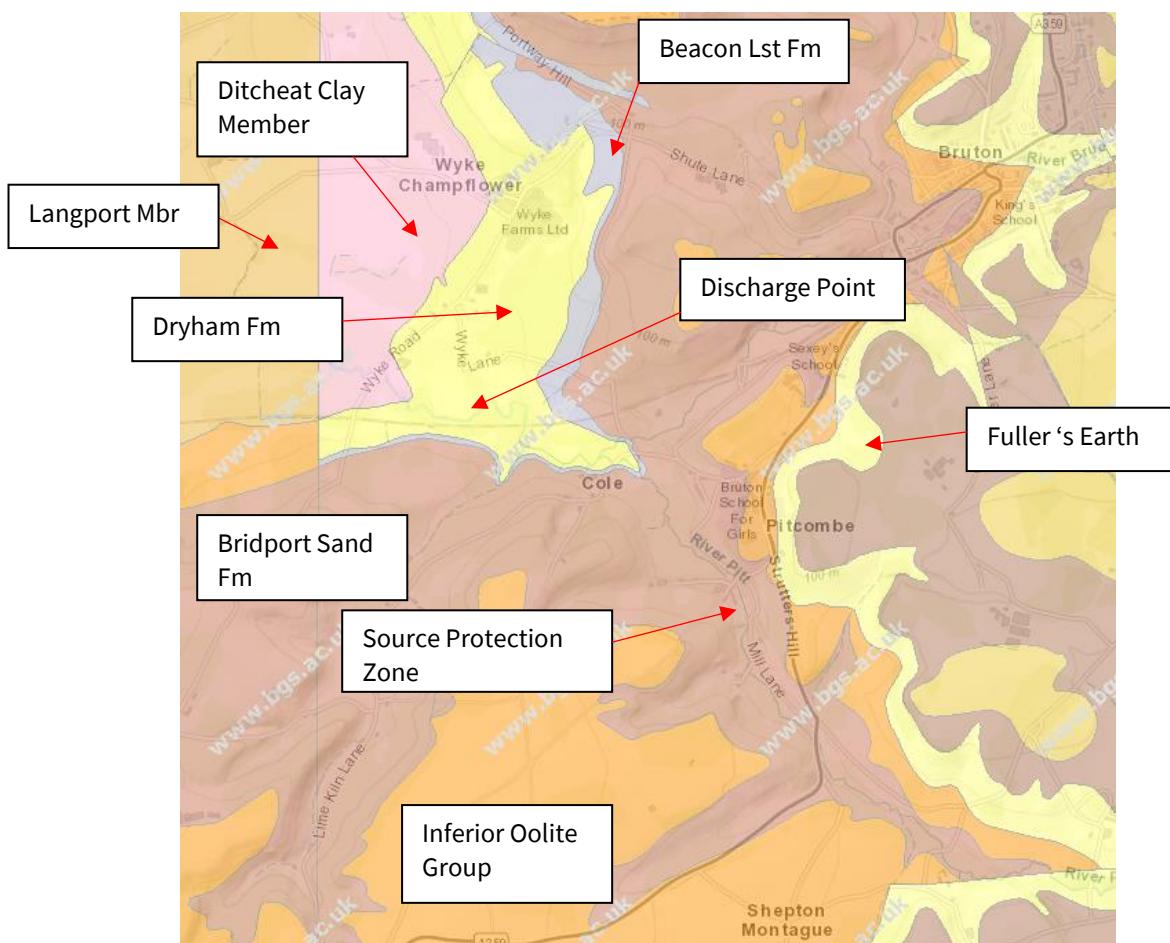
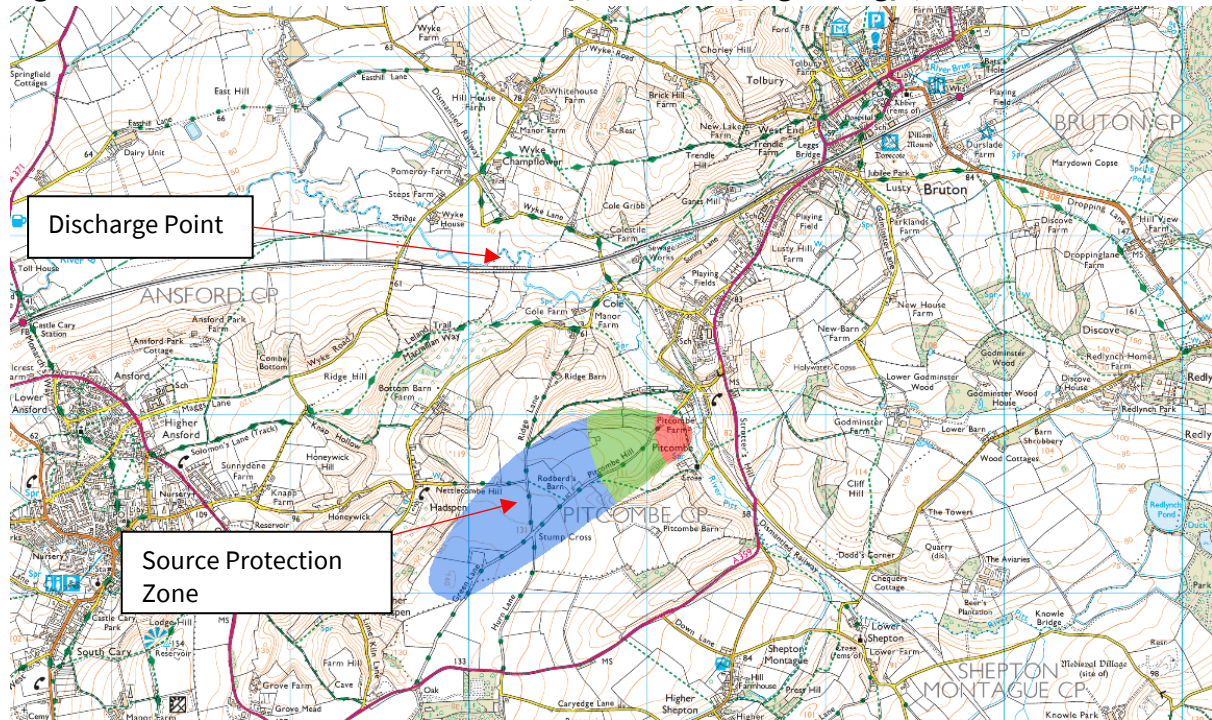
Figure 7 V-notch Location and Culvert Route to River Brue



The route of the pipe and the discharge is not in a groundwater Source Protection Zone (SPZ) and there are no SPZ's associated with the strata that underlies the site (The Dryham Formation). The

closest SPZ is located in the Bridport Sand Formation 1.1km to the southeast of the River Brue at the point of discharge and is in an upstream location (Figure 8).

Figure 8 Source Protection Zones (Top) and Underlying Geology (Bottom)



4 River Brue

4.1 River Flow Rate

The River Brue flow is gauged at Lovington, some 7km downstream of the discharge point to the west and after the confluence with the River Alham (Figure 10). Therefore, in order to normalise the flow, an estimate has been provided using the LowFlows model. A comparison of the gauged (Lovington) and modelled flow data is presented as Figure 9 and Table 3, with the lower flow data also illustrated as Figure 11

Figure 9 River Brue Flow Rates at Gauged (Lovington) and Modelled Locations

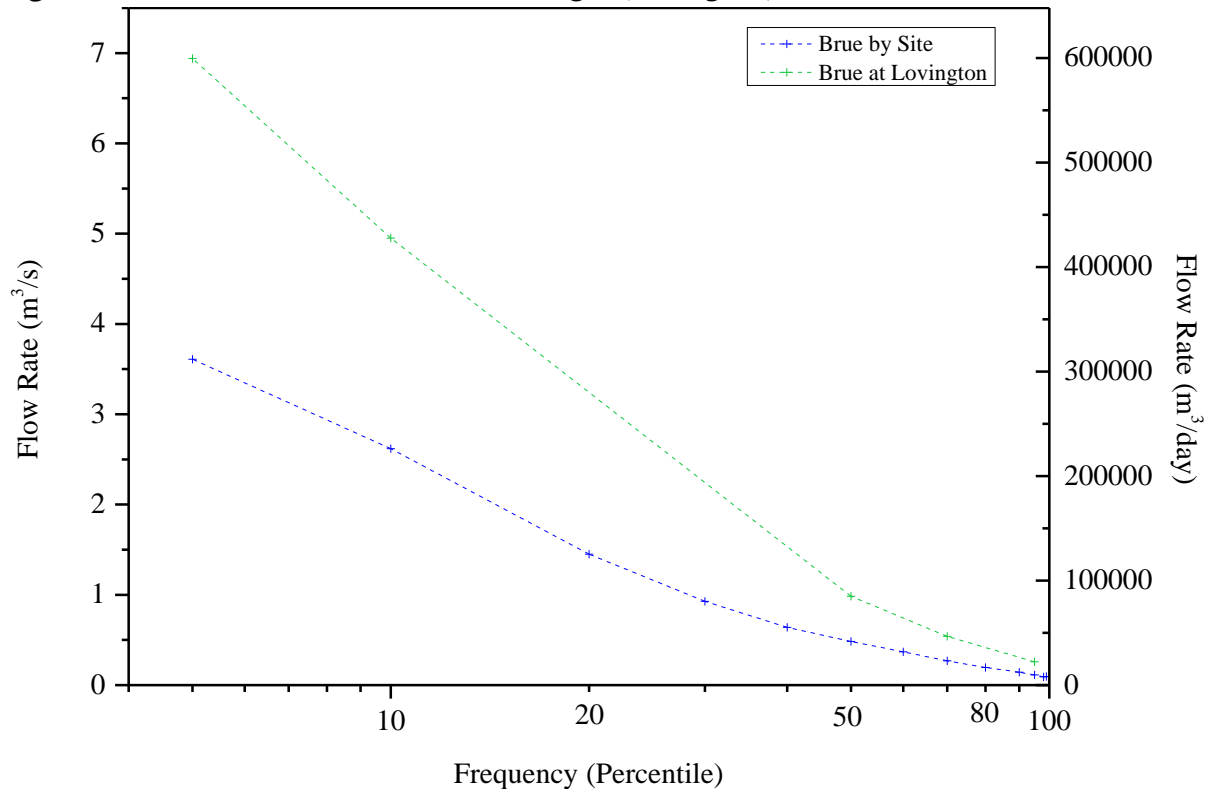


Table 3 River Brue Flow Rate Summary at the Site and Lovington Gauging Station (52010²)

	River Brue Flow Rates				Initial Dilution after Mixing Discharge at 1,500m ³ /day
	Site	Lovington Station	Site	Lovington Station	
	m ³ /s	m ³ /s	m ³ /day	m ³ /day	
Average	0.98	1.94	84,240	167,184	56
Percentile Flow Rates					
5 th (High Flow)	3.61	6.94	311,904	599,616	208
10 th	2.62	4.95	226,282	427,680	151
50 th (Median)	0.48	0.98	41,818	85,018	28
70 th	0.27	0.54	23,242	46,656	15
90 th	0.14		12,262		8
95 th (Low Flow)	0.11	0.26	9,763	22,378	7

² accessible at <https://nrfa.ceh.ac.uk/data/station/info/52010>

Figure 10 Lovington Gauging Station (52010) Location

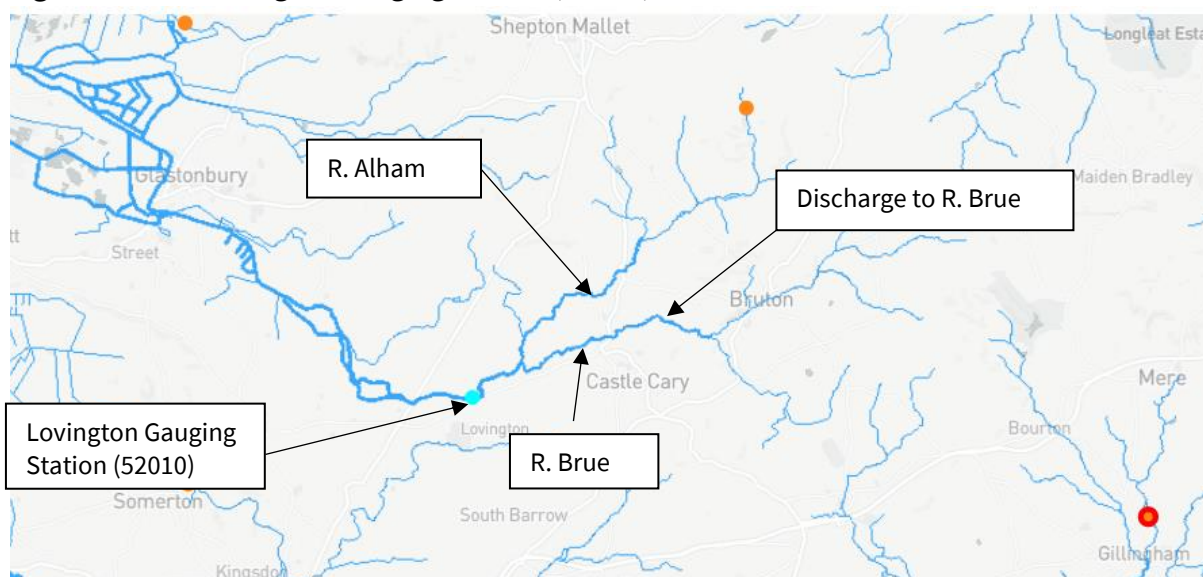
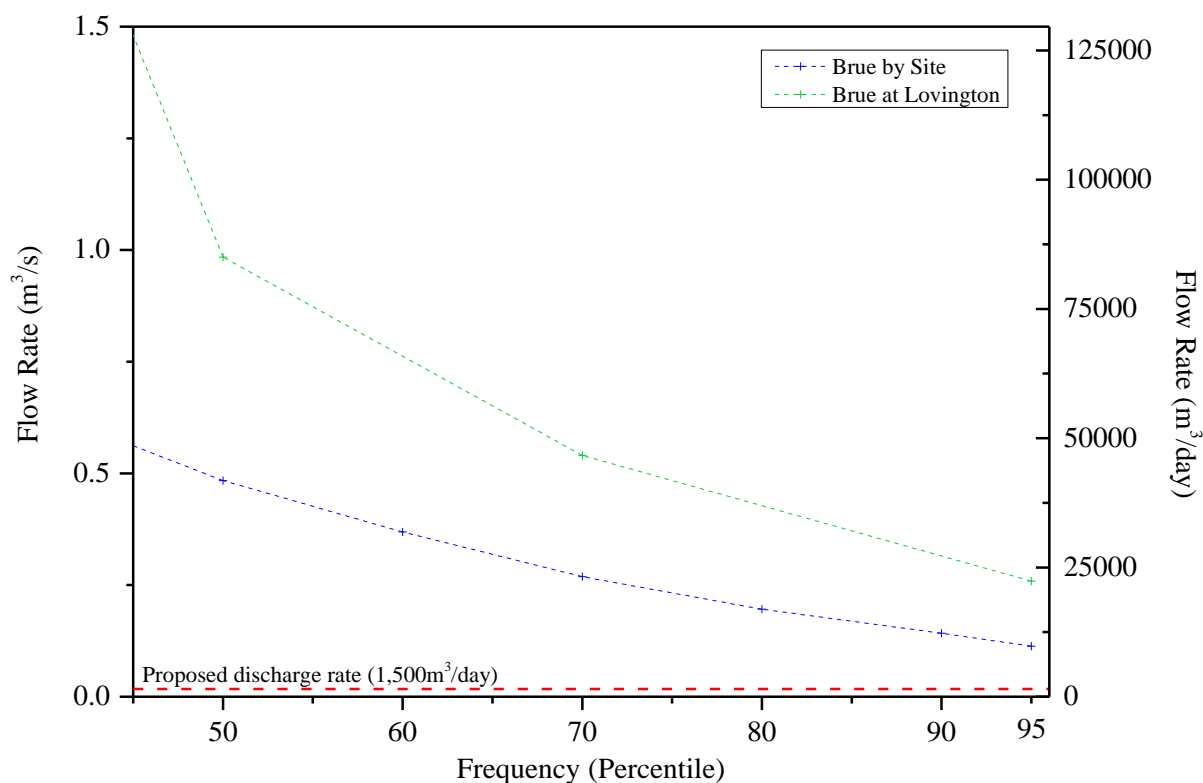


Figure 11 River Brue Flow Rates under Low Flow Conditions



4.2 Water Quality

The River Brue is monitored by the Environment Agency along the stretch of river where the discharge takes place both upstream (at Cole) and downstream prior to the Confluence with the River Alham. The data collected demonstrates that for key discharge consent parameters, water quality either improves or stays the same along this stretch of the river (Table 4). The water quality would be described as Good to Moderate with respect to phosphate (Figure 12) and High with respect to Dissolved Oxygen (Figure 13). There is no discernible change in the River Brue water quality as a result of the site's discharge at the current rates.

Figure 12 River Brue Phosphate

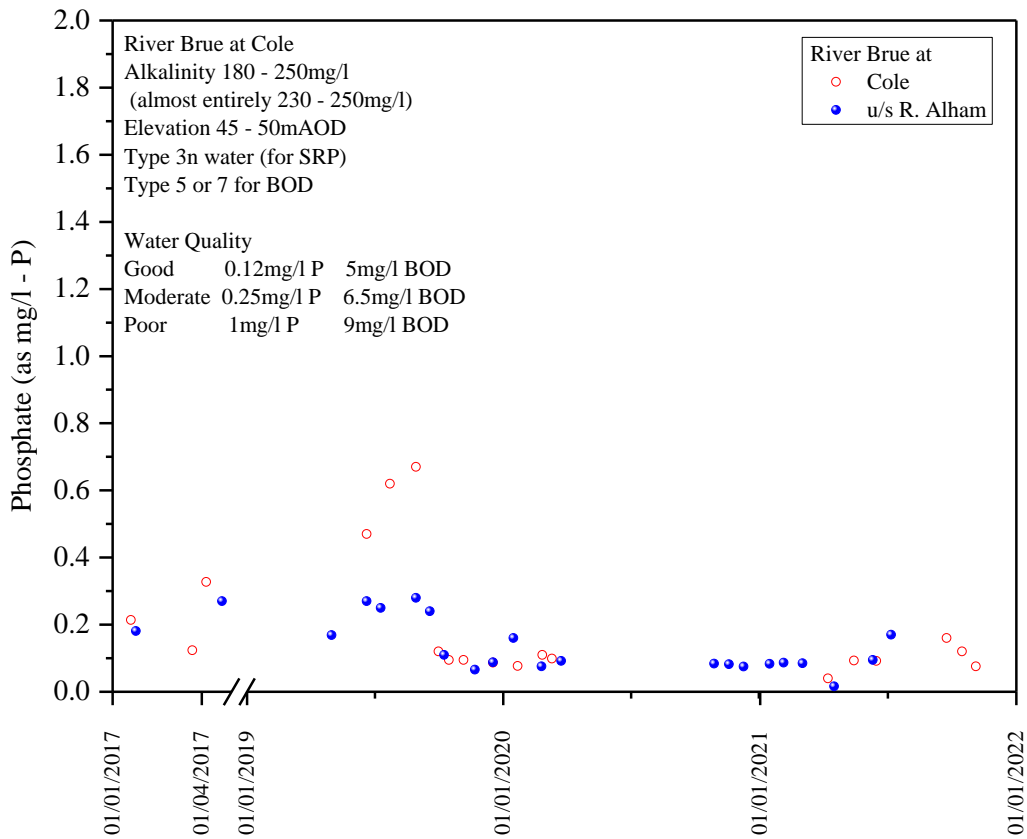


Figure 13 River Brue Dissolved Oxygen

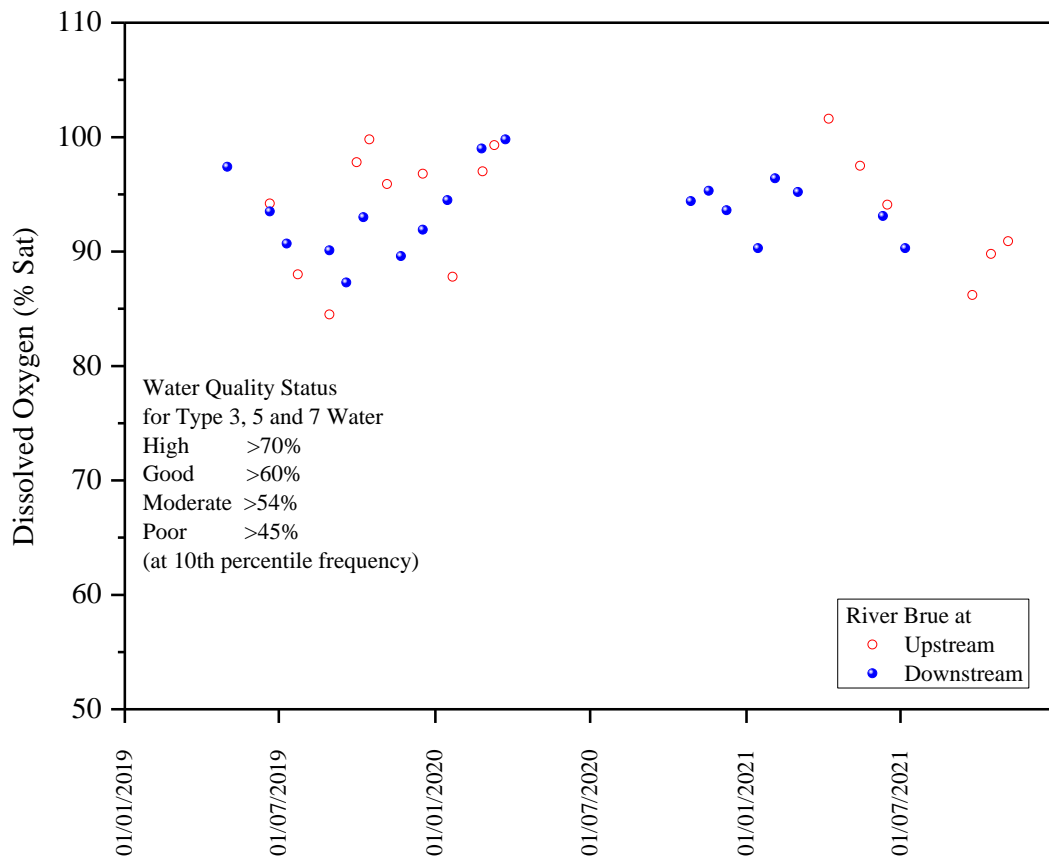


Table 4 Environment Agency Monitoring Programme at Cole (u/s) and before the Confluence with the River Alham (d/s) 2019 – Nov 2021

	Alkalinity		Ammoniacal -N		Orthophosphate reactive as P		Oxygen Dissolved % Saturation		pH	
	u/s	d/s	u/s	d/s	u/s	d/s	u/s	d/s	u/s	d/s
Average	226	255	0.12	0.05	0.19	0.13	94	95	8.0	8.2
Median	240	265	0.10	0.04	0.10	0.09	95	94	8.1	8.2
95 th Percentile	256	290	0.27	0.08	0.63	0.27	100	101	8.2	8.3
90 th Percentile	252	290	0.23	0.07	0.55	0.25	100	99	8.2	8.3
10 th Percentile	178	221	0.05	0.03	0.08	0.07	87	90	7.9	8.0
Max	260	290	0.30	0.19	0.67	0.28	102	115	8.3	8.5
Min	170	150	0.04	0.03	0.04	0.02	85	87	7.7	7.9

u/s – upstream of the discharge point at Cole

d/s – downstream of the discharge point and upstream of the confluence with the River Alham

5 Effects of Mixing

5.1 Introduction

The Environment Agency developed the “H1 methodology” for screening the effects of a discharge into a receiving water. The guidance originally consolidated as the H1 Annex D methodology for surface water discharges in 2011 was updated in 2016³ as part of the Environment Agency’s transition to online guidance on the gov.uk internet pages. However, the H1 Annex D2 guidance⁴ Assessment of sanitary and other pollutants within Surface Water Discharges, which replaced the former Annex E (Surface Water Discharges - Complex)⁴ has not been withdrawn and is still applicable. Notably the calculation methodology is the same.

The current format for undertaking the assessment and screening methodology follows a 4-Step approach.

- Step 1 is a comparison with EQS levels
- Step 2 is a mixing calculation to calculate a Process Contribution (PC) for the discharge
- Step 3 is a Predicted Environmental Concentration (PEC) following mixing within the receiving water
- Step 4 is a comparison of how the PEC compares with the relevant Environmental Quality Standard (EQS)

³ Environment Agency (2011) Horizontal Guidance Note H1 – Environmental Risk Assessment for Permits. Annex (d) Surface Water Discharges (basic) and as updated (2016) at <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

⁴ Environment Agency (2014). H1 Annex D2. Assessment of sanitary and other pollutants within Surface Water Discharges.

The key components within an organic (milk) based effluent derived from the food processing industry have been identified in the existing discharge consent, namely BOD, ammoniacal-N and phosphate.

For Step 1 the relevant criteria comparison is either a 90th percentile or an annual average concentration, with the water quality standards applying as illustrated within Table 5

Table 5 Water Quality Standards and Comparison with Daily Data

Type	Phosphate as mg/l PO ₄ -P	Ammoniacal-N as mg/l NH ₄ -N	BOD as mg/l O ₂	pH
	as Annual Average	as 90 th Percentile Concentration		
Good	0.12	0.6	5.0	pH > 5.2 & <9
Moderate	0.25	1.1	6.5	
Poor	1.00	2.5	9.0	
Site discharge at EQS frequency (for full statistics see Table 2)				
Discharge	1.09	1.51		Range 7.2 – 8.6
Permit Limit	(5)	5	10	

5.2 Step 1 Comparison with EQS

The Step 1 stage of the environmental assessment is a comparison of the concentration with the relevant EQS, and for toxic substances a negligible Process Contribution is as a first tier test, is a discharge at <10% of the EQS.

For BOD the Permit Limit is set at approximately the same concentration as a “Poor” water quality, whilst for ammoniacal-N, the Permit Limit is double the concentration of a “Poor” water quality. For phosphate, the routine data demonstrates that the treated effluent is being discharged at a concentration consistent with a “poor” water quality.

Notably the monitoring data for the River Brue ammoniacal-N and phosphate does not indicate a discernible change in water quality. Therefore although this test apparently indicates that the discharge is not negligible, neither has it been detrimental to the river quality at the current discharge rates and quality range.

5.3 Process Contribution and Predicted Environmental Concentration Calculations

The Process Contribution is a dilution / mixing calculation is derived using Equation 1, and the Predicted Environmental Concentration is derived using Equation 2.

However, there is a second tool the River Quality Planning (RQP) tool⁵ which, unlike Equation 1 and Equation 2 incorporates a Monte Carlo simulator which allows the statistical variation to be considered during the assessment.

⁵ Environment Agency (January 2020) RQP-MPER Manual v6.0b

Process Contribution (PC)

$$PC = \frac{EFR \times RC}{EFR + RFR} \quad (\text{Equation 1})$$

Predicted Environmental Concentration (PEC)

$$PEC = \frac{(EFR \times RC) + (RFR \times BC)}{EFR + RFR} \quad (\text{Equation 2})$$

Where:

PC Process Contribution (mg/l)
RC Release Concentration (mg/l)
EFR Effluent Flow Rate (m³/s)
RFR River Flow Rate (m³/s)

PEC Predicted Environmental Concentration (mg/l)
BC Background Concentration (mg/l)

5.4 River Mixing Sensitivity Analysis

Process contributions have been calculated for BOD, ammoniacal-N and phosphate for median (Table 6), average (Table 7) and low (0) flow conditions in the River Brue, for various release concentrations.

The Process Contribution is purely a function of the release concentration, release rate and the river flow rate. Of these, three parameters, the first and third are expected to be variable, *i.e.* flow rates do vary on a day to day basis, whilst the concentration output from a treatment plant always varies within a narrow range, and therefore fluctuates around a median concentration, within a relatively tightly constrained range as illustrated in Table 2, Figure 2 and Figure 3.

This type of variability is also recognised by the setting of phosphate water quality standards as annual average, with ammonium and BOD based on 90th percentile concentrations. Significantly none of these parameters have any toxicity effects at the released concentrations, including for ammoniacal-N, which is only toxic in the ammonia form and only exists under high pH conditions, not the neutral to slightly alkaline conditions within the River Brue or the treated effluent.

Table 6 Process Contribution Sensitivity Analysis under Median R. Brue Flow Conditions

Substance	EQS Type and Discharge at Permit Limit or Statistical based Conc	Discharge Rate	River Flow Rate	Discharge Conc	Process Contribution	EQS mg/l	PC as % EQS
		EFR	RFR	RC	PC		
		m ³ /s	m ³ /s	mg/l	mg/l		
BOD	Good – Limit	0.0174m ³ /s (1,500m ³ /day)	0.48m ³ /s (Median Flow)	10.0	0.35	5	6%
	Moderate - Limit			10.0	0.35	6.5	5%
Ammoniacal-N	Good Limit			5.0	0.17	0.6	29%
	Moderate Limit			5.0	0.17	1.1	16%
	Good 90 th			1.5	0.05	0.6	8%
Phosphate	Moderate Limit			5.0	0.17	0.25	69%
	Moderate Average			1.1	0.04	0.25	14%
	Moderate Median			0.6	0.02	0.25	7%
	Poor Limit			5.0	0.17	1	17%

Table 7 Process Contribution Sensitivity Analysis under Average R. Brue Flow Conditions

Substance	EQS Type and Discharge at Permit Limit or Statistical based Conc	Discharge Rate	River Flow Rate	Discharge Conc.	Process Contribution	EQS	PC as % EQS
		EFR	RFR	RC	PC		
		m ³ /s	m ³ /s	mg/l	mg/l		
BOD	Good – Limit	0.0174m ³ /s (1,500m ³ /day)	0.98m ³ /s (Mean Flow)	10.0	0.17	5	3%
	Moderate - Limit			10.0	0.17	6.5	3%
Ammoniacal-N	Good Limit			5.0	0.09	0.6	15%
	Moderate Limit			5.0	0.09	1.1	8%
	Good 90 th			1.5	0.03	0.6	4%
Phosphate	Moderate Limit			5.0	0.09	0.25	35%
	Moderate Average			1.1	0.02	0.25	8%
	Moderate Median			0.6	0.01	0.25	4%
	Poor Limit			5.0	0.09	1	9%

Table 8 Process Contribution Sensitivity Analysis under Low Flow R. Brue Flow Conditions

Substance	EQS Type and Discharge at Permit Limit or Statistical based Conc	Discharge Rate	River Flow Rate	Discharge Conc.	Process Contribution	EQS	PC as % EQS
		EFR	RFR	RC	PC		
		m ³ /s	m ³ /s	mg/l	mg/l		
BOD	Good	0.0174m ³ /s (1,500m ³ /day)	0.14m ³ /s (90 th %ile Flow)	10.0	1.10	5	22%
	Moderate			10.0	1.10	6.5	17%
Ammoniacal-N	Good Limit			5.0	0.62	0.6	92%
	Moderate Limit			5.0	0.62	1.1	50%
	Good 90 th			1.5	0.19	0.6	28%
Phosphate	Moderate Limit			5.0	0.62	0.25	221%
	Moderate Average			1.1	0.14	0.25	48%
	Moderate Median			0.6	0.08	0.25	27%
	Poor Limit			5.0	0.62	1	55%

BOD

Under average and median River Brue flow conditions, a BOD released at the current Permit Limit (10mg/l) and the proposed 1,500m³/day discharge rate, the resultant Process Contribution is only 3% of the Good Water Quality EQS threshold of 5mg/l. Given that BOD is to be assessed as a 90th percentile concentration, then a BOD released constantly at the permit limited criteria is considered as a negligible contribution to water quality (*i.e.* <4% of EQS).

There may be periods when this 4% period is exceeded, however, they are temporary and would only occur for short periods of time.

Ammoniacal-N

Ammoniacal-N is similarly regulated under a 90th percentile criteria. There is a greater relative impact from ammoniacal-N on the River Brue as compared to BOD, however, the impact itself is low, albeit not negligible. Under average and median River Brue flow conditions, ammoniacal-N released constantly at the Permit Limit (5mg/l) at the proposed discharge rate would result in a Process Contribution of 15 – 30% of the Good Water Quality threshold.

Notably if this release was at the 90th percentile concentration for the treated effluent, the resulting PC would be 4% and 9% of the EQS under mean and median flow conditions respectively.

A release at the proposed Permit Limit (5mg/l at 1,500m³/day) could cause the resultant water quality to change from a “Good Standard” to a Moderate Standard if constantly under low flow conditions in the River Brue. However, these conditions would be temporary and do not take into consideration that a change in water status (from Good to Moderate) due to ammoniacal-N would not occur at the 90th percentile treated effluent ammoniacal-N concentration.

Phosphate

Phosphorus standards, as measured by PO₄-P are lower than ammoniacal-N and vary from 0.12mg/l (Good) to 1mg/l (Poor). Phosphate concentrations in the effluent fluctuate from slightly below the proposed 5mg/l Permit Limit (at 4.6mg/l), with average (mean) and median daily concentrations at 1.1mg/l and 0.6mg/l respectively. These are between the Moderate and Poor phosphorus annual mean concentration limits.

Releases at the Mean (average) and Median treated effluent concentration under Mean and Median flow conditions are calculated to cause a Process Contribution of 4-9% of the Moderate Water Quality EQS under Mean (average) flow conditions and 8 – 16% of the Moderate EQS under Median flow conditions. This equates to a Process Contribution of 0.01 – 0.04mg/l as shown in Table 6 and Table 7.

Under low flow conditions, the Process Contribution is expected to increase to 0.08 – 0.14mg/l (0). Although this is a significant proportion of the Moderate Water Quality Standard, such an occurrence can be demonstrated to be temporary, and even under low flow conditions in the River Brue, and if released constantly at the proposed Permit Limit (*i.e.* 5mg/l @ 1,500m³/day). The water quality would result in a marginal change in concentration.

5.5 Predicted Environmental Concentration

BOD released under the proposed Permit Conditions (*i.e.* 10mg/l at 1,500m³/day) is not predicted to cause harm to the River Brue. Consequently, no further consideration is warranted. Ammonium and phosphate released at 5mg/l are however expected to cause a greater relative impact given their lower EQS thresholds.

The actual effects can be estimated by considering the background concentration and using the calculation as set out in Equation 2. Assuming a constant background of 0.07mg/l ammoniacal-N, the 90th percentile concentration downstream of the site and 0.09mg/l phosphate (as PO₄-P) based on the median concentration downstream of the site, then the Predicted Environmental Concentration (PEC) itself will be a conservative estimate of the actual impact as these concentrations already incorporate the mixing effects of a discharge based on the same concentration limits and 50% of the proposed discharge rate (*i.e.* up to 750m³/day).

These background concentrations were selected as ammoniacal-N is assessed against a 90th percentile concentration and phosphate against an annual average. The resultant PEC for the various scenarios discussed for the Process Contribution calculations are presented as Table 9 for average (mean) flow, Table 10 for median River Brue flow conditions and Table 11 for low flow conditions.

Table 9 Process Contribution Sensitivity Analysis under Average Flow R. Brue Flow Conditions

Substance	EQS Type and Discharge at Permit Limit or Statistical based Conc.	Discharge Conc.	Process Contribution	Back-Ground	Predicted Environmental Concentration	EQS
		RC	PC		PEC	
		mg/l	mg/l	mg/l	mg/l	
Ammoniacal-N	Good Limit	5.0	0.09	0.07	0.16	0.6
	Moderate Limit	5.0	0.09	0.07	0.16	1.1
	Good 90 th	1.5	0.03	0.07	0.10	0.6
Phosphate	Moderate Limit	5.0	0.09	0.09	0.18	0.25
	Moderate Average	1.1	0.02	0.09	0.11	0.25
	Moderate Median	0.6	0.01	0.09	0.10	0.25
	Poor Limit	5.0	0.09	0.09	0.18	1

Table 10 Process Contribution Sensitivity Analysis under Median Flow R. Brue Flow Conditions

Substance	EQS Type and Discharge at Permit Limit or Statistical based Conc.	Discharge Conc.	Process Contribution	Back-Ground	Predicted Environmental Concentration	EQS
		RC	PC		PEC	
		mg/l	mg/l	mg/l	mg/l	
Ammoniacal-N	Good Limit	5.0	0.17	0.07	0.24	0.6
	Moderate Limit	5.0	0.17	0.07	0.24	1.1
	Good 90 th	1.5	0.05	0.07	0.12	0.6
Phosphate	Moderate Limit	5.0	0.17	0.09	0.26	0.25
	Moderate Average	1.1	0.04	0.09	0.12	0.25
	Moderate Median	0.6	0.02	0.09	0.11	0.25
	Poor Limit	5.0	0.17	0.09	0.26	1

Table 11 Process Contribution Sensitivity Analysis under Low Flow R. Brue Flow Conditions

Substance	EQS Type and Discharge at Permit Limit or Statistical based Conc.	Discharge Conc.	Process Contribution	Back-Ground	Predicted Environmental Concentration	EQS
		RC	PC		PEC	
		mg/l	mg/l	mg/l	mg/l	
Ammoniacal-N	Good Limit	5.0	0.55	0.07	0.61	0.6
	Moderate Limit	5.0	0.55	0.07	0.61	1.1
	Good 90 th	1.5	0.17	0.07	0.23	0.6
Phosphate	Moderate Limit	5.0	0.55	0.09	0.63	0.25
	Moderate Average	1.1	0.12	0.09	0.20	0.25
	Moderate Median	0.6	0.07	0.09	0.15	0.25
	Poor Limit	5.0	0.55	0.09	0.63	1

Ammoniacal-N

The data demonstrates that under the average (mean and median) flow conditions, ammoniacal-N released at the proposed Permit Limit conditions (5mg/l @ 1,500mg/l) then the Predicted Environmental concentration will be less than 50% of the EQS. The water quality will therefore remain at a Good Standard with respect to ammoniacal-N.

Under low flow conditions, the PEC equates to the EQS (*i.e.* at 0.6mg/l) if consistently released at the proposed Permit Limit. However, this is an upper threshold as 90th percentile effluent concentrations are significantly lower, and the resultant PEC is calculated as 0.23mg/l.

This 90th percentile PEC is actually below the 0.3mg/l High Standard EQS threshold level.

It is therefore considered that an aerobic biological effluent treatment plant that performs under normal operating fluctuations, with an upper limit to the release concentration (*i.e.* a Permit Limit) of 5mg/l would not cause an adverse or harm to the River Brue.

Furthermore, it is not expected that there would be a discernible change in water quality with respect to ammoniacal-N downstream of the existing discharge point from an increase in discharge rate from 750m³/day to 1,500m³/day.

Phosphate

With regards to phosphate, the PEC for releases to the River Brue will approximate to the Good Standard EQS (*i.e.* from 0.10 – 0.12mg/l) assuming the median and average release concentration. Under low flow conditions, there may be a slight reduction in water quality towards a Moderate Standard (0.15 – 0.2mg/l). However, this is only temporary and is not sustained.

If the discharge was consistently at the proposed conditions (5mg/l at 1,500m³/day), then water quality could theoretically be at a moderate standard under average flow conditions (*i.e.* at 0.26mg/l, *c.f.* 0.25mg/l EQS). However, it would not slip below the 1mg/l Poor Standard.

It should be noted that the background concentration already incorporated the phosphate content from a discharge at 50% of the proposed limit. Therefore any conclusions drawn from such a deterministic approach are overly conservative, and although theoretically discernible are unlikely to cause a change in River Brue water status following an increase in the discharge volume.

Notwithstanding the above, the River Quality Planning (RQP) Tool can provide informative information on how the discharge should be considered. Where this tool is useful is that for a given river flow rate distribution and a consistent discharge rate, the tool can be used to derive a statistical distribution for the effluent quality at the point of discharge. Screen captures have been taken from the model output (*e.g.* Figure 14) and the data summarised as (Table 12)

Table 12 River Quality Planning Tool – Phosphate Discharge to the River Brue at 1,500m³/day: Sensitivity analysis to Define Release Conditions

WQ Target mg/l	Bgrd mg/l	Required Discharge		Bgrd mg/l	Required Discharge	
		Mean mg/l	95 th %ile mg/l		Mean mg/l	95 th %ile mg/l
0.20	0.09	3.4	9.5	0.13	2.2	6.3
0.18	0.09	2.8	7.8	0.13	1.6	4.6
0.16	0.09	2.2	6.2	0.13	1.0	2.9
0.12	0.09	1.0	5.0	0.13	N/A	N/A

The RQP tool demonstrates that a suitable discharge condition could be written using a statistical tool, for which the “required condition” would be to base the discharge on an upper limit of 5mg/l at the 95th percentile frequency, as long as the average discharge consent was 1mg/l (Table 12). This

is exactly the condition being achieved, with median phosphate concentrations at 0.6mg/l, average concentrations at 1.1mg/l and maximum concentrations at 4.6mg/l (Table 2).

Figure 14 RQP Output Assuming a Quality Objective of 0.12mg/l P and Background 0.09mg/l

Tony Warr ... (Version 6.0) ... 25/09/19

discharge Wyke Farm
river Brue
pollutant Phosphate

MASS BALANCE: Monte Carlo
Calculations: 26 November 2021 at 06:01

mean upstream river flow 0.98
the 95-percentile low flow 0.11
mean discharge flow 0.013
standard deviation 0.0016
mean u/s river quality 0.09 (0.0000 - 0.18)
standard deviation 0.080 (0.026 - 0.13)
number of samples 4

downstream target 0.12
mean M

calculate required discharge quality
calculate impact of input discharge quality

old data - WORD
old data - EXCEL
old data - NOTE
new discharge
calculate
sensitivity
Excel Word Note
menu quit
OUT

mean d/s river quality 0.12 (0.0000 - 2.13)
standard deviation 0.094 (0.32 - 1.62)
number of samples 4

required discharge mean 0.99 (0.0000 - 2.13)
standard deviation 0.97 (0.32 - 1.62)
number of samples 4
the 95-percentile 2.77 (1.35 - 47.6)
the 99-percentile 4.95 (2.16 - 225)
the 99.5-percentile 5.89 (2.32 - 400)

mean discharge quality 0.0001 (0.0000 - 0.0002)
standard deviation 0.0001 (0.0000 - 0.0002)
number of samples 4
the 95-percentile 0.0003 (0.0001 - 0.0051)
the 99-percentile 0.0005 (0.0002 - 0.025)
the 99.5-percentile 0.0006 (0.0002 - 0.045)

correlation: river and discharge flow 0.6000
correlation: river flow and quality 0.0000
correlation: discharge flow and quality 0.0000

6 Summary and Conclusion

The Wyke Farms Ltd dairy is proposing to increase production capacity of their Bruton Site operations. This will necessitate an increase in the effluent volume produced from the residual milk volume after separation to produce cheese and other dairy products.

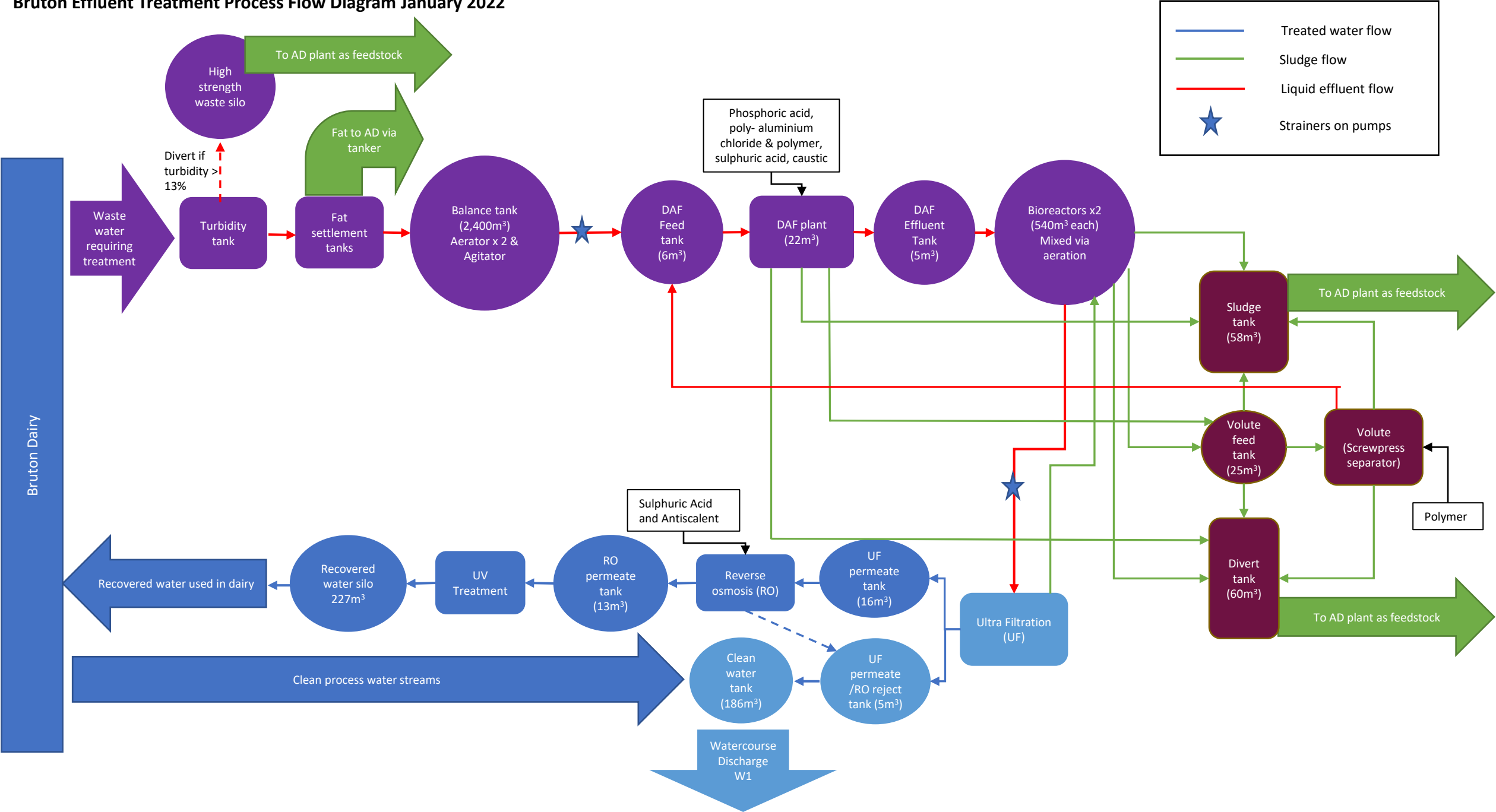
A Permit Variation is therefore required to allow for an increase in treated effluent volume from 750m³/day to 1,500m³/day.

Risk assessment and water-flow-quality modelling demonstrates that the receiving River Brue water chemistry is unlikely to be discernibly changed downstream of the site for effluent treated to the same standards as currently demonstrated. Treatment is by a modern standard membrane biological reactor system in combination with an earlier solids, fats and grease removal step. The membrane Ultrafiltration system is the final polishing step which will also ensure that milk solids and treatment biomass are removed from the discharge effluent.

No change to the discharge conditions is required for BOD and ammoniacal-N, which should remain at 10mg/l and 5mg/l respectively. The same 5mg/l upper limit to the phosphate (as PO₄-P) content is recommended.

Appendix A Process Flow Diagram

Bruton Effluent Treatment Process Flow Diagram January 2022





IRELAND | UK | UAE | BAHRAIN | KSA

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