CHELSON MEADOW LEACHATE TREATMENT PLANT VARIATION OVERVIEW: EPR CP3731LZ

The application is to vary the permit to:

- Increase from the current 650,000m^3 to 850,000m^3 the total annual volume of leachate accepted at the LTP and subsequent treated effluent discharge to the River Plym
- Regularise discharge of treated effluent at any state of tide during peak leachate production ('Emergency mode')
- Remove condition 3.1.3 in relation to the periodic monitoring of soil and groundwater, because the site is built on an old landfill.
- Consolidate the old discharge consent/ Water Discharge Activity (WDA) from 1983 (Appendix A), ref. SWWA 289/1/1 with associated annual fee, with the current installation permit, ref. EPR/CP3731LZ.
- Remove on ethical grounds the Direct Toxicity Assessment from Table S3.1

This variation does not seek to modify the permit boundary, site infrastructure, site operations or any chemical determinands subject to current permit conditions.

Chelson Meadow Leachate Treatment Plant (LTP)

Chelson Meadow Leachate Treatment Plant is adjacent to the east bank of the River Plym, east of the city of Plymouth and south of the A38 trunk road. The National Grid Reference for the centre of the site is approximately SX50612 54476. The LTP Permit boundary occupies an area of approximately 0.63 ha. in the southwest corner of the former closed Chelson Meadow landfill (Figure 1, Plate 1). The main infrastructure of the LTP was constructed in 1996 and operated under the landfill waste licence, in compliance with the 1983 discharge consent (WDA).

Chelson Meadow Landfill commenced in ca. 1965 and waste tipping ceased in March 2008. The landfill base is the natural geology; it operates on the historic principal of dilute and disperse, generating leachate which is collected and treated to prevent pollution of ground and surface water.

Regulatory Context

The Environmental Permit (the permit) for Chelson Meadow LTP, issued 28th March 2007, permitted a total treatment and discharge volume of 488,000m^3 with indicative treatment parameters for ammoniacal-nitrogen, Biological Oxygen Demand (BOD) and suspended solids (SS at 105^{o}C). PCC assumed that the Permit superseded the WDA. In reality, the WDA continued parallel with the Permit with the annual fee being levied and paid.

A variation for significant changes in site infrastructure and operations was issued on 12th December 2011. The variation allowed for an increase in the discharge volume to 650,000m^3.

The original WDA specified effluent should be discharged over a maximum 2-hour period starting half an hour after high tide is detected by sensors. This practice has continued throughout regulation by the permit even though it is not a permit condition. On issue of the variation in 2011 the operational philosophy (not formalised as a condition) was to adhere to the original tidal window when possible, but to discharge outside this period if circumstances required (i.e during times of exceptional leachate production) provided treated effluent composition was compliant with permit conditions.

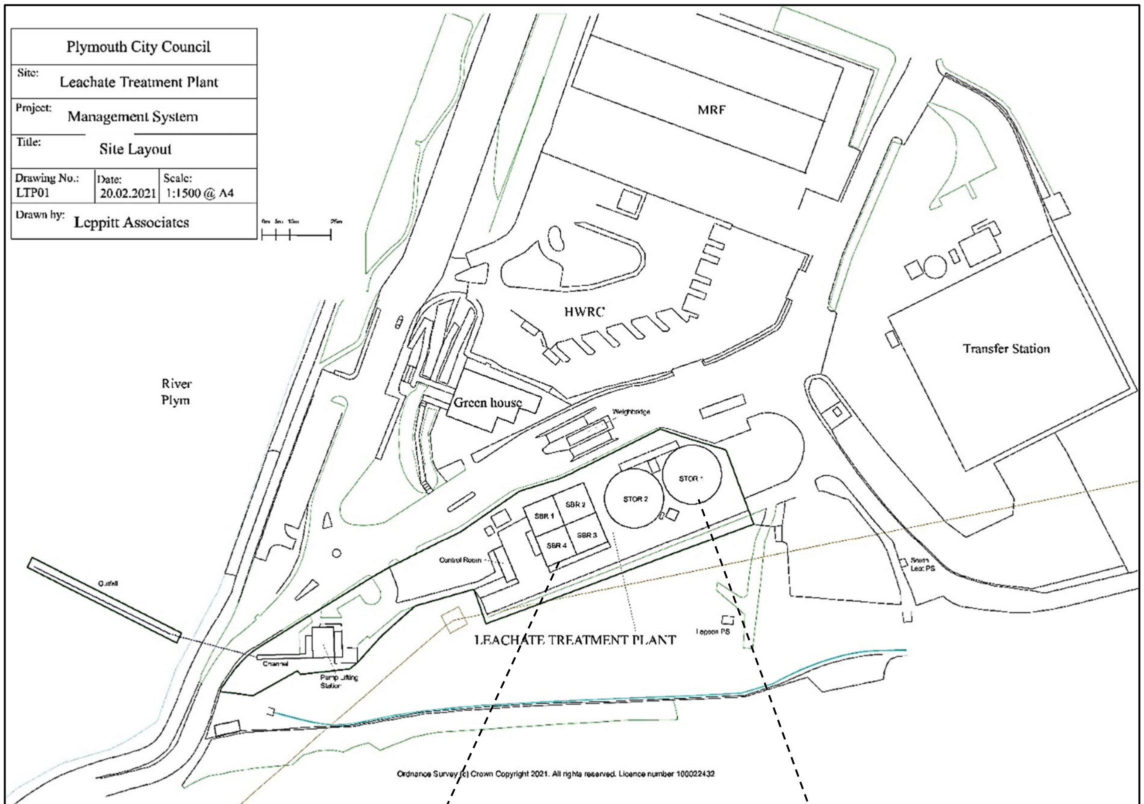


Figure 1: Chelson Meadow LTP permit boundary, showing major infrastructure and additional waste facilities on the closed landfill.

Plate 1: Leachate Treatment Plant, looking southwest from the lagoon pumping station, Chelson Meadow, Plymouth 2021. Infrastructure components from left to right are: Sequential Batch Reactors (SBRs), STOR 2 & STOR 1

Supporting Documents

The application to vary the permit contains the following sections:

1. Application Forms
2. Overview
3. EA Pre-app Response
4. WAMITAB Qualifications
5. Management System
6. Non-Technical Assessment
7. Environmental Risk Assessment
8. Raw Materials Assessment
9. Habitat Assessment
10. Receiving Waters Impact Assessment
11. Noise Assessment & Management Plan
12. Site Report (2011 version, Hyder Ltd.)

LTP Operation (Summary drawn from site Management System (MS), Section 5 of the application, section 5.2 within the MS)

The LTP has two storage tanks (storage tanks 1 & 2, referred to hereafter as STOR1 & STOR2, respectively) each with a capacity of 2250m^3. Under normal operating conditions STOR 1 contains raw leachate and STOR 2 is used for the storage of treated leachate.

All landfill leachate entering the LTP is derived from the Chelson Meadow landfill via four pumping stations, which pump leachate to STOR1. The LTP has four sequential batch reactors (SBRs) where leachate sourced from STOR1 is treated. Under normal operating conditions, treated leachate is exported to STOR2 for containment prior to discharge during the high tide window.

Each SBR has a capacity of 740m^3 when full; only 330m^3 is released as treated discharge and the remainder is retained along with enough active microbial population to maintain the system. Whenever leachate enters the SBRs it is diluted by more than 50% because 410m^3 is retained after the previous discharge.

When little leachate is generated (e.g. dry periods) output from a single SBR only may be discharged during the high tide window, amounting to ca. 660m^3 per day. Under normal operating conditions in winter, output ranges from ca. 1650m^3 to 2310m^3.

The LTP has three modes of operation: normal, peak and emergency.

NORMAL MODE

Normal operation involves 330m^3 of leachate being pumped from STOR1 to a designated SBR depending on how full the storage tank is, and if leachate is required by the SBR. The latter depends on how many SBRs are currently in use.

Once full the SBR enters the reaction phase during which the blower aerates the leachate to suspend and mix it with microbial biomass. The reaction phase can take 6-7 hours depending on the strength of the incoming leachate and the state (quality) of the microbial biomass.

Table 1 illustrates changes to the leachate in SBR1 during a typical reaction phase operating in Normal Mode. Samples were taken from: leachate prior to discharge from STOR1; the receptor SBR before filling commenced; and then hourly (starting from zero hours) during a 7-hour reaction phase. On this occasion the incoming leachate was in the top 10% for concentration of ammoniacal-nitrogen recorded on 54 occasions throughout 2019 (see Table 2 later).

Key parameters that change over the reaction 7-hour period and indicate successful leachate treatment are:

- A progressive decline in NH_3 and concomitant proportional increase in NO_3
- The final concentration of NO_2 is below 0.02mg/l ensuring minimal toxicity to the active microbial biomass
- Alkalinity (HCO_3) declines as it is utilised by actively reproducing bacteria
- Suspended solids are high while the blowers are in operation (see 'Comments' in Table 1), indicating the microbial biomass is suspended, available for nitrification, but not at excessive density

At the end of the reaction phase the blowers stop and leachate is left to settle for ca. 3 hours so the microbial biomass can sink to the bottom of the SBR and is not discharged with treated leachate. Over the next hour, 330m^3 is decanted by gravity from the top of the liquor level and pumped to STOR2. Once decant is complete, the SBR is available to receive more leachate if required. If more than two SBRs are in use, they will discharge to STOR2 a minimum of one hour after each other.

The number of SBRs brought into operation at any one time depends on how much leachate is in STOR1, which is filled continuously at a rate determined by input from the landfill. In Normal Mode STOR2 discharges after high tide has been sensed by the tide sensor. Whatever volume of treated effluent is in STOR2 will be released over a maximum of a 2-hour period, commencing half an hour after high tide is detected. If tides permit, two separate tank discharges may occur within 24 hours.

PEAK MODE

Peak mode occurs when incoming leachate fills STOR1 quicker than can be treated when operating under Normal Mode. When STOR1 is at 65% capacity the system switches to pre-set 'Peak Modes' for treatment. This reduces the reaction phase to ca. 3 hours with 2 hours settling. However long the SBR has been operating in a phase (reaction or settling), it will switch immediately to the Peak Mode setting. For example, the reaction phase may be 4 hours into a 7-hour period, but on detecting the switch to Peak Mode it will stop the reaction phase immediately and commence settling.

Peak Mode is designed to enable the LTP to cope with increased volumes of leachate, but the discharge of the treated liquor is still restricted to the same tidal window as for normal operation. Peak Mode works on the principal that when more leachate is generated (during periods of higher rainfall), it is weaker (see winter periods shown in Table 2) and therefore a shorter reaction period is as effective as the longer period required when the leachate is stronger. This is indicated in Table 2 by the consistently low concentration of ammoniacal nitrogen in outfall treated leachate irrespective of incoming leachate strength.

Peak mode permits each SBR to always undertake two treatment cycles between successive tidal discharge windows rather than the single discharge under normal operating conditions (excepting days when there are two high tides).

EMERGENCY MODE

When the volume of leachate exceeds the capacity of the LTP in Peak Mode the system switches to Emergency Mode, whereby STOR2 empties to the River Plym at any time irrespective of tidal status or when the emergency started. Emergency mode is triggered when STOR1 reaches 80-85% capacity.

In Emergency mode, each SBR can complete five treatment cycles within a 24-hour period because the leachate is sufficiently dilute that the reaction time required to achieve permit compliance is much reduced. With four SBRs operating there is the capacity to treat up to 6600m^3 in a 24-hour period.

On the rare occasions when the LTP has experienced these extreme operating conditions, additional monitoring is undertaken to demonstrate that effluent is still permit compliant. More usually, provided there are no other constraints individual SBRs in Emergency Mode undergo two treatment cycles between successive tidal events (N.B. discharge is not restricted to the tidal window in Emergency Mode).

Once STOR2 has been emptied by discharging to the River, STOR1 and STOR2 function together via a connecting valve to provide the additional storage capacity required for incoming leachate as there is no need to store treated effluent until the next high tide (the storage capacity for incoming leachate is doubled compared to Normal and Peak Modes). This is achieved by discharging direct from the SBRs at the end of settling period whatever the tidal status, and there is no delay between discharge events from the different SBRs. Depending on the volume of leachate entering the STORs (and therefore the SBRs), the reaction and settling phases can be altered as required (e.g. 2 hours and 1 hour, respectively).

Entries in red in Table 2 indicate occasions when samples were taken from the LTP operating in Emergency Mode, i.e. approximately one third of the data entries. The mean concentration of ammoniacal nitrogen for incoming leachate during periods of Emergency operation was ca. 28mg/l, compared to 73mg/l for other modes of operation relating to data in Table 2 (Standard Error = 1.51 and 2.69, respectively).

The permit condition for ammoniacal nitrogen in effluent discharged to the River is 10mg/l, but the LTP is operated on a philosophy of minimising the concentration (see outfall concentrations in Table 2). On rare occasions, if increased throughput is essential to maintain operations, effluent may be discharged with ammoniacal nitrogen at 10mg/l: this still represents permit compliance.

Table 1: Detailed chemical analysis of incoming leachate, SBR liquor and treated leachate (before full settling) within the SBR sampled at hourly intervals during the reaction phase on one operational occasion July 24th 2019, Chelson Meadow LTP. N.B. At 7hrs the SBR is not being aerated (aeration is intermittent during the second half of the reaction phase).

Date: 24.07.2019			SBR: 39							
	Leachate	**1/2 Empty**	**React 0hrs**	**React 1hrs**	**React 2hrs**	**React 3hrs**	**React 4hrs**	**React 5hrs**	**React 6hrs**	**React 7hrs**
pH	8.1	8.3	8.0	8.0	8.0	7.8	7.7	7.7	8.0	8.5
Cond µS	2500	2000	2200	2200	2200	2200	2100	2000	2000	2000
HCO3 mg/l	1205	311	1265	880	1290	1160	1430	395	343	316
TOC mg/l	32	55	205	260	274	337	322	371	363	35
BOD mg/l	8	6	24	37	22	25	29	18	17	<5
COD mg/l	98	104	494	752	756	705	635	912	1012	101
SS 105°C	52	460	2300	1940	2840	2260	2180	3240	3360	156
SS 500°C	20	300	1660	1420	2060	1600	1530	2470	2530	109
TON mg/l	<1.3	95.3	51.9	60.1	65.3	80.3	89.8	93.9	101.2	97.1
NH3 mg/l	100	<0.5	45	37	30	22	14	6.4	<0.5	<0.5
NO3 mg/l	<1.3	95.271	51.233	58.995	63.460	78.077	87.031	90.162	100.042	97.097
NO2 mg/l	0.09	<0.02	0.64	1.11	1.86	2.21	2.81	3.74	1.14	<0.02
Cl mg/l	345	351	343	335	345	350	348	341	343	345
P mg/l	0.356	1.27	7.94	7.05	8.82	7.99	8.25	8.05	7.70	0.445
S04 mg/l	17	25	61	56	66	61	63	60	60	20
Ca mg/l	146	189	677	610	761	670	708	695	683	161
Mg mg/l	41	41	50	49	51	50	51	50	50	41
K mg/l	81	80	86	86	86	87	86	86	86	80
Na mg/l	225	229	231	233	232	234	233	232	233	226
Fe mg/l	28	78.8	580	505	661	566	607	593	578	30.0
Mn mg/l	1.36	12.5	115	101	132	114	122	119	117	5.08
Cu mg/l	0.521	<0.085	<0.085	<0.085	<0.085	<0.085	<0.085	<0.085	<0.085	<0.085
Zn mg/l	0.231	0.101	0.765	0.650	0.878	0.756	0.827	0.782	0.754	<0.09
Pb mg/l	0.0923	<0.05	0.181	0.176	0.227	0.173	0.201	0.194	0.177	<0.05
Cd mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Cr mg/l	<0.03	<0.03	0.0416	0.0373	0.0476	0.0427	0.0407	0.0384	0.0406	<0.03
Ni mg/l	0.0171	<0.01	0.0308	0.0324	0.0381	0.0227	0.0363	0.0298	0.0344	<0.01
COMMENTS			Aerating	Aerating	Aerating	Aerating	Aerating	Aerating	Aerating	Not Aerating

Table 2: Concentration (mg/l) of Ammoniacal Nitrogen in incoming (from STOR1 and potentially STOR2) and treated leachate (River Outfall) at Chelson Meadow LTP sampled on multiple occasions during 2019. Entries in red relate to samples taken when the LTP was in Emergency Mode.

Date & Time of Sampling	NH_3 (mg/l) Incoming Leachate (STOR1)	Date & Time of Sampling	NH_3 (mg/l) Treated Leachate (Outfall)
02/01/2019 08:40	18	02/01/2019 09:20	0.5
15/01/2019 08:40	64	15/01/2019 09:00	0.5
21/01/2019 08:10	45	22/01/2019 07:45	0.5
28/01/2019 12:30	32	28/01/2019 12:15	0.5
01/02/2019 10:05	33	01/02/2019 10:00	0.5
11/02/2019 09:00	26	11/02/2019 16:30	0.5
18/02/2019 09:20	30	18/02/2019 11:00	0.5
25/02/2019 08:45	42	25/02/2019 10:15	0.5
01/03/2019 09:00	52	01/03/2019 08:50	0.5
11/03/2019 08:50	33	12/03/2019 10:10	0.5
22/03/2019 15:15	44	18/03/2019 16:30	0.5
26/03/2019 08:30	45	26/03/2019 12:45	0.5
01/04/2019 10:00	60	01/04/2019 17:35	0.5
08/04/2019 09:00	44	08/04/2019 11:20	0.5
15/04/2019 09:10	49	15/04/2019 15:25	0.5
22/04/2019 08:20	66	22/04/2019 08:25	0.5
23/04/2019 09:45	70	23/04/2019 10:20	0.5
29/04/2019 07:40	66	29/04/2019 16:05	0.5
01/05/2019 08:05	75	01/05/2019 08:15	0.5
07/05/2019 09:10	71	07/05/2019 09:00	2.7
13/05/2019 10:00	65	13/05/2019 14:40	0.5
21/05/2019 08:45	80	21/05/2019 09:10	0.5
28/05/2019 08:00	87	28/05/2019 11:00	2.1
03/06/2019 08:50	89	04/06/2019 11:00	0.5
17/06/2019 08:45	72	17/06/2019 09:00	0.5
24/06/2019 17:20	80	24/06/2019 09:40	0.5
01/07/2019 08:45	85	01/07/2019 11:30	0.5
07/07/2019 09:35	97	07/07/2019 09:25	0.5
08/07/2019 11:00	94	08/07/2019 10:30	0.5
15/07/2019 08:40	96	15/07/2019 09:10	0.5
22/07/2019 10:30	98	23/07/2019 11:30	0.5
29/07/2019 08:15	110	29/07/2019 10:50	0.5
01/08/2019 09:35	99	01/08/2019 09:40	0.5
05/08/2019 10:30	110	05/08/2019 10:55	0.5
27/08/2019 10:00	94	27/08/2019 11:40	0.5
01/09/2019 08:35	88	01/09/2019 08:30	0.5
09/09/2019 08:35	110	09/09/2019 10:30	0.5
16/09/2019 11:00	100	17/09/2019 09:45	0.5
23/09/2019 09:50	110	23/09/2019 11:15	0.5
30/09/2019 07:55	22	30/09/2019 08:25	0.5
03/10/2019 07:40	26	03/10/2019 13:25	0.5
07/10/2019 08:50	29	07/10/2019 13:15	0.5
14/10/2019 07:55	19	14/10/2019 08:50	0.5
21/10/2019 08:30	27	21/10/2019 09:15	0.5
28/10/2019 08:30	25	28/10/2019 14:15	0.5
04/11/2019 08:00	24	04/11/2019 08:15	0.5
11/11/2019 10:20	26	12/11/2019 09:20	0.5
18/11/2019 08:30	32	18/11/2019 11:30	0.5
25/11/2019 08:10	25	25/11/2019 09:15	0.5
02/12/2019 09:00	30	02/12/2019 10:45	0.5
09/12/2019 08:30	32	09/12/2019 15:30	0.5
16/12/2019 09:00	26	16/12/2019 10:10	0.5
22/12/2019 09:30	23	22/12/2019 09:35	0.5
30/12/2019 10:25	37	30/12/2019 08:15	0.5

The extent to which the LTP operated in Emergency Mode over the period 2012 to 2021 is shown in Table 3, expressed as the volume and proportion of total discharge released. Total annual rainfall is also provided, though this is not always a good predictor of how reliant the LTP will be on Emergency Mode because it is intensity and duration of rainfall on the landfill and surrounding surface water drainage system (linked to the LTP) that determines inflow of leachate to the LTP. Also, Table 3 does not reflect maintenance issues affecting the availability or otherwise of SBRs. Table 3 does *not* show evidence of increasing reliance on Emergency Mode in managing leachate treatment over the period 2012-2021.

Table 3: The importance of Emergency Mode to the discharge to the River Plym of effluent from the Chelson Meadow LTP over the 10-year period 2012-2021, showing days spent in Emergency Mode and the associated percentage of the total annual effluent discharged in Emergency Mode.

Year	No. of days in Emergency Mode	Volume discharged in Emergency Mode m^3	Total Volume Discharged to R Plym m^3	% of Total Volume Discharged in Emergency Mode	Total Annual Rainfall (mm) MET Mountbatten
2012	74	243240	770809	32	1370.2
2013	36	134510	578535	23	1003.2
2014	106	333030	707759	47	1132.0
2015	20	65340	608117	11	946.0
2016	50	175530	593404	30	956.4
2017	5	14520	569109	3	1021.6
2018	111	339460	632276	54	1066.8
2019	95	270930	684584	40	1125.6
2020	68	240390	701130	34	1102.8
2021	48	145669	670291	22	999.6

Leachate Characteristics 2010-2021

Table 4 and Figure 2 show the total volume of treated leachate discharged to the River Plym between 2010 and 2021. Over this period the permit volume limit was breached on five occasions: in 2012 and 2014 and in the consecutive years 2019, 2020 and 2021. Breaches of the volume condition of the permit are not associated with breaches to the limit for ammoniacal nitrogen or any other chemical determinands with permit limits.

Corresponding total annual rainfall taken from the Mountbatten Meteorological (MET) Office recording station are also provided in Tables 3, 4 and Figure 2. [N.B. it is the intensity and duration of rainfall on the landfill and surrounding surface water drainage system (linked to the LTP) determines inflow of leachate to the LTP and not the annual total as such]. Figure 2 shows that as rainfall increases more leachate is generated, but evidence from Table 2 demonstrates that with increased volume the ammoniacal nitrogen is diluted and treatment remains effective (Table 2). For the period 2010-2021 most rainfall occurred in 2012, which is also when the largest volume of leachate was generated.

Figure 3 shows a subset of the data from 2008 to 2021 (selected because monitoring was undertaken weekly from 2008 onwards); statistics for the linear regression of the decline in ammoniacal nitrogen over time are also provided. Figure 3 highlights repeated seasonal fluctuation in the concentration of ammoniacal nitrogen in incoming leachate, with late summer peaks, and lowest values over winter.

Table 4: Total volume (m^3) of treated leachate discharged to the River Plym from Chelson Meadow LTP 2010-2021 with corresponding total annual rainfall data (mm, Mountbatten, Plymouth). Figures in red exceed the permit volume limit, figures in green are within the limit.
The exceedance in 2021 occurred in the last week of the calendar year and was caused by extreme rainfall in short period of time.

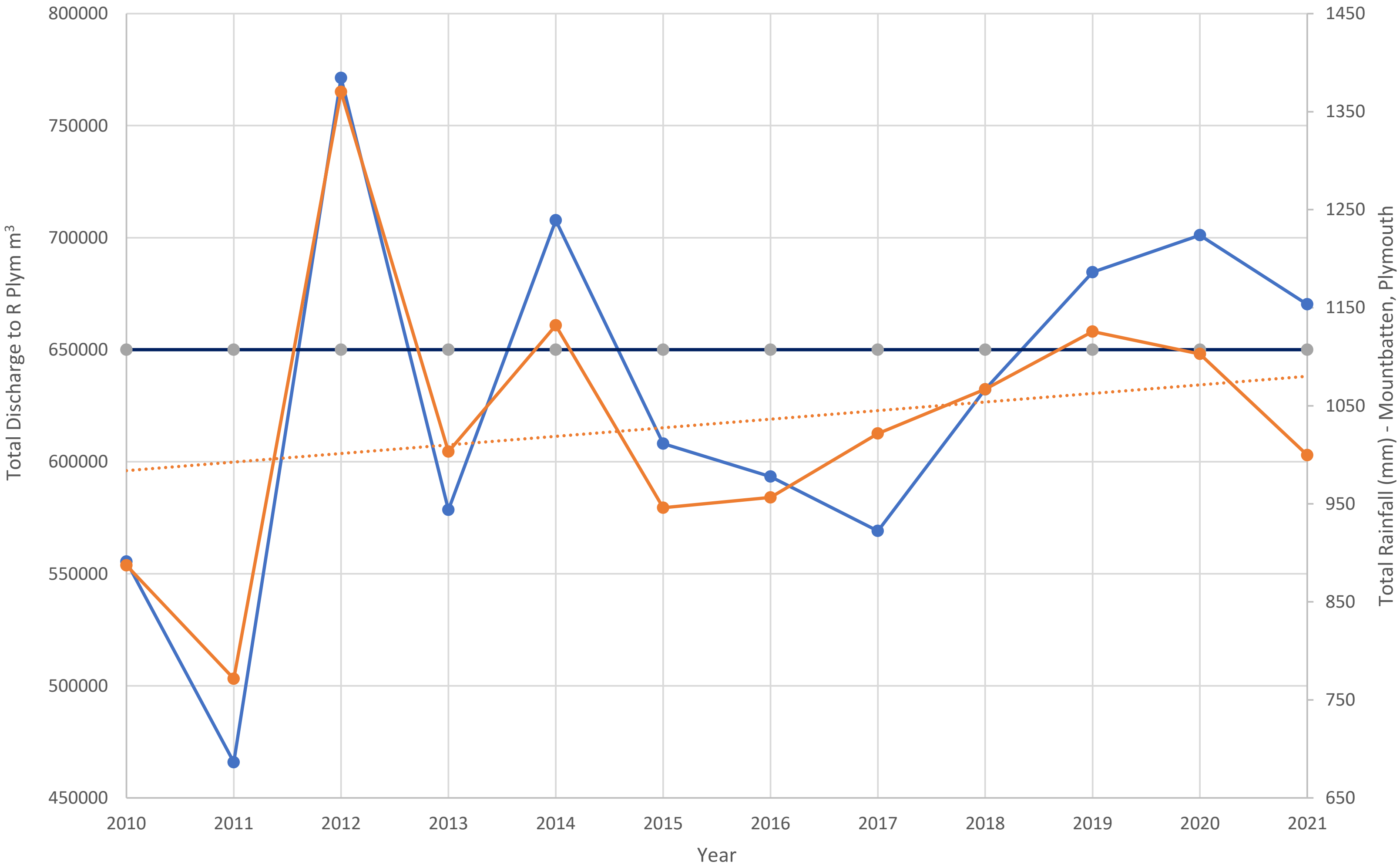
Year	**Quantity m^3**	**Rain (mm) MET**
2010	555,450	887.3
2011	465,938	771.5
2012	771,309	1370.2
2013	578,535	1003.2
2014	707,759	1132.0
2015	608,117	946.0
2016	593,404	956.4
2017	569,110	1021.6
2018	632,276	1066.8
2019	684,584	1125.6
2020	701,130	1102.8
2021	670,291	999.6

Figure 4 illustrates the same gradual decline in the concentration of ammoniacal nitrogen for the longer period of 2002-2021, expressed as the mean of all available figures for the 12-month period from each year. The concentration of ammoniacal nitrogen in 2021 was less than 50% of the 2002 figure, a decline which cannot be attributed to dilution from increased rainfall alone (see shallow gradient to upward overall rainfall trend shown on Figure 2). Figure 5 provides summary statistics for the years 2008-2021 when monitoring was weekly; it is included to show the full range of concentrations recorded per calendar year.

Table 5 shows the high efficacy of leachate treatment by the LTP in 2012, which had the highest total annual rainfall of the period 2010 to 2021 (complete annual data sets for all years), the highest total volume of leachate generated by the landfill and highest volume of effluent discharged from the LTP for the twelve-year period considered. Table 6 shows the months in which the highest rainfall occurred, specifically April, June, August, November and December.

Data for the twelve-year period 2010 to 2021 show a clear negative linear relationship between the annual mean concentration of NH3-N in incoming leachate and total annual volume of treated effluent discharged (Figure 6). Extrapolation using the linear term suggests that for a calendar year where the volume generated approaches 850,000, incoming leachate would have a mean NH3-N concentration of ca. 42 mg/l. This would be diluted by half as the leachate enters the SBR and consequently the biological treatment system would only require a couple of hours for reaction time to reduce the concentration to below 10mg/l (current permit limit). Even in Emergency Mode, this short reaction period would be achievable.

Figure 2: Total annual outfall of treated leachate (m_3, blue line) from Chelson Meadow LTP and corresponding total annual rainfall (mm, orange line, Mountbatten, Plymouth) between 2010 and 2021, and showing an upward trend in rainfall over time (linear regression)



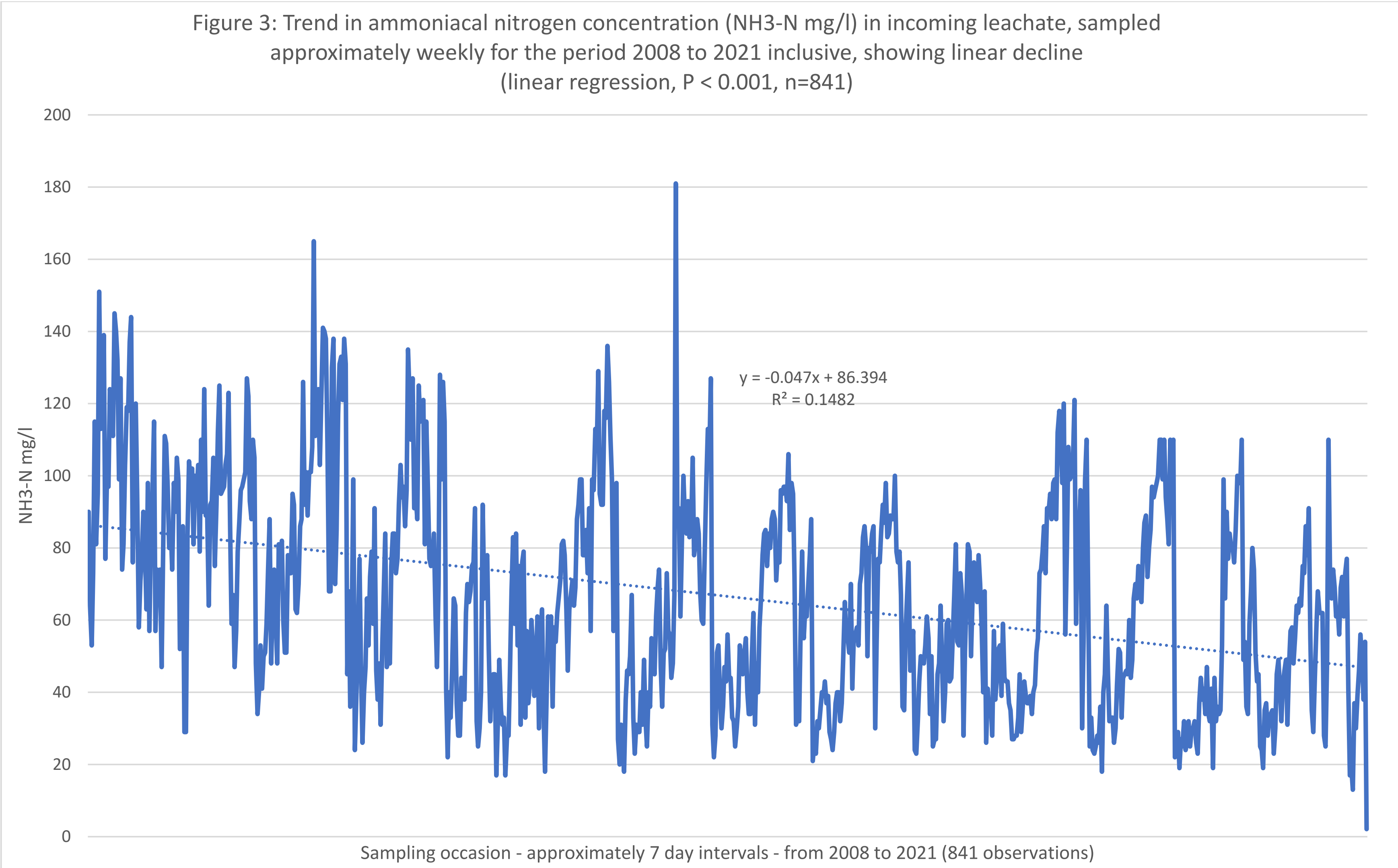


Figure 3: Trend in ammoniacal nitrogen concentration (NH3-N mg/l) in incoming leachate, sampled approximately weekly for the period 2008 to 2021 inclusive, showing linear decline (linear regression, P < 0.001, n=841)
NH3-N mg/l
200
180
160
140
120
100
80
60
40
20
0
y = -0.047x + 86.394
R² = 0.1482
Sampling occasion - approximately 7 day intervals - from 2008 to 2021 (841 observations)

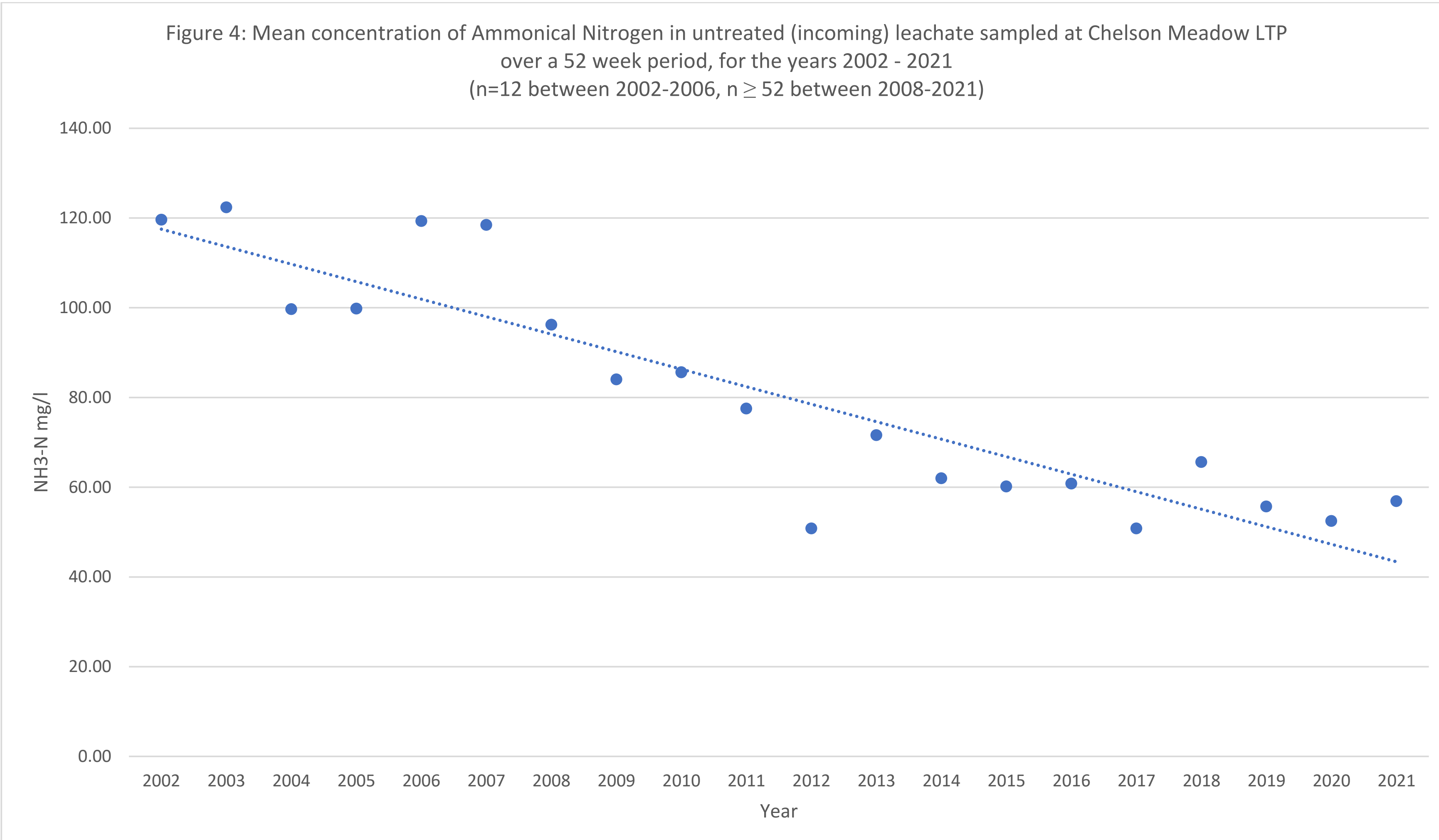


Figure 4: Mean concentration of Ammonical Nitrogen in untreated (incoming) leachate sampled at Chelson Meadow LTP
over a 52 week period, for the years 2002 - 2021
(n=12 between 2002-2006, n ≥ 52 between 2008-2021)
NH3-N mg/l
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year

Figure 5: Box & Whisker plots for ammoniacal nitrogen concentration (NH3-N mg/l) in incoming leachate sampled approximately weekly at the LTP, summarised according to the calendar years 2008-2021 inclusive

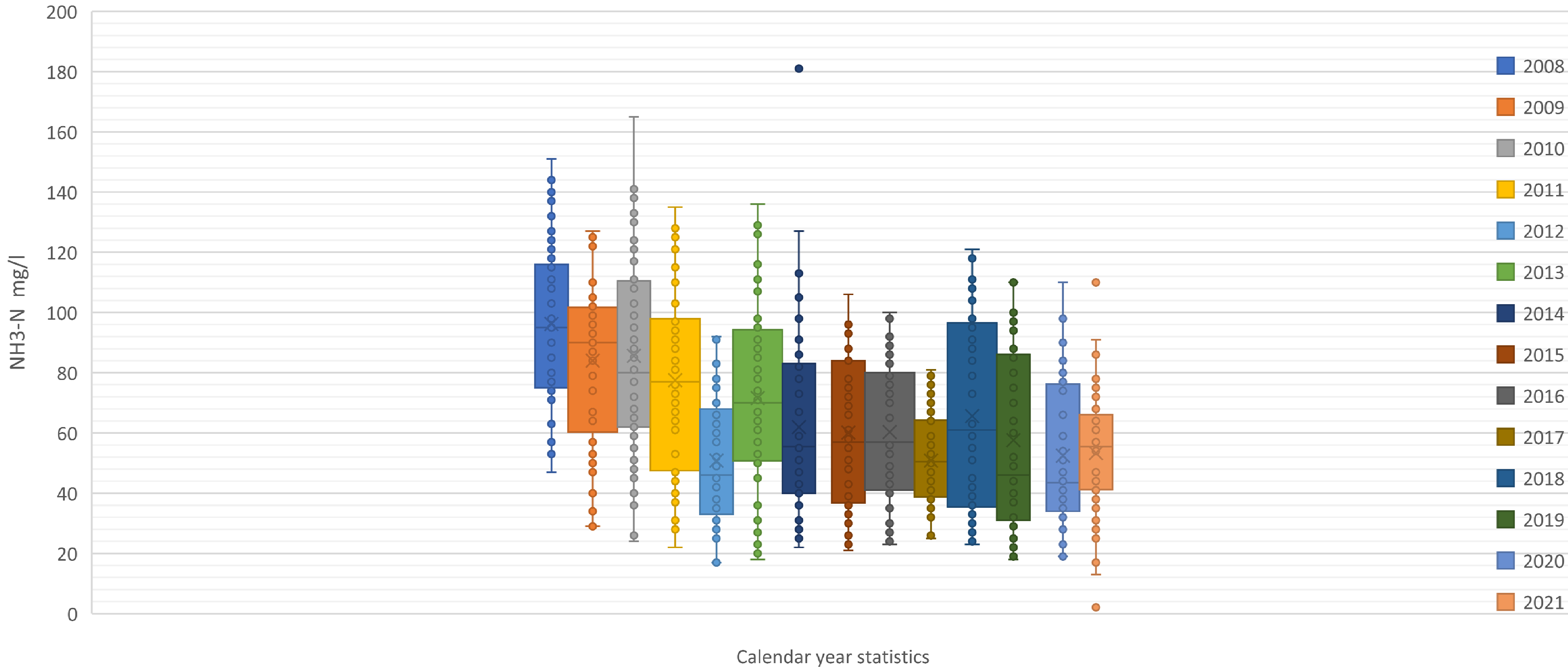


Table 5: Concentration (mg/l) of Ammoniacal Nitrogen in incoming (STOR1) and treated leachate (outfall/effluent) at Chelson Meadow LTP sampled on multiple (approximately weekly) occasions during 2012

Date & Time of Sampling	NH_3 (mg/l) Incoming Leachate (STOR1)	Date & Time of Sampling	NH_3 (mg/l) Treated Leachate (Outfall)
02/01/2012 12:35	40	02/01/2012 12:40	0.2
09/01/2012 10:35	38	09/01/2012 18:30	0.2
23/01/2012 18:10	62	23/01/2012 18:30	0.2
01/03/2012 09:00	70	01/03/2012 11:00	2.9
06/03/2012 17:00	65	06/03/2012 17:15	0.2
14/03/2012 09:05	68	14/03/2012 10:50	2.6
18/03/2012 13:50	75	19/03/2012 00:00	5.9
25/03/2012 15:30	76	25/03/2012 20:45	0.2
02/04/2012 10:20	91	02/04/2012 17:45	4.6
24/04/2012 09:01	32	24/04/2012 09:00	0.2
25/04/2012 16:10	25	25/04/2012 14:30	0.2
04/05/2012 11:00	30	04/05/2012 16:50	0.2
17/05/2012 17:30	40	17/05/2012 17:20	0.2
21/05/2012 16:30	92	21/05/2012 19:40	0.2
23/05/2012 17:00	66	23/05/2012 12:30	0.2
30/05/2012 10:00	78	31/05/2012 09:00	0.2
07/06/2012 11:40	52	07/06/2012 11:15	0.2
14/06/2012 09:25	32	14/06/2012 13:40	0.2
18/06/2012 10:05	44	18/06/2012 13:25	0.2
25/06/2012 12:30	45	25/06/2012 12:15	0.2
27/06/2012 09:30	32	27/06/2012 08:30	0.2
05/07/2012 09:15	49	05/07/2012 09:30	0.2
05/07/2012 09:17	35	05/07/2012 11:10	0.2
07/07/2012 08:00	31	07/07/2012 12:50	0.2
07/07/2012 08:02	33	07/07/2012 15:50	0.2
07/07/2012 13:50	17	07/07/2012 17:05	0.2
07/07/2012 13:52	28	08/07/2012 08:00	0.2
10/07/2012 09:45	28	10/07/2012 09:35	0.2
18/07/2012 10:35	46	18/07/2012 09:00	0.2
24/07/2012 11:10	68	24/07/2012 11:00	0.2
01/08/2012 09:05	83	03/08/2012 07:50	0.2
07/08/2012 08:45	59	07/08/2012 10:30	0.2
13/08/2012 11:55	84	13/08/2012 16:05	0.2
20/08/2012 09:15	53	20/08/2012 09:05	0.2
28/08/2012 10:05	31	28/08/2012 10:05	0.2
12/09/2012 10:55	76	12/09/2012 10:55	0.2
17/09/2012 08:15	79	17/09/2012 07:55	0.2
24/09/2012 10:40	33	24/09/2012 13:15	0.2
02/10/2012 08:30	57	02/10/2012 08:15	0.2
08/10/2012 09:00	37	08/10/2012 13:10	0.2
16/10/2012 08:15	42	16/10/2012 07:45	0.2
30/10/2012 08:05	53	30/10/2012 07:15	0.2
07/11/2012 08:05	39	07/11/2012 11:25	0.5
14/11/2012 10:00	46	15/11/2012 07:25	0.2
19/11/2012 11:55	61	19/11/2012 10:10	0.2
27/11/2012 09:55	30	27/11/2012 11:00	0.2
12/12/2012 08:45	63	12/12/2012 08:45	1.3
17/12/2012 09:05	36	17/12/2012 08:55	0.2
27/12/2012 14:00	18	27/12/2012 12:10	0.2

Table 6: Total monthly rainfall for 2012, Meteorological Office, Mountbatten, Plymouth, and the total volume of treated effluent discharged monthly to the River Plym

Month in 2012	**Total monthly rainfall (mm)**	**Total effluent discharged (m3)**
January	59.7	65243
February	31.8	57260
March	22.0	33223
April	133.9	40556
May	48.6	57650
June	168.0	67640
July	112.2	79200
August	151.9	50550
September	63.2	45860
October	118.6	68337
November	175.2	97980
December	285.1	107810

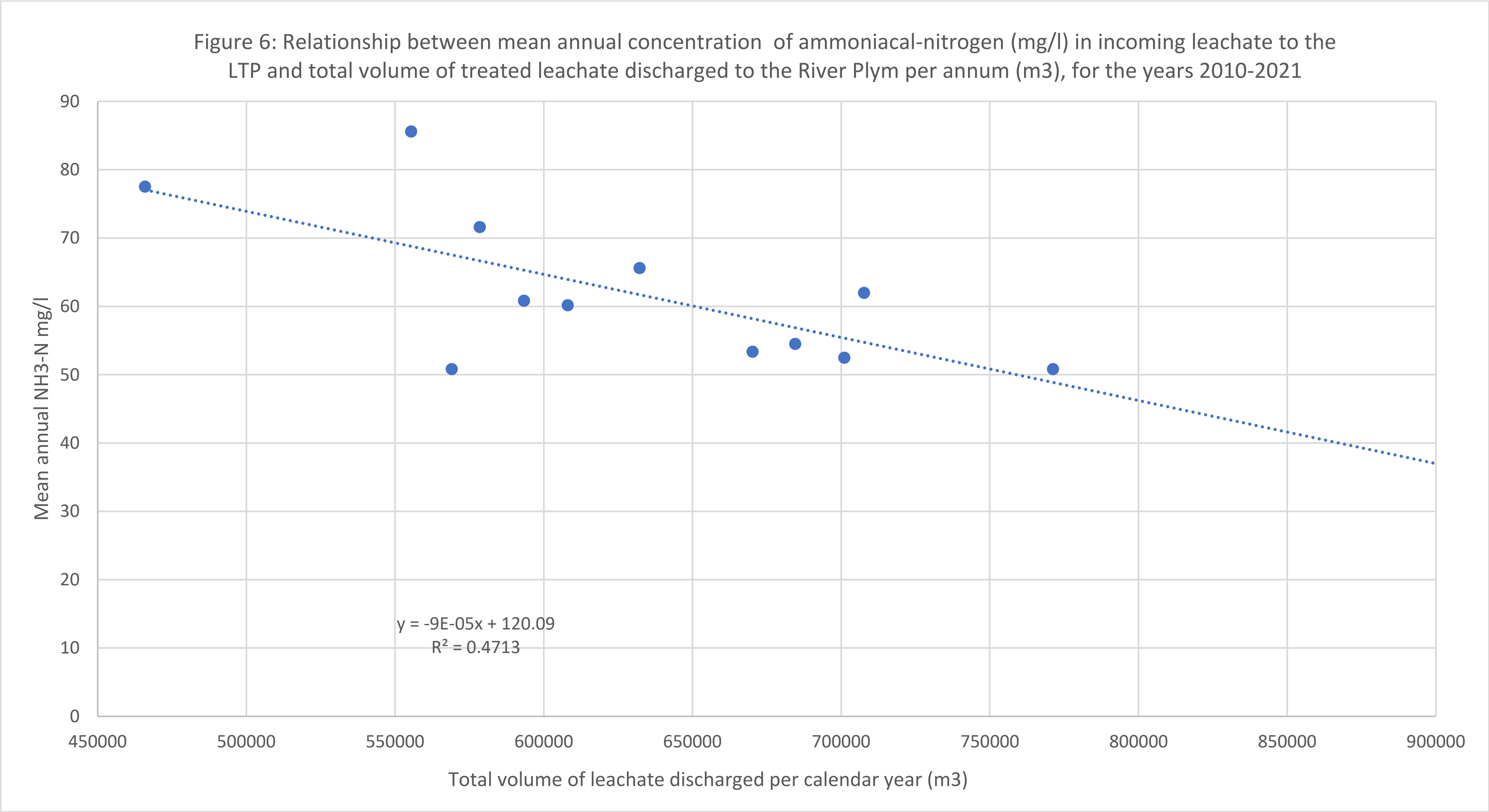


Figure 6: Relationship between mean annual concentration of ammoniacal-nitrogen (mg/l) in incoming leachate to the
LTP and total volume of treated leachate discharged to the River Plym per annum (m3), for the years 2010-2021
Mean annual NH3-N mg/l
0
10
20
30
40
50
60
70
80
90
450000
500000
550000
600000
650000
700000
750000
800000
850000
900000
Total volume of leachate discharged per calendar year (m3)
y = -9E-05x + 120.09
R² = 0.4713

LTP Permit Breaches & the River Plym - Long-Term Sustainability

Irrespective of the volume of treated leachate discharged, the concentration of ammoniacal nitrogen has not exceeded the permit condition of 10mg/l over the period 2010 and 2021 inclusive: expressed as an annual non-parametric statistic it was consistently below 1mg/l (Table 7). Both Suspended Solids (SS) and Biochemical Oxygen Demand (BOD) have also been maintained within permit limits in the long term (Tables 8 & 9, respectively). Although there were occasions in 2008 when SS exceeded the limit, Table 9 shows that the annual summary statistics have declined to a consistently low value.

Table 7: Summary non-parametric statistics for annual concentration ($n \geq 52$) of ammoniacal nitrogen (NH_3 mg/l) in treated outfall to the River Plym from the LTP, 2010-2021

	NH_3 (mg/l) statistic (annual, $n \geq 52$)	
Year	**Median**	**Mode**
2010	0.20	0.15
2011	0.20	0.20
2012	0.20	0.20
2013	0.87	0.20
2014	0.30	0.20
2015	0.20	0.20
2016	0.20	0.20
2017	0.30	0.30
2018	0.30	0.30
2019	0.50	0.50
2020	0.50	0.50
2021	0.50	0.50

Table 8: Summary parametric and non-parametric statistics for annual concentration ($n \geq 52$) of Biochemical Oxygen Demand (BOD mg/l) in treated outfall to the River Plym from the LTP, 2010-2021. Permit limit = 10mg/l

	BOD (mg/l) statistic (annual, $n \geq 52$)		
Year	**Median**	**Mean**	**Mode**
2008	4.0	4.0	4.0
2009	5.0	4.0	4.0
2010	5.0	5.0	5.0
2011	4.0	4.0	4.0
2012	5.0	5.0	5.0
2013	5.0	5.0	5.0
2014	5.0	4.0	4.0
2015	5.0	5.0	5.0
2016	5.0	5.0	5.0
2017	5.0	5.0	5.0
2018	5.0	5.0	5.0
2019	4.0	3.5	3.5
2020	4.0	3.5	3.5
2021	4.0	4.0	4.0

Table 9: Summary parametric and non-parametric statistics for annual concentration (n ≥ 52) of Suspended Solids Demand (SS 105ºC mg/l) in treated outfall to the River Plym from the LTP, 2010-2021. Permit limit = 75mg/l

Suspended Solids 105ºC (mg/l) statistic (annual, n ≥ 52)			
Year	**Median**	**Mean**	**Mode**
2008	50	50	50
2009	38	45	38
2010	36	55	29
2011	35	43	30
2012	44	47	49
2013	34	37	23
2014	30	31	23
2015	30	31	30
2016	29	32	29
2017	32	35	32
2018	33	38	33
2019	23	27	14
2020	21	22	19
2021	21	22	19

As it operates currently, evidence presented shows the LTP can treat effectively inputs of leachate exceeding 770,000m^3, especially since the concentration of ammoniacal nitrogen is declining with time and shows a negative relationship with the volume of leachate generated by the landfill. This permit variation therefore requests that an additional margin of 80,000m^3 is granted because there is no evidence that this increase poses an environmental risk to the River Plym when the LTP is within the usual operational parameters.

The revised maximum of 850,000m^3 will provide a safety margin above the initial figure of 800,000m^3 stated in the pre-app document. The original volume of 800,000m^3 is only 30,000m^3 above the maximum volume treated in the worst-case scenario single calendar year (2012). With a treatment capacity of 6600m^3 available during Emergency Mode, 30,000m^3 would allow for only around 7 days of additional critical treatment capacity, which may be insufficient in the face of climate change.

Surface Water Management

Some of the input to the LTP is not landfill infiltrate (leachate) but is attenuated surface water. Figure 7 shows the surface area of different sections of the Chelson Meadow Waste Facility. Drainage of parts of the hard infrastructure are directed to the LTP, which was historic practice determined by site topography and other design constraints. Key surface water inputs pass through one of two oil interceptors prior to entering the LTP.

Figure 7 also indicates the layout of the surface water and leachate drainage system. Surface water generated by rainfall drains to the LTP from areas hatched in green, amounting to 17,511m^2 of impermeable surface. Plate 2 provides an aerial view of the hard surfaces (N.B. not the same orientation as Figure 7).

Using the 2012 and 2019 figures for total annual rainfall (mm, two years chosen to illustrate high rainfall) gives a crude idea of the volume of surface water generated from the total area of hard surface, amounting to 23,994m^3 and 19,710m^3 potentially contributing to the breach of permit limit in those two years: these inputs represent only 3.11% and 2.9% of the effluent output from the LTP, respectively. Even if it was possible to redirect surface water the permit limit would still have been breached in both 2012 and 2019.

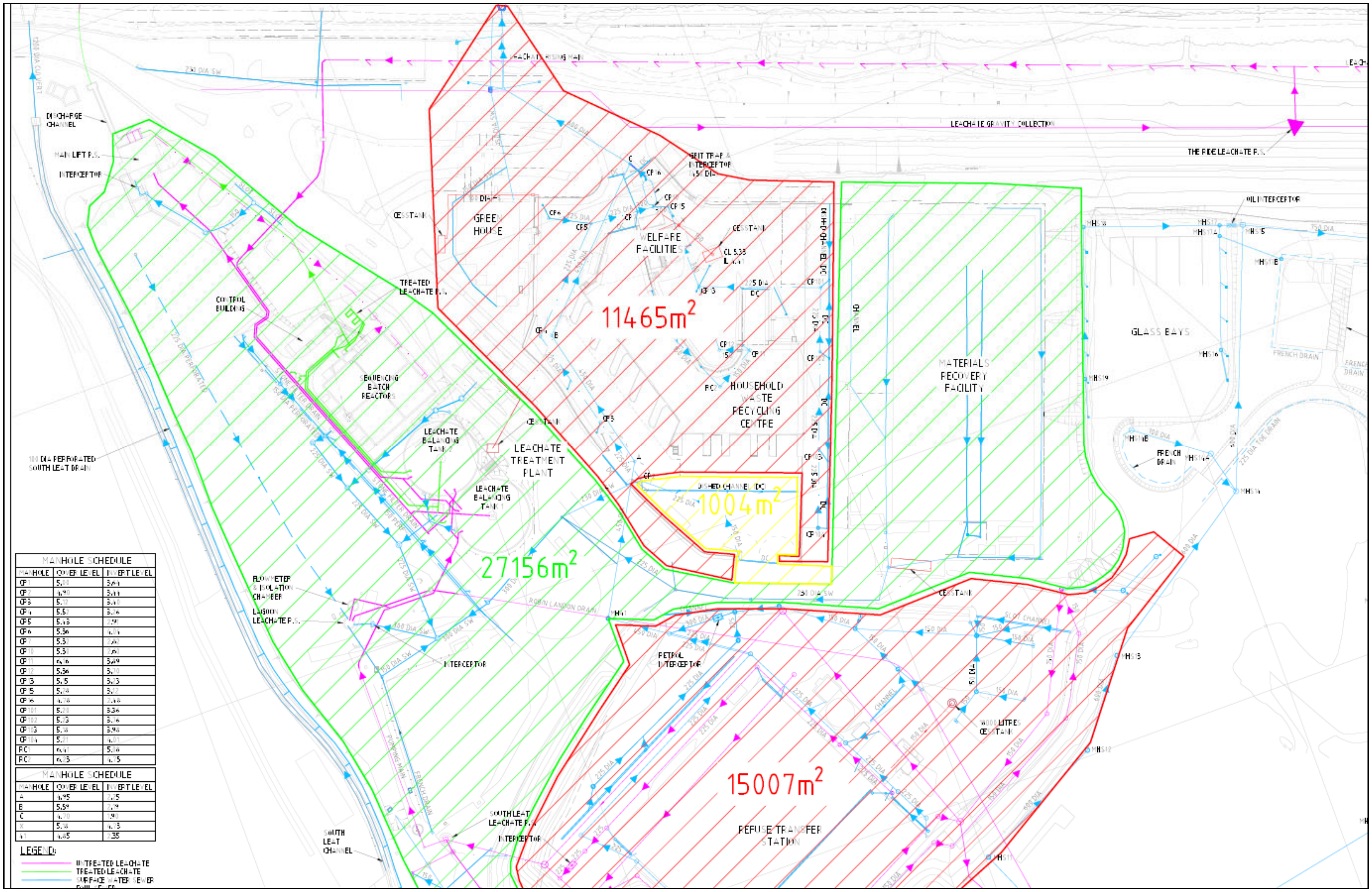


Figure 7: Surface water and leachate drainage system for Chelson Meadow Waste Facility (Hyder 2007)

Plate 2: Aerial view showing the section hatched in green on Figure 7, detailing the area of impermeable surface draining surface water to the LTP.

Habitat Assessment

A Habitats Assessment is provided in Section 9 of the application. The assessment identifies features of the Plymouth Sound and Estuaries Special Area of Conservation (SAC) and Plym Estuary County Wildlife Site (CWS) that are potentially sensitive receptors to putative negative impacts from an increase in the volume of treated effluent discharged from the LTP.

The assessment includes a comprehensive, generic risk assessment cataloguing hazards associated with operation of the LTP and how these may impact ecological receptors in the locality. It includes the predicted impact from modelled climate change (to 2050) on these risks, based on changes to key climatic parameters.

The Habitat Assessment incorporates the outcome of a Controlled Waters Risk (see next section) and concludes that provided that current LTP operational controls and monitoring protocols are adhered to, the proposed increase to the total annual discharge will not result in a significant deterioration in water quality in the River Plym and is unlikely to have a measurable negative impact on the integrity of the SAC and/or CWS.

Controlled Waters Risk Assessment

The potential risk to sensitive habitat receptors from treated leachate was evaluated from long term monthly and List 1 monitoring for the outfall using data from 2013 to 2021 (Section 10 of the application, Arcadis 2021).

Arcadis used a sequential 4-Tier assessment process to determine substances that may require control through a numeric emission limit specified in the permit variation, for which the total permissible outfall would be 850,000m^3 compared to the current 650,000m^3. In the context of the outfall pipe, the River Plym is defined as a transitional water rather than coastal or estuarine, and the appropriate screening tests applied.
Surface water pollution risk assessment for your environmental permit - GOV.UK (www.gov.uk).

Test 1 is based on comparison of substances detected above the laboratory method detection limit (MDL) against the appropriate Water Quality Standard (WQS). Where possible, consideration was also made against the Annual Average (AA) Environmental Quality Standard (EQS) and the Maximum Acceptable Concentration (MAC) EQS.

For Test 2, substances exceeding the WQS (or other relevant Standards) were evaluated in terms of their Process Contribution (PC), which takes account of the effect of dilution within the River Plym of effluent released during the high tide window (i.e. at times of high flow rate in the river).

Test 3 was applied to those substances whose PC exceeded 4% of the WQS. In Test 3 the Predicted Environmental Concentration (PEC) is calculated by including the Background Concentration (BC) of a substance in the River Plym. Further modelling is likely to be required when the difference between the PEC and BC is greater than 10% of the WQS.

Test 4 identifies substances for which the PEC exceeds the EQS, and for which further modelling may be required.

Additional screening was applied to Priority Hazardous Pollutants (PHPs) for coastal and estuarine waters, by comparing the annual limit in the discharge, expressed as the total kg/yr of a listed substance (estimated from known concentrations and the proposed increased outfall volume of 850,000m^3), with the tabulated significant load limit (see link above). Total cadmium, total mercury and hexachlorocyclohexane (HCH) were all screened and shown as within the significant load limit.

For completeness, tests were applied according to AA and MAC WQS criteria for both low and mean flow conditions in the River. Most test failures occurred at low flow rates and therefore represent conservatism in the assessment. A summary of the outcomes is provided in Table 7, in which the laboratory MDL is provided along with the total number of samples events available and the number of these that exceeded the MDL.

Table 7: Summary of determinands exceeding criteria for screening Tests 3 & 4 of the Pollution Risk Assessment for treated effluent from the LTP (Arcadis 2021)

Compound	Failure at Test 3	Failure at Test 4	No of detects above MDL*	No of samples analysed*	Laboratory MDL* (µg/l)	Estuarine EQS (µg/l)	
						AA	MAC
Total Ammonia	Yes	No	73	472	200 - 500	1,100	8,000
Total Iron	Yes	No	91	92	1,100	1,000	NA
Total Copper	Yes	Yes	18	92	10 - 85	3.76	NA
Total Zinc	Yes	No	8	92	40 - 100	6.8	NA
Total Lead	Yes	Yes	19	91	20 - 50	1.3	14
Total Cadmium	Yes	Yes	0	91	2 - 5	0.2	NA
Total Chromium	Yes	Yes	0	92	5 - 30	0.6	32 (95th)
Total Nickel	Yes	No	4	92	10 – 70	8.6	34
Total Mercury	Yes	No	1	6	0.1 – 0.2	NA	0.07
Alpha-HCH	Yes	Yes	1	5	0.003 – 0.004	0.0002	0.02
EH>C16-C24	Yes	No	5	6	10	90*	
EH>C24-C40	Yes	No	5	6	10	90*	

* Based on data collected between October 2013 and June 2021

The assessment results are highly conservative because:

- the laboratory analyses determined total metal concentrations in treated effluent whereas comparator WQS/EQS are dissolved concentrations. In most situations, total metal concentrations can be expected to be greater than dissolved concentrations.
- the laboratory MDL for metals failing tests 3 & 4 is an order of magnitude higher than the comparator EQS. Other than iron, metals were not detected in most samples analysed and accordingly the PEC is likely to be a significant over-estimate.
- Only a small number of samples were available for alpha-HCH and mercury, limiting confidence in the outcome of the screening tests.
- If 95th percentile rather than maximum concentrations are applied to the MAC EQS comparison, ammonia does not exceed the criterion for test 3.

Overall, Arcadis (2021) conclude that:

Based on the calculations undertaken, and taking into consideration the large number of conservatisms within the screening assessment (including those relating to assumptions around effluent flow parameters), it is considered unlikely that the proposed increase in treated effluent discharge volumes would result in a significant deterioration in water quality in the River Plym.

Noise Assessment

Section 11 of the application contains the Noise Impact Assessment for the LTP blowers. The blowers were installed in 1996. Other than the adjacent landfill and associated waste operations the nearest noise receptor was the cement works approximately 70m to the south of the LTP permit boundary. Consequently, at the time of installation, noise from the LTP was not assessed formally. The site of the cement works is now a residential development, some of which is occupied; the potential nuisance from operational noise must now be considered.

In 2016 the EA requested that the noise generated by the blowers should be reduced. The replacement system is due to be installed in 2022, and its specification will be in line with the recommendations of the Noise Impact Assessment based on the methodology and assessment protocols of BS 4142:2014+A1:2019.

No complaints about noise generated by the LTP have been received by PCC.

Remove condition 3.1.3 in relation to the periodic monitoring of soil and groundwater, because the site is built on an old landfill.

The LTP was constructed on the historic landfill, so the permit boundary is on the landfill. The only exposed ground is the outfall channel leading to the River Plym; all other surfaces are engineered. There is one borehole within the permit area, which was installed as part of ground investigations for construction of the landfill cut-off wall. There is one borehole just beyond the permit boundary. This could be deemed 'down-gradient' but is within made ground on The Ride, which was constructed to help drain the land before the original landfill was engineered in reclaimed estuary.

One set of soil samples have been taken from opposite the outfall channel (inside and beyond the permit boundary), and water samples drawn from the two boreholes. Results are presented in the Site Conditioning Report for the application.

There are no appropriate data representing 'baseline' conditions for the permit area and with most of the area engineered over emplaced waste, further sampling is considered redundant. Leachate arises from the landfill. Leachate is collected at the LTP, where it is treated. If leachate is emitted from the LTP through operational or catastrophic infrastructure failure it can only return to (i) the landfill either directly through infiltration or (ii) the leachate drainage system, which will return it to the LTP. With no appropriate baseline, and no clean ground beneath the LTP, and impermeable engineered surfaces throughout, continued soil and groundwater sampling is inappropriate.

SOUTH WEST WATER AUTHORITY
~~DEVON RIVER AUTHORITY~~

Register of Conditions imposed under Section 7 of the Rivers (Prevention of Pollution) Act, 1951 as extended by the Clean Rivers (Estuaries and Tidal Waters) Act, 1960 and the Rivers (Prevention of Pollution) Act, 1961.

Folio No. 289

Act under which Consent is issued or Notice is served 1960

Date of Application	Name and Address of Applicant or Person to whom Consent is issued or upon whom Notice is served imposing or varying conditions	Full Address or other sufficient description of land or premises to which the conditions relate including reference to plans if any
1-7-1983	Devon County Council County Hall Exeter Devon	Discharge of trade effluent from Chelson Meadow Refuse Tip, Devon to the estuary of the River Plym - as described in Form P/A/1 dated 1 July 1983 and accompanying drawings.

(a) General

The terms of this Consent will not, without the consent in writing of the person to whom this Consent is given (or his successor) be altered before the expiration of the period ending with the seventeenth day of August 1985.

(b) As to outlet

The 800 mm plastic pipe outlet shall be sited at NGR SX ~~50425445~~* and used only for the discharge of tip leachate during the period from the time of high water plus half an hour up to the time of high water plus two and a half hours.

* 50435446 ... DBR/WD/W2 ... 7 3 95

(c) As to discharge

1. The maximum rate of discharge of effluent to controlled waters shall not exceed three thousand two hundred and forty (3240) cubic metres (712800 gallons) in any one hour

2. The maximum volume of effluent discharged to controlled waters shall not exceed twelve thousand nine hundred and sixty one point seven six (12961.76) cubic metres (2,851200 gallons) in any period of twenty-four (24) hours.

3. For the purpose of applying the aforementioned conditions a sample taken from the measuring weir shall be deemed to be the same as a sample taken at the outfall to the controlled waters.

~~County Hall, Exeter~~
3-5 Barnfield Road, Exeter

Date of Consent or Notice 18 August 1983

Clerk
Solicitor to the Authority

Appendix A: Discharge Consent No – SWWA 289/1/1 for Chelson Meadow Waste Facility, issued 1983