Fugitive Emissions Leak Detection & Repair Plan

Trowbridge Bioresources Centre 11799

Contents

1. Scope

This Leak Detection and Repair (LDAR) Plan is applicable to both operators: Wessex Water Services Ltd (WWSL) and Wessex Water Enterprises Ltd (WWEL), their contractors and subcontractors. There is a requirement to provide a LDAR plan for waste installation activities to provide a clear process for the detection, monitoring, repair and associated recording of any leaks.

The scope of this programme is the biogas facility at Trowbridge WRC and STC (Trowbridge BC), and relates to releases of volatiles from the biogas digesters and related systems. This programme will be followed at all times when the plant is operational.

In line with the standard BS EN 15446:2008 (*Fugitive and diffuse emissions of common concern to industry sectors*) it is applied to all products of which at least 20% by weight has a vapour pressure higher than 0.3 kPa at 20°C. For the system under consideration this relates to release of methane (biomethane).

There are some types of emission that may cause pollution but do not have set limits in permit conditions. In permits these are called ‘emissions not controlled by emissions limits’ or ‘fugitive emissions’. For an installation permit these can include fumes, leaks, gaseous emissions (i.e. volatile organic compounds (VOCs) and dust.

This plan covers LDAR for identified possible fugitive emissions at Trowbridge BC within the IED permitted area which is shown as a green line in Figure 1 below. WWEL responsibility is identified on the plan by means of demarcation (Figure 2).

A report on LDAR activities is completed annually by the Site Manager and sent to the Head of Bioresources. This report details the identified releases in the reporting period, and the subsequent repair work completed. An estimation of the total releases to atmosphere from the plant is also included in the report.

KEY FOR ASSET		
ITEM	DESCRIPTION	QTY.
	SLUDGE STORAGE AND TREATMENT	
A	SLUDGE RECEPTION TANK	1
B	SLUDGE STRAINPRESSES	2
C	PRE-THICKENED SLUDGE STORAGE TANK 1	1
D	PRE-THICKENED SLUDGE STORAGE TANK 2	2
E	GRAVITY BELT THICKENERS	2
F	GBT FILTRATE PUMPING STATION	1
G	THICKENED SLUDGE TANK	1
H1-6	ACID PHASE DIGESTION	6
I1 & I2	MESOPHILIC ANAEROBIC DIGESTERS	2
J1 & J2	SECONDARY DIGESTERS	2
K	DEWATERING BELT PRESS	2
K1	BELT PRESS STACK 1	1
K2	BELT PRESS STACK 2	1
L	DEWATERING CENTRIFUGE	2
L1	SKIP LOADING AREA 1	1
L2	SKIP LOADING AREA 2	1
M	DEWATERING LIQUOR TRANSFER PUMPING STATION	1
N1 & N2	LIQUOR BALANCING TANKS	2
O	RETURN LIQUOR PUMPING STATION	1
P	CENTRATE SAFETY VENT	1
Q	SKIP HOLDING AREA	1
	BIOGAS COLLECTION, STORAGE AND UTILISATION	
R	GAS HOLDER	1
S	DEHUMIDIFIER CHILLER	1
T	BOILERS	2
T2	BOILER STACK	2
U	CHP ENGINE	1
U1	CHP STACK	1
V	WASTE GAS BURNER (FLARE STACK)	1
W	GAS UPGRADING PLANT	1
W1	GRID ENTRY UNIT	1
X	BIOMETHANE FLARE	1
Y	PROPANE TANKS	3
	SITE ASSETS	
Z1	DIESEL TANK	1
Z2	SITE GENERATOR	1

Figure 1: Aerial view of the IED permitted area at Trowbridge BC.

Figure 2: WWSL / WWEL Demarcation locations

2. Definitions

LDAR is defined as 'a work practice designed to identify leaking equipment so that emissions can be reduced through repairs'. A component that is subject to LDAR requirements must be monitored at specified regular intervals to determine whether it is leaking. Any leaking component must then be repaired or replaced within a specified time frame.

Definitions for different leak rates for releases that are not planned to occur in the normal operation of the biogas plant are given below:

- **High leak rate** – These releases are in the range $>10^{-3}$ kg/s and will generally always lead to a hazard area classification as required by the Dangerous Substances and Explosive Atmosphere Regulation (DSEAR 2002). E.g., releases from the operation of Pressure Vacuum Relief Valve (PVRVs).
- **Medium leak rate** – These releases are in the range 10^{-3} to 10^{-5} kg/s, that generally will lead to a hazardous area classification of negligible extent in a well-ventilated area. E.g. low pressure releases from flanges, valves and booster pumps on biogas systems
- **Low leak rate** – These releases are $<10^{-5}$ kg/s and lower – note BS EN 60079-10-1 (British Standard for Hazardous Area Classification of Gases and Vapours used in DSEAR assessments) defines releases in the range of 10^{-7} to 10^{-9} kg/s as "small" releases that are considered to be fugitive emissions.

Release rates above relate to biogas. The sludge and liquors do not meet the 20% weight VOC threshold from the BS EN 15446:2008 standard for measurement of fugitive releases, and therefore have been determined to not be sources for inclusion in this LDAR plan. Therefore, all the fugitive emission sources are on the gas system only.

When a leak is detected the estimated leak rate and time from leak detection to repair will be used to calculate the total release to atmosphere that will be reported in the yearly LDAR report.

3. Plan Review

A third-party audit of the LDAR programme will be initially carried out annually. This review frequency can be changed based on the results of the programme, the conclusions of the third-party audits and the results of management reviews.

LDAR inspection frequencies can be altered based on the results of third-party audits, the results of other inspection reports and the level of leak control being achieved.

The LDAR programme will be updated where opportunities for improvements are identified, for example in the management review.

An electronic version of this plan is available on Source and any unprinted copies will be uncontrolled.

4. Training of Personnel

Leak detection and leak monitoring training is encompassed within the standard site training provided to each personnel before working within the IED bioresource permit boundary. Staff therefore have the skill set to identify possible fugitive emissions whilst completing their day-to-day responsibilities.

Toolbox talks and briefings will be given to operational staff with regards to the requirements of this procedure.

5. Roles and responsibilities

Role	Key Responsibility
Head of Bioresources	• Providing assistance and guidance in updating and maintaining the LDAR procedure. • Reviewing the annual LDAR activity report and the efficacy of the programme activities to ensure that the programme is followed, remains effective and leads to continual improvement in leak reduction.
Site Manager	• Co-ordinate the implementation of the LDAR plan on site. • Produce an annual report to the Head of Bioresources on the LDAR activities completed in the reporting period, including an estimation of total releases to atmosphere of volatile materials. • Ensuring that defined practices and processes are communicated to all relevant personnel. • Ensuring competent personnel are available to monitor and assess the requirements of the LDAR plan. • Ensuring that any refresher training is provided to all personnel on site. • Ensuring that leaks and fugitive emissions are reported, investigated and repaired in a timely manner. Any outstanding actions are resolved. • Report failings in the LDAR procedure to the Head of Bioresources.

	• Highlight leaks caused by corrosion for discussion during the management review.
Operational Staff	• Ensure they are fully conversant with the LDAR procedure and leak reporting requirements. • Ensure adequate control measures are in place prior to commencement of a monitoring or repair task. • Ensure they take reasonable care to ensure that their actions do not have an adverse impact on the health and safety of personnel or on the environment.
External Contractors	• All personnel are to follow the requirements of this LDAR plan and cooperate fully with WW systems of work. • Third parties need to demonstrate competence before being allowed to undertake work on the site.

Table 1: Roles and responsibilities

6. Identification of components and equipment which have the potential to produce fugitive emissions

Reducing Leak Potential by Design

Pipework and equipment is designed such that the risk of leaks due to corrosion is limited. Wessex Water uses a combination of internal design standards and the Water Industry Mechanical and Electrical specification (WIMES) standards to design assets to prevent leaks, for example by limiting the number of flanges and purchasing seal-less and leak-less equipment.

Plant is tested for leaks prior being brought into service by an appropriate test method such as hydrostatic or compressed gas pressure leak testing.

Reducing Leak Potential by Operation

The plant operations will reduce potential release events by taking, but not limited to, the following actions:

- Use of standard operating procedures (SOPs) and operator training to reduce process fluctuations that are likely to lead to high pressures and hence operation of PVRVs and PRV. Responses to high digester pressure situations are also addressed in the SOPs.
- Pressure sensors are installed on the plant and monitored by operational staff. High pressure alarms trigger automatic sequences within control systems to minimise the risk of releases of volatile materials to atmosphere.
- Defined operational envelopes for biogas plant to reduce potential instability in pressure and operation of the plant.
- Maintenance of gas consuming assets (CHP and Gas to Grid plant) to reduce the need to vent to atmosphere or flare-off excess gas.

Identification of fugitive release points

Release points are initially identified by visual inspection of the plant in areas where leaks would lead to volatile (methane) materials entering the environment. The following are considered to be candidates for potential leaks that need to be detected when they are used on primary digesters, associated biogas systems including pipework, boiler houses and CHP units.

- Pipework flanges

- Screwed pipework connections
- Seals on low-speed rotating equipment – valves
- Seals on high-speed rotating equipment – gas booster pumps, gas mixing pumps
- Pressure relief valves (PRVs) and pressure/vacuum relief valves (PVRVs)

The following are not considered to be candidates for inclusion in the programme:

- Solid sections of continuous pipework
- Connections or construction that complies with BS EN 1127-1:2019 (*Explosive Atmospheres*), Annex B.3 (enhanced tightness).
- Pipework containing digested sludge or liquors.

Although the above are not candidates for specific LDAR activities, optical gas monitoring and other techniques described in Section 9 will detect leaks from these items.

An assessment was carried out to identify the proposed operational equipment and components that have the potential to leak and release fugitive emissions to air. These are detailed in Table 2 in Appendix 1, and the current proposed locations are shown in the plan in Appendix 2 at the end of this document. When the capital scheme is completed, the details held in Table 2, Appendix 1 shall be reviewed to reflect the as-built system.

The risk level for the individual components of the biogas system that fall within the LDAR programme are shown in Appendix 3 and shall be reviewed and updated to reflect the as-built system upon completion of the capital scheme.

7. Arrangements for estimating the size of fugitive emissions

Risk-based estimation of release rate

For the identified components (sources of potential fugitive releases) the release rate is estimated based on the pressure differential between the inside and outside of the release point and the potential hole cross-sectional area of the leak. Values for the cross-sectional area have been taken from relevant standards for example those relating to hazardous area classification BS EN 60079-10-1 or IGEM standards. The pressures used in the calculation are those given in the design document for the gas system pressure profile (D9920-4030).

Pressure is also actively measured at various points in the biogas system by instrumentation (c.f. annotated component risk list in Appendix 3). PVRVs will be calibrated yearly in line with manufacturer's requirements to ensure that they activate at the required pressures. The release rate of volatile material that is released from the PVRVs has been assumed to be the nominal design rate for methane production within the digester.

Calculations based equations in BS EN 60079-10-1 have been used to determine the flow rate through the potential hole that has generated the leak.

For liquids the equations is:

$$W = C_d S \sqrt{2 \rho \Delta p} \ (\text{kg/s}) \qquad \text{(B.1)}$$

Note: for sludges, the methane leak rate is taken as the liquid release rate multiplied by the maximum solubility of methane in at an appropriate temperature for that release.

For subsonic gases the equation is:

$$W_g = C_d S p \sqrt{\frac{M}{ZRT}\frac{2\gamma}{\gamma-1}\left[1-\left(\frac{p_a}{p}\right)^{(\gamma-1)/\gamma}\right]\left(\frac{p_a}{p}\right)^{1/\gamma}} \text{ (kg/s)}$$

Classification of leaks

Based on the potential flow rate estimated in the previous section. These leaks are then graded into the follow classifications:

- High leak rate, $>10^3$ kg/s (>3.6 kg/hr)
- Medium leak rate, 10^{-3} – 10^{-5} kg/s (3.6 kg/hr – 0.036 kg/hr)
- Low leak rate, less than 10^{-5} kg/s (<0.036 kg/hr)

The results of this classification are be tabulated to allow audit and inspection. The release points are shown on a site plan (Appendix 2) and component risks are detailed in Appendix 3.

Where components are located in buildings (CHP and boilerhouse) the ventilation rates in those areas have been designed to reduce concentrations to a level where hazardous area classification is not required. These ventilation rates are based on industry standards produced by IGEM. This means that the environmental impacts and health and safety risks at the release locations are the same as for the individual point source releases.

Leak rate estimation for detected leaks

The values in Annex C, Table C.1 of BS EN 15446:2008 are being used to correlate the screening values to the emission rates.

Estimates of the type and volume of release from each leak location

When a leak is detected the estimated leak rate and time from leak detection to repair will be used to calculate the total release to atmosphere that will be reported in the yearly LDAR report.

8. Fugitive emissions risk assessment- A risk-based programme of work for monitoring and controlling emissions

Table 2 in Appendix 1 shows that a systematic approach has been applied based on risk and cost–benefit to gas fugitive emissions to prioritise monitoring locations and repair or investment.

Leak detection equipment

Detection equipment used must meet the specification, performance and calibration requirements laid down in the British Standard BS EN 15446:2008. Surveys for fugitive releases also follow the procedures laid down in that standard.

Any equipment used for leak detection must be certified to an appropriate standard and be calibrated. Currently, a “Opgal EyeCGas Camera 2.0” is used to complete plant surveys.

Screen values of 100,000 ppm are used for the detection of leaks.

Leak detection activities

The pipework and fittings associated with biogas and primary digester systems are visually inspected daily for obvious signs of leaks or damage regardless of the leak potential. The methods laid out in Section 9 below will also be used to detect unexpected volatile releases.

For potentially high leak rate components the following activities take place:

- PRV and PVRVs are fitted on gas systems with pressure monitoring which are configured to notify the operator when a PVRV activates through a control system alarm.
- PRV and PVRVs will be inspected six-monthly with an optical gas imaging equipment or other gas sniffing device.
- Daily visual/odour inspection of PRV and PVRVs.
- Maintenance of the components in line with manufacturer's recommendations and the requirements of written schemes of examination.
- Redundancy in design means that a "standby" PVRV is available on each digester, allowing any leaking PVRV to be isolated and maintained.

For potentially low and medium leak rate components the following activities take place:

- Preventative maintenance relating to reduction in likelihood of a leak.
- Components will be inspected six-monthly with an optical gas imaging equipment or gas sniffing devices.

For potentially low leak rate components the following activities take place:

- Components will be inspected six-monthly with an optical gas imaging equipment or gas sniffing devices.

Other considerations: The potential for releases due to open ended pipework will be managed using blanks and plugs.

The frequency that components and equipment will be repaired is also determined on the size of the leak identified and the estimated size of the fugitive emission as detailed in the risk assessment Table 2. Best industry practice requires that modifications will not be undertaken without having first undertaken an occupational health, safety and environmental review, and an engineering review in conjunction with an economic justification.

All repairs undertaken are to be recorded on Work and Assets Management system (WAM – company work management programme). Section 10 shows a flow diagram structure for the repair and recording of the leakage repair, using WAM.

Operational asset maintenance is governed by the (OPSS001) Operational Asset Maintenance Strategy and WAM contains the master record of work carried out on all sites. WAM is available for operations to schedule work with tasks, raise ad-hoc and emergency work, but also provides a record of work completed and outcomes. These records will provide an audit trail for any work relating to leak detection and repair.

Reports using the WAM Job Dashboard will be run to detail work completed, alongside response times and follow-on tasks. Activities are arranged on a daily, weekly, monthly basis or at less frequent basis e.g. yearly. Periodic activity audits are carried out by line managers.

Any operational person is required to raise a reactive leak detection task on WAM to ensure that any work required is actioned quickly. There are several user guides available on Wessex Water intranet to provide assistance. The Site Manager is responsible for ensuring that the leak repairs are completed in line with this procedure.

The same process applies to recording and tracking of leaks identified from unknown sources detailed in Section 9.

9. Methods used for detecting unknown emission sources

The site maintenance programme, as well as odour sniff testing and personal gas monitors are used to identify unknown fugitive emission sources, as detailed below.

Monitoring and maintenance of waste installation activities

Trowbridge BC is manned seven days a week and routine maintenance jobs are included on the “weekly routine task list” which are recorded via the work and asset management system. Operators inspect the entire process during their normal working day for any unusual appearance, smells or equipment failure. Combined with the maintenance programme, Operations also make use of the following procedures for detecting leaks or emissions:

Sniff tests

The odour management plans (WWSL (TRTWP547) and WWSL (GENCO070)) make provision for “sniff tests” which are completed on a weekly basis by operational staff. It is accepted that operational staff become adapted to odours from site, however it will provide a baseline for routine observations.

Monthly sniff tests are carried out by non site based staff (Regional Scientist / Graduate Scientist) who are not normalised to site odours.

A third-party odour sniff test is scheduled to be undertaken once every 6 months for comparison with Wessex Water (operator and monthly tester) observations. The third-party sniff test shall include both on and off-site locations based on surrounding sensitive receptors and complaint locations.

It is acknowledged that odour sniffing is concentrated on identifying odours but can prove to be advantageous in indicating the presence of different VOCs and other gases.

Gas monitors

It is compulsory for all operational staff and non site based staff to wear gas monitors whilst working on and attending site. The monitors are set up with sensors for oxygen, hydrogen sulphide, carbon monoxide and flammable LEL (lower explosion limit). The alarm set points are included in Table 3 below. Further information on gas monitors is included in WW TBT511 (Toolbox Talk on PGMs Waste) and S3CS281021-01 (Safety Alert – Waste Portable Gas Monitor).

Again, it is acknowledged that gas monitors are not identifying VOCs directly, and are not designed to find leaks, but will identify methane to provide an indicative warning that different VOCs and other gases could be present. Rapid beeping and flashing red means a dangerous atmosphere and the area is evacuated immediately. See the section below on reporting mechanisms.

Gas type	Low alarm	High alarm
O2 – Oxygen	19%	23%

H2S – Hydrogen Sulphide	5 ppm	10 ppm
CH4 – Flammable gases, Methane	10%	20%
CO – Carbon Monoxide	20 ppm	100 ppm

Table 3: Gas monitor sensor low and high alarms

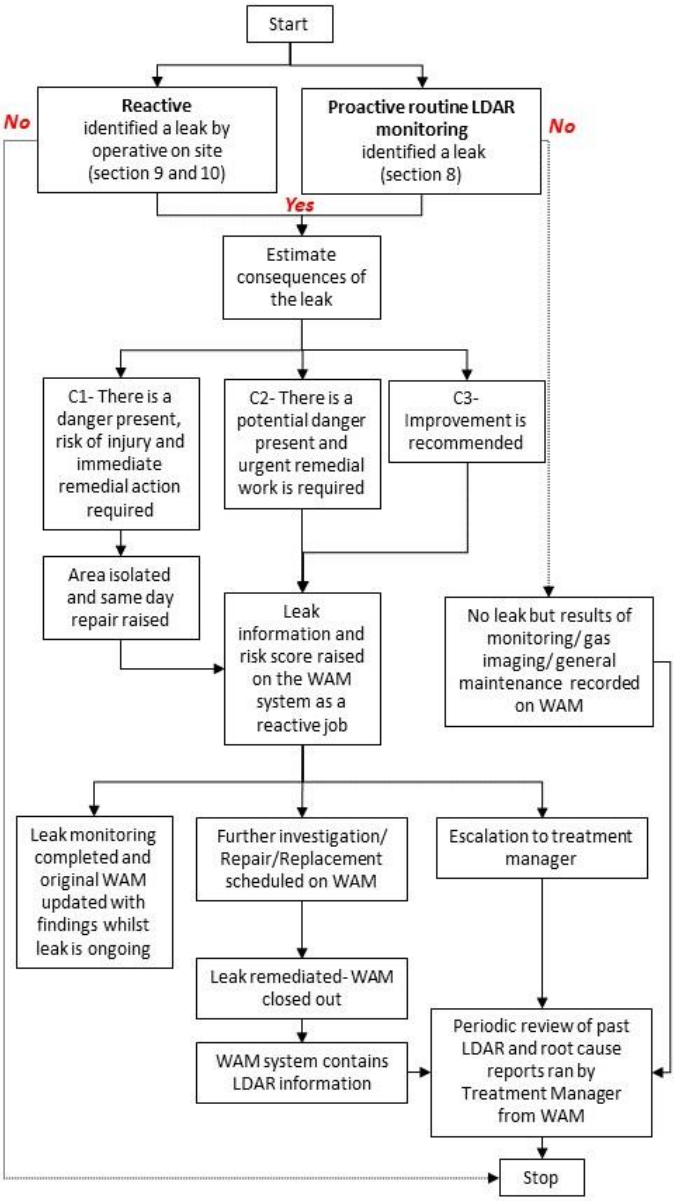
Optical gas imaging

Optical gas imaging as described in Section 8 will be completed; this methodology detects unknown fugitive emission sources as well those from known assets being inspected in Table 2.

Any leaks identified from unknown sources using the methods above are recorded on the WAM system as described in Section 8 above and Section 10.

10. Method of reporting and mitigating unknown emissions sources

Any leaks identified from unknown sources using the methods above in Section 9, are recorded on the WAM system as described in Section 8. The process for reporting mitigating leaks via the WAM system is shown in the flow diagram below.



Revision history

Issue	Date	Description	Prepared by
1	August 2023	New issue	S Ward K Ebere B Brebner M Dolan

11. Appendix 1: Table 2: Leak detection source locations at Trowbridge BC

Trowbridge STW LDAR Candidate Release Point (Biogas)													
Site Plan Release Point Ref.	TRW Location Name	Pipe Size (in.)	Pressure (mbarg)	Release Type					Release Size (IGEM) / mm2	Release Rate Per Point* (kg/s)	Release Rate Per Point* (kg/hr)	Hi / Med / Lo	Release Comment
				Flange	Valve	Threaded Pipe	Condensate Pot	PVRV / PRV					
1	Primary Digestor 1 (MAD) PVRV #1 64-V-0013A	10	25	3	1	1	0	1	250	1.67E-02	60.12	Hi	
2	Primary Digestor 1 (MAD) 1 PVRV #2 64-V-0013B	10	25	3	1	1	0	1	250	1.67E-02	60.12	Hi	
3	Primary Digestor 2 (MAD) PVRV #1 64-V-1013A	10	25	3	1	1	0	1	250	1.67E-02	60.12	Hi	
4	Primary Digestor 2 (MAD) PVRV #2 64-V-1013B	10	25	3	1	1	0	1	250	1.67E-02	60.12	Hi	

5	Primary Digestor 1 (MAD) Gas Mixing Pipework and Compressor	3	2000	TBD	5	TBD	0	0	2.5	1.26E-03	4.536	Hi	
6	Primary Digestor 2 (MAD) Gas Mixing Pipework and Compressor	3	2000	TBD	5	TBD	0	0	2.5	1.26E-03	4.536	Hi	
7	Primary Digestor Common (MAD) Gas Mixing Pipework and Compressor	3	2000	TBD	8	TBD	0	0	2.5	1.26E-03	4.536	Hi	
8	Primary Digestor 1 (MAD) Gas Pipework to Gas Offtake Main	10	21	TBD	4	TBD	0	0	0.25	1.53E-05	0.05508	Med	

9	Primary Digestor 2 (MAD) Gas Pipework to Gas Offtake Main	10	21	TBD	4	TBD	0	0	0.25	1.53E-05	0.05508	Med	
10	Primary Digestor 2 (MAD) & APD Gas Offtake Main to Gas Holder	10	21	TBD	25	TBD	1	0	0.25	1.53E-05	0.05508	Med	
11	APD Common Gas Header PVRV #1	8	21	2	1	1	0	1	200	1.23E-02	44.28	Hi	
12	APD Common Gas Header PVRV #2	8	21	2	1	1	0	1	200	1.23E-02	44.28	Hi	
13	APD 1 Gas Pipework to Common /Mixing Offtake	8	21	TBD	3	1	0	0	0.25	1.53E-05	0.05508	Med	

14	APD 2 Gas Pipework to Common /Mixing Offtake	8	21	TBD	3	1	0	0	0.25	1.53E-05	0.05508	Med	
15	APD 3 Gas Pipework to Common /Mixing Offtake	8	21	TBD	3	1	0	0	0.25	1.53E-05	0.05508	Med	
16	APD 4 Gas Pipework to Common /Mixing Offtake	8	21	TBD	3	1	0	0	0.25	1.53E-05	0.05508	Med	
17	APD 5 Gas Pipework to Common /Mixing Offtake	8	21	TBD	3	1	0	0	0.25	1.53E-05	0.05508	Med	
18	APD 6 Gas Pipework to Common /Mixing Offtake	8	21	TBD	3	1	0	0	0.25	1.53E-05	0.05508	Med	
19	APD Gas Mix	6	2000	TBD	TBD	TBD			2.5	1.26E-03	4.536	Hi	

	Compressor 1&2												
20	APD Gas Lift Compressor 1&2	6	2000	TBD	TBD	TBD			2.5	1.26E-03	4.536	Hi	
21	Gas Holder 16-T-0001	N/A	21	TBD	TBD	TBD	2	0	0.25	1.53E-05	0.05508	Med	There is leak detection system integral to the gas holder that continously monitor presence of gas release. So leak in the inner membrane into the outter membrane

													would be detected by a Methane Gas Monitor
22	Gas Holder Pipework to PRV	10	21	TBD	TBD	TBD	TBD	TBD	0.25	1.53E-05	0.05508	Med	
23	Gas Holder PRV 16-E-0001	10	25	TBD	1	TBD	0	1	250	1.67E-02	60.12	Hi	
24	Gas Line to Chiller	TBD	21	TBD	TBD	TBD	0	0	0.25	1.53E-05	0.05508	Med	
25	Chiller 16-E-002	TBD	21	TBD	TBD	TBD	0	0	2.5	1.53E-04	0.5508	Med	
26	Gas Bypass Line for Chiller	TBD	21	TBD	TBD	TBD	0	0	0.25	1.53E-05	0.05508	Med	
27	Gas line from Chiller Bypass to Gas Boosters	TBD	21	TBD	TBD	TBD	0	0	0.25	1.53E-05	0.05508	Med	
28	Gas Booster	TBD	175	6	2	4	0	0	2.5	4.34E-04	1.5624	Med	

	1 16-B-0002A												
29	Gas Booster 2 16-B-0002B	TBD	175	6	2	4	0	0	2.5	4.34E-04	1.5624	Med	
30	Gas Line to Boilers	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
31	Gas Line to Siloxane	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
32	Siloxane Plant	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
33	Gas Bypass Line from Siloxane	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
34	Gas Line to CHP from Siloxane	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
35	Gas line from Gas Boosters to Flare	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
36	Flare Stack 16-U-0006	TBD	175	TBD	TBD	TBD	1	0	2.5	4.34E-04	1.5624	Med	
37	Liquor balancing tanks (1)	N/A	Nom.	N/A	N/A	N/A	0	0	N/A	1.51E-03	5.418	Hi	

37	Liquor balancing tanks (2)	N/A	Nom.	N/A	N/A	N/A	0	0	N/A	1.51E-03	5.418	Hi	
38	Boilers	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
39	Boiler Stack	TBD	175	TBD	TBD	TBD	0	0	2.5	4.34E-04	1.5624	Med	
40	CHP Engine	TBD	175	TBD	TBD	TBD	1	TBD	2.5	4.34E-04	1.5624	Med	
41	CHP Stack	TBD	175	TBD	TBD	TBD	0	TBD	2.5	4.34E-04	1.5624	Med	
42	Biomethane upgrading plant												
42	Raw gas from gas sludge processing to pre-treatment blower	3	175	5	6	0	0	0	2.5	4.34E-04	1.5624	Med	

42	Raw gas from pre-treatment blower to shell & tube heat exchanger	3	300	2	0	0	0	0	2.5	5.60E-04	2.016	Med	
42	Shell & tube heat exchanger (X-00001)	N/A	300	0	0	0	0	0	2.5	5.60E-04	2.016	Med	
42	Raw gas from shell & tube heat exchanger to Bup process gas room	5	300	9	3	0	0	0	2.5	5.60E-04	2.016	Med	

42	Raw gas from pre-treatment to compressor inlet	5	300	13	3	0	1	1	2.5	5.60E-04	2.016	Med	
42	Pressure safety valve (PSV 10101)	1	300	2	0	0	0	0	25	1.12E-02	40.32	Hi	
42	Compressor: B-10301	N/A	9500	0	13	0	1	0	5	4.29E-03	15.444	Hi	

42	Compressor outlet to A-Column	2	9500	25	5	0	3	1	5	4.29E-03	15.444	Hi	
42	Pressure safety valve (PSV 10301)	1	12000	4	0	0	0	0	25	2.29E-02	82.44	Hi	
42	Raw gas from compressor to A-column	1.25	9500	5	0	0	0	0	2.5	2.14E-03	7.704	Hi	

42	Product gas from A-column to dryers	1.25	9000	4	10	0	0	1	2.5	2.11E-03	7.596	Hi	
42	Pressure safety valve (PSV 10501)	2	12000	2	0	0	0	0	50	4.59E-02	165.24	Hi	
42	Water & biomethane carry over to F-column	4	9000	9	2	0	0	0	2.5	1.91E-06	0.006876	Lo	Small amount of biomethane gas will be released from the residual liquid if

													leakage occurs
42	Biomethane slip line back to the compressor inlet	1.25	1300	15	4	0	0	1	2.5	1.07E-03	3.852	Hi	
42	Pressure safety valve (PSV 10901)	2	12000	2	0	0	0	0	50	4.59E-02	165.24	Hi	

42	A-Column K-10501	N/A	9500	0	0	0	0	0	2.5	2.14E-03	7.704	Hi	
42	F-Column, K-10901	N/A	9000	0	0	0	0	0	2.5	2.11E-03	7.596	Hi	
42	Dryer, K-10701	N/A	9000	0	0	0	0	0	2.5	2.11E-03	7.596	Hi	

42	Dryer, K-10702	N/A	9000	0	0	0	0	0	2.5	2.11E-03	7.596	Hi	
42	Product gas from A-column to both dryers inlets	1.25	9000	12	6	0	1(K-10601)	0	2.5	2.11E-03	7.596	Hi	
42	Product gas from both dryers to carbon vessls	1.25	8000	34	10	0	0	0	2.5	2.03E-03	7.308	Hi	

42	Regeneration line back to compressor inlet	1	1000	18	9	0	0	0	2.5	9.58E-04	3.4488	Med	
42	Recirculation line back to compressor inlet	1.25	8500	8	3	0	0	0	2.5	2.07E-03	7.452	Hi	
42	Dryer regeneration line	2	1000	16	8	0	0	2	2.5	9.58E-04	3.4488	Med	

42	Pressure safety valve (PSV 10701)	1	12000	4	0	0	0	0	25	2.29E-02	82.44	Hi	
42	Pressure safety valve (PSV 10702)	1	12000	4	0	0	0	0	25	2.29E-02	82.44	Hi	
42	Product gas from dryers to carbon vessels line	1.25	8000	8	5	0	0	0	2.5	2.03E-03	7.308	Hi	

42	Product gas to GEU line	3	8000	16	7	0	0	2	2.5	2.03E-03	7.308	Hi	
42	Changeover pipeworks	4	8000	12	5	0	0	0	2.5	2.03E-03	7.308	Hi	
42	Pressure safety valve (PSV 10703)	1	12000	2	0	0	0	0	25	2.29E-02	82.44	Hi	

42	Pressure safety valve (PSV 10703)	1	12000	2	0	0	0	0	25	2.29E-02	82.44	Hi	
43	Grid Entry Unit												
43	Gas from the biomethane upgrade plant to Propane injection system inclusive	2	8500	7	5	0	0	0	2.5	2.07E-03	7.452	Hi	

43	From Propane injection system to the pressure regulator on the reject gas line	2	7000	12	11	0	0	2	2.5	1.95E-03	7.02	Hi	
43	From Propane injection system to the pressure regulator on the gas to grid line	2	7000	12	12	0	0	1(pressure relief for propane)	2.5	1.95E-03	7.02	Hi	
43	Creep relief /flap vent #1 (V01) - reject line	1	150	0	0	25	0	10	25	4.03E-03	14.508	Hi	

43	From the pressure regulator on the reject line to the exit of the GEU	4	80	5	12	0	0	1 (V01)	0.25	2.97E-05	0.10692	Med	
43	From the pressure regulator to the to the ROV (remote operated valve) Room	3	7000	6	9	0	0	1(V04)	2.5	1.95E-03	7.02	Hi	
43	Creep relief /flap vent #1 (V04) - G2G line	1	7800	0	0	29	0	1	25	2.02E-02	72.72	Hi	

43	GSWR Analyser vent line off gas pipework	0.5	1500	0	0	5	0	1	1	4.52E-04	1.6272	Med	
43	Propane vent line	0.8	16000	14	0	8	0	1	20	1.99E-02	71.64	Hi	
43	Ofgem Analyser vent line off gas pipework	1mm	1500	0	0	17	0	1	1	4.52E-04	1.6272	Med	

43	ROV room	3	7000	TBD	6	TBD	TBD	TBD	2.5	1.95E-03	7.02	Hi	
43	Bottle room pressure relief vent, V7	0.5	3000	0	3	13	0	3	12	7.05E-03	25.38	Hi	
44	Propane tanks (1,2,3)	N/A	6800	0	0	0	0	1	2.5	1.93E-03	6.948	Hi	
43	Liquid propane transfer pumped from propane tank to the GEU	1.25	11000	TBD	17	0	0	TBD	5	4.48E-03	16.128	Hi	

43	Propane vapour transfer from the propane tank to flare stack pilot system	1	100	0	4	TBD	TBD	TBD	0.25	3.31E-05	0.11916	Med	
43	Propane tank relief valve (PVRV)	1.5	17240	0	0	6	0	6	75	7.62E-02	274.32	Hi	
43	Raw gas analysers pump vent	0.5	100	0	16	TBD	1	0	12	1.59E-03	5.724	Hi	
43	Product gas vent from the analysers	0.5	700	0	13	TBD	TBD	TBD	12	3.95E-03	14.22	Hi	
43	Biomethane analysis	1.25	700	0	TBD	TBD	0	0	2.5	8.22E-04	2.9592	Med	
45	Biomethane Flare (G2G)	4	80	34	4	0	0	0	0.25	8.71E-05	0.31356	Med	
46	Centrifuge safety vent stack	8	Nom.	0	0	0	0	0	200	1.14E-05	0.04104	Lo	The vent is connected to the liquor. Potential

													release of biogas (flashing) from centrate and cake processi ng

12. Appendix 2: Location of release points (Red numbering correspond to entries in Table 2)

Note: diffuse releases from, but not limited to solid pipework, digesters, and gas holder may also occur around the release points marked above, see Appendix 3 for detail.

13. Appendix 3: Detailed LDAR Leak Point Component Risk Register

Appendix 3 is appended as a separate document.

Reference: TRTWF551 Trowbridge BC LDAR Component Risk Register