# Fugitive Emissions Leak Detection & Repair Plan

# Avonmouth Bioresources Centre 11800

**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 Avonmouth WRC and STC (Avonmouth 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 Avonmouth BC within the IED permitted area which are shown as green and red lines in Figure 1a and 1b below. The orange line is the wider Water Recycling Centre (WRC) boundary of Avonmouth WRC. At Avonmouth BC there are two demarcation locations between WWSL and WWEL:

1. The last flange on the biogas pipework before entering each CHP engine – 5 demarcation points in total.
2. The T piece on the biogas pipework feeding the gas to grid pipelines

This report covers both operators.

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.

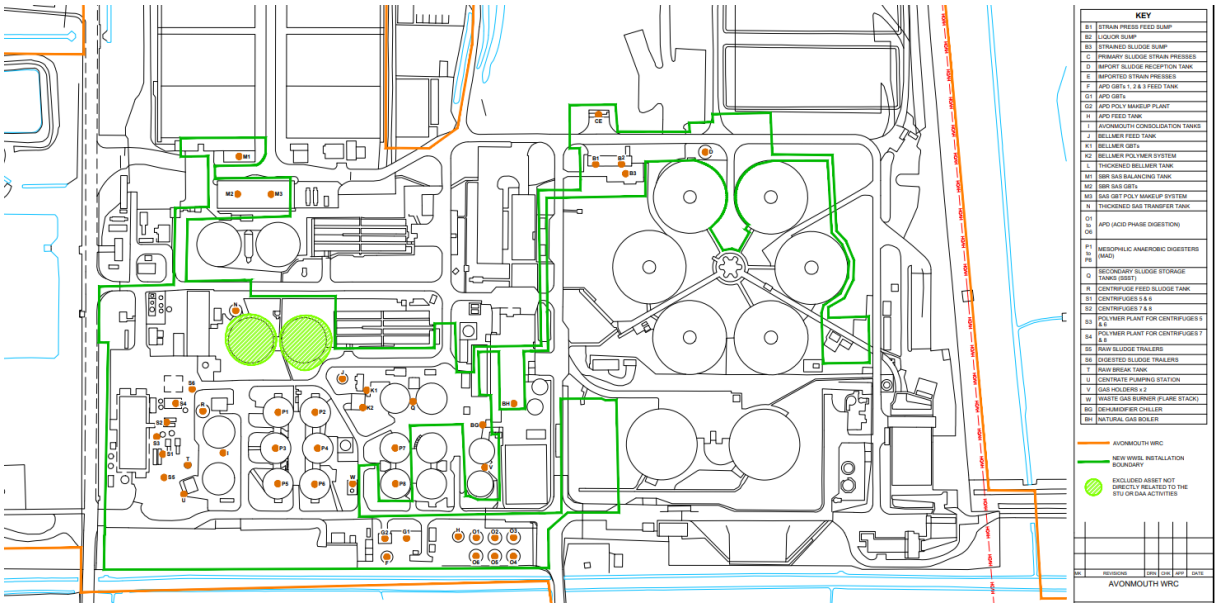



Figure 1a: Aerial view of the WWSL IED permitted area at Avonmouth BC.

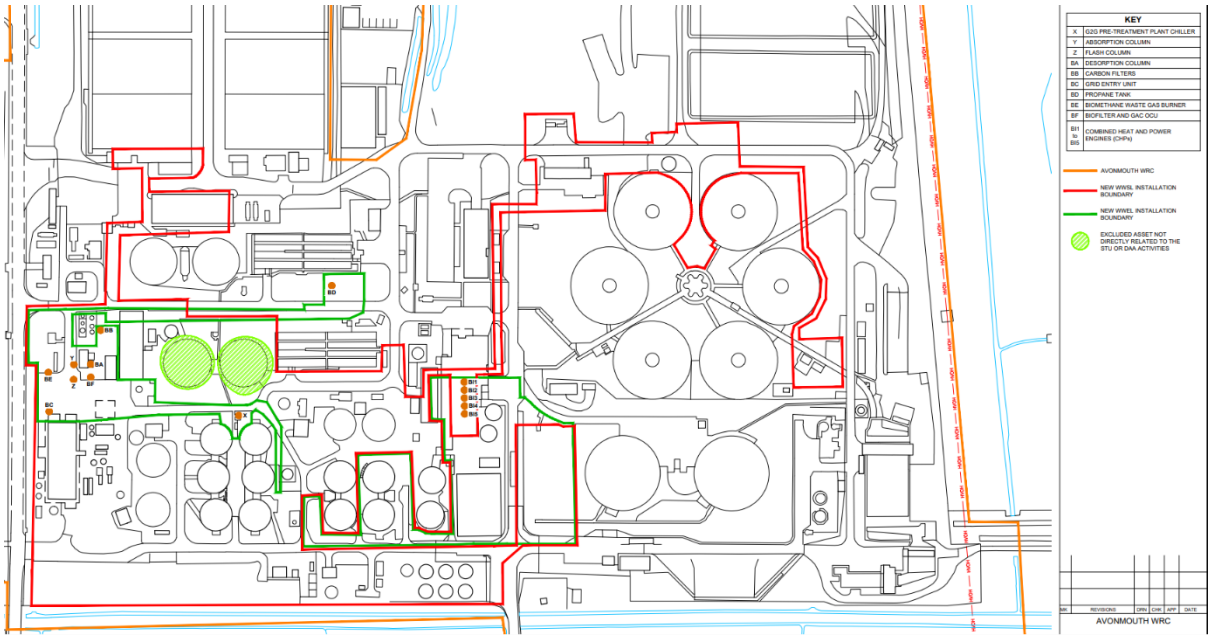



Figure 1b: Aerial view of the WWEL IED permitted area at Avonmouth BC.

## 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.<br>• 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.<br>• Ensuring that defined practices and processes are communicated to all relevant personnel.<br>• Ensuring competent personnel are available to monitor and assess the requirements of the LDAR plan.<br>• Ensuring that any refresher training is provided to all personnel on site.<br>• Ensuring that leaks and fugitive emissions are reported, investigated and repaired in a timely manner. Any outstanding actions are resolved.<br>• Report failings in the LDAR procedure to the Head of Bioresources.<br>• 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.<br>• Ensure adequate control measures are in place prior to commencement of a monitoring or repair task.<br>• 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.<br>• 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 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.

## 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. 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:

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

**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).

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 quantum gas camera 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 with detection and alarm devices are fitted and will notify the operator when a PVRV activates through a control system alarm.
- PRV and PVRVs are 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 "spare" 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

Avonmouth BC is manned 24 hours, seven days a week and routine maintenance jobs are included on the operator task sheets. 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 plan (TRTWP157) makes 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*

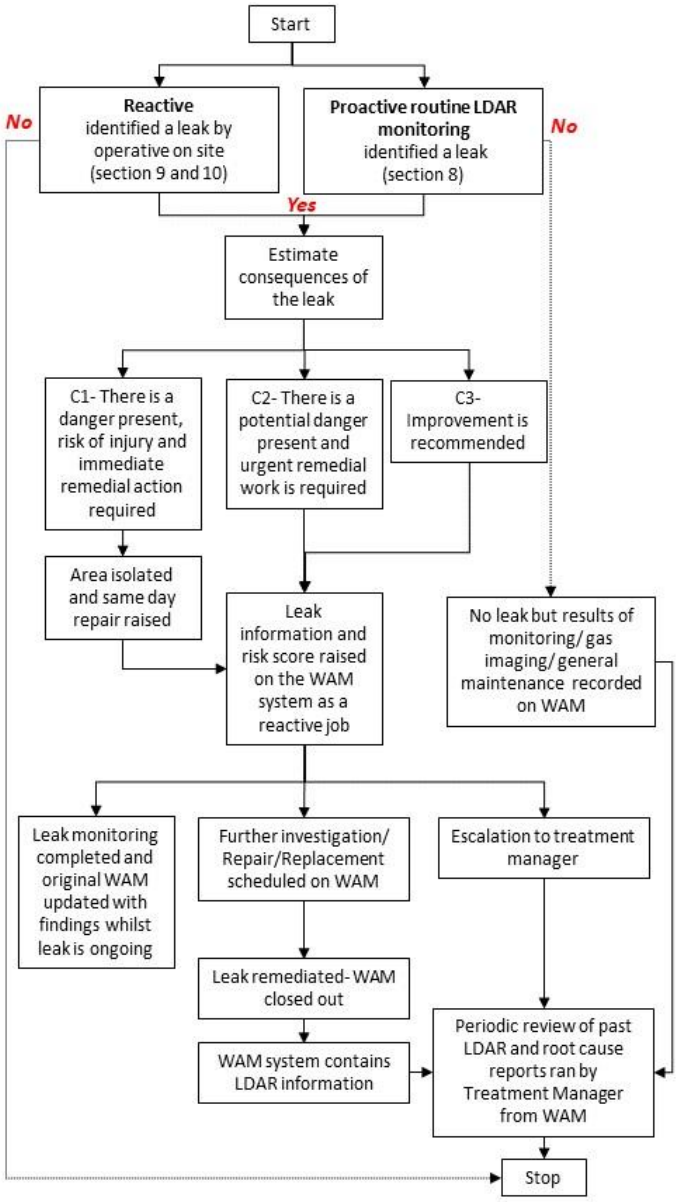
Optical gas imaging

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 | December 2023 | First issue | S Sahota<br>L Tooze<br>M Dolan<br>K Ebere |

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

| Site Plan Release Point Ref. | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Flange | Valve | Threaded Pipe | Condensate Pot | PVRV / PRV | | | | |
| 1 | **Gas mixing and gas lift compressors** | | | | | | | | | | | |
| 1 | APD gas pipework | TBD | 20-25 | 31 | 28 | TBD | TBD | 5 | 2.50E-01 | 1.67E-05 | 0.06012 | Med |
| 1 | Gas lift and gas mixing pipework | 2 inch | 2000 | 9 | 32 | TBD | TBD | 4 | 2.50E+00 | 1.26E-03 | 4.536 | Hi |
| 1 | **APD reactors 2 & 5** | | | | | | | | | | | |
| 1 | Gas from reactor 2 & 5 to gas main header | TBD | 20-25 | 12 | 18 | TBD | TBD | 2 | 2.50E-01 | 1.67E-05 | 0.06012 | Med |
| 1 | Gas lift and gas mixing pipework | TBD | 2000 | 14 | 30 | TBD | TBD | 0 | 2.50E+00 | 1.26E-03 | 4.536 | Hi |
| 1 | **APD reactors 1 & 6** | | | | | | | | | | | |
| 1 | Gas main header from reactor 1 & 6 to 2 & 5 | TBD | 20-25 | 9 | 14 | TBD | TBD | 2 | 2.50E-01 | 1.67E-05 | 0.06012 | Med |
| 1 | Gas lift and gas mixing pipework | TBD | 2000 | 9 | 15 | TBD | TBD | 0 | 2.50E+00 | 1.26E-03 | 4.536 | Hi |
| 1 | **APD reactors 3 & 4** | | | | | | | | | | | |
| 1 | Gas main header from reactors 3 & 4 to gas to grid | TBD | 20-25 | 9 | 10 | TBD | TBD | 2 | 2.50E-01 | 1.67E-05 | 0.06012 | Med |
| 1 | Gas lift and gas mixing pipework | TBD | 2000 | 14 | 31 | TBD | TBD | 0 | 2.50E+00 | 1.26E-03 | 4.536 | Hi |
| 2 | APD reactor 1 PVRV | 8 | 32 | 3 | 1 | 1 | 0 | 1 | 2.00E+02 | 1.51E-02 | 54.36 | Hi |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | APD reactor 2 PVRV | 8 | 32 | 3 | 1 | 1 | 0 | 1 | 2.00E+02 | 1.51E-02 | 54.36 | Hi |
| 4 | APD reactor 3 PVRV | 8 | 32 | 3 | 1 | 1 | 0 | 1 | 2.00E+02 | 1.51E-02 | 54.36 | Hi |
| 5 | APD reactor 4 PVRV | 8 | 32 | 3 | 1 | 1 | 0 | 1 | 2.00E+02 | 1.51E-02 | 54.36 | Hi |
| 6 | APD reactor 5 PVRV | 8 | 32 | 3 | 1 | 1 | 0 | 1 | 2.00E+02 | 1.51E-02 | 54.36 | Hi |
| 7 | APD reactor 6 PVRV | 8 | 32 | 3 | 1 | 1 | 0 | 1 | 2.00E+02 | 1.51E-02 | 54.36 | Hi |
| 8 | APD gas header line PVRV | 8 | TBD | TBD | TBD | TBD | TBD | TBD | 2.00E+02 | 1.51E-02 | 54.36 | Hi |
| 9 | **Dig 1** | | | | | | | | | | | |
| 9 | Gas from dig 1 to gas main header | TBD | 20-25 | 8 | 17 | TBD | TBD | 1 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 9 | Gas lift and gas mixing pipework | TBD | 2000 | 16 | 18 | TBD | TBD | 0 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 10 | **Dig 3** | | | | | | | | | | | |
| 10 | Gas from dig 3 to gas main header | TBD | 20-25 | 8 | 16 | TBD | TBD | 1 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 10 | Gas lift and gas mixing pipework | TBD | 2000 | 13 | 20 | TBD | TBD | 0 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 11 | **Dig 2** | | | | | | | | | | | |
| 11 | Gas from dig 2 to gas main header | TBD | 20-25 | 8 | 18 | TBD | TBD | 1 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 11 | Gas lift and gas mixing pipework | TBD | 2000 | 15 | 18 | TBD | TBD | 0 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 12 | **Dig 4** | | | | | | | | | | | |
| 12 | Gas from dig 4 to gas main header | TBD | 20-25 | 9 | 18 | TBD | TBD | 1 | 0.25 | 1.67E-05 | 0.06012 | Med |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | Gas lift and gas mixing pipework | TBD | 2000 | 16 | 18 | TBD | TBD | 0 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 13 | **Dig 1 and 3 gas mixing** | | | | | | | | | | | |
| 13 | Gas from dig 1,3, to mixing | TBD | 20-25 | 11 | 18 | TBD | TBD | 0 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 13 | Gas to dig 1, 3, | TBD | 2000 | 15 | 20 | TBD | TBD | 3 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 14 | **Dig 2 and 4 gas mixing** | | | | | | | | | | | |
| 14 | Gas from dig 2, 4, to mixing | TBD | 20-25 | 10 | 18 | TBD | TBD | 0 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 14 | Gas to dig 2, 4, | TBD | 2000 | 16 | 16 | TBD | TBD | 3 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 9 | Digester 1 PVRV | 6 | 42.5 | 3 | 1 | 1 | 0 | 1 | 150 | 1.31E-02 | 47.16 | Hi |
| 11 | Digester 2 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 10 | Digester 3 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 12 | Digester 4 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 15 | **Dig 5** | | | | | | | | | | | |
| 15 | Gas from dig 5 | TBD | 20-25 | 8 | 20 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 15 | Gas to dig 5 | TBD | 2000 | 10 | 14 | TBD | TBD | 2 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 16 | **Dig 6** | | | | | | | | | | | |
| 16 | Gas from dig 6 | TBD | 20-25 | 6 | 17 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 16 | Gas to dig 6 | TBD | 2000 | 10 | 12 | TBD | TBD | 2 | 2.5 | 1.26E-03 | 4.536 | Hi |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | **Dig 7** | | | | | | | | | | | |
| 17 | Gas from dig 7 | TBD | 20-25 | 10 | 19 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 17 | Gas to dig 7 | TBD | 2000 | 10 | 15 | TBD | TBD | 2 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 18 | **Dig 8** | | | | | | | | | | | |
| 18 | Gas from dig 8 | TBD | 20-25 | 16 | 22 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 18 | Gas to dig 8 | TBD | 2000 | 12 | 13 | TBD | TBD | 2 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 19 | **Dig 9** | | | | | | | | | | | |
| 19 | Gas from dig 9 | TBD | 20-25 | 12 | 20 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 19 | Gas to dig 9 | TBD | 2000 | 12 | 13 | TBD | TBD | 2 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 20 | **Dig 10** | | | | | | | | | | | |
| 20 | Gas from dig 10 | TBD | 20-25 | 11 | 21 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 20 | Gas to dig 10 | TBD | 2000 | 12 | 13 | TBD | TBD | 2 | 2.5 | 1.26E-03 | 4.536 | Hi |
| 15 | Digester 5 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 16 | Digester 6 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 17 | Digester 7 PVRV | 6 | 37.8 | 3 | 1 | 1 | 0 | 1 | 150 | 1.23E-02 | 44.28 | Hi |
| 18 | Digester 8 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 19 | Digester 9 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |
| 20 | Digester 10 PVRV | 6 | 36 | 3 | 1 | 1 | 0 | 1 | 150 | 1.20E-02 | 43.2 | Hi |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Mad 1, 2 and APD to Flare | TBD | 28-38 | 18 | 22 | TBD | 1 | 0 | 0.25 | 2.06E-05 | 0.07416 | Med |
| 22 | **Gas holder 1 and 2** | TBD | 20-25 | 18 | 38 | TBD | TBD | 2 | 0.25 | 1.67E-05 | 0.06012 | Med |
| 22 | Gas holder PVRV 1 | TBD | 36 | 3 | 1 | 1 | 0 | 1 | 200 | 1.60E-02 | 57.6 | Hi |
| 22 | Gas bag hydrostatic pressure release vessel | TBD | TBD | 2 | 1 | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| 23 | Natural gas feed to CHP | | | | | | | | | | | |
| 23 | Natural gas from below ground and gas meter station to boiler room and gas boosters | TBD | 220 | 27 | 29 | TBD | TBD | 0 | 2.5 | 4.84E-04 | 1.7424 | Med |
| 24 | Natural Gas booster 1 & 2 to biogas pre treatment and workshop | TBD | 138-161 | 11 | 24 | TBD | 0 | 0 | 2.5 | 4.17E-04 | 1.5012 | Med |
| 24 | Natural gas line to Boiler | TBD | 220 | 7 | 9 | TBD | TBD | 2 | 2.5 | 4.84E-04 | 1.7424 | Med |
| 25 | Biogas Line to Pre treatment | 16 | 20 | 15 | 0 | 0 | 0 | 0 | 0.25 | 1.50E-05 | 0.054 | Med |
| 25 | Biogas pre treatment | 16" | 20 | 3 | 1 | 0 | 1 | 0 | 0.25 | 1.50E-05 | 0.054 | Med |
| 25 | Biogas Pre treatment | 10" | 40 | 7 | 1 | 0 | 1 | 0 | 0.25 | 2.11E-05 | 0.07596 | Med |
| 25 | Biogas Pre treatment | 6" | 40 | 12 | 4 | 0 | 0 | 0 | 0.25 | 2.11E-05 | 0.07596 | Med |
| 26 | Biogas Pre treatment to BUP | 16" | 40 | 28 | 1 | 0 | 2 | 0 | 0.25 | 2.11E-05 | 0.07596 | Med |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | Biogas Pre treatment to BUP | 10" | 40 | 7 | 1 | 0 | 0 | 0 | 0.25 | 2.11E-05 | 0.07596 | Med |
| 27 | BUP upgrading plant | | | | | | | | | | | |
| 27 | BUP inlet to Blowers | 10 | 34 | 18 | 2 | 0 | 0 | 1 | 0.25 | 1.95E-05 | 0.0702 | Med |
| 27 | Blowers to compressors | 10 | 1000 | 13 | 0 | 0 | 1 | 1 | 2.5 | 9.58E-04 | 3.4488 | Med |
| 27 | Blowers to compressors | 5" | 1000 | 8 | 4 | 0 | 0 | 0 | 2.5 | 9.58E-04 | 3.4488 | Med |
| 27 | compressors outlets | 3 | 6300 | 4 | 4 | 0 | 0 | 0 | 5 | 3.78E-03 | 13.608 | Hi |
| 27 | Compressor outlets to A-column | 5" | 6300 | 21 | 7 | 0 | 0 | 0 | 5 | 3.78E-03 | 13.608 | Hi |
| 27 | Dryers | 3" | 6300 | 34 | 17 | 0 | 1 | 2 | 2.5 | 1.89E-03 | 6.804 | Hi |
| 27 | Carbon Filters | 4 | 3000 | 13 | 14 | 0 | 0 | 2 | 2.5 | 1.47E-03 | 5.292 | Hi |
| 27 | Carbon Filters PRV | 1.5 | 3000 | 8 | 0 | 0 | 0 | 0 | 37.5 | 2.20E-02 | 79.2 | Hi |
| 28 | grid entry unit inject line | 4" | 3500 | 9 | 2 | 0 | 0 | 0 | 2.5 | 1.55E-03 | 5.58 | Hi |
| 28 | grid entry unit inject line | 2" | 3500 | 5 | 1 | 0 | 0 | 3 | 2.5 | 1.55E-03 | 5.58 | Hi |
| 28 | grid entry unit inject line PRV | 0.5" | 3500 | 0 | 7 | 28 | 0 | 0 | 12.5 | 7.76E-03 | 27.936 | Hi |
| 28 | grid entry unit inject line | 4" | 1300 | 10 | 2 | 0 | 0 | 1 | 2.5 | 1.07E-03 | 3.852 | Med |
| 28 | grid entry unit inject line PRV | 1" | 1300 | 0 | 0 | 12 | 0 | 0 | 25 | 1.07E-02 | 38.52 | Hi |
| 28 | GEU Propane injection | 1" | 13000 | 7 | 4 | 33 | 0 | 1 | 2.5 | 2.35E-03 | 8.46 | Hi |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | GEU Propane injection | 0.5" | 13000 | 12 | 6 | 74 | 0 | 1 | 2.5 | 2.35E-03 | 8.46 | Hi |
| 28 | GEU Propane injection | 4" | 13000 | 5 | 1 | 0 | 0 | 0 | 2.5 | 2.35E-03 | 8.46 | Hi |
| 29 | Reject line to waste burner | 4" | 3420 | 4 | 1 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 29 | Reject line to waste burner | 8" | 3420 | 4 | 0 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 30 | Waste burner | 6" | 3420 | 1 | 0 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 30 | Waste burner | 8" | 3420 | 5 | 2 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 30 | Waste burner | 5" | 3420 | 8 | 4 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 30 | Waste burner | 4" | 3420 | 4 | 2 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 30 | Waste burner | 8" | 3420 | 4 | 0 | 0 | 0 | 0 | 2.5 | 1.54E-03 | 5.544 | Hi |
| 30 | Pilot lines | 0.5 | 9000 | 8 | 4 | 84 | 0 | 0 | 2.5 | 2.11E-03 | 7.596 | Hi |
| 31 | Propane tank | 1.5" | 13000 | 15 | 12 | 41 | 0 | 2 | 2.5 | 2.35E-03 | 8.46 | Hi |
| 31 | Propane tank | 1" | 13000 | 1 | 0 | 0 | 0 | 0 | 2.5 | 2.35E-03 | 8.46 | Hi |
| 31 | Propane tank PRV's | 2" | 17000 | 1 | 0 | 5 | 0 | 0 | 50 | 2.53E-03 | 9.10800 | Hi |

**12. Appendix 2: Location of release points (black numbering corresponds to entries in Table 2)**