Ryedale Gas Project

Flood Risk Assessment

24 March 2010
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EXECUTIVE SUMMARY

URS Corporation Ltd ("URS") was commissioned by Moorland Energy to undertake a Flood Risk Assessment (FRA) for a new gas pipeline and associated processing facility. The pipeline will run from the existing Ebberston Welll Site to a gas processing facility which will be located at Hurrell Lane, to the east of Thornton-le-Dale.

Using available information URS has identified the flood risk to the site from all sources and this assessment considers flood risk to the proposed development, and the effect of the proposed development on flood risk, both to the development itself and elsewhere.

The following conclusions can be made regarding flood risk to the proposed development.

- The proposed pipeline route and Hurrell Lane Gas Facility site lie in Flood Zone 1, the zone of lowest flood risk. There are land drains next to the Hurrell Lane site. These serve small catchment areas upstream of it. Flood risk from other sources was also assessed as low. Overall, the proposed development is considered to be at low risk of flooding from all sources.

- The proposed pipeline will be buried along its entire route, and the area affected by construction reinstated. No impacts on flood risk or surface water runoff are expected as a result of the pipeline.

- The Hurrell Lane Gas Facility site is currently greenfield. The proposed development will turn a substantial part of the site area into impermeable surfaces. If not managed properly, the surface water runoff generated at the site will increase flood risk to other areas, and the development itself.

- Surface water runoff from the Hurrell Lane Gas Facility site will be limited to the 1 in 1 greenfield rate of 1.4l/s/ha. In order to achieve that, a storage pond of up to 990m^3 will be provided on site, to attenuate the runoff to the greenfield rate.

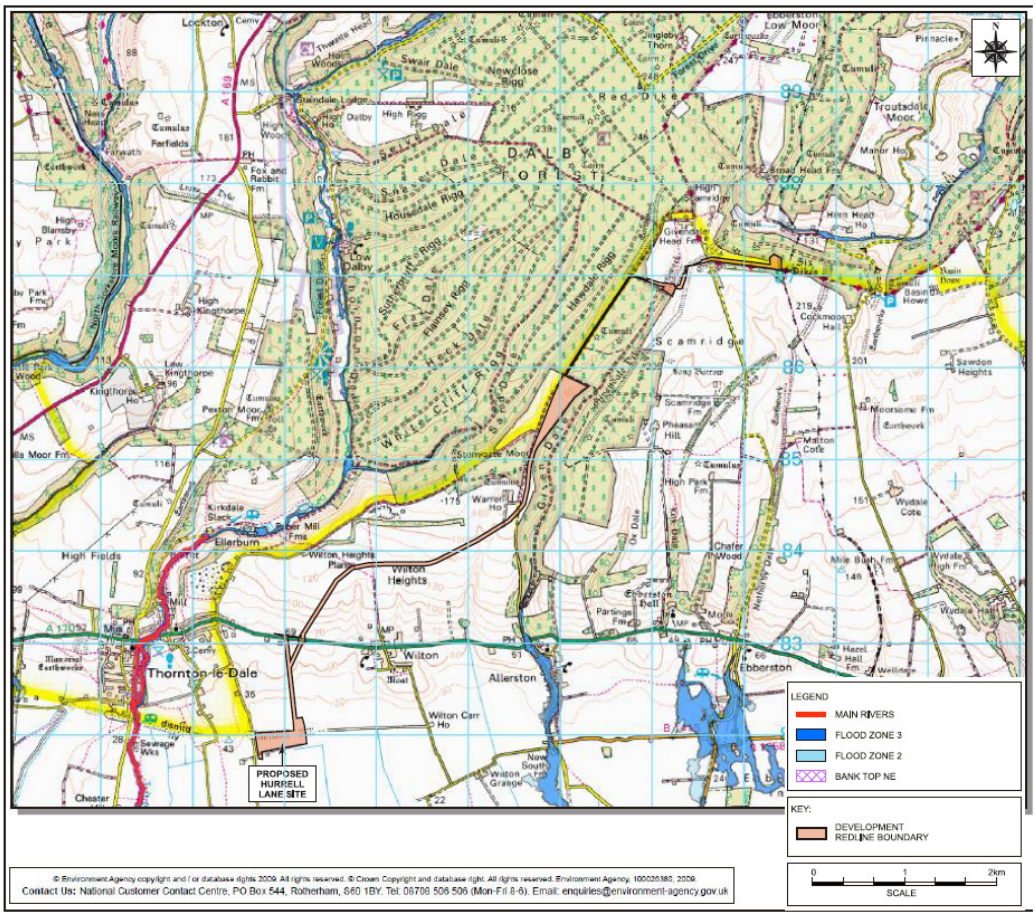
1. INTRODUCTION

1.1. Background

URS Corporation has been comissioned by Moorland Energy to provide technical services in relation to an Environmental Impact Assessment (EIA) for a new gas pipeline and associated processing facility in North Yorkshire. This includes the production of a Flood Risk Assessment (FRA). The pipeline will run from the existing Ebberston Well Site (approximate NGR 490330, 487150) to a gas processing facility which will be located at Hurrell Lane, just outside Thornton-le-Dale. The Hurrell Lane Gas Facility site is approximately 6ha in size and centred at NGR 481840, 4819002. The pipeline will be buried along its entire length.

A FRA is required as the site for the Hurrell Lane Gas Facility is greater than 1 ha in size. The site lies in Flood Zone 1, as defined by the Environment Agency (EA) Flood Zone Map as shown in Figure 1. This classifies the site as being at Low Risk from fluvial and tidal sources and in land assessed as having an annual probability of fluvial flooding and tidal flooding of less than 1 in 1000 (0.1%).

Figure 1 Site in Relation to the Environment Agency Flood Zones (provided by EA, Ref RFI/2009/10014)



The entire pipeline route is also shown to be in Flood Zone 1. Also, as the pipeline will be buried and the area affected by the pipeline construction reinstated to current soil and vegetation cover, it is considered that with the development complete, there will be no increases in flood risk to the affected area or other areas as a result of the proposed development. The FRA therefore focusses on the Hurrell Lane Gas Facility.

1.2. Scope of Works

The aim of this study is to carry out a FRA that meets the requirements of PPS25 and which, with reference to surface water drainage, considers the specific needs of the EA and the local internal drainage board. As the pipeline will be buried along its entire length, the FRA focusses on the gas processing site.

In order to meet this aim, and given the data available, the following tasks were determined and completed:

- Undertake consultation with, and obtain data from the EA, Thornton Internal Drainage Board (IDB), Ryedale District Council (RDC) and Yorkshire Water (YW);
- Review the information obtained from the EA and use it to assess fluvial flood risk;
- Assess, from the consultation responses, flood risk from other sources;
- Review and assess the current foul and surface water runoff generated at the site and identify suitable measures to manage and control drainage from the site, giving consideration to the requirements of Thornton IDB and the EA; and
- Identify suitable and appropriate mitigation measures to manage the flood risks to the site and to other areas as a result of the proposed development.

The structure of this FRA follows the proforma for new development suggested in Annex C of the PPS25 Practice Guide[1].

1.3. Data Sources

Data collected during the course of this assessment is presented in the following table, which also identifies the source of this data and provides comment on its use and suitability.

[1] Department for Communities and Local Government (2006) Planning Policy Statement 25: Development and Flood Risk – Practise Guide, June 2008.

Table 1 .1 Data Collected

Data	Source	Use / Comment
Proposed pipeline routes and site plans	Moorland Energy	Information on pipeline route and proposed uses at Hurrell Lane Gas Facility site
Flood extent data for watercourses along pipeline route, and in the vicinity of the Hurrell Lane Gas Facility site	EA	Flood risk data for fluvial flooding
Geology	BGS Map, Solid and Drift edition, Pickering, Sheet 54, 1:50,000	To aid with the determination of flood risk from groundwater sources
Local watercourses	Thornton Internal Drainage Board, OS Maps	Identify potential sources of flooding
Planning Policy	Local Planning Authority	
Strategic Flood Risk Assessment	Ryedale District Council website	Identify flood risk issues for the area
Asset location plans	Yorkshire Water Services (YWS)	Locating sewers

2. DEVELOPMENT DESCRIPTION AND LOCATION

2.1. What type of development is proposed and where will it be located?

The development proposals are to transfer gas from the existing Ebberston Wellsite to the Hurrell Lane Gas Facility off Hurrell Lane, at the ouskirts of Thornton-le-Dale via 7.5km of pipeline. A connection will be made into one of the existing gas pipelines that runs to the south of Hurrell Lane, transporting the processed gas in an existing pipeline to the existing above ground infrastructure (AGI) at Pickering, for transfer into the National Transmission System (NTS).

Construction of the pipeline will be within a corridor of 42m wherever possible. In sections where there is a reduced working width because of constraints then additional areas, above the 42m width will need to be taken to accommodate materials from the reduced working areas. The strip will contain two pipelines – one for the gas and another one transporting condensates from the processing plant to the well site. There will also be a fibre optic cable for power. The pipelines and fibre optic cable will be buried below ground along its entire length. On completion of the construction, the affected strip of land will be reinstated. Rreinstatement of the surface of the land is normally carried out within the same season as construction.

The Hurrell Lane Gas Facility will consist of processing plant, and associated offices and car parking facilities.

The proposed pipeline route is indicated on Figure 2. Figure 3 shows the proposed processing plant on Hurrell Lane, Thornton-le-Dale.

Figure 2 Proposed Pipeline Route

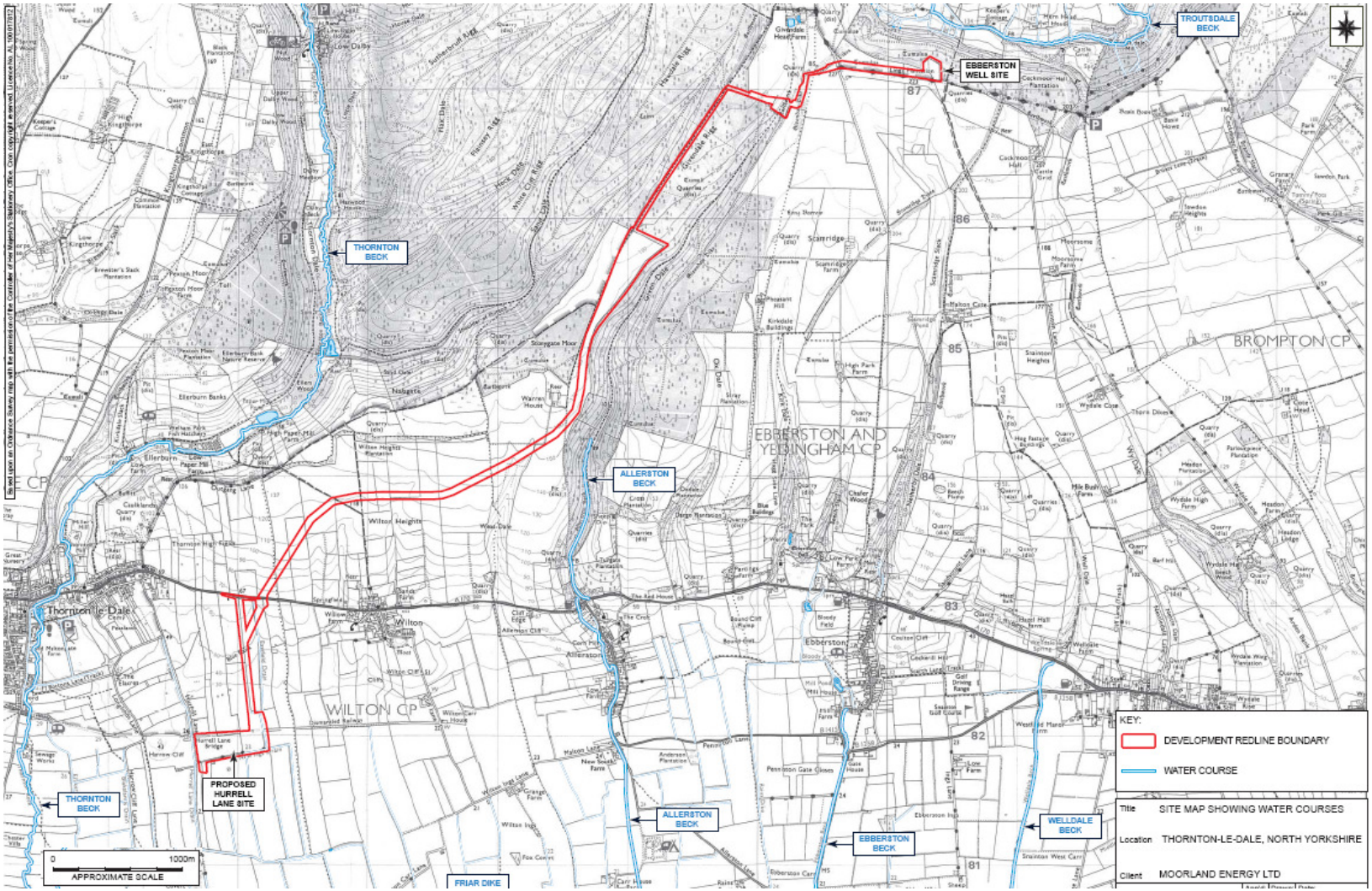
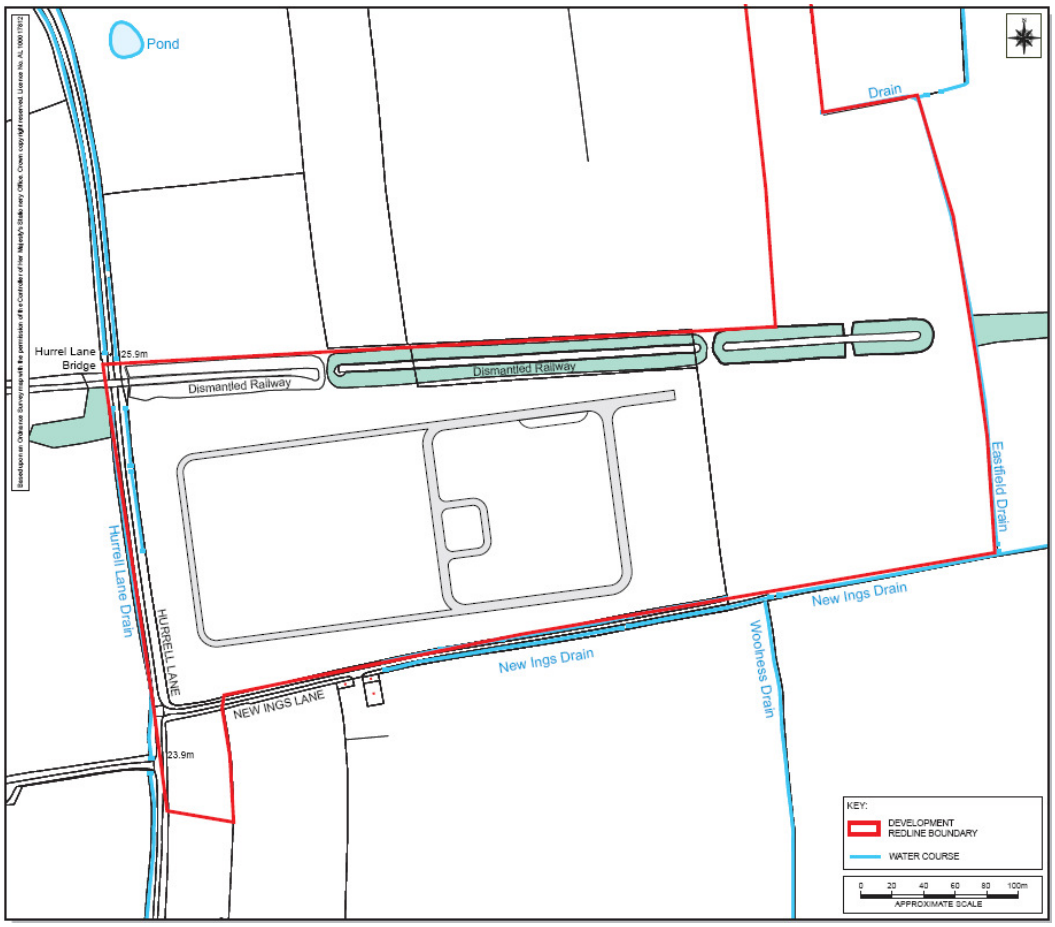


Figure 3 Proposed Processing Plant at Hurrell Lane.



2.2. What is its vulnerability classification

According to Table D.2 of PPS25, the development is Essential Infrastructure. It is considered to be strategic gas utility infrastructure.

2.3. Is the proposed development consistent with the Local Development Documents?

The Yorkshire and Humber Plan

The Yorkshire and Humber Plan, published in May 2008[2] is the current Regional Spatial Strategy to 2026. The Plan contains the following policies relating to water resources and flood risk:

[2] Government Office for Yorkshire and The Humber (May 2008), The Yorkshire and Humber Plan, Regional Spatial Strategy to 2026.

- Policy YH1 Overall Approach and Key Spatial Priorities – a main aim of the Yorkshire and Humber Plan is to avoid increasing flood risk and manage land and river catchments in order to mitigate flood events.

- Policy YH2 Climate Change and Resource Use – Plans and strategies should help to meet targets set out in the Regional Economic Strategy by, amongst other things, encouraging water efficient buildings and minimising resource demands from development, and help provide successful adaptation to the predicted impacts of climate change by minimising threats and impacts of increased flood risk, increased storminess, increased pressure on water resources, supply and drainage systems.

- Policy ENV1 Development and Flood Risk – The Region will manage flood risk pro-actively by reducing the causes of flooding to existing and future development, especially in tidal areas, and avoid development in high flood risk areas where possible. Allocation of areas for development will follow a sequential approach and will be in the lowest risk sites appropriate for the development (identified by Strategic Flood Risk Assessments).

  Flood management will be required to:

  - facilitate development in cities where there is little development land available outside high flood risk zones, provided the sequential approach has been used to inform decisions regarding flood risk;

  - provide flood storage, habitat creation and managed realignment around river corridors as required; and

  - provide positive land management for flood alleviation.

- Policy ENV2 Water Resources – The region will safeguard water resources and encourage water efficiency.

- Policy ENV3 Water Quality - The region will maintain high standards of water quality. Plans and strategies should: prevent development that could pollute surface and underground water resources especially in Source Protection Zones and close to above ground water resources of reservoirs and some rivers; and provide for adequate sewerage infrastructure and treatment capacity and promote more sustainable waste water treatment methods.

North Yorkshire County Council Mineral Local Plan

North Yorkshire County Council is preparing a Minerals and Waste Development Framework to replace the Council's current Mineral and Waste Local Plans. The relevant policy from the "saved" policies of the Mineral Local Plan[3] is;

[3] North Yorkshire County Council (1997); Mineral Local Plan

Policy 4/10 Water Protection – proposals will only be granted permission if they do not cause unacceptable impact of surface or ground water resources.

North York Moors National Park Authority Core Strategy

The North York Moors National Park Authority Core Strategy[4], states that the impacts of climate change on the National Park will be mitigated by avoiding development in flood risk areas, facilitating flood protection provision and improve flood storage (Core Policy D – Climate Change). Development Policy 2 Flood Risk states that development will only be permitted with the sequential approach as per PPS25, where it will not lead to increased flood risk in other areas and where (if required) a Flood Risk Assessment has been carried out.

Ryedale Local Plan

At present the Development Plan for Ryedale consists of the Regional Spatial Strategy (The Yorkshire and Humber Plan) together with saved policies from the Ryedale Local Plan[5] and the emerging Local Development Framework (LDF). The LDF is currently under review and due to be adopted at the end of 2010. The Core Strategy is anticipated to be published to the Planning Inspectorate in Autumn 2010.

The Local Plan was adopted in March 2002. Policy U3 Surface Water Runoff, states that a development must not create additional surface water run-off. Those developments that increase the risk of flooding must include appropriate attenuation or mitigation measures, including restoration of the floodplain. The policy also states that Council will strongly support the use of sustainable drainage systems.

2.4. Please provide evidence that the Sequential Test and where necessary the Exception Test has been applied to the selection of this site for this development type.

The proposed development is shown on EA flood risk mapping to lie in Flood Zone 1, the zone of lowest flood risk. From observations made during the site visit, and inspection of Ordnance Survey (OS) mapping for the pipeline route, there are no notable watercourses crossed by the pipeline route, or next to the proposed processing site at Hurrell Lane.

As the Hurrell Lane Gas Facility site and the pipeline route lie in Flood Zone 1, the Proposed Development satisfies the requirements of the Sequential Test. According to Table D3 of PPS 25, an Exception Test is not required for Essential Infrastructure in Flood Zone 1.

[4] North Yorkshire Moors National Park Authority (2008); Core Strategy and Development Policies.

[5] District Council (2002) The Ryedale Local Plan

3. DEFINITION OF THE FLOOD HAZARD

3.1. What sources of flooding could affect the site?

The Proposed Development consists of a pipeline from the existing Ebberston Well Site to the proposed Hurrell Lane Gas Facility. The pipeline will be buried along its entire length and on completion of the scheme, the pipeline route will be reinstated to current conditions. Flood risk is therefore assessed primarily in relation to the Hurrell Lane Gas Facility.

Fluvial

There are no watercourses along the pipeline route or in the immediate vicinity of the Hurrell Lane Gas Facility. As shown on Figure 1, the nearest main watercourse with high risk flood zones, Thornton Beck, runs about 1.2km to the west of the Site. The risk of flooding from fluvial sources is therefore low.

Land drainage

Land drains run along the Hurrell Lane Gas Facility site's western and southern boundaries. Hurrell Lane Drain starts about 800m to the north of the site and runs along the western boundary of the site in a southerly direction. New Ings Drain starts about midway the southern boundary of the site, and flows in an easterly direction. It is considered that the risk of flooding from the drains is low, given the small areas that they drain.

The pipeline route crosses the Eastfield Drain about 1km to the north of the Hurrell Lane Gas Facility Site. According to OS background mapping, the crossing will be a short distance from the start of the drain, estimated at about 100m. Thus even the construction phase is not likely to result in significant disruption to the land drainage system, or to result in flooding problems.

The Thornton IDB, who is responsible for the drains in the locality of the Site, has advised that this area is not known to suffer from flooding problems.

Sewer flooding

The Hurrell Lane Gas Facility Site is located over 1 km from the nearest built up area of Thornton-le-Dale. Asset location plans received from YW show that the only sewer infrastructure in the immediate vicinity of the Site is a foul water rising main located on New Ings Lane at the southern boundary. There is therefore, low risk of flooding, from sewers.

Overland flow

The Hurrell Lane site lies in an area served by land drains, and the surrounding area is essentially greenfield. Therefore, generation and conveyance of overland flow will be limited. As such, the risk of flooding from overland flow is low.

Groundwater flooding

The EA has advised that the proposed route is mainly underlain by the Corallian Limestone Aquifer, which is a Principal Aquifer. Drift cover is mainly thin or absent in the proposed route and so, the Corallian Limestone Principal Aquifer is close to the surface and is vulnerable. The aquifer is dominated by flow through solutionally enlarged fractures and fissures and is recharged rapidly via sinkholes. Groundwater levels are high at the boundary between the Corallian Limestone and the Ampthill Clay and Kimmeridge Clay formation and springs are commonplace. Based on this information, groundwater levels are therefore expected to be generally high. However, the presence of the network of drains in the area surrounding the Hurrell Lane Gas Facility Site would prevent groundwater from reaching the surface. Therefore the risk of groundwater flooding is considered low. Any subsurface components of the proposed development however, is likely to be affected by shallow groundwater.

3.2. For each identified source, describe how flooding would occur, with reference to any historic records wherever these are available.

The site is considered to be at low risk of flooding from all sources, as discussed under Section 3.1 above. The Site is nonetheless considered most susceptible to flooding if the capacity of the land drains was lost, causing out-of-channel flows. Capacity of the channels could be lost through blockages or clogging through lack of maintenance. This would result in overland flow. With the loss of drainage, it is also possible that local groundwater levels would rise.

It is noted however, that the site lies at the upstream extent of the local land drainage system. Therefore the risk of flooding is low as the catchment area for the Hurrell Lane Drain past the site is relatively small and there are no other drains that lie upstream of the site.

3.3. What are the existing surface water drainage arrangements for the site?

The site is currently greenfield. Surface water runoff from the Site is collected by the Hurrell Lane Drain, which runs along its western boundary, or New Ings Drain, which starts at its southern boundary. The Thornton IDB is responsible for maintaining the drains that the site discharges to.

4. PROBABILITY

4.1. Which flood zone is the site within?

The EA has provided a flood risk map for the area (Figure 1). This shows that the Hurrell Lane Gas Facility, and the pipeline route lie in Flood Zone 1, areas of land with less than a 1 in 1000 (0.1%) chance of flooding each year from rivers or the sea.

4.2. If there is a Strategic Flood Risk Assessment for this site, what does it show?

In March 2006, a SFRA was produced for the Ryedale District Council (RDC), Scarborough Borough Council (SBC), and North York Moors National Park Authority (NYMPA) (collectively known as Northeast Yorkshire). The SFRA was produced before the promulgation of PPS 25, under PPG 25. For the Thornton-le-Dale area, the SFRA states high flood risk only as being associated with Thornton Beck. As shown on Figure 2, the Hurrell Lane Gas Facility Site is located a considerable distance from the watercourse. The SFRA does not identify the Site as being at risk of flooding.

4.3. What is the probability of the site flooding taking account of the contents of the SFRA and of any further site-specific assessment?

The Site lies entirely in Flood Zone 1, the area of land with less than a 1 in 1000 (0.1%) chance of flooding each year from rivers or the sea.

4.4. What are the existing rates and volumes of runoff generated by the site?

The Hurrell Lane Gas Facility Site is currently unoccupied and is also greenfield. Surface water runoff generated at the Site drains into the land drains that border the site.

The EA's preferred method for calculating greenfield run-off from a site is the method described in Institute of Hydrology (IoH) Report 124[6] for flood estimation from small rural catchments. Using the IoH 124 methodology, which utilises site parameters such as area, soil type and annual average rainfall, the peak greenfield (undeveloped) runoff rate for a range of return period storms, including the impact of climate change, has been

[6] Marshall, D.C.W. & Bayliss, A.C. (1994) *Flood estimation for small catchments*. Report No. 124. Wallingford

estimated and the results are presented in Table 4.1 below. The flows were estimated using the IoH method tools available within the MicroDrainage WinDes software package.

Table 4.1 Greenfield Run-Off Rates, calculated using IoH 124 Method

Return Period, Years (AEP)	Flow l/s
QBAR	32.2
1 (100%)	27.7
2 (50%)	30.4
5 (20%)	40.3
10 (10%)	46.7
25 (4%)	55.0
30 (3.3%)	50.6
50 (2%)	61.0
100 (1%)	67.0
200 (0.5%)	76.1
1000 (0.1%)	98.0

5. CLIMATE CHANGE

5.1. How is flood risk at the site likely to be affected by climate change?

Climate change is currently predicted to increase the wetness of winters and the dryness of summers. In addition, the intensity of storm events is anticipated to increase. PPS25 states that when assessing the likely impact of climate change on peak rainfall intensities the following increases such be incorporated: 5% expected by 2025; 10% by 2055; 20% by 2085; and 30% by 2115. The primary impact of these increased rainfall intensities to flood risk at the site will be to increase the volume of surface water runoff generated at the Site and increase pressure on the land drains serving the site. This will be taken into account in the development of mitigation measures.

6. DETAILED DEVELOPMENT PROPOSALS

6.1. Please provide details of the development layout, referring to the relevant drawings.

The proposal is for a 7.5km buried pipeline to transfer gas from the existing Ebberston Wellsite to the proposed processing plant on land off Hurrell Lane. A connection will be made into one of the existing gas pipelines that runs to the south of Hurrell Lane, to transfer the processed gas into the national transmission system.

The pipeline route is shown on Figure 3, and the layout of the Hurrell Lane processing plant is shown below.

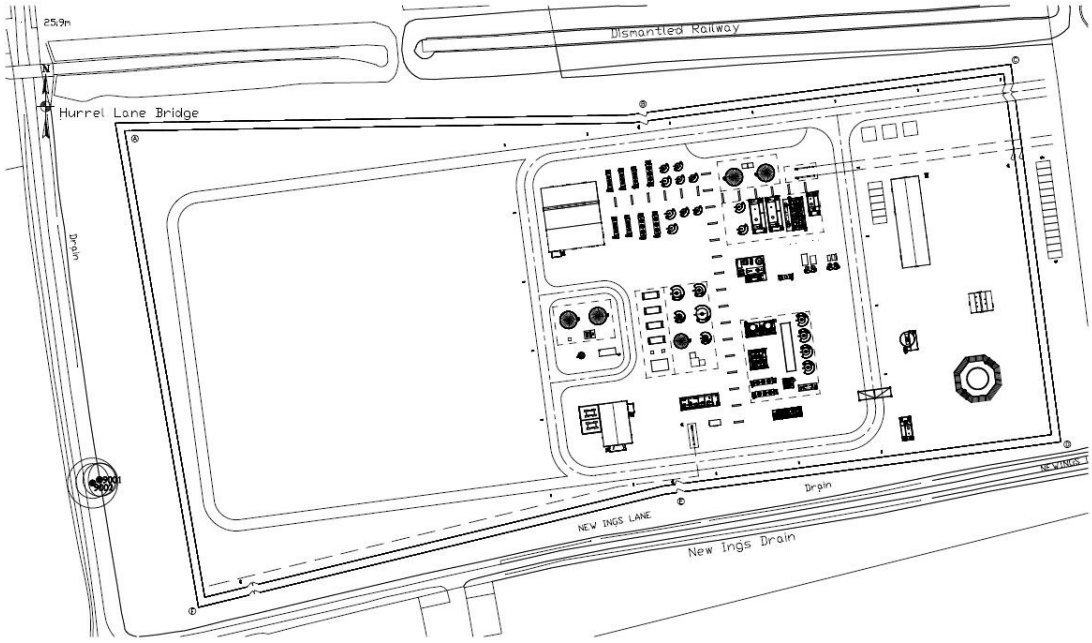


Figure 4 Hurrell Lane Gas Facility Layout Plan.

6.2. Where appropriate, demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are least risk of flooding.

As the entire site lies within Flood Zone 1, the whole development will be located in an area with a low risk of fluvial flooding. No part of the development will be at high risk of flooding and consequently, there is no preferred layout with respect to flood risk.

The Proposed Development is in an area of low flood risk and will also not impact on the drainage system.

7. FLOOD RISK MANAGEMENT MEASURES

7.1. How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?

As discussed under Section 3.1, the Site is currently at low risk of flooding from fluvial sources, as well as from land drainage, overland flow, sewers and groundwater. However, the Proposed Development will introduce impermeable surfaces at the Hurrell Lane Gas Facility. If not managed properly the associated increases in the rate of surface water runoff will lead to increases in flood risk to the development itself, and to other areas.

Surface water runoff management

PPS 25 requires that surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

To meet this requirement, surface water runoff from the Proposed Development will be limited to greenfield rates. The EA has specified that the discharge should be limited to the greenfield run-off from a 1 in 1 year storm (1.4l/s/ha) and sufficient storage to ensure that storm water resulting from a 1 in 100 year event can be stored on the site without risk to people or property and without overflowing into the watercourse. The Thornton IDB has also stated that the discharge should be limited to 1.4l/s/ha.

In line with PPS25, the use of Sustainable Drainage Systems (SUDS) is proposed. SUDS aim to reduce the amount and rate of water flow by a combination of infiltration to the ground, holding water in storage areas and slowing down the movement of water.

Given the use of land drains in the area, it is likely that shallow groundwater is prevalent. Therefore, the use of infiltration-based techniques, such as soakaways is considered to be restricted. It is proposed that attenuation storage be provided at the development site, to control the rate of discharge from the site.

The site designers have advised that the total impermeable area for the site will be an estimated 7,632m^2. Based on this, it is estimated that 990m^3 of storage will be required to limit runoff from these impermeable surfaces to the greenfield rate of 1.4l/s/ha as required by the EA.

Output of the calculations using the MicroDrainage Windes software package are included in Appendix A. The required storage will be confirmed through detailed design. In the calculations, it is assumed that piped drainage systems will serve the site roads and the area covering the main plant area, the office building and car parking area towards eastern end of the Site, estimated to be about 2ha.

In order to control pollution more effectively, separate drainage systems are proposed. Surface water runoff from plant concreted areas, buildings, roads and car parking areas will be collected separately from runoff from the area of the pig receiver and other equipment (such as compressors, separators) where there is a higher possibility for pollutants. The systems will pass through separate appropriately designed oil interceptors before discharge to the storage pond.

8. OFF-SITE IMPACTS

8.1. How will you ensure that your proposed development and measures to protect your site from flooding will not increase flood risk elsewhere?

The mitigation measures described in Section 7 will be designed to prevent runoff from the completed development impacting areas elsewhere. In order to maintain this protection, maintenance of the drainage systems will be necessary.

8.2. How will you prevent run-off from the completed development causing an impact elsewhere?

By limiting runoff to the 1 in 1 greenfield rate, for all rainfall events up to the 1 in 100 storm, including allowances for climate change, the proposed Hurrell Lane Gas Facility will not increase flood risk to other areas.

9. RESIDUAL RISKS

9.1. What flood-related risks will remain after you have implemented the measures to protect the site from flooding?

The main residual risk following the implementation of mitigation measures will be from a failure of the drainage system such as a blockage, or loss of storage through vegetation growth. There also remains the risk of rainfall events in excess of the 1 in 100 event for which the drainage system is designed.

9.2. How, and by whom, will these risks be managed over the lifetime of the development?

Regular proactive maintenance will be undertaken to ensure the drainage system continues to operate as it has been designed. Following detailed design, maintenance procedures will be included in the overall site maintenance procedures, which will be the responsibility of the site operators.

The drainage design will follow such guidance as CIRIA C635, to manage the risk from exceedance flows, and any overland flow from other areas reaching the site.

10. CONCLUSIONS

The following conclusions can be made regarding flood risk to the proposed development.

- The proposed pipeline route and Hurrell Lane Gas Facility site lie in Flood Zone 1, the zone of lowest flood risk. There are land drains next to the Hurrell Lane site. These serve small catchment areas upstream of it. Flood risk from other sources was also assessed as low. Overall, the proposed development is considered to be at low risk of flooding from all sources.

- The proposed pipeline will be buried along its entire route, and the area affected by construction reinstated. No impacts on flood risk or surface water runoff are expected as a result of the pipeline.

- The Hurrell Lane Gas Facility site is currently greenfield. The proposed development will turn a substantial part of the area into impermeable surfaces. If not managed properly, the surface water runoff generated at the site will increase flood risk to other areas, and the development itself.

- Surface water runoff from the Hurrell Lane Gas Facility site will be limited to the 1 in 1 greenfield rate of 1.4l/s/ha. In order to achieve that, a storage pond of up to 990m^3 will be provided on site, to attenuate the runoff to the greenfield rate.

Appendix A – Attenuation Storage Calculations

Summary of Results for 100 year Return Period (+30%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m^3)	Status
15 Summer	1.6	1.6	0.2782	0.2782	278.3	O K
30 Summer	1.7	1.7	0.3767	0.3767	376.7	O K
60 Summer	2.0	2.0	0.4842	0.4842	484.3	O K
120 Summer	2.2	2.2	0.5958	0.5958	595.8	O K
180 Summer	2.3	2.3	0.6578	0.6578	657.8	O K
240 Summer	2.4	2.4	0.7043	0.7043	704.4	O K
360 Summer	2.5	2.5	0.7703	0.7703	770.3	O K
480 Summer	2.6	2.6	0.8163	0.8163	816.4	O K
600 Summer	2.6	2.6	0.8508	0.8508	851.0	O K
720 Summer	2.7	2.7	0.8778	0.8778	878.0	O K
960 Summer	2.7	2.7	0.9168	0.9168	916.8	O K
1440 Summer	2.8	2.8	0.9593	0.9593	959.5	O K
2160 Summer	2.8	2.8	0.9798	0.9798	979.7	O K
2880 Summer	2.8	2.8	0.9768	0.9768	976.8	O K
4320 Summer	2.8	2.8	0.9628	0.9628	962.9	O K
5760 Summer	2.8	2.8	0.9448	0.9448	944.8	O K
7200 Summer	2.7	2.7	0.9233	0.9233	923.5	O K
8640 Summer	2.7	2.7	0.9008	0.9008	900.8	O K
10080 Summer	2.7	2.7	0.8783	0.8783	878.2	O K
15 Winter	1.6	1.6	0.2782	0.2782	278.3	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	97.74	19
30 Summer	66.27	34
60 Summer	42.78	64
120 Summer	26.52	124
180 Summer	19.67	184
240 Summer	15.91	244
360 Summer	11.76	364
480 Summer	9.47	482
600 Summer	8.00	602
720 Summer	6.97	722
960 Summer	5.60	962
1440 Summer	4.10	1442
2160 Summer	2.99	2160
2880 Summer	2.39	2620
4320 Summer	1.74	3328
5760 Summer	1.39	4096
7200 Summer	1.17	4904
8640 Summer	1.02	5784
10080 Summer	0.90	6560
15 Winter	97.74	19

Summary of Results for 100 year Return Period (+30%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m^3)	Status
30 Winter	1.7	1.7	0.3767	0.3767	376.7	O K
60 Winter	2.0	2.0	0.4842	0.4842	484.3	O K
120 Winter	2.2	2.2	0.5958	0.5958	595.9	O K
180 Winter	2.3	2.3	0.6583	0.6583	658.1	O K
240 Winter	2.4	2.4	0.7048	0.7048	704.8	O K
360 Winter	2.5	2.5	0.7713	0.7713	771.1	O K
480 Winter	2.6	2.6	0.8173	0.8173	817.5	O K
600 Winter	2.6	2.6	0.8523	0.8523	852.4	O K
720 Winter	2.7	2.7	0.8798	0.8798	879.7	O K
960 Winter	2.7	2.7	0.9193	0.9193	919.3	O K
1440 Winter	2.8	2.8	0.9638	0.9638	964.0	O K
2160 Winter	2.8	2.8	0.9883	0.9883	988.2	O K
2880 Winter	2.8	2.8	0.9878	0.9878	987.7	O K
4320 Winter	2.8	2.8	0.9658	0.9658	965.8	O K
5760 Winter	2.8	2.8	0.9423	0.9423	942.4	O K
7200 Winter	2.7	2.7	0.9133	0.9133	913.1	O K
8640 Winter	2.7	2.7	0.8818	0.8818	881.6	O K
10080 Winter	2.6	2.6	0.8498	0.8498	849.7	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
30 Winter	66.27	34
60 Winter	42.78	64
120 Winter	26.52	122
180 Winter	19.67	182
240 Winter	15.91	240
360 Winter	11.76	358
480 Winter	9.47	476
600 Winter	8.00	596
720 Winter	6.97	712
960 Winter	5.60	944
1440 Winter	4.10	1400
2160 Winter	2.99	2076
2880 Winter	2.39	2712
4320 Winter	1.74	3412
5760 Winter	1.39	4328
7200 Winter	1.17	5256
8640 Winter	1.02	6144
10080 Winter	0.90	7064