



New England Resource Recovery Centre

Flood Risk Assessment



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1.0 INTRODUCTION

1.1 Context

SLR Consulting Limited (SLR) has been appointed by Viridor to undertake a Flood Risk Assessment (FRA) in support of a full planning application for a proposed Resource Recovery Facility at New England Quarry.

1.2 Site Location and Features

The site is located south of Lee Mill, just off the A38, and is bound by the River Yealm on its eastern boundary, a minor tributary of the Yealm on its northern and New England Hill road on its southern (see Drawing No. 9-1).

The site covers an area of approximately 35 hectares (ha). The application site is a mothballed quarry for the extraction of road stone and aggregate.

Topographic survey information (see Drawing No. 9-2) indicates that site elevations range from approximately 36m OD at the river to over 90m OD at the western boundary.

The topography of the application site has been largely altered by the quarrying activity. The site consists of a relatively flat man made plateau in the north (the proposed location of the Energy from Waste - EfW) which slopes away steeply to a small tributary to the north and the Yealm to the east.

The quarry is cut in a series of terraces to a depth of 35m OD. To the east of the quarry the land slopes steeply from approximately 48m OD to the Yealm at 36mOD.

1.3 Development Proposals

It is proposed to construct an EfW facility in the northern half of the site and to landfill the current quarry void in the southern part of the site.

The site will accept up to 275,000 tonnes of waste per annum and be active for 25 years.

Access to the site will be provided through the construction of a new access road from the A38 Lee Mill junction running south along the eastern side of the River Yealm, past Strashleigh Hams landfill, crossing the river on a new bridge at the northernmost extent of the application site. The locations of proposed road, EfW and landfill are shown on Drawing 9-3.

1.4 Flood Zone Classification

Reviewing the Environment Agency Flood Zone Map (included in Appendix A) shows the proposed EfW and landfill site are shown to be located within Flood Zone 1 (indicating that they have a less than 0.1% annual chance of flooding).

Discussions with the EA has confirmed that the flood zones for the River Yealm are approximations based on JFLOW generalised mapping only and are not based on catchment hydraulic modelling.

The proposed access road and part of the current site entrance off New England Road are shown (on the EA Flood Zone Map) to be located within Flood Zones 1, 2 and 3. Flood Zone 3 (high probability) is defined as an area of land with a 1 in 100 or greater annual probability of river flooding (>1%). Flood Zone 3 is split into two parts FZ3a and FZ3b.

FZ3b – the Functional Floodplain (up to the 20 year return period flow or 5% probability of annual occurrence) is deemed to be not developable in PPS25 unless the proposed development is water compatible or part of essential infrastructure such as transport links or electricity generating power stations. The generating potential of the facility implies that the EfW could be considered to be essential infrastructure and therefore would need a transport link to maintain its operation.

FZ3a – the High Probability flood risk area comprises land between the 20 year and 100 year flood events, or between 5% and 1% probability of occurrence in any one year. This zone is deemed appropriate for Less Vulnerable and water-compatible use.

FZ2 – the Medium Probability flood risk area comprises land between the 100 and 1000 year flood events, or between the 1% and 0.1% probability of occurrence in any one year.

FZ1 – the Low Probability flood risk area comprises land with less than 0.1% probability of flooding in any one year.

These extent of these Flood Zones at the application site are challenged later in the FRA using the results of hydraulic modelling carried out as part of the site investigation proposals.

1.5 Appropriateness of Development Proposals

Table D2 of PPS25¹ sets out the flood risk vulnerability associated with various types of development.

The separate parts of the site fall into different categories of vulnerability. The proposed energy from waste plant as a waste treatment facility is classified as a ‘Less Vulnerable Development’, the landfill part of the site falls under the “More Vulnerable Development” classification. Alternatively as the EfW is an electricity generating station it is classified in the highest vulnerability class of “Essential Infrastructure”.

When considering a development the EA policy is one of “Precautionary Principle” in that where a site consists of several different development elements the whole site should be considered against the highest risk vulnerability classification. In this case therefore the electricity generating station element of the site sets the flood risk category to be considered in the FRA.

Information provided by the EA in the form of PPS25 flood risk area maps shows that much of the access road is deemed to lie in FZ3, although the EfW and landfill area are located in Flood Zone 1, outside the 0.1% annual probability flood envelope.

1.6 Sequential Test

According to PPS25 the Sequential Test gives preference to locating new development in Flood Zone 1. The development areas of the EfW and landfill site are located within Flood Zone 1 and therefore the current proposals meet the requirements of the Sequential Test.

The issue of the access being partly within a higher flood risk zone is discussed later in the fluvial modelling section.

¹ Planning Policy Statement 25: Development and Flood Risk, December 2006

1.7 Exception Test

If the site is deemed to pass the Sequential test by the LPA in line with Table D3 of PPS25, the Exception Test should be applied in this instance for the access road part of the development as it lies in Flood Zone 3a.

The Exception Test has three parts:

- a) The development provides wider sustainability benefits to the community that outweigh flood risk;
- b) The development must be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land; and
- c) The FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce the flood risk overall.

2.0 FLOOD RISK ASSESSMENT METHODOLOGY AND OBJECTIVES

It is recognised that developments that are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. Current guidance on development and flood risk² identifies several key aims for a development to ensure that it is sustainable in flood risk terms. These aims are as follows:

the development should not be at a significant risk of flooding and should not be susceptible to damage due to flooding;

- the development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, are threatened;
- normal operation of the development should not be susceptible to disruption as a result of flooding;
- safe access to and from the development should be possible during flood events;
- the development should not increase flood risk elsewhere;
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences;
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk. The responsibility for any operation and maintenance required should be clearly defined;
- future users of the development should be made aware of any flood risk issues relating to the development;
- the development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues;
- the development should not lead to degradation of the environment; and
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change.

This FRA is undertaken with due consideration of these sustainability aims.

The key objectives of the FRA are:

- to assess the flood risk to the proposed development and to demonstrate the feasibility of appropriately designing the development such that any residual flood risk to the development and its users would be acceptable;
- to assess the potential impact of the proposed development on flood risk elsewhere and to demonstrate the feasibility of appropriately designing the development such that the development would not increase flood risk elsewhere; and
- to satisfy the requirements of national planning policy guidance which require FRAs to be submitted in support of planning applications.

² CIRIA, 2004, Funders Report CP/102 Development and Flood Risk – Guidance for the Construction Industry.

2.1 Project Scope

In order to achieve the aims outlined above, a staged approach has been adopted in undertaking this FRA, in accordance with current best-practice guidance. A screening study has initially been undertaken to identify whether there are any potential sources of flooding at the site which may warrant further consideration. Any potential flooding issues identified in the screening study have subsequently been considered in a scoping study. The aim of the scoping study is to review all available information and provide a qualitative assessment of the flood risk to the site and the impact of the site on flood risk elsewhere.

The FRA has been undertaken with due regard to the PPS25 advice for Development and Flood Risk.

2.2 Report Structure

This FRA has the following report structure:

Section 3 identifies the sources of information that have been consulted during the FRA;

Section 4 outlines the flood risk to the existing and proposed development and outlines the proposed mitigation measures to be implemented.

Section 5 presents a summary and conclusions.

3.0 SOURCES OF INFORMATION

3.1 Flood Zone Maps & Flood Defence Data

Information regarding the current flood risk at the application site has been obtained from the Environment Agency, Bodmin office³.

Part of the site and proposed access roads have been shown to be located within Flood Zones 2 and 3 with the remainder of the site, including the proposed EfW and landfill locations being located within Flood Zone 1.

3.2 Historic Flooding

The EA have confirmed nine historic flood events within 5km of the application site. None of these occurred within the application site boundary, although six of these events occurred upstream at Marks Bridge in Lee Mill.

3.3 Site Data

Topographical surveys for the application site boundary have been provided by Viridor, while a topographical survey of the River Yealm valley from the A38 junction in the north to Popples Bridge in the south has been undertaken by SLR Consulting. LIDAR data has also been purchased to cover the application area and proposed access route.

A site plan is included as Drawing 9-2 showing current site levels of the application site. A proposed development plan showing the final contouring of the landfill and the level of the EfW are included as Drawing FRA 2

3.4 Flow data

Flow data for the River Yealm and the tributary to the east has been calculated from the Flood Estimation Handbook (FEH) using a pooled donor method based on the catchment characteristics of the River Yealm.

3.5 Site Walkover

A site walkover was undertaken by an experienced SLR Engineering Hydrologist on 5 August 2009.

³ EA response to information request, dated 17th April 2009, EA Ref: C/CSC/11104

4.0 FLOOD RISK ASSESSMENT

4.1 Introduction

CIRIA Report C624, Development and Flood Risk – Guidance for the Construction Industry, defines three levels of FRA:

- Level 1 – Screening Study;
- Level 2 – Scoping Study; and
- Level 3 – Detailed Study.

The Level 1 screening study is undertaken to ascertain whether a FRA is required. A Level 2 Scoping Study should be undertaken if a FRA is required and assesses whether there is sufficient quantitative information is already available to complete an FRA appropriate to the scale and nature of the proposed development. The Level 3 detailed study should be undertaken if the Level 2 review concludes that further quantitative analysis is required to assess flood risk issues related to the development site.

4.2 Level 1 – Screening Study

All potential sources of flooding must be considered for any proposed development. A summary of the potential sources of flooding and a review of the potential risk posed by each source at the application site is presented in Table 4-1.

**Table 4-1
Potential Risk Posed by Flooding Sources**

Potential Source	Potential Flood Risk to Application Site?	Justification
Fluvial flooding	Yes	Access road and part of site located within the flood plain of River Yealm
Tidal / tidally influenced flooding	No	Site Located >20Km from tidal Yealm estuary
Flood Defence Breach (Failure)	No	No Flood Defences protecting the site
Flooding from rising / high groundwater	No	Groundwater well below ground level across site
Overland flow flooding	Yes	The overland flow flooding originates from the quarry void which is to be filled with the resulting surface water collected by new drainage systems within the site
Flooding from artificial drainage systems	No	No utility pipelines found within the vicinity of the site
Flooding due to infrastructure failure	No	No water storage structures are found within

the vicinity of the site

4.3 Level 2 – Scoping Study

Following the screening study additional information has been gathered in order for an experienced SLR Engineering Hydrologist to assess the flood risk at site. A site visit was also undertaken in August 2009.

4.3.1 Fluvial Flood Levels

No modelled flood levels were available from the EA for the River Yealm adjacent to the application site. ISIS hydraulic modelling has been undertaken to establish fluvial flood levels at the site.

4.3.2 Tidal flooding

Due to its inland location, the site is not deemed to be at risk of tidal flooding.

4.3.3 Groundwater Flooding

Underlying geology at site is shown as low permeability dolerite and slates. Groundwater monitoring at ten boreholes between 2005 and 2009 indicate groundwater levels to be located between 2m and 18m below ground level. No incidences of groundwater flooding have been recorded at the site so the risk is deemed to be negligible.

4.3.4 Sewer & Water Main Flooding

There are no known sewers or water mains running through the application site. There is deemed to be no risk from sewer or water main flooding.

4.3.5 Historical Flood Events

No historical flood events have been recorded on the application site in the data provided by the Environment Agency under reference CSC11104.

4.3.6 Existing Flood Defence Arrangements

The site does not benefit, nor rely upon the presence of formal flood defences.

4.3.7 Summary

It is concluded that a further hydraulic study into the flood risks posed to and as a result of the proposed access road is warranted. This extra study will involve ISIS modelling of the River Yealm from the A38 in the north to Popples Bridge in the south. This is considered below at Section 4.4.1. The proposed redevelopment of the EfW and landfill areas of the site would be appropriate with respect to PPS25 with due consideration and management of residual flood risk.

4.4 Level 3 – Detailed Study

4.4.1 Fluvial Flooding

The proposed development area of the EfW and landfill are located within Flood Zone 1, representing a less than 0.1% probability of flooding. This confirms there is no need to further consider flood risk from fluvial factors for this part of the site.

As outlined within section 1.3, based upon the Flood Zone Maps published by the EA, the proposed access road is shown to lie within 'high risk' Flood Zone 3 (which represents a greater than 1% annual probability of flooding) associated with the River Yealm.

No modelled flood levels were available from the EA for the River Yealm adjacent to the site. Therefore a detailed hydrological and hydraulic assessment has been undertaken in order to establish flood levels at the site.

Hydraulic Modelling: Summary of methodology

Hydraulic modelling has been undertaken for the River Yealm from the A38 bridge in the north to Popples Bridge in the south using ISIS software.

River sections have been drawn at regular intervals along the length of the river using levels obtained by SLR surveyors and supplemented with ground truthed LIDAR data; these have been supplemented by interpolated sections at various key points along the river.

River flows have been calculated using pooling analysis based on flow data from rivers of comparable size, length and topography. Based on this pooling data the following growth curves have been created, as set out in Table 4-2 below. Based on these growth curves and pooled flow calculations flows for the River Yealm and the east tributary have been calculated using ISIS for 2 year, 20 year (FZ3b), 50 year, 100 year (FZ3a), 100 year plus 20% climate change and 1000 year (FZ2) return periods.

**Table 4-2
River Yealm Growth Curves**

Return Period (yrs)	Growth Curve	Pooled flow (Cumecs)
2	1.000	20.039
5	1.311	26.268
10	1.525	30.569
20 (FZ3b)	1.748	35.029
25	1.823	36.531
50	2.069	41.464
75	2.224	44.567
100 (FZ3a)	2.339	46.878
100 + 20%		56.253
500	3.082	61.760
1000 (FZ2)	3.461	69.357

Hydraulic Modelling: Summary of Findings

Hydraulic modelling confirms that out of bank flooding of the River Yealm will occur during both 1000 year and 100 year+20% return period rainfall events, however the areas over which flooding will occur does not match up with those shown on the EA Flood Zone maps. The results of the modelling showing revised flood zones 2, 3A+20% and 3B are shown on Drawings FRA1 and FRA2.

The access road is shown to be outside of the functional floodplain (FZ3b). Two length of the access road are shown to be in FZ3a and FZ2. A third area of flooding occurs at the southern end of the site around the former quarry entrance and the former weighbridge / office building. This shape and levels of this southern area creates a bowl in the centre. No further development of this area is proposed.

When considering the 100 year+20% flood the Yealm first breaks out east over a short length of 15 -20m between Section 6 and 7, 260m south of the A38. This is a very local area of flooding of approximately 300m² due to a low section in the river bank and is predicted to pond up to 300mm deep.

The second outbreak occurs to the east between sections 10 and 11 where the topography of the land suggests that in such an event the flood water will first fill the adjacent pond before flowing east into a shallow valley which trends in a southerly direction. Any flood water will follow this valley before joining the eastern tributary. The access road crosses this breakout area of approximately 90m in length.

The modelling suggests that just two very short sections of the proposed access road would be flooded if constructed at existing ground level during a 100 year plus climate change flood event; a thin stretch of land near to section 6, and where the main outbreak of floodwater occurs between sections 10 and 11. Mitigation for these sections is discussed in section 4.5 below.

The modelling confirms that the previous quarry entrance and operations area in the south eastern corner is located within the floodplain of 100 year plus climate change flood event. In such an event it is likely that this bowl area would fill up before reaching a level where flows head south out of the site onto New England Road through what is currently the site entrance. From here they continue south and east rejoining the Yealm near Popples Bridge. No residential property is affected at Popples Bridge by this flooding.

4.4.2 Off-Site Impact: Drainage

The application area is currently open land with limited surface run-off. The proposed development will alter this by creating impermeable areas in the form of roads, the EfW and associated buildings, and the landfill, once fully filled and capped.

The filling of the quarry void will also impact the hydrology of the site. Currently the quarry void is known to capture and store surface water run-off, although the water level within the void is known to often overtop and flow down the former internal site access road during the winter and other wet periods. The capping of the landfill will remove this current summer storage.

The proposed SuDS mitigation strategy is set out in Section 4.8.

Proposed Mitigation Measures

The following measures have been taken into account during evolution of the development proposals in order to manage flood risk at the site.

4.5 Fluvial Flood Mitigation Scheme

Modelling of the current River Yealm flood regime has established revised flood zones. The two areas that require mitigation due to engineering works are along the access road on the eastern bank of the Yealm.

At the first location near reach 6 – 7 the eastern bank of the Yealm will be reprofiled to create a two stage channel over a 75 – 100m length.

At the second location near reach 10 - 11 a new bridge will be constructed to cross the main transfer flow that heads east to the pond and then onto the eastern tributary. The ground levels under the bridge and downstream will be reprofiled to create a flow route that maintains the existing flow regime and does not increase the flood risk.

The new bridge crossing of the River Yealm from east to west has been designed to clear span the 1000 year flood event extent. The soffit of the bridge will provide at least 1m of freeboard to the 100 year+20% flood event because of the likely impact of trees being washed down river at this location. In the 1000 year event this freeboard is reduced by 170mm.

Generally the new access road will be set 500mm above the current ground levels to the east of the River Yealm. Locally the road will be higher at the two bridges where freeboard to the bridge soffit is required to avoid impact of floating debris during higher return period flood events.

A modelling report showing the impact of the proposed mitigation measures is provided in Appendix D. Copies of the drawings 0350/08 & 0350/09 showing the layout of the two bridges are included in this FRA.

As these bridges cross watercourses and part of the road falls within 7m of a Main River Land Drainage Consent issued by the EA will be required to construct these parts of the scheme.

4.6 Flood Warning System and Evacuation Plan

Although the proposed mitigation works should ensure that the proposed development is not at risk of flooding, given the proximity of the River Yealm to the site access road it is proposed that the site operator would subscribe to the EAs automated flood warning service.

4.7 Site Drainage – Application of Sustainable Drainage Systems

Current guidance promotes sustainable water management through the use of Sustainable Drainage Systems (SuDS). A hierarchy of techniques is identified:

1. **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).

3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
4. **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

It is generally accepted that the implementation of SuDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

Sustainable drainage techniques include the following:

- prevention measures / source control measures including sedum (green) roof technology;
- source control measures including rainwater harvesting;
- infiltration devices to allow water to soak into the ground, that can include individual soakaways and communal facilities;
- filter strips and swales, which are vegetated features that hold and drain water downhill mimicking natural drainage patterns;
- filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground and provide storage if needed; and
- basins and ponds to hold excess water after rain and allow controlled discharge that avoids flooding.

The aforementioned approaches all offer significant advantages in reducing flood risk when compared to conventional piped methods by attenuating the rate and quantity of surface water runoff from site.

4.8 Site Proposals

All run-off from the proposed development, including from the EfW, roads and landfill will be deemed to be additional run-off as no existing formal drainage system exists on the former site. This rate of runoff has been determined using the current 'industry best practice' guidance as outlined in the Interim Code of Practice for SuDS⁴. The recommended methodology for sites up to 50 hectares in area is the Institute of Hydrology Report 124 method (IoH124). Table 4-3 below indicates the Greenfield runoff for the site.

⁴ Office of the Deputy Prime Minister, National SuDS Working Group, July 2004, Interim Code of Practice for Sustainable Drainage Systems

The site has been split into three separate areas to the west of the River Yealm and a fourth for the access road east of the River Yealm.

- Northern Area – consists of the EfW, associated buildings, car parks and roads and the northern half of the landfill. This pond also acts as the area to intercept any runoff water used in fire fighting should an incident occur;
- Southern Area – includes the southern half of the landfill, current site entrance area and the main access road from the current site entrance to the landfill;
- Access Road (On-Site) – The proposed access road within the current site boundary (i.e. west of the River Yealm);
- Access Road (Off-Site) – The proposed access road to the east of the River Yealm from the A38 junction south.

The following parameters have been incorporated into the runoff calculations:

- Catchment Area: 8.954Ha (measured using AutoCAD from the site survey);
- Average Annual Rainfall (SAAR): 1225mm/year (from Flood Estimation Handbook CD-ROM);
- Soil: 0.3 from Flood Study Report (FSR) Soil Maps;
- Total Impermeable Areas (measured using AutoCAD from the site survey and proposed development plans respectively)
 - Total Site: 8.95ha
 - Northern Area: 5.42ha
 - Southern Area: 3.2ha
 - Access Road: 0.29ha
- FSR Region 8a - Devon & Cornwall – Growth Curve Factors

**Table 4-3
Greenfield run-off from New England**

Return Period (years)	Whole site runoff (l/s)	Northern Area runoff (l/s)	Southern Area (l/s)	Access Road (on-Site)	Access Road (off-Site)
Mean Annual Flood (MAF)	34.4	19.0	11.4	1.0	3.0
2 year	30.3	16.7	10.0	0.9	2.6
30 year	73.6	40.7	24.3	2.2	6.4
100 year	100.7	55.7	33.3	3.0	8.7
100 year + Climate Change	131.0	72.4	43.3	3.9	11.3

Note

1. 30% added to rainfall data to account for long-term climate change in accordance with PPS25
2. Runoff rates interpolated from a 50Ha donor catchment

It is proposed that attenuation storage be provided in the form of attenuation ponds in the northern area, southern area and along the access road. The WinDes software suite was used to calculate the required volumes and design of the attenuation ponds in order to limit the discharge rate to those calculated in Table 4-3 above. Based on these calculations attenuation lagoons have been designed for all areas of the site, as shown on drawings FRA 3 & 4. Cross Sections of the proposed attenuation ponds are included as drawing FRA 5.

It is proposed that runoff from areas of external traffic movement would be routed through a combined silt/hydrocarbon separator prior to being passed to the attenuation ponds.

Emergency sluices/shut off valves would be fitted to the outflow from the attenuation ponds around the EfW so that, in the unlikely event of a fire on site, firewater runoff would be contained on site prior to appropriate disposal.

Northern Area

The designed volume of the proposed northern pond includes a freeboard allowance of 430mm .

For the northern portion of the site ponds with a combined footprint of 3245m² has been designed at 2.4 deep, with average 1:4 sides. The pond design indicates a maximum flow of 71.6 l/s during a worst case 100 years plus climate change rainfall event, which would fill the pond to 73% of capacity, as detailed in Table 4-4 below.

**Table 4-4
WinDes Results from Northern Ponds**

Return period (years)	Allowable outflow (l/s)	Modelled outflow (l/s)	Water depth (m)
2	16.7	16.5	0.961
30	40.7	20.8	1.487
100 +CC	72.4	71.6	1.964

The attenuation pond has been designed as follows:

- Pond Volume: 3544m³
- Maximum footprint: 3245m²
- Depth: 2.4m
- Outflow control: Orifice
 - Diameter: 0.091m
- Overflow Control: Pipe
 - Diameter: 0.25m
 - Slope: 1:80
 - Length: 10m
 - Invert level: 1.67m above base of pond

This pond is constructed in County Wildlife Site which has a wetland habitat. The area has a series of springs or issues that are fed by groundwater from the south. Flows run to the north and join a minor watercourse running along the small valley immediately north of the EfW area. The groundwater flow rates that issue are very small and will not impact on the storage volume of the proposed pond as the outfall flow control device permits a larger flow than the groundwater likely to be generated.

Other locations for this pond have been considered, but due to a series of constraints relating to the required footprint of storage, the local topography, the location of engineered fill slopes associated with the EfW building and the need to retain any potential fire runoff water close to the building before it impacts on groundwater or watercourses it has not been possible to find an alternative location for the main attenuation pond.

Southern Area

For the southern portion of the site a pond with a footprint of 2622m² has been designed at 1m deep, with 1:3 sides. The pond design indicates a maximum flow of 42.8 l/s during a worst case 100 years plus climate change rainfall event, which would fill the pond to 90% of capacity, as detailed in Table 4-5 below.

**Table 4-5
WinDes Results from Southern Pond**

Return period (years)	Allowable outflow (l/s)	Modelled outflow (l/s)	Water depth (m)
2	10	9.5	0.390
30	24.3	12.5	0.645
100 +CC	43.3	42.8	0.900

The attenuation pond has been designed as follows:

- Pond Volume: 2230m³
- Maximum footprint: 2622m²
- Depth: 1m
- Outflow control: Orifice
 - Diameter: 0.088m
- Overflow Control: Pipe
 - Diameter: 0.25m
 - Slope: 1:80
 - Length: 10m
 - Invert level: 0.6m above base of pond

Access Road (West)

A small attenuation pond has been designed for the access road from the top of the EfW plateau (60m OD) to the River Yealm bridge, an area of 0.29ha. The pond has been designed with a footprint of 344m², 1 m deep and with 1:3 sides. The WinDes results indicate that the pond as designed will create a maximum flow of 3.8l/s and a maximum depth of 0.830m, as detailed in Table 4-6 below.

**Table 4-6
WinDes Results from Access Road Pond**

Return period (years)	Allowable outflow (l/s)	Modelled outflow (l/s)	Water Depth (m)
2	0.9	0.9	0.353
30	2.2	1.2	0.594
100 +CC	3.9	3.8	0.830

The attenuation pond has been designed as follows:

- Pond Volume: 250m³
- Maximum footprint: 344m²
- Depth: 1m
- Outflow control: Hydro-brake
 - Type: Md5

- Diameter: 51mm
- Overflow Control: Orifice
 - Diameter: 0.06m
 - Invert level: 0.7m above base of pond

Access Road (East)

The access road pond to the east of the river has been designed as a 1m deep elongated pond which runs adjacent to the road for approximately 90m at its lowest point shortly before it crosses the river. This location is outside of the flood zone and will include a petrol interceptor.

The pond has been designed to be 90m long, 9.5 m wide and 1m deep with 1:2 sides. The WinDes results indicate that the pond as designed will create a maximum flow of 11.2l/s and a maximum depth of 0.888m, as detailed in Table 4-67 below.

**Table 4-7
WinDes Results from East Access Road Pond**

Return period (years)	Allowable outflow (l/s)	Modelled outflow (l/s)	Water Depth (m)
2	2.6	2.6	0.390
30	6.4	3.3	0.647
100 +CC	11.3	11.2	0.888

The attenuation pond has been designed as follows:

- Pond Volume: 565m³
- Maximum footprint: 851m²
- Depth: 1m
- Outflow control: Hydro-brake
 - Type: Md7
 - Diameter: 79mm
- Overflow Control: Pipe
 - Diameter: 0.10m
 - Slope: 1:80
 - Length: 10m
 - Invert level: 0.7m above base of pond

In the surface water management plan for the site the nomenclature for the attenuation ponds is as follows:

- Northern Ponds is the North West Ponds
- Southern Pond is the South East Pond
- Access Road (East) Pond is the Access Road Pond 1
- Access Road (West) Pond is the Access Road Pond 1

5.0 SUMMARY AND CONCLUSIONS

5.1 Summary

SLR Consulting Limited (SLR) has been appointed by Viridor to undertake a Flood Risk Assessment (FRA) in support of a full planning application for the proposed EfW and Landfill development of land at New England Quarry for industrial/waste use.

Based upon the indicative EA Flood Maps, the EfW and landfill areas of the site lie in Flood Zone 1. Part of the access road lies in Flood Zones 1, 2 and 3 whilst the original quarry site entrance area at Popples Bridge lies in Flood Zones 2 and 3.

ISIS hydraulic modelling has been undertaken to clarify the flood zones through the site in more detail.

The result of this modelling shows the primary flood risk associated with the new developed site is to two short lengths of the site access road, east of the River Yealm and a residual risk of surface water runoff from site causing an increased flood risk downstream in the River Yealm.

An existing area of flood risk in the former quarry office and weighbridge area at Popples Bridge will remain unchanged.

The two short lengths of access road will have local earthworks regrading undertaken to mitigate the impact of the new access road in the two locations.

Two new bridges are proposed, one to span the River Yealm and the other to span an area of earthworks regrading. Adequate freeboard to avoid floating debris impact to the underside of the bridges will be provided in the detailed design.

SuDS techniques are proposed in order to control and manage the surface water runoff risk, thus mitigating the off-site impact.

5.2 Conclusions

This FRA demonstrates that:

- there are no flood related issues that cannot be mitigated or designed into the site layout;
- that flood risk issues at this site are manageable during the operational phase, and ;
- that future site occupants can be safeguarded for the lifetime of the development.

Thus the requirements of paragraph 6 and Annex D of PPS25 have been met.

The site has no constraints in relation to flood risk and could therefore be delivered as envisaged in the Conceptual Masterplan which provides SUDS features and surface water disposal solutions that mimic the existing regime i.e. Source Control.

The site is duly presented as being sustainable in terms of flood risk, subject to proposed mitigation measures (see sections 4.5 & 4.8) being implemented.

6.0 CLOSURE

This report has been prepared by SLR Consulting Limited with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Viridor; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

DRAWINGS

APPENDICES

Appendix A

Environment Agency Flood Zone Map

