Flood Risk Review

Gregory's Farm Development P1543/14/FUL

Brockweir

On Behalf of

Hewelsfield and Brockweir Parish Council

Quality Management

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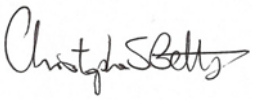
Reviewed by:	Chris Betts	
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Executive Summary

This Flood Risk Review demonstrates that the proposed development could not be operated with minimal risk from flooding, would increase flood risk elsewhere and is not compliant with the requirements of the NPPF.

The development should therefore be precluded on the grounds of flood risk.

The primary flood risk posed to the site is fluvial flooding from the culverted watercourse. Fluvial flooding poses a high actual risk and a high residual flood risk to the site due to a failure or blockage (complete or partial) of the culverted watercourse, the risk of flooding from fluvial flooding is considered to be of **high significance**. Surface water flooding also poses **high significant** flood risk to the site.

Any flooding would result in an 'extreme' flood zone which poses a 'danger for all' with 'extreme danger: flood zone with deep fast flowing water as per the Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose - Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD/2321/TR1.

The site is located within Flood Zone 3b 'Functional Floodplain', land where water has to flow or be stored in times of flood and land which would flood with an annual probability of 1 in 20 (5%) or greater in any year. This has been confirmed within the Forest of Dean District Council SFRA.

'More vulnerable' uses are not appropriate within Flood Zone 3b 'Functional Floodplain'. The vulnerability of the site will be increased from a 'less vulnerable' use to a 'more vulnerable' residential use. The proposed development will therefore increase the vulnerability of the development and will introduce new more vulnerable development into the Flood Zone.

Deculverting (daylighting) this section of watercourse provides an opportunity to restore a more 'natural' stream within diverse in-channel and bankside habitats that link with woodlands upstream. It may also provide an interesting recreational facility for the local public.

The design of the river channel should be based on the historical layout, fluvio-geomorphology, flooding considerations (i.e. capacity to discharge the 1 in 100 year plus climate change event) and proposed use of the site for residential purposes. The design should also take into account any existing and future land drainage connections. At the

moment the designed scheme is not based on any of these factors, will provide no additional benefits and will only make the current flooding situation in this area of Brockweir worse.

No assessment of the current and proposed surface water runoff rates from the site has been undertaken. The surface water runoff from the site will need to be attenuated. There is no space available on this site to provide a pond/basin or lagoon and due to the steepness of the site this would pose a flood risk to site and off-site locations. There is little space on site for the use of attenuation tanks, oversized drainage networks and or cellular storage.

The watercourse has a limited capacity to accept any discharge from the site. It can therefore, be concluded that a sustainable drainage solution using SUDS methods would be hard to achieve the surface water runoff from the site cannot be adequately drained and will not provide any additional gains.

It is likely that flooding of the dwellings on the site and downstream from the site would occur in the event of local drainage system failure and/or design exceedance. Also due to the contaminated nature of the made ground if infiltration does occur it is likely that contamination will be mobilised causing a pollution incident.

The development proposals should be considered by the LPA to not satisfy the Sequential and Exception Tests as set out in the NPPF.

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Appendix 1 ***Photographs of Historic Flood Events***

1 Introduction

1.1 Background

Hydrogeo Limited (Hydrogeo) were commissioned by Hewelsfield and Brockweir Parish Council (the client) to undertake a review of the flood risk and drainage related impacts associated with the proposed residential development of Gregory's Farm and the old CPL Oil Depot, Brockweir.

The site comprises a variety of buildings, agricultural barns of steel framed construction roofed and clad in asbestos and steel. Historically, the northern part of the site comprised a water powered corn mill and associated buildings. The mill land and buildings were historically used for various purposes including a coal yard, bus depot and, most recently, an oil storage and distribution depot which ceased several years ago, the site has since been derelict and disused. The oil depot itself was subject to a phase of site investigation and remediation works following a series of oil spills and pollution incidents.

The southern part of the site formed part of Townsend Farm which included the fields to the south and east of the site and also fields bordering the River Wye. It is understood that the main farmhouse was sold off together with the land bordering the river and was renamed Brockweir Farm. The remaining land including the farm buildings and a small cottage was used as the HAPPA horse sanctuary for some 25 years until its closure in late 2012.

The site has been disused since 2012. In February 2014, planning permission was granted for one new house on part of the Townsend Farm site. This part of the site, which includes existing stone outbuildings and a cottage, together with barns and most of the land of the farm, does not form part of the present application.

This review includes a technical appraisal of the available information published on the Forest of Dean District Council (FODDC) planning website at July 2015.

1.2 Objectives

The objectives of this study are to review pre-existing information, data and reports relating to the flood risk and drainage in the area plus a visual inspection of the area surrounding the site to identify any potential flooding sources and drainage issues associated with the proposed development.

The review concludes with an opinion on whether the development site is suitable, or not, based on the identified existing level of information potential impacts of flooding, drainage and future site users.

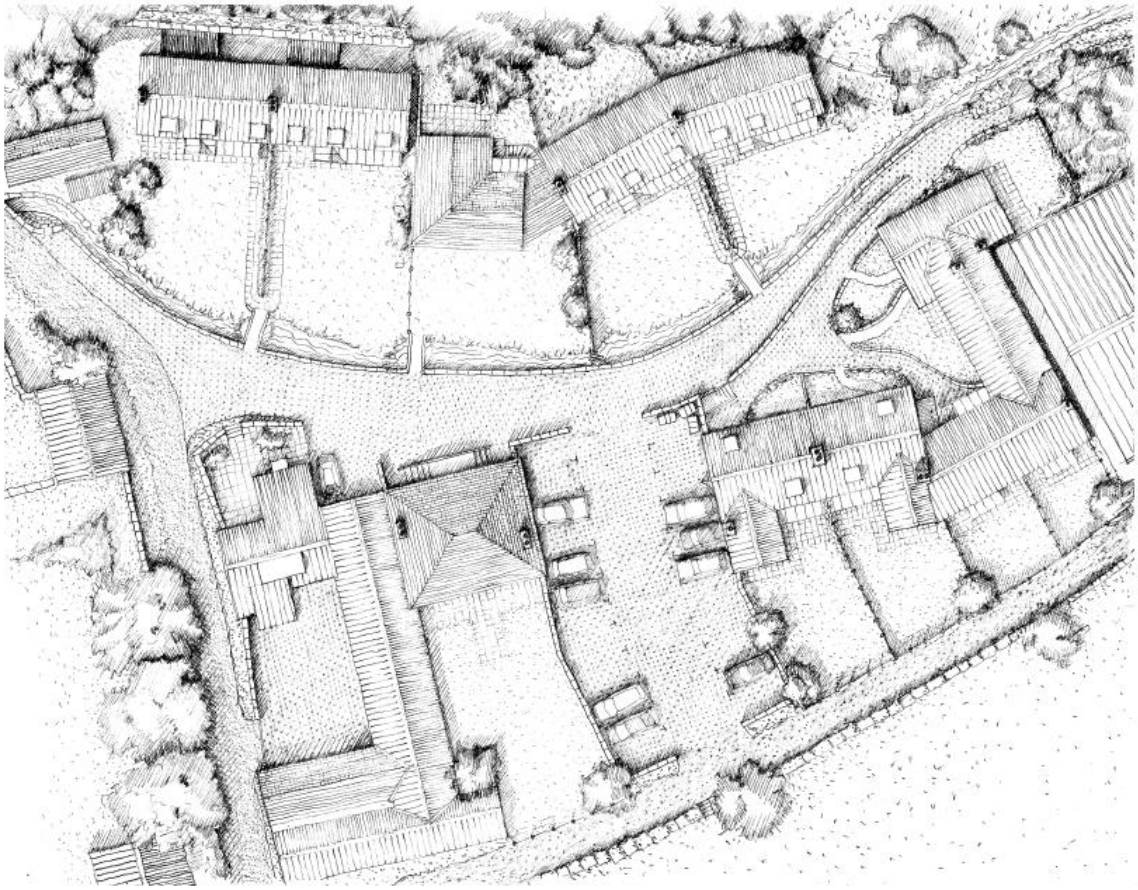
This report addresses technical issues but also aims to summarise the key points in a non-technical manner to aid client understanding and decision making for the planning authority and future developer.

2 Background and Key Issues

2.1 Site Location

Figure 2-1 shows the proposed development.

Figure 2-1 – Proposed Development



2.2 Ground Levels and Topography

The site falls from east to west by approximately 5.00m.

2.3 Catchment Hydrology

Flowing through the site is a culverted watercourse, the outfall of the pipe is 600mm in diameter however, it is understood that smaller sections of pipe are located beneath the site of approximately 450mm in diameter. Below the site the watercourse flows under the road and flows for another 100m before discharging into the River Wye.

2.4 Site Geology and Hydrogeology

A review of the British Geological Survey (BGS) map sheet 233 (Monmouth) and 250 (Chepstow) was undertaken as part of this study. Brockweir is on the boundary of the two Geological Sheets (250 Monmouth and 233 Chepstow).

The sheets indicate that the site is located in close proximity to alluvium (superficial deposits) associated with the River Wye. On the geological plan the site itself is shown to be underlain by the Tintern Sandstone Formation a buff-yellow sandstone with local lenticles of pebbles and subordinate marl partings. The Tintern Sandstone Formation rests conformably on quartz conglomerate of the Quartz Conglomerate Group described as an upper portion of sandstones with alternations of marl, and a lower portion of lenticular quartz-conglomerate beds with sandstones, grits and quartzites. The Quartz Conglomerate Group in turn overlies the Brownstones Formation, red, brown and purple fluvial sandstones with red mudstone interbeds.

The National Resources Wales (NRW) website confirms that the site is underlain by a Secondary A Aquifer, the Tintern Sandstone Formation.

By definition a Secondary A comprises - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

3 Existing Reports

3.1 Flood Risk Assessment

A review of the FODDC planning portal provided a number of reports relating to the site area. The most relevant to this review was a single report entitled *Flood Risk Assessment, Brockweir Houses, development of the former oil depot & HAPPA sites*. February 2015, Report Reference: Rev A 23/02/2015.

A previous report has been produced for the site, entitled *Flood Risk Analysis*, *Brockweir Houses, development of the former oil depot & HAPPA sites*. September 2014, Report Reference: 17/09/2014. However, it is understood that this has been superseded by the Flood Risk Assessment.

3.2 Hydrogeo Review of the Flood Risk Assessment

The report identifies that the primary flood risk posed to the site is from the culverted watercourse however, the report has not assessed this flood risk in any detail and therefore, under estimates the flood risk posed by the culverted watercourse. No assessment of the flood flows generated by the watercourse has been undertaken and the existing capacity of the culvert has not been calculated. The report has assessed the risk from the watercourse under 'normal' flow conditions which is not an assessment of flood risk.

The report confirms that the site is located within Flood Zone 3 the report fails to mention that the site therefore has 'high probability' of fluvial flooding with a 1 in 100 or greater annual probability of river flooding (>1%) in any year. However, the Forest of Dean District Council Strategic Flood Risk Assessment (SFRA) further delineates Flood Zone 3 and shows that the site located within Flood Zone 3b 'Functional Floodplain with a 1 in 20 or greater annual probability of river flooding (>5%) in any year.

No assessment of the flood risk from any other flood sources apart from fluvial and tidal sources has been undertaken. The National Planning Policy (NPPF) requires that all flood sources are assessed in detail these are; fluvial (river) flooding, tidal (coastal) flooding, groundwater flooding, surface water (pluvial) flooding, sewer flooding and flooding from artificial drainage systems/infrastructure, failure should also be assessed within a Flood Risk Assessment.

An assessment of historic flood events has not been undertaken in any great detail therefore; the existing flood risk posed to the site will be under estimated. No

assessment of the effects on climate change on the flood risk has been undertaken which is a requirement of the NPPF.

The Sequential and Exception Tests must be passed for residential uses within Flood Zone 3. The Sequential and Exception Tests have not been undertaken within the Flood Risk Assessment although it was concluded, within the report, that there are no 'reasonably available' sites for housing in Brockweir. It is impossible to come to this conclusion without actually undertaking the Sequential Test. It should also be noted that the search area should not only cover Brockweir but a much wider search area.

With regards to surface water runoff it has been concluded within the Flood Risk Assessment that due to the increase in permeable surfaces on site that the surface water runoff will decrease. No assessment of the surface water runoff from the existing or the proposed site has been undertaken. No assessment of the required attenuation storage volumes has been undertaken and a discharge point has not been identified.

Within the Flood Risk Assessment it is proposed that the existing culverted watercourse will be opened up and the watercourse flow within an open channel. Very limited information is provided on how this will be undertaken and very little information is provided on the proposed capacity of this open channel. The size and capacity of the open channel should be based on design flows calculated for the catchment with the effects of climate change taken into account.

Within the Flood Risk Assessment it is proposed that foul water will discharge to a package treatment works which will either discharge to the watercourse or via infiltration. No assessment of the location of the package treatment works has been included within the report or whether this is a viable means of foul water discharge.

4 Flood Risk

4.1 Sources of Flooding

This section assess the flood risk posed by fluvial and surface water flooding however, to comply with the requirements of the NPPF the flood risk posed by fluvial (river) flooding, tidal (coastal) flooding, groundwater flooding, surface water (pluvial) flooding, sewer flooding and flooding from artificial drainage systems/infrastructure failure should also be assessed within a Flood Risk Assessment.

The key consequences of flooding are death/personal injury, extensive damage to property, properties uninhabitable for long periods, properties cannot be sold, insurance unavailable or too expensive, expense of installing flood resilience measures and business interruptions.

4.2 Fluvial (river) Flooding

The site has a long history of flooding from the watercourse that flows through the site and from surface water runoff. The site and Brockweir has flooded on numerous occasions over the last 20 years from the culverted watercourse (see Section 4.4).

The culverted watercourse poses the primary flood risk to the site. The flood risk posed by the watercourse is exacerbated when the watercourse becomes tide locked by high tides on the River Wye and surface water runoff from surrounding fields.

It is important to understand the hydrological nature of the watercourse due to its implications on fluvial flood risk at the site. Such an investigation was undertaken using 'industry standard' techniques such as the Centre for Ecology and Hydrology (CEH) Flood Estimation Handbook (FEH) CD-ROM v3.0[1], the FEH Statistical Method and the Revitalised Rainfall Runoff (ReFH) Method[2]. These methods are based on robust hydrological modelling techniques and are described in the Flood Estimation Handbook (FEH)[3].

Catchment descriptors from the FEH CD-ROM v3.0 can be used to infer the physical nature of the catchment and its possible response to a rainfall event. The peak flows calculated using the FEH Statistical Method and the ReFH Method have been compared

[1] Flood Estimation Handbook CD-ROM v3.0 2009, Centre for Ecology and Hydrology.
[2] Flood Estimation Handbook, Supplementary Report No. 1 2007, The revitalised FSR/FEH rainfall-runoff method, Centre for Ecology and Hydrology.
[3] Flood Estimation Handbook 1999, Restatement and application of the Flood Studies rainfall-runoff method, Volume 4, Institute of Hydrology.

(see Table 4-1). It is expected that results using the different methods will vary. Table 4-1 shows that the peak flows for the watercourse range from 0.80m^3/s for the 1 in 2 year event up to 6.83m^3/s for the 1 in 1000 year event.

Climate change allowances must be taken into account over the whole lifetime of the development. Therefore, the peak river flows for the 1 in 100 year event have been increased by 20% to account for the effects of climate change in accordance with the Planning Practice Guidance to the NPPF. During the 1 in 100 year (plus climate change) event the peak flow has been calculated to be 4.28m^3/s.

Table 4-1 - Peak Flows for the Watercourse.

Return Period (yrs)	Peak Discharge (m^3/s)	
	ReFH Method	FEH Statistical Method
2	0.80	0.95
25	1.60	2.39
100	2.30	3.57
100 + cc	2.76	4.28
1000	4.60	6.83

The outlet of the culvert has been measured at 600mm however, it is understood that there are smaller sections of the pipe (see Figure 4-1). Therefore, using a conservative pipe size of 450mm it have been calculated that the size of the pipe is undersized to discharge the flood flows generated by this catchment.

The maximum capacity of the culvert located on the site, calculated using the using the Colebrook-White equation, is 0.72m^3/s. When comparing the culvert capacity with the peak flood flows generated within the watercourse catchment (see Table 4.1) it can be seen that the culvert only has the capacity to discharge events smaller than the 1 in 2 year event. Any event greater than the culvert capacity of 0.72m^3/s would result in flooding which on average would be 1 in 2 years.

Figure 4-1 – Existing pipe of approximately 450mm in diameter

Also there is a high risk of culvert failure or blockage (complete or partial). If a 50% blockage of the culvert was to occur, which is highly likely, the capacity of the culvert would be 0.047m^3/s. Flooding would then occur during 'normal' flow conditions.

There is a high potential for a collapse of the culvert as has historically occurred. A collapse of the culvert would block flows and could lead to water backing up and flooding the site and off-site locations. This is likely to occur where culverts are old and in poor repair such as at this site. If a partial blockage or failure of the culvert were to occur the capacity of the culvert would be exceeded and flooding would occur.

There is a high potential for a blockage of the culvert as has historically occurred. Given the small size of the culvert at 450mm to 600mm it is likely that the culvert becomes blocked. There is a large source of readily available debris (large and small) and sediment upstream from the culvert within the wooded areas.

If the capacity of the culvert is exceeded, the water then spills from the culvert inlet and follows the contours of the surrounding area. Water would travel to the west, the water would then follow the slope of the site to the west before inundating properties downstream of the site.

Water depths of 300mm have been historically recorded at the site and due to the steep slope of the watercourse this would result in water velocities of up to 3.00m/s.

Using an estimate of water velocity of 3.00m/s and a maximum water depth of 300mm any flooding would result in an 'extreme' flood zone which poses a 'danger for all' with 'extreme danger: flood zone with deep fast flowing water as per the Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose - Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD/2321/TR1.

Fluvial flooding poses a high actual risk and a high residual flood risk to the site due to a failure or blockage (complete or partial) of the culverted watercourse, the risk of flooding from fluvial flooding is considered to be of **high significance**.

Taking the above into account the Flood Risk Assessment has under estimated the flood risk posed by the culverted watercourse.

4.3 Surface Water (pluvial) Flooding

No assessment of surface water flooding has been undertaken within the Flood Risk Assessment.

The site is situated on and adjacent to areas of poor permeability and areas with geology which may result in surface water flooding. The site and Brockweir has flooded on numerous occasions over the last 20 years from surface water runoff (see Section 4.4).

The catchment upstream of site is over 4km^2 which as noted in Section 4.2 generates large volumes of water during a rainfall event. Due to the geology of the catchment this surface water cannot rapidly infiltrate into the soil substrate, the infiltration capacity is exceeded and overland flow is generated. The topography of the catchment results in this overland flow, flowing to the west towards the site and Brockweir. The numerous small incised watercourses and valleys is evidence of this surface water runoff.

The flood risk posed by surface water is exacerbated when the watercourse becomes tide locked by high tides on the River Wye, by the small capacity of the culvert on the watercourse and the regular blockage/collapse of the culvert.

The Environment Agency Surface Water flood map shows that the site has a high risk of surface water flooding with a chance of flooding of greater than 1 in 30 (3.3%) years. This would result in water depths of between 300mm and 900mm with velocities of over 0.25m/s.

Using an estimate of water velocity of 0.25m/s and a maximum water depth of 900mm any flooding would result in an 'extreme' flood zone which poses a 'danger for all' with 'extreme danger: flood zone with deep fast flowing water as per the Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose - Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD/2321/TR1.

The risk of flooding from surface water flooding is considered to be of **high significance**.

Taking the above into account the Flood Risk Assessment has under estimated the flood risk posed by surface water flooding.

4.4 Historic Flooding

No assessment of historic flood events has been undertaken within the Flood Risk Assessment which will lead to an under estimation of the flood risk. There are many records of anecdotal information of flooding at the site and within the village of Brockweir. The Environment Agency and Forest of Dean District Council have been involved with historic flood events at this site and within Brockweir.

Many other flood events have occurred at the site and within Brockweir. Some of the most recent major flood events include 1992, 2002, November 2008, December 2013 and January 2014. Water depths of up to 300mm have been recorded at the site. Figures 4-2 to 4-8 shows recent flood events at the site and within Brockweir. Further photographs are included within Appendix 1.

Figure 4-2 – Flooding December 2013

Figure 4-3 – Flooding December 2013

Figure 4-4 – Recent example of flash flooding in the village of Brockweir

Figure 4-5 – Recent flooding and associated debris

Figure 4-6 – Recent flooding of the site

Figure 4-7 – Damage caused by flooding

Figure 4-8 – Recent flooding

It is understood that in a two week period at the end of December 2013 and at the start of January 2014 that the site and surrounding area was flooded eleven times.

Anecdotal evidence suggests that floodwater passes down through the site and joins with floodwater from the main road and adjacent fields causing widespread and prolonged flooding of Brockweir. The floodwater has been described as a torrent, forceful and destructive.

Recently floodwater has torn up tarmac, shattering it and washing it into the River Wye. Cars have been moved from one side of the oil depot to the other in recent floods and the roads become impassable and extremely dangerous.

It is also understood that pollution and debris has been washed out from the site to downstream locations during these flood events.

4.5 Environment Agency Flood Zones

A review of the Environment Agency's Flood Zones indicates that the site is located within Flood Zone 3 and therefore has a 'high probability' of fluvial flooding, with a 1 in 100 or greater annual probability of river flooding (>1%) any year.

However, having assessed the fluvial flood risk posed to the site (see Section 4.1) and historic flood events it is clear that the flood risk posed to the site is greater than 1 in 100 years. Therefore, the site should be designated as being located within Flood Zone 3b 'Functional Floodplain', land where water has to flow or be stored in times of flood, land which would flood with an annual probability of 1 in 20 (5%) or greater in any year. This has been confirmed within the Forest of Dean District Council SFRA.

The Environment Agency Flood Zones and acceptable development types are explained in Table 4-2. Table 4-2 shows that 'more vulnerable' uses are not appropriate within Flood Zone 3b 'Functional Floodplain'.

4.6 Flood Vulnerability

In the Planning Practice Guidance appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in the Planning Practice Guidance, the existing use of the site is 'less vulnerable' and the proposed residential development is classified as 'more vulnerable'.

The vulnerability of the site will be made worse as part of the planning application; the vulnerability of the site will be increased from a 'less vulnerable' use to a 'more vulnerable' use. The proposed development will therefore increase the vulnerability of the development and will introduce new more vulnerable development into the Flood Zone.

Table 4-3 of this report and the Planning Practice Guidance to the NPPF states that 'more vulnerable' uses are not appropriate within Flood Zone 3b 'Functional Floodplain'.

Table 4-2 Environment Agency Flood Zones and Appropriate Land Use.

Flood Zone	Probability	Explanation	Appropriate Land Use
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year	Most development type are generally acceptable
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable
Zone 3b	'Functional Floodplain'	Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)	Some development types not acceptable

Table 4-3 Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification(see Table 1 of the Technical Guidance to the NPPF)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	×	Exception test required	✓
Zone 3b 'Functional Floodplain'	Exception test required	✓	×	×	×

Key:

✓: Development is appropriate, ×: Development should not be permitted.

4.7 Proposed Open Channel

Deculverting (daylighting) this section of watercourse provides an opportunity to restore a more 'natural' stream within diverse in-channel and bankside habitats that link with woodlands upstream. It may also provide an aesthetically pleasing watercourse for the local public. At the moment the designed scheme will provide none of these benefits and will only make the situation worse.

Simply excavating the watercourse and removing the concrete would produce a far from natural channel.

The design of the river channel should be based on the historical layout, fluvio-geomorphology, flooding considerations (i.e. capacity to discharge the 1 in 100 year plus climate change event) and proposed use of the site for residential purposes. The design should also take into account any existing and future land drainage connections. At the moment the designed scheme is not based on any of these factors.

The proposed channel should be adequately sized to discharge the 1 in 100 year (plus climate change) event therefore, the capacity of the open channel should be a minimum of 4.28m^3/s. The channel has been sized assuming normal flow conditions and also from the size of the bridge under the downstream road. The size of the channel is based on the cross sectional area of the watercourse (e.g. m^2) which is incorrect. It is feasible for example to have a very wide and shallow channel which can discharge a totally different volume of water compared to a very deep and narrow channel.

The channel should be sized so that it can discharge the flood flows generated by the catchment taking into account slope, roughness coefficient (e.g. manning's n), water velocities, climate change etc. The new channel should vary in bank slope and bed width, and bed slope. At the moment the designed scheme has not been designed accordingly.

When considering this type of scheme, where the stream flows through culverts/bridges, it is good practice to build in 'sediment traps'. These can take many forms and do not have to resemble deep holes or even be maintained once the site has stabilised. At the moment the designed scheme has not been designed accordingly.

A 'buffer zone' between the open channel and any permanent structures such houses, fences etc. should be maintained to allow for access and maintenance to the open channel as well as providing additional flood storage. This is also a requirement of the

Environment Agency, Forest of Dean District Council and Lead Local Flood Authority. At the moment the designed scheme has not been designed accordingly.

A section of the existing culvert could also be retained with its end filled with concrete for existing land drainage connections and to provide extra flood storage with an overflow to the open channel providing a further benefit.

4.8 Impact of Open Channel on Flood Risk

The impact on flood risk posed to off-site locations has also not been adequately assessed within the Flood Risk Assessment. If the watercourse can discharge a larger volume of water during a flood this may pose a greater flood risk to properties located downstream of the site. Larger quantities of floodwater will be conveyed downstream quicker causing flooding.

Historically the watercourse will have already burst its bank upstream with any floodwater dissipating over a much wider area and being stored upstream on this site and within the surrounding area. The watercourse will convey larger volumes of water downstream quicker posing a greater flood risk to off-site locations.

The impact of the greater flood flows within the channel on the road bridge has not been assessed. Does the road bridge have the capacity to convey these greater flood flows? Also the impact of a collapse or blockage of the road bridge has not been undertaken. Due to the greater flood flows within the channel it is more likely that a collapse of the bridge could occur as it has not been designed to convey these higher flood flows.

It is also more likely that a blockage of the road bridge will occur in the future as the culvert will not be there to catch debris that flows down the watercourse. The road bridge will catch this debris with it becoming blocked due to its small size.

If a storm that exceeds the design events occurs flooding of properties will occur. The proposed channel is located in close proximity to the proposed dwellings causing these to flood and the watercourse will also cause flooding of properties located downstream.

The positioning of the watercourse appears to put the liability on future land owners along its entire length due to the close proximity to the proposed dwellings. The proposed open watercourse will also have to be wide and deep to convey the flood flows that area generated within the catchment this will pose health and safety issues if the site is used for residential uses with children and animals etc. No design of the watercourse has been undertaken but to due to the large size of the watercourse required it is highly likely that

the watercourse will have to be concrete lined which will pose its own issues for flood risk, ecology, aesthetics, pollution, health and safety etc.

No detailed assessment of access and egress from the site during a flood event has been undertaken. A number of the houses can only be assessed by footbridges therefore; it will not be safe to cross the watercourse during a flood event via these footbridges. It is likely that the footbridges will be washed away during a flood event. NPPF, Environment Agency guidance and the Forest of Dean District Council SFRA requires that safe access and egress can be maintained during the 1 in 100 year (plus climate change) event. Based on the current proposed design it is considered highly unlikely that safe access and egress can be maintained during the 1 in 100 year (plus climate change) event.

5 Surface Water Drainage

5.1 Surface Water Management Overview

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A surface water management strategy for the site proposals has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The requirement for managing surface water runoff from developments depends on the pre-developed nature of the site. If it is an undeveloped greenfield site then the impact of the development will need to be mitigated so that the runoff from the site replicates the natural drainage characteristics of the pre-developed site. In the case of brownfield sites, drainage proposals will be measured against the existing performance of the site, although it is preferable for solutions to provide runoff characteristics that are similar to greenfield behaviour.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

It should be acknowledged that the satisfactory collection, control and discharge of surface water runoff are now a principle planning and design consideration. This is reflected in recently implemented guidance and the recently released National Sustainable Drainage Systems (SUDS) Standards.

It is necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably.

5.2 Surface Water Runoff Rates

No assessment of the current and proposed surface water runoff rates from the site has been undertaken. The site is currently covered in impermeable surfaces and it is proposed to reduce the impermeable surfaces on the developed site which it has been concluded will reduce the surface water runoff from the site due to increased infiltration.

However, no assessment on whether the ground conditions will allow infiltration of rainfall has been undertaken. The site is underlain by made ground therefore, it is unlikely that the infiltration rate will allow rainfall to infiltrate into the ground. It is likely that the infiltration rate will be exceeded causing ponding and surface water runoff.

Also due to the contaminated nature of the made ground if infiltration does occur it is likely that contamination will be mobilised causing a pollution incident.

The provision of suitable storage on site to mitigate the flood risk resulting from the development of the site will be required. The proposed surface water runoff from the site should be restricted to greenfield runoff rates. QBAR (rural) has been calculated to be 0.204l/s.

Therefore, the surface water runoff from the site will need to be attenuated. Due to the probability that infiltration methods cannot be used the surface water will need to be stored on the site before discharged to the watercourse or the sewers. Due to the low greenfield runoff rates, poor infiltration rates and contaminated land the volume of attenuation storage required will be very large.

There is no space available on this site to provide a pond/basin or lagoon and due to the steepness of the site this would pose a flood risk to site and off-site locations. There is little space on site for the use of storage tanks, oversized drainage networks and or cellular storage.

One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and bio-diversity. Systems incorporating these features are often termed SUDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible. It is highly unlikely that the proposed scheme will provide any of these additional gains.

The surface water runoff from the site cannot be discharged via infiltration therefore; it will either have to be discharged to the watercourse or to the public sewers. The watercourse and public sewers have limited capacity to accept any discharge from the site.

It can therefore, be concluded that a sustainable drainage solution using SUDS methods cannot be achieved the surface water runoff from the site cannot be adequately drain and will not provide any additional gains as described above.

5.3 Designing for Local Drainage System Failure/Design Exceedance

When considering residual risk it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. This has not been assessed within the Flood Risk Assessment.

The capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground[4]. It is likely that flooding of the dwellings on the site and downstream from the site would occur in the event of local drainage system failure and/or design exceedance

There will be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the sewers, lateral drains connecting the properties to the underground storage areas and from the culverted watercourse. It is very likely that a catastrophic failure would occur. An exceedance or blockage event of the sewers would affect the proposed dwellings.

Flows would flow to the lower ground levels downstream from the site where other dwellings are located. It is considered that there is an increased risk to the dwellings on the site and dwellings located adjacent to the site.

[4] CIRIA (2006) Designing for exceedance in urban drainage – good practice.

6 Sequential Approach

6.1 Sequential Test

The risk-based Sequential Test in accordance with the NPPF aims to steer new development to areas at the lowest probability of flooding (i.e. Flood Zone 1).

The site is located within Flood Zone 3b 'Functional Floodplain', land where water has to be flow or be stored in times of flood. Table 4-2 of this report and the Planning Practice Guidance state that 'more vulnerable' uses are not appropriate within Flood Zone 3b.

There, are 'reasonably available' sites for this type of development within the Forest of Dean District. There is no specific evidence to indicate land for a similar type of development which is at a lower flooding risk is unavailable within the Forest of Dean District.

The Strategic Housing Land Availability Assessment identifies 137 sites that could be developed for between 1 and 15 dwellings. There are also likely to be 'windfall' sites that could be developed for this number of dwellings which are 'reasonable' available.

The development proposals should therefore be considered by the LPA to not satisfy the Sequential Test as set out in the NPPF.

6.2 Exception Test

Applications located within Flood Zone 3b subject to the Exception Test as confirmed within Table 4-2 of this report and Table 3 of the Planning Practice Guidance to the NPPF.

For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA.

The key emphasis of the NPPF is to achieve sustainable development. The NPPF provides the following aims under the umbrella of sustainable development.

1. Building a strong, competitive economy
2. Ensuring the vitality of town centres
3. Supporting a prosperous rural economy

4. Promoting sustainable transport
5. Supporting high quality communications infrastructure
6. Delivering a wide choice of high quality homes
7. Requiring good design
8. Promoting healthy communities
9. Protecting Green Belt land
10. Meeting the challenge of climate change, flooding and coastal change
11. Conserving and enhancing the natural environment
12. Conserving and enhancing the historic environment
13. Facilitating the sustainable use of mineral

The proposed development does not contribute to the aims shown above. The site will not provide wider sustainability benefits to the community that outweigh flood risk and will not deliver considerably wider sustainability benefits than could conceivably only be achieved through use of the site for residential purposes.

The development proposals should therefore be considered by the Council to not satisfy the first condition of the Exceptions Test as set out in the NPPF.

b) A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

This FRA has not demonstrated that the development will be safe, without increasing flood risk elsewhere.

The development proposals should therefore be considered by the LPA to not satisfy the Exception Test as set out in the NPPF.

7 Summary and Conclusions

7.1 Introduction

This report, forms a review of the flood risk and derange related impacts associated with the proposed residential development of Gregory's Farm and the old CPL Oil Depot, Brockweir.

7.2 Flood Risk

The primary flood risk posed to the site is posed by fluvial flooding from the culverted watercourse. Fluvial flooding poses a high actual risk and a high residual flood risk to the site due to a failure or blockage (complete or partial) of the culverted watercourse, the risk of flooding from fluvial flooding is considered to be of **high significance**. Surface water flooding poses a **high significant** flood risk to the site.

Any flooding would result in an 'extreme' flood zone which poses a 'danger for all' with 'extreme danger: flood zone with deep fast flowing water as per the Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose - Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD/2321/TR1.

The site is located within Flood Zone 3b 'Functional Floodplain', land where water has to flow or be stored in times of flood, land which would flood with an annual probability of 1 in 20 (5%) or greater in any year. This has been confirmed within the Forest of Dean District Council SFRA.

'More vulnerable' uses are not appropriate within Flood Zone 3b 'Functional Floodplain'. The vulnerability of the site will be increased from a 'less vulnerable' use to a 'more vulnerable' use. The proposed development will therefore increase the vulnerability of the development and will introduce new more vulnerable development into the Flood Zone.

7.3 Proposed Open Channel

Deculverting (daylighting) this section of watercourse provides an opportunity to restore a more 'natural' stream within diverse in-channel and bankside habitats that link with woodlands upstream. It may also provide an aesthetically pleasing watercourse for the local public.

The design of the river channel should be based on the historical layout, fluvio-geomorphology, flooding considerations (i.e. capacity to discharge the 1 in 100 year plus climate change event and proposed use of the site for residential purposes. The design should also take into account any existing and future land drainage connections. At the moment the designed scheme is not based on any of these factors, will provide no additional benefits and will only make the current situation worse.

Within the local area there are a number of schemes which could be referenced as case studies by any perspective developer and any consultant engaged to advise on development and deculverting. Photographs provided by the Parish council are referenced as Figure 7.1 and Figure 7.2 for information.

Figure 7-1 Recently Completed Works Angidy, Tintern

Figure 7-2 Recently Completed Works Angidy, Tintern

7.4 Surface Water Drainage

No assessment of the current and proposed surface water runoff rates from the site has been undertaken.

The surface water runoff from the site will need to be attenuated. There is no space available on this site to provide a pond/basin or lagoon and due to the steepness of the site this would pose a flood risk to site and off-site locations. There is little space on site for the use of storage tanks, oversized drainage networks and or cellular storage.

The watercourse and public sewers have limited capacity to accept any discharge from the site. It can therefore, be concluded that a sustainable drainage solution using SUDS methods cannot be achieved the surface water runoff from the site cannot be adequately drained and will not provide any additional gains.

It is likely that flooding of the dwellings on the site and downstream from the site would occur in the event of local drainage system failure and/or design exceedance. Also due to the contaminated nature of the made ground if infiltration does occur it is likely that contamination will be mobilised causing a pollution incident.

7.5 Sequential Approach

The development proposals should be considered by the LPA to not satisfy the Sequential and Exception Tests as set out in the NPPF.

7.6 Conclusion

In conclusion, the development will be situated in Flood Zone 3b ‘Functional Floodplain’ with a chance of flooding of greater than 1 in 20 years (5%).

This Flood Risk Review demonstrates that the proposed development would not be operated with minimal risk from flooding, would increase flood risk elsewhere and is not compliant with the requirements of the NPPF.

The development should therefore be precluded on the grounds of flood risk.

Appendices

Appendix 1

Photographs of Historic Flood Events


020 200 2206
BROCKWEIR
MORAVIAN CHURCH


F607 TJJ
PK51 WHR


URGENT
FUEL
OILS


URGENT
FUEL
OILS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CPL Petroleum


CPL Petroleum