Gloucestershire County Council

Strategic Flood Risk Assessment

Initial Site Assessments

Potential Waste Sites

FINAL

March 2009

Halcrow Group Limited

Gloucestershire County Council

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1 Introduction

1.1.1 In September 2008 Halcrow completed a Level 1 Strategic Flood Risk Assessment (SFRA) for Gloucestershire, which delineates the study area into zones of low, medium and high risk in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25). The Level 1 SFRA also provides specific spatial planning and development control recommendations for future development within the study area, including a document relating to planning implications of flood risk on minerals and waste sites, which should be utilised in conjunction with this report.

1.1.2 Following completion of the Level 1 SFRA, a more detailed interrogation of Gloucestershire County Council's emerging waste allocations has been carried out in accordance with the Practice Companion Guide to PPS25. This takes the form of a desk top study and uses the data gathered and analysed as part of the Level 1 SFRA. This report represents the initial assessment of the waste sites in Gloucestershire. This report should not be viewed in isolation, but in conjunction with the Level 1 SFRA reports.

1.2 Implementation of the Level 1 SFRA

1.2.1 The Level 1 SFRA has been carried out to meet the requirements of PPS25, ensuring flood risk is taken onto account at all stages of the planning process and therefore appropriately informing the development of the County Council's Minerals and Waste Development Framework (MWDF). The implementation of the SFRA is underpinned by the execution (by the Council) of the Sequential Test, as outlined below.

1.3 The Sequential Test

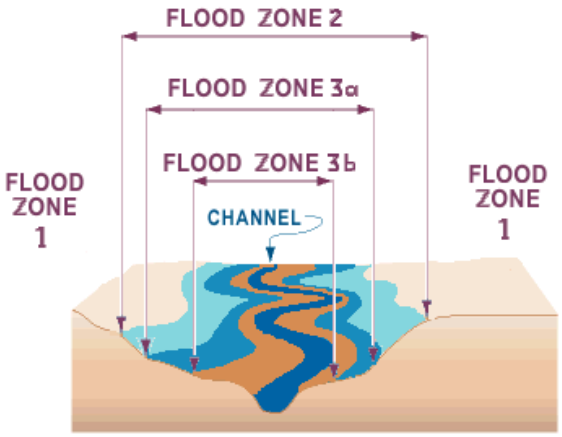
1.3.1 The primary objective of PPS25 is to steer vulnerable development towards areas of lowest flood risk. PPS25 advocates a sequential approach to guide the planning decision making process (i.e. the allocation of sites). In simple terms, this requires planners to seek to allocate sites for future development within areas of lowest flood risk in the first instance. Preference should therefore be given to locating new development in Flood Zone 1, Low Probability (see section 1.4). If there is no reasonably available site in Flood Zone 1, the flood vulnerability (see Table 1, Table D3 of PPS25) of the proposed development can be taken into account in locating development in Flood Zone 2 (Medium Probability) and then Flood Zone 3 (High Probability). Within each Flood Zone new development should be directed away from 'other sources' of flood risk as indicated by the Level 1 SFRA, and towards the adjacent zone of lower probability of flooding. This is referred to as the Sequential Test.

1.3.2 As an integral part of the sequential approach, PPS25 stipulates permissible development types in Table D3 (flood risk vulnerability and Flood Zone 'compatibility'). This considers both the degree of flood risk posed to the site, and the likely vulnerability of the proposed development to damage (and indeed the risk to the lives of the site tenants) should a flood occur. Provided the Sequential Test is carried out and it can be demonstrated that there are no sites available fully in Flood Zone 1, a site can be developed in accordance with Table D3 of PPS25. It is important to note that where a 'tick' is shown in Table D3 of PPS25, this does not imply that development may immediately proceed; the Sequential Test must still be applied and passed.

1.3.3 The recommendations provided in this report are in accordance with the requirements in Table D3 of PPS25.

1.4 Flood Zones and Development Requirements

1.4.1 Flood Zones show the areas potentially at risk of flooding from rivers or the sea, ignoring the presence of defences.



1.4.2 This section gives the definition of Flood Zones and the appropriate development permissible in each as defined by PPS25, and subsequent requirements for development in each zone as required by the Environment Agency. This information forms the basis of the recommendations for the Gloucestershire waste sites.

1.4.3 It should be noted that flooding from surface water, groundwater, sewers and impounded water bodies can occur in any zone, even Flood Zone 1.

Zone 1: Low Probability

1.4.4 This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%). Generally there is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1, though the following should be considered:

- Flooding from other sources can occur in Flood Zone 1 and the site's vulnerability to this should be assessed. For sites with evidence of flooding from other sources or historic flood events (where the source may be unknown), the Sequential Approach should be used to steer new development away from these areas. An assessment of likely significance of flood risk should be carried out in terms of likely probability of flooding and potential consequences/flood damages (advice from a drainage specialist may be required, such as the SFRA consultant, the Environment Agency, a highways drainage engineer and/or the planning authority drainage specialist). The purpose is to identify sites with significant flood risk, which may need to be facilitated by a Level 2 SFRA. If a site with significant flood risk is identified within Zone 1, this should be considered as if it was in the High Probability Zone 3a, for further application of the Sequential Test in Zone 3a, bearing in mind that if a more vulnerable land use is required for the site, it will have to pass the Exception Test. Where these tests are passed, the development must include flood resilience and resistance measures. The potential site owners/residents must also be made aware that they live/work in a localised flood risk area.

- For any development site containing or located adjacent to a watercourse without Flood Zone information, it is recommended that a minimum 8m development easement from the top of bank is applied, to allow appropriate access for routine maintenance and emergency clearance. A site specific FRA should be undertaken.

- For sites where the access and egress routes are within Flood Zone 3 or 2, the site should be considered as if being within that higher Flood Zone itself. Sites without safe dry access routes during flood events are not likely to be able to proceed unless road raising works could

be identified that would not impede flood flows or cause a loss in the floodplain storage capacity of the floodplain. This may not always be possible.

- It is important to note that most potential sites that pass the Sequential Test in Zone 1 will still require site-specific FRAs. The vulnerability to flooding from other sources (as well as from river flooding) and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, with appropriate mitigating action, should be incorporated in an FRA. This need only be brief unless the factors above or other local considerations require particular attention. It is recommended that FRAs are produced for Zone 1 sites of less than one hectare, at locations where there are records of previous flood incidents.

- Typically, a Drainage Impact Assessment will be required to demonstrate that the treatment and control of surface water runoff can provide a level of betterment, incorporating the use of various SUDS techniques, which should take into account the local geological and groundwater conditions. As a minimum, there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified. Where possible strategic SUDS should be used. Space should also be set-aside for SUDS at the master planning stage.

1.4.5 **Specific considerations for waste sites in Flood Zone 1:** All types of waste facilities are permitted in Flood Zone 1 provided the recommendations for development, as outlined above, are implemented.

Zone 2: Medium Probability

1.4.6 This zone comprises land assessed as having 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. Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category, though it will be necessary to undertake the Sequential Test. Where other planning pressures dictate that 'highly vulnerable' land uses should proceed, it will be necessary to ensure that the requirements of the Exception Test are satisfied; this requires a Level 2 SFRA. It is recommended that prior to incorporating the Sequential Test within the SA, the following actions take place:

a) Apply the measure of avoidance/prevention by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, ensuring flood risk areas remain as open space and river enhancements are undertaken (such as the removal of culverts) as part of the regeneration process.

b) Provisionally adopt land uses that are fully compatible with the vulnerability classification of PPS25, to try to avoid the need to apply the Exception Test where possible.

1.4.7 After application of the Sequential Test, development in Flood Zone 2 should consider the following:

- A detailed site-specific FRA should be prepared in accordance with PPS25 and Council Development Control policies

- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm
- Safe dry pedestrian access to and from the development should be possible above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for climate change and emergency vehicular access should be possible during times of flood
- Flood resistance and resilience should be incorporated into the design
- People (including those with restricted mobility) should be able to remain safe inside the new development up to a 0.1% AEP (1 in 1000 year) event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety should be practicable up to a 0.1% AEP (1 in 1000 year) event
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified. Space should be set-aside for SUDS.
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone from top of bank, to allow appropriate access for routine maintenance and emergency clearance.

1.4.8 **Specific considerations for waste sites in Flood Zone 2:** Following application of the Sequential Test, waste treatment (except landfill and hazardous waste facilities) and landfill and sites used for waste management facilities for hazardous waste are permitted in Flood Zone 2, provided the recommendations above are implemented. However, installations requiring hazardous substances consent would have to undergo the Exception Test and would therefore require a Level 2 SFRA.

Zone 3a: High Probability

1.4.9 This zone comprises land assessed as having 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. Land use with High Probability Flood Zone 3a should be restricted to the 'less vulnerable' uses to satisfy the requirements of the Sequential Test. For 'more vulnerable' uses it is necessary to ensure that the requirements of the Exception Test are satisfied, which will require a Level 2 SFRA. Again, prior to incorporating the Sequential Test within the SA, the following actions should take place:

c) Apply the measure of avoidance/prevention by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, ensuring flood risk areas remain as open space and river enhancements are undertaken (such as the removal of culverts) as part of the regeneration process.

d) Provisionally adopt land uses that are fully compatible with the vulnerability classification of PPS25, to try to avoid the need to apply the Exception Test where possible.

1.4.10 After application of the Sequential Test, development in Flood Zone 3a should consider the following:

- A detailed site-specific FRA should be prepared in accordance with PPS25 and Council Development Control policies. Properties situated within close proximity to formal defences or water retaining structures (reservoirs/canals) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Council, the Environment Agency and/or the operating authority, as appropriate.

- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and de-culverting). This should be optimised by developing land sequentially, with areas at risk of flooding favoured for green space. There should be a positive gain in the floodwater storage capacity provided and there should not be any detrimental impact on floodwater flow conveyance.

- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm. Within defended the areas the maximum water level should be assessed from a breach analysis. Where there is sufficient depth between the underside of the floor slab and the existing ground level, under-floor voids should be included with adequate void openings.

- The development should allow safe dry pedestrian access to and from the development above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for climate change . Emergency vehicular access should be possible during times of flood.

- An evacuation plan should be prepared. With respect to new developments, those proposing the development should take advice from the LPAs emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. All access requirements should be discussed and agreed with the Council and the Environment Agency.

- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 600 mm above the 1 in 100 year flood level plus climate change.

- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified. Space should be set aside for SUDS.

- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone from top of bank, to allow appropriate access for routine maintenance and emergency clearance.

- For sites where the access and egress routes are within Flood Zone 3 or 2, the site should be considered as if being within that higher Flood Zone itself.

For many watercourses in Gloucestershire, Flood Zone 3b has not been modelled no information exists to differentiate Flood Zones 3a and 3b. Therefore when carrying out the Sequential Test it should be assumed that where Flood Zone 3b has not been modelled, its extent would be equal to Flood Zone 3a, unless, or until, an FRA can demonstrate otherwise.

1.4.11 **Specific considerations for waste sites in Flood Zone 3a:** Following application of the Sequential Test, waste treatment (except landfill and hazardous waste facilities) is permitted in Flood Zone 3a, provided the recommendations for development above are implemented. However, landfill and sites used for waste management facilities for hazardous waste in this Flood Zone would have to undergo the Exception Test and would therefore require a Level 2 SFRA. Installations requiring hazardous substances consent are not permitted in Flood Zone 3a.

Zone 3b: The Functional Floodplain

1.4.12 This zone comprises 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, or is designed to flood in an extreme (0.1%) flood, including water conveyance routes). The SFRA maps Flood Zone 3b where it has been produced. Where no modelled outlines have been produced, Flood Zone 3b has been shown to equal Flood Zone 3a. Therefore for any development site falling in Flood Zone 3a with no 3b available, this section should be used to understand the requirements of development.

1.4.13 Development in High Probability Flood Zone 3b should be restricted to 'water-compatible uses' only. PPS25 dictates that 'essential infrastructure' can be located in Flood Zone 3b if the Exception test is passed (this would require a Level 2 SFRA). However, appropriate judgement should be exercised when attempting the Exception Test for essential infrastructure in Flood Zone 3b. Essential infrastructure includes: essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; and strategic utility infrastructure, including electricity generating power stations and grid and primary substations. Essential transport infrastructure may be appropriate if designed in such a way that flood flow routes and flood storage areas are not affected (e.g. designing a bridge to cross the flood risk area). However, utility infrastructure may be less appropriate due to the potential consequences that may occur should the utility site become flooded (as demonstrated by the flooding of Mythe Treatment Works, Castlemeads electricity sub-station and the near-flooding of the Walham electricity sub-station during the summer 2007 flood events).

1.4.14 The following should be considered:

- 'Essential infrastructure' in this zone must be designed and constructed to remain operational in times of flood and not impede water flow.

- Associated buildings, such as boathouses, should be situated outside 3b and should follow the guidance for development in the relevant Flood Zone (as outlined above)

- Building extensions proposed in 3b should be discouraged. Where permitted, they should follow the guidelines of 3a (as outlined above). The local authority should request and review an FRA for the extension. The FRA should demonstrate that the extension will minimise the impact on flow conveyance and lost storage.

1.4.15 **Specific considerations for waste sites in Flood Zone 3b:** There are no waste facilities permitted for development in Flood Zone 3b.

1.4.16 Table D3 of PPS 25 (Table 1) provides a visual indication of the different land uses that are and are not permitted in each Flood Zone, and where the Exception Test must be applied. Table 2 is adapted from Table 1 and specifically incorporates mineral and waste sites.

Table 1: Flood Risk Vulnerability and Flood Zone 'Compatibility' (Table D3 of PPS25)

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	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

Table 2: Flood Risk Vulnerability and Flood Zone 'Compatibility' (adapted from Table D3 of PPS25)

Flood Risk Vulnerability and Flood Zone 'Compatibility' Table for mineral and waste land uses					
Flood Risk Vulnerability Classification	**Mineral and Waste Land Uses**	**Flood Zone**			
		1	**2**	**3a**	**3b**
Essential Infrastructure		✓	✓	***ET***	***ET***
Water Compatible	Sand and Gravel Workings	✓	✓	✓	✓
Less Vulnerable	Waste treatment (except landfill and hazardous waste facilities) and Minerals working and processing (except for sand and gravel working)	✓	✓	✓	***X***
More Vulnerable	Landfill and sites used for waste management facilities for hazardous waste	✓	✓	***ET***	***X***
Highly Vulnerable	Installations requiring hazardous substances consent	✓	***ET***	***X***	***X***

ET : Exception Test Required

✓ : Development is appropriate

X : Development should not be permitted

2 Site Recommendations

2.1 Method

2.1.1 A desk top appraisal has been carried out for a total of 104 potential waste sites within Gloucestershire. The results of the assessment can be found in Appendix A. Site plans are shown in Appendix B.

2.1.2 The SFRA GIS data has been viewed in conjunction with GIS polygons of the potential sites and 10k OS data. All main and minor watercourses running through or adjacent to the sites have been noted, and the flood risk posed by these watercourses. Where a watercourse has no Flood Zone data this has been noted and recommendations given.

2.1.3 The 'undefended' Flood Zone maps, produced as part of the Level 1 SFRA, have been used to assess flood risk posed to each site. The Flood Zone maps show the extent of flooding, and do not depict the depth, velocity or period of inundation of flooding, which would normally be assessed in a Level 2 SFRA (undertaken when the need to apply the Exception Test is identified). To support the analysis of risk posed to each site, an assessment of the relative confidence of the Flood Zone data has been made. This relates to the method which has been used to generate the Flood Zones. Where detailed modelling has been carried out (as ascertained by the Level 1 SFRA) the Flood Zones will have a high confidence, while Flood Zones derived from JFLOW can be less robust. Where JFLOW Flood Zones affect the sites, an assessment has been made regarding the robustness of the information, based on professional judgement.

2.1.4 It has also been important to consider the impacts of climate change on flood risk and the resultant risk to sites. The climate change maps produced in the Level 1 SFRA, which show the possible impacts of climate change on fluvial flood risk, have been used in this assessment.

2.1.5 The historic flood maps and flooding from all sources data within the Level 1 SFRA has been used to assess whether any of the sites have flooded historically, and the source of the flooding. At this stage, it is not deemed necessary to carry out surface water mapping for all 104 sites; it is recommended that this is considered when the current list of potential sites have been reduced to a smaller 'preferred list' of potential sites.

2.1.6 Finally, an assessment of potential residual risk posed to each site has been made by reviewing the location and nature of defences, culverts, canals and reservoirs.

2.1.7 This chapter puts forward a summary of the findings of the site assessments, with recommendations. Site-specific FRAs will be required for all proposed development greater than 1 hectare in size, regardless of their position in the Flood Zones. The level of detail will depend on the level of flood risk at the site (as outlined in this assessment). The onus is on the developer to provide this information in support of a planning application. General details about FRA requirements and the level of detail required can be found in Appendix E of PPS25, as well as Chapter 10 of the Minerals and Waste Level 1 SFRA report.

2.2 Type of Waste Facilities

2.2.1 The 104 potential waste sites reviewed as part of this report are all potential sites for the residual treatment of municipal waste. This could range from mechanical or biological processes to

advanced/modern thermal treatment. The sites could be used also for managing commercial waste, but it is assumed that these could be similar processes. Landfill and hazardous waste facilities are not being considered within the potential 104 sites.

2.2.2 Sites for the residual treatment of municipal waste (excluding landfill and hazardous waste facilities) are defined in Table D2 of PPS25 as 'less vulnerable'. Provided the Sequential Test is carried out and it can be demonstrated that there are no sites available fully in Flood Zone 1, a site can be developed in accordance with Table D3 of PPS25, which states that less vulnerable uses can occur in any Flood Zone except Flood Zone 3b. However, this does not imply that development may immediately proceed; the Sequential Test must still be applied and passed.

2.3 Flood Risk Suitability Assessment Criteria

2.3.1 PPS25 should not be applied in isolation, but as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy, and it is recognised that flood risk forms just one material planning considerations among many. To assist the Council in assessing flood risk issues in conjunction with other planning considerations, each site has been assigned with a 'suitability' ranking, outlined in Table 3.

Table 3: Flood Risk Suitability Assessment Criteria

Scoring Code	Criteria Definition
1	Site is mainly in Flood Zone 3b
2	Site is mainly in Flood Zone 3a
3	Site is mainly in Flood Zone 2
4	Site is mainly in Flood Zone 1 but affected by Flood Zones 2, 3a and 3b
5	Site is fully in Flood Zone 1

2.3.2 It should be noted that historical flooding, flood risk from other sources and residual risk has also been incorporated into the suitability assessment. Where any of these risks are present, the scoring code has been reduced, commensurate with the level of risk (noted, where relevant, in Appendix A).

2.4 Summary of Results

2.4.1 Each of the 104 potential waste sites has been assessed and the results can be summarised as follows:

Table 4: Summary of the suitability assessment of all sites

Suitability Score	Definition	Number of Sites
1	Site is mainly in Flood Zone 3b*	26
2	Site is mainly in Flood Zone 3a*	4
3	Site is mainly in Flood Zone 2*	12
4	Site is mainly in Flood Zone 1 but affected by Flood Zones 2, 3a and 3b*	32
5	Site is fully in Flood Zone 1*	30

*Historical flood risk, flood risk from other sources and residual risk has been incorporated into the determination of the suitability score.

2.5 Suitability Score 5: Sites in Flood Zone 1

2.5.1 There are 30 sites which lie fully in Flood Zone 1 and in accordance with Sequential Testing requirements, should be chosen for development in preference to any other sites assessed in this study. These are:

- Cotswolds: 26, 28, 29, 37 and 312
- Cheltenham: 409, 418 and 420
- Tewkesbury: 246, 253, 295, 299, 468, 559 and 561
- Forest of Dean: 52, 78, 290, 528 and 530
- Gloucester: 370, 371, 389 and 540
- Stroud: 145, 203, 433, 465, 545 and 546

2.5.2 Section 1.4 gives guidelines for development in Flood Zone 1, which should be adhered to if any of these sites are developed. In each case Appendix A should be referred to ascertain any particular requirements for each individual site.

2.6 Suitability Score 4: Sites in Flood Zone 1 but affected by Flood Zones 2, 3a and 3b

2.6.1 There are 32 sites which lie mainly in Flood Zone 1, but are affected in some way by Flood Zones 2, 3a and/or 3b. In some cases, other local factors have caused the criteria rating to be reduced to 4 (see Appendix A for details). These are:

- Cotswolds: 309, 439 and 525
- Cheltenham: 294, 415, 417 and 421
- Tewkesbury: 272, 424, 502, 560 and 562
- Forest of Dean: 51, 57, 58, 88, 93, 510 and 527
- Gloucester: 382, 532, 534, 537, 538, 541, 542 and 543
- Stroud: 205, 208, 544, 548 and 555

2.6.2 These sites, in addition to those fully in Flood Zone 1, should also be chosen for development in preference to all other sites, provided the flood risk areas (Flood Zones 2, 3a and 3b) which affect the sites remain as open space (i.e. the principle of avoidance). Again, Section 1.4 gives guidelines for development in Flood Zone 1, which should be adhered to if any of these sites are developed. These sites will be subject to a detailed FRA to confirm flood levels on site, so that development can be appropriately planned away from Flood Zones 2 and 3. Appendix A should be reviewed for any specific considerations that need to be taken into account.

2.7 Suitability Score 3: Sites in Flood Zone 2

2.7.1 There are 12 sites situated predominantly in Flood Zone 2. In most cases, the sites placed in this category generally started with a rating of 4 but have been reduced to 3 due to local residual risk arising from culverts and/or defences, and/or recorded incidents of flooding (from various sources). In some cases, the Flood Zone data is coarse and the rating has been reduced to 3 to ensure a conservative estimate of flood risk; in these instances, further work will be needed to refine the Flood Zone data and adequately guide the Sequential Test.

2.7.2 There were few sites which fell solely in Flood Zone 2; in most cases Flood Zones 3a and 3b also affected the site, or flooding from 'other sources' had been recorded. The sites in this category are:

- Cotswolds: None
- Cheltenham: 2
- Tewkesbury: 252, 300 and 472
- Forest of Dean: None
- Gloucester: 357, 388, 461 and 535

- Stroud: 436, 437, 464 and 552

2.7.3 In line with the requirements of the Sequential Test, sites in Flood Zone 2 can be developed if it can be demonstrated that there are no other suitability available sites in Flood Zone 1, away from 'other sources' of flooding. Section 1.4 gives guidelines for development in Flood Zone 2, which should be adhered to if any of these sites are developed. When considering the development of these sites, the site should be developed sequentially, i.e. by locating the most vulnerable parts of the development in the lowest risk flood zone. Where possible, the flood risk areas should be kept as open space. Appendix A should be referred to ascertain specific issues in each site, which should be assessed further either as part of a Level 2 SFRA, or site-specific FRA.

2.8 Suitability Score 2: Sites in Flood Zone 3a

2.8.1 There are 4 sites with a suitability score of 2. As outlined the previous section, local historic flooding and residual risk issues have caused the rating to be reduced to 2, or where the Flood Zone data is coarse and a conservative estimate of the risk is required. In these instances, further work will be needed to refine the Flood Zone data and adequately guide the Sequential Test.

2.8.2 Sites with a suitability score of 2 are:

- Cotswolds: None
- Cheltenham: 411 and 422
- Tewkesbury: None
- Forest of Dean: None
- Gloucester: 536
- Stroud: 550

2.8.3 In line with the requirements of the Sequential Test, sites in Flood Zone 3a can be developed if it can be demonstrated that there are no other suitability available sites in Flood Zones 1 and 2, away from 'other sources' of flooding. Section 1.4 gives guidelines for development in Flood Zone 3a, which should be adhered to if any of these sites are developed. When considering the development of these sites, the site should be developed sequentially, i.e. by locating the most vulnerable parts of the development in the lowest risk flood zone. Where possible, the flood risk areas should be kept as open space. Appendix A should be referred to ascertain specific issues in each site, which should be assessed further either as part of a Level 2 SFRA, or site-specific FRA.

2.9 Suitability Score 1: Sites in Flood Zone 3b

2.9.1 There are 26 sites which have been given a suitability rating of 1. This has occurred when most of the site falls in Flood Zone 3b; where the flood risks are sufficiently complex and/or extensive; or where the Flood Zone data is very coarse and a conservative estimate of the risk has been made. In many cases, Flood Zone 3b has been derived from Flood Zone 3a, as no information exists to differentiate. Sites with a suitability score of 1 are:

- Cotswolds: None
- Cheltenham: 518
- Tewkesbury: 462, 558 and 563
- Forest of Dean: 291 and 526
- Gloucester: 129, 359, 531, 533 and 539
- Stroud: 163, 177, 179, 187, 189, 190, 191, 193, 209, 547, 549, 553, 554, 556 and 557.

2.9.2 In accordance with PPS25 requirements, development in Flood Zone 3b is restricted to water-compatible developments. There are no waste facilities permitted for development in Flood Zone 3b. It should also be noted that where Flood Zone 3b encroaches a site, this area must remain as open space.

2.10 General Recommendations

2.10.1 The results of this assessment will allow Gloucestershire County Council to ensure that flood risk is taken into account at the first stages of the waste site planning process. The underlying goal of this assessment is to ensure that PPS25 requirements are applied to all development sites, specifically the requirements of the Sequential Test.

2.10.2 Appendix A outlines the confidence in the Flood Zones used to undertake this assessment. Recommendations for Flood Zone improvements are given for some sites; following application of the Sequential Test, should the development of these sites be considered, a Level 2 SFRA will be required to give an improved understanding of flood risks. Some sites behind defences and near culverts have been identified; should these sites be considered for development, a Level 2 SFRA will be required to assess the residual risks.

2.10.3 It is recommended that surface water flood risk mapping is undertaken for the 'preferred' sites.

2.10.4 FRAs will be required for all sites chosen for development, even those in Flood Zone 1 (see section 1.4 for details). Where Flood Zones 2, 3a and 3b affect a site, an FRA will need to confirm flood levels on-site, as well as the predicted effects of climate change and any residual risks. The risk of flooding from other sources should also be assessed. As an integral part of the FRA, a drainage impact assessment will be required to assess the appropriate SUDS techniques that should be adopted to attenuate runoff. Adoption of SUDS is critical to ensure that the development does not exacerbate flood risk elsewhere, and should be reviewed at the masterplanning stage, specifically the

space required in the site for SUDS. It is important that a strategic approach to SUDS adoption is applied to each site.

2.10.5 It is imperative that the development does not exacerbate localised flooding problems, which may increase as a result of climate change (causing increases in the duration, frequency and intensity of rainfall events). The implementation of SUDS systems must be ensured, and careful consideration to overland flow routes (e.g. avoiding obstructing these) as part of the site design should be encouraged. Any SUDS design must take account of groundwater and geological conditions. It is also crucial to recognise that PPS25 considers not only the risk of flooding posed to new development, but it also seeks to positively reduce the risk of flooding posed to existing properties downstream of the site. It is strongly recommended that this principle be adopted as the underlying 'goal' for developers and Council development control teams. Developers should be encouraged to demonstrate that their proposal will deliver a positive reduction in flood risk, whether that be by reducing the frequency or severity of flooding (for example, through the introduction of SUDS), or by reducing the impact that flooding may have on the community (for example, leaving areas of Flood Zone 3a as open space, thereby reducing the number of people within the site that would otherwise be at risk). This should be reflected through the inclusion of a positive statement within the detailed FRA that clearly and concisely summarised how this reduction in flood risk will be delivered.

2.11 SUDS and Open Space

2.11.1 The requirement for SUDS should be assessed at the masterplanning stage, in order to ensure that adequate space is made for water within the development site and that SUDS are not precluded from the development due to overambitious density/capacity requirements. Site specifications should set aside a certain percentage of each site for open space and SUDS schemes. This report indicates where open space within sites should be implemented, which can help the Council achieve required green infrastructure targets. However, the most appropriate SUDS scheme will vary between sites and a drainage impact assessment (carried out as part of an FRA) should be completed as early as possible in the masterplanning process.

2.12 Options for De-Culverting

2.12.1 Culverts have been identified in many of the 104 potential sites. Options for de-culverting and restoration to natural channel should be explored at the masterplanning stage (which may necessitate the need for technical work, either through the FRA or preliminary work).

2.13 Environment Agency Sign-Off

2.13.1 The Environment Agency has been consulted throughout this site assessment process and their response to the report is outlined in Appendix C. Note that the letter also refers to Water Quality work which was not undertaken as part of this assessment.

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APPENDIX A

Site Assessments

APPENDIX B

Site Plans

APPENDIX C

Environment Agency Sign-Off Letter