Drainage and Wastewater Management Plan

Summary of the methodology for the Baseline Risk and Vulnerability Assessment (BRAVA) on:

Risk of Sewer Flooding in a 1 in 50 year Storm

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Version 1.1

from Southern Water

Contents

1. Background

1.1. Purpose

The purpose of this document is to provide a summary of the method for undertaking the Baseline Risk and Vulnerability Assessment (BRAVA) for the planning objective on the **risk of sewer flooding in a 1 in 50 year storm**.

The BRAVA is an important step in the development of Drainage and Wastewater Management Plans (DWMPs). It is an assessment of current and future risks for each of the planning objectives below and is undertaken for the sewer catchments that were flagged during the Risk Base Catchment Screening (RBCS).

All Water and Sewerage Companies (WaSCs) are required to complete a BRAVA and report to Water UK on the following six common planning objectives:

1. Risk of sewer flooding in a 1 in 50 year storm
2. Storm overflow performance
3. Risk of WTW compliance failure
4. Internal sewer flooding risk
5. Pollution risk
6. Sewer collapse risk

We have developed this methodology in accordance with the Water UK guidance on 'BRAVA planning objectives for national reporting' published on 29 July 2020. An extract from the Water UK guidance on the planning objective for the risk of sewer flooding in a 1 in 50 year storm is provided in the Annex to this document.

1.2. Definitions

The risk of sewer flooding in a 1 in 50 year storm is defined as the likelihood that flooding will occur as a result of rainfall in a storm that has a 2% (1 in 50) probability occurring in any given year. It is a metric which is used to measure the resilience of our drainage systems in extreme wet weather. The metric is a single hazard, single consequence measure. This means it only considers one event i.e. the 1 in 50 year storm (the hazard), and the number of properties located in the area that could be flooded in the event (the consequence). The damage to the properties is not calculated. At this stage the assessment counts all properties with a postal address in the area, including blocks of flats. It has been designed by Water UK to assess existing and future resilience to an extreme wet weather event.

All water companies have a requirement to undertake resilience assessment of the 1 in 50 year storm, and report to Ofwat, the water industry economic regulator, every year.

1.3. Reporting Requirements

Water UK requires all WaSCs to use Reporting guidance – Risk of sewer flooding in a storm. Data on the number of properties that could be affected by 1 in 50 year storm within a sewer catchment is reported for the 2020 baseline and the 2050 planning horizon. The method of assessment is described in section 3.1.

2. Data Sources

The following is a short description of the source of the data that has been used to assess the risk of flooding due to a 1 in 50 year storm event and where it has been obtained from.

1.4. Population growth and planned development

Population data for each of the sewer catchments is obtained from the Experian 7.1 database, which provides current and projected (future) population levels across our operating region. This population data is collated for each sewer catchment for the 2020 baseline and for the projected 2050 planning horizon.

The data obtained from Experian 7.1 for the 2050 horizon has been used in a hydraulic model to assess the volume of wastewater flow from future developments. We have then estimated the impact of development in each sewer catchment during a 1 in 50 year storm.

Information on the projected developments is obtained from our Developer Enquiry Tracking System (DETS) database. This contains applications for residential developments and details of the proposed size and location.

The information in the DETS database is collated by our Developer Services Team from consultations with local authorities. It provides forecasts on when development in any area is likely to be implemented. This is used in the modelling assessments to predict the future impact of developments on the sewer network and wastewater treatment works.

1.5. Climate Change

For sewer catchments where we have a hydraulic model of the system, we have applied an uplift of 20% to design storms that account for the impact of climate change when assessing the long term (2050) planning horizon. There is no distinction between summer and winter storms in the application of the climate change uplift.

No climate change uplift is applied for assessing the short term (2025) planning horizon.

This approach is based on the Capacity Assessment Framework (CAF) Guidance Document published by Water UK.

1.6. Hydraulic Models

We have a number of computer based hydraulic models of our sewer networks to support the management, maintenance and investment in these systems. We use a software platform called Infoworks ICM (Integrated Catchment Modelling) to model surface water and wastewater flows through pipes.

Approximately 36% of our 381 sewer catchments have hydraulic models. Generally the models are available for our largest and most complex sewer catchments and, collectively, our models cover the sewers serving over 90% of all our customers. Of these models, approximately 75% will

be used for the first round of the DWMPs. The remaining 25% of the hydraulic models are being reviewed for suitability with the intention to use them in the future iterations of the DWMPs.

1.7. Urban Creep

Urban creep is the increase in impervious surface within an urban area due to extension of properties or addition of new paved areas which leads into increase in surface runoff.

United Kingdom Water Industry Research (UKWIR) study “Impact of Urban Creep on Sewerage Systems” (2010) sets out methods of estimating urban creep. We adopted a simplified version of Method 3 of the UKWIR study to estimate urban creep within our sewerage system and used it as an input in network modelling to assess network capacity and the risk of flooding.

The overall urban creep rate (m^2/annum) for a network model is calculated based on residential property types - Detached, Semi-Detached, Terraced, and Flats in accordance with UKWIR Method 3 (see Table 1 below). An urban creep uplift is calculated as a percentage of the mapped residential roof area based on OS Master Map and OS Address Base Premium. Urban creep for a modelled sub-catchment is calculated by multiplying the modelled residential roof area by the urban creep uplift. Urban creep is then applied as paved area.

Table 1: Urban Creep rate for residential properties

Property Type	Urban creep Rate (m^2/property/year)	Data Source
Detached	0.795	UKWIR
Semi-Detached	0.366	UKWIR
Terraced	0.196	UKWIR
Flats	0	UKWIR
Residential - Default	0.738	UKWIR
Non Residential	0	UKWIR

For models where the residential and non-residential areas are not defined separately by land use, a model sub-catchment property count is required. In this case the creep area is calculated from the roof area and urban creep uplift. A further modification is carried out based on the residential/non-residential roof area split to correct the urban creep calculation in mixed land used sub-catchments. This factor is not applied to some types of older models if it is not possible to carry out a reliable property count.

No urban creep is applied to non-residential properties. No urban creep is applied to modelled sub-catchments with impermeable area <5% of the contributing area.

1.8. Historical Flooding

Historical flooding incidents for extreme weather events are recorded in our Sewer Incident Record Form (SIRF) database. These incidents have been collated in the Internal Flooding Risk assessment for all catchments, and extracted to moderate banding based on vulnerability grade for small non-modelled catchments (serving less than 2000 PE) for the planning objective – flood risk due to 1 in 50 year storm.

3. Method of Assessment

The risk of sewer flooding in a 1 in 50 year storm event is calculated based on the predicted volume of flood water escaping from a manhole for modelled catchments. For non-modelled catchments, a vulnerability grade assessment is undertaken based on the catchment characteristics. These are detailed in this section.

3.1. Process – Baseline 2020 Assessment

Each year, we report to Ofwat on the number of properties in our sewer catchments that are at risk of flooding in a 1 in 50 year storm. The 2020 baseline assessment has used this data from our last submission to Ofwat in June 2020.

The risk of flooding for modelled sewer catchments is determined by firstly identifying manholes that are predicted to flood in 1 in 50 year storm using the hydraulic models of the sewer network (where models are available). A zone (or area) around the manhole is then defined to show the potential extent of flooding. This is produced by digitally mapping a circle from the centre of each affected manhole. The size of the circle (or buffer) is dependent on the volume of predicted flooding as follows;

- 15m radius for flood volumes below 25m^3
- 30m radius for flood volumes up to 100m^3
- 50m radius for flood volumes over 100m^3

Within the modelling software, a Feature Manipulation Engine (FME) collates the results of the modelling and determines the flood buffer radius for each affected manhole. It counts the number of properties (with postal addresses) within the flood buffer zone and determines the total number of properties potentially at risk from flooding within that catchment.

For sewer catchments without a hydraulic model we take a different approach. For these catchments, a vulnerability assessment of the catchment is undertaken based on a number of vulnerability characteristics as set out in Ofwat's guidance for reporting the risk of sewer flooding in a storm: Risk of Sewer Flooding in a Storm - Appendix A. These characteristics include:

(a) geographic topography (ground surface and features) that routes flows to one location and hence creates a high vulnerability area
(b) catchments with a rapid flow response to rainfall
(c) catchments with a high proportion of combined (surface and foul water) sewers
(d) history reported incidents of sewer flooding

(e) high urban population density (which increases the likelihood of customers being affected)
(f) high reliance on pumping stations to convey wastewater from customers to treatment facilities.

Although Ofwat's guidance lists the most relevant vulnerability characteristics against vulnerability grades, the list is not exhaustive and each WaSC can modify it as most appropriate to their catchments.

Each catchment is graded between 1 (low vulnerability) and 5 (high vulnerability). Catchments with a greater than 4000 population equivalent (PE) are split into smaller operational areas and are assigned a localised vulnerability score. The population equivalent is a measure of the number of customers served by a wastewater treatment works taking into account the local population and a measurement of trade effluent (expressed as an equivalent number of people).

The vulnerability grading is a very crude means of assessing risk of flooding from the sewer network in a catchment. It is used where a hydraulic model is not available for the sewer catchment. We have models for the larger sewer catchments and, in total, our models cover the catchments that serve over 95% of our customers. The vulnerability grading method places several small catchments (<2000 PE) in the most vulnerable grade. We have looked at these catchments alongside historical data of flooding. Where there has been no previous record of internal flooding resulting from extreme weather, we have moderated the BRAVA results for these catchments from significant to band 0 (i.e. not significant).

The number of properties within each vulnerability grade is subsequently determined and normalised per 10,000 connections for each sewer catchment in order to enable a standardised comparison between catchments.

Percentages of normalised number of properties at risk for each catchment are separately grouped for modelled and non-modelled catchments, and the assessment thresholds for banding are determined based on calculated quartiles (i.e. 25th and 75th percentiles) for the modelled and non-modelled groups.

The results are presented based on the percentile thresholds and banding criteria (0, 1 or 2) as detailed in section 3.3 and 3.4 to report the normalised total number of properties at risk for each band within the sewer catchment.

3.2. Process – Future 2050 Assessment

The future risk assessment for 2050 is calculated for each sewer catchment using the available hydraulic models. The models are updated with the projected population growth data from Experian 7, alongside an uplift in the volume and intensity of rainfall to account for climate change and a calculation of urban creep.

For each sewer catchment without a hydraulic model, we have used the approach and results for the 2020 baseline date, as described in section 3.1. We have then applied the growth forecasts, based on data obtained from Experian 7 and DETS, to increase the number of properties at risk in 2020 to estimate the future number of properties at risk from a 1 in 50 year storm in 2050.

We have applied a moderation for small non-modelled catchments with a PE less than 2,000 (PE < 2,000) where there are no historical records of internal flood incidents as a result of extreme weather, as per section 3.1.

The results are presented using the threshold and banding criteria (0, 1 or 2) as detailed in section 3.3 and 3.4 for reporting the normalised total number properties at risk for each band within the sewer catchment.

3.3. Process Charts – Modelled and Non-modelled Catchments

The processes for assessing modelled and non-modelled catchments for the baseline (2020) and future (2050) planning horizons are summarised in the charts shown in Figure 1 and Figure 2 below.

Figure 1: Process flow chart for risk of flooding due to 1 in 50 year storm (Modelled Catchments)

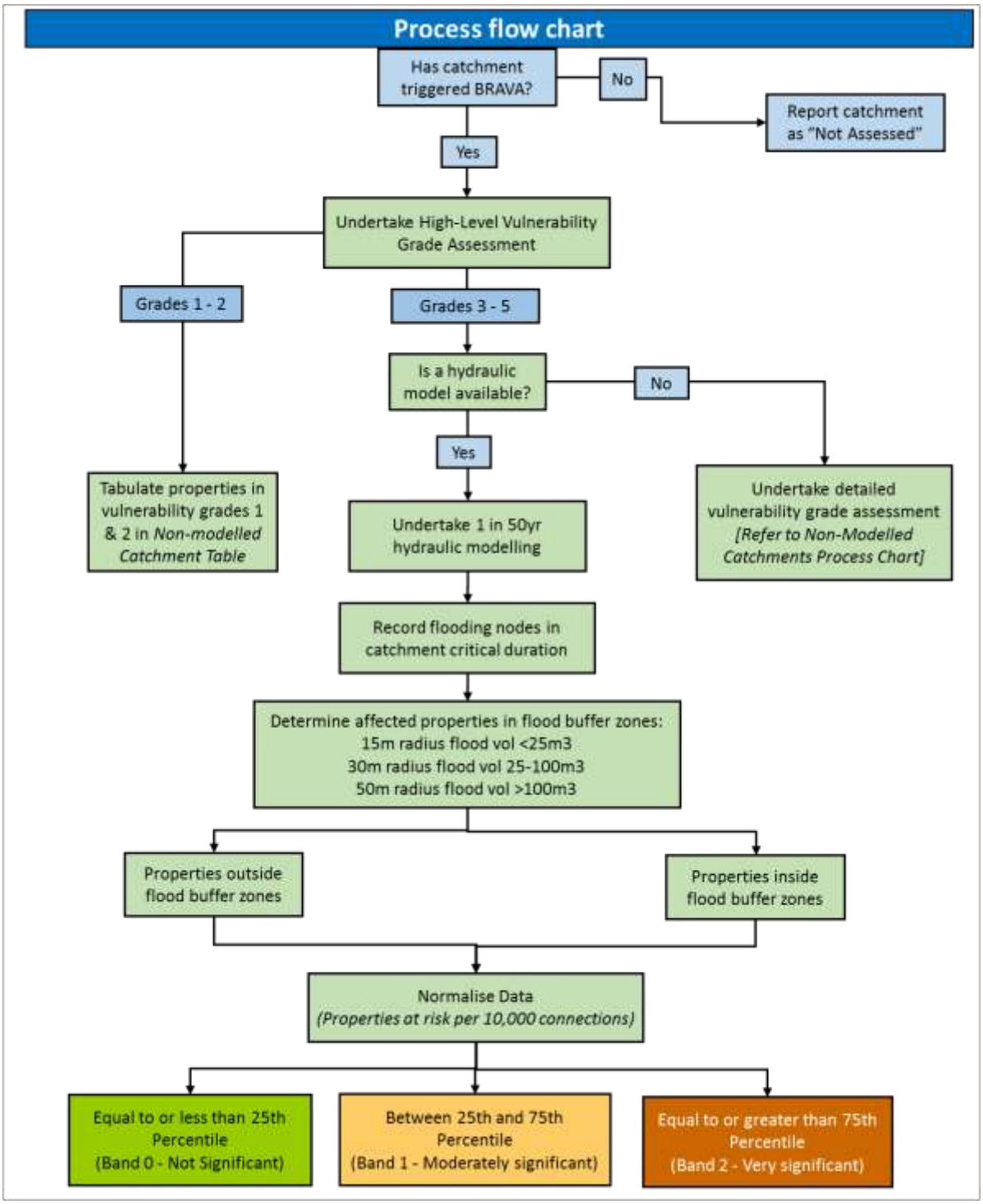
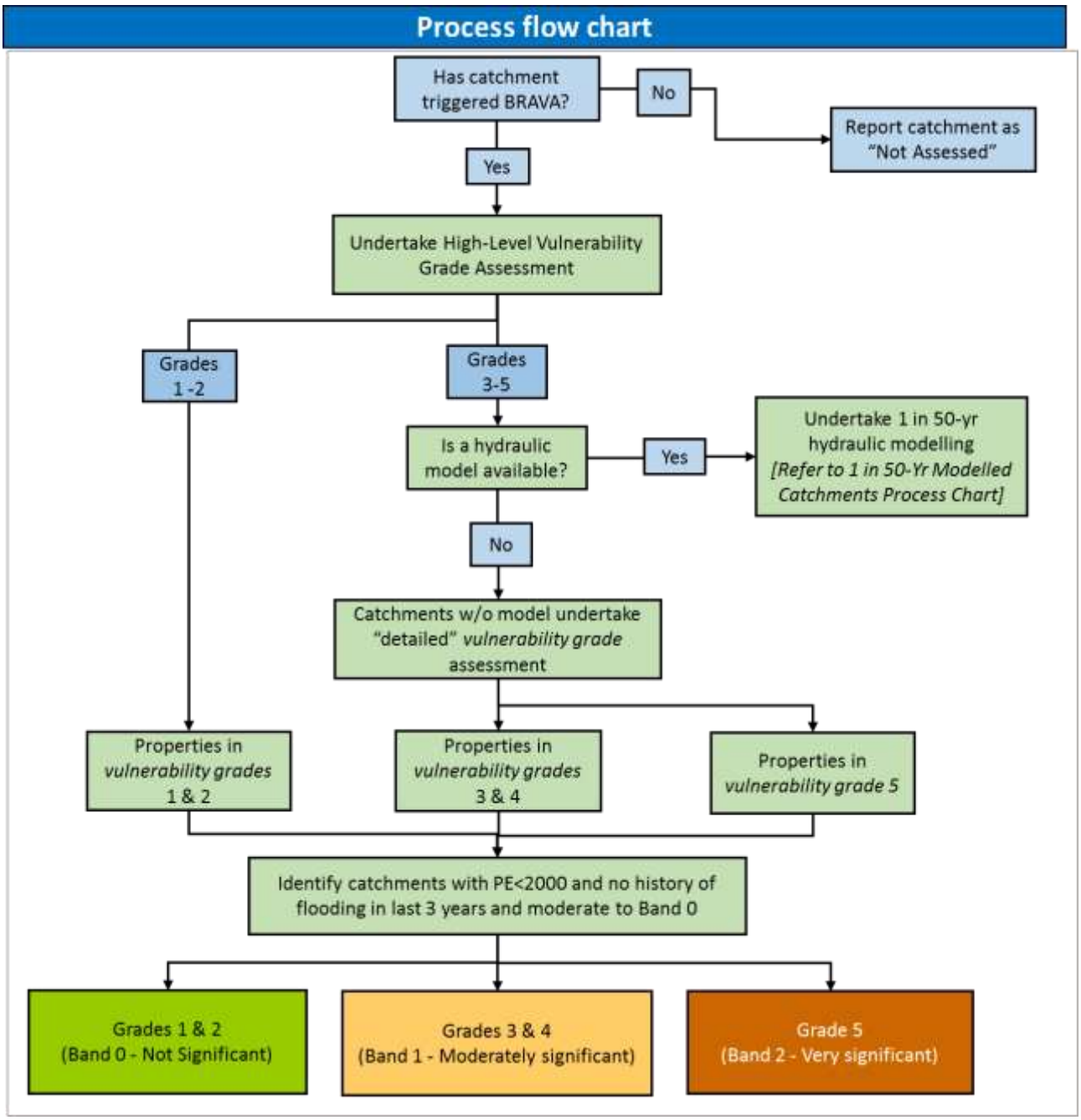


Figure 2: Process flow chart for risk of flooding due to 1 in 50 year storm (Non-Modelled Catchments)



3.4. Outputs from the BRAVA

The output from the BRAVA on the risk of flooding in a 1 in 50 year storm is an estimate of the number of properties in areas at risk from flooding in each sewer catchment as follows:

- number of properties at risk of flooding, normalised per 10,000 connections, for modelled catchments
- number of properties within each vulnerability grade, normalised per 10,000 connections, for non-modelled catchments.

The normalised scores are calculated for the 2020 baseline and also for the 2050 assessment, then assigned to one of three bands as specified by Water UK. The thresholds for these bands are determined by each water company.

We have set the thresholds for each risk band using the grading system from Ofwat's guidance for reporting the Risk of Sewer Flooding in a Storm. The grading system is assigned to a band 0, 1 or 2 to indicate the level of risk (as set out in the Water UK guidance).

The thresholds for the three bands are based on the quartile in which the normalised number of properties falls into, as shown in the table below:

Assessment Criteria / Thresholds	Band	
Equal to or less than 25th percentile of properties at risk per 10,000 connections	0	*Not Significant*
Between 25th - 75th percentile of properties at risk per 10,000 connections	1	*Moderately Significant*
Equal to or greater than 75th percentile of properties at risk per 10,000 connections	2	*Very Significant*

The results are reported to Water UK in an Excel spreadsheet format.

Southern Water
16 March 2021

4. Annex: Water UK guidance on the Planning Objective

Planning Objective: Risk of Sewer Flooding in a 1 in 50-year storm

<table>
<tr>
<td><u>Objective/Definition</u>

• To be applied to all catchments that have triggered a BRAVA assessment through the RBCS process.
• This approach will provide a sewer flood risk input to complement the National Infrastructure Assessment of properties at risk from river/sea & surface water flooding.
• It will be consistent with, but will not reflect exactly, the annual reporting for the Ofwat common resilience performance commitment, as set out below under ‘baseline assessment’.
• Approach to be undertaken in accordance with the guidance set out by Ofwat, apart from as below:
https://www.ofwat.gov.uk/wp-content/uploads/2019/04/Reporting-guidance-Risk-of-sewer-flooding-in-a-storm_final_290319.pdf
• As per the Ofwat methodology it includes ‘internal’ hydraulic sewer flooding only but, unlike the Ofwat methodology, will not exclude catchments under 2,000 PE or apply vulnerability grades/functional areas.</td>
<td><u>Definition clarifications</u>

Results to be presented at Baseline (2020) and 2050-time horizons.

<u>Thresholds</u>
• Bands of 0, 1 & 2 to be applied; with 0 as ‘Not Significant’, 1 as ‘Moderately Significant’ and 2 as ‘Very Significant’. Where a catchment does not trigger BRAVA, these will be flagged as ‘Not Applicable’.
• Thresholds for bands to be developed by each company appropriate to their needs and to ensure outputs are meaningful to inform stakeholder engagement.

<u>Maps</u>
• To be produced for an L2 based on bands 0, 1 & 2.

<u>Tables</u>
• To be produced for L1, L2 & L3 and include only 0, 1 & 2 banding.
• Subject to a review of compliance with data protection regulations, additional detail at an L3 could be included, for example % population at risk.
• L1 & L2 to additionally include numbers of properties at risk of sewer flooding in a 1 in 50-year storm.</td>
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<tr>
<td><u>Baseline Assessment</u>
• Baseline position (2020) to be produced in accordance with the guidance set out by Ofwat for the PR19 performance commitment, except where a hydraulic model is not available for a catchment, then an informed assessment of risk will be undertaken by the company to identify properties likely to be at internal flood risk.
• This will provide a more representative assessment of current risk for planning purposes, rather than assuming all properties are at risk in a non-modelled catchment as per the Ofwat methodology which is intended to incentivise companies to expand their hydraulic models to more catchments over time.
• Each company will determine the thresholds it will use to ensure the results appropriately reflect their risk and provide an overview of their calculations.</td>
<td><u>2050 Assessment</u>
• Same methodology as Baseline Assessment, with:
○ Rainfall uplifted to include forecast climate change impacts up to 2050 epoch.
○ Growth and creep to be added in line with best available central estimate / company approach.</td>
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