ATKINS

Newent Drainage Investigation Feasibility Report

Forest of Dean District Council

Plan Design Enable

Forest of Dean
DISTRICT COUNCIL

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Document History

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Executive Summary

Atkins Consultants Ltd (Atkins) was appointed in July 2008 by the Forest of Dean District Council to carry out modelling and hydraulic assessment of historical flooding in the town of Newent and an area of Cliffords Mense.

Watery Lane, Johnstone Road, Peacock Gardens and the Town Centre are prone to flooding and have been affected by the recent heavy storm events in June 2007 and January 2008 as well as in previous years as far back as 1993. The Model Build and Calibration used to assess the flooding in Newent is reported in this document.

The modelling and hydraulic assessment of Cliffords Mense has been reported in the following Document: 5075404-56-DG-010 - Cliffords Mense Flood Risk and Options Report I1.

Prior to hydraulic assessment and solution development in Newent the following were undertaken:

- Manhole, CCTV and river section surveys were undertaken in the vicinity of Watery Lane, Johnstone Road, Peacock Gardens and the parts of the Town Centre.
- The model has been calibrated against photographic and drawing evidence of flooding at the above areas.

The hydraulic model has been calibrated to an appropriate level from the information supplied. The model is deemed suitable for identifying the cause of historical flooding in the town and identifying outline options to resolve/mitigate against future incidents.

This report details the outline options identified in Newent to resolve flooding to an appropriate level of service. The surface water sewer system was found to be in a poor serviceable and structural condition and as such those lengths of sewer have been highlighted for appropriate action. In general the surface water sewer system was considered to be of an adequate capacity to resolve flooding at Watery Lane, Johnstone Road, Peacock Gardens with some minor sewer upsize required (approximately 67m).

The model does not predict surface water flooding in the town centre, any flooding which does occur may be as a result of poor serviceability of the highway drainage discharging to the combined sewerage system. Investigations into the combined sewerage system are outside the scope of this report.

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Glossary of Terms

Term	Meaning / Definition
EA	Environment Agency
SAAR	Stochastic Average Annual Rainfall
FEH	Flood Estimation Handbook
FSR	Flood Studies Report
UCWI	Urban Catchment Wetness Index
CDA	Critical Duration Analysis
FoD	Forest of Dean
FoDDC	Forest of Dean District Council
OS	Ordnance Survey
WWTW	Waste Water Treatment Works
DAP	Drainage Area Plan
LiDAR	Light Detection and Ranging
DMRB	The Design Manual for Roads and Bridges

1. Introduction and Objectives

1.1 Introduction

Atkins Consultants Ltd. (Atkins) was appointed by Forest of Dean District Council (FoDDC) to investigate the cause of significant flooding observed in the summer of 2007 in the town of Newent, Forest of Dean (FoD).

The summer of 2007 flooding affected Watery Lane, Johnstone Road, Peacocks Gardens and the town Centre in Newent, FoD. The mechanisms and processes of flooding in these areas are not well understood and the degree to which these flooding problems are linked is also not known.

Newent is located in Vale Of Leadon, Forest of Dean and comes under boundary of the FoDDC, and has experienced a significant amount of flooding in the summer 2007 incidents as well as other recorded events as far back as 1993. Flooding has been observed from a number of locations across the town and some local residents suggest flooding occurs approximately up to 12 times in a year in parts of Newent.

1.2 Objectives

The main objectives of the study are to construct a hydraulic model of the catchment that will enable:

- Calibration of historic flooding in the catchment.
- Outline solution development to resolve or mitigate the impacts of flooding in the following locations:
    - Watery Lane/Johnstone Road.
    - Peacock Gardens.
    - Town Centre.

2. Catchment Description

2.1 General Description

Newent is a small town (population approximately 5080) located in the Forest of Dean, Gloucestershire. Newent is located approximately 12 miles to the west of Gloucester and three miles east of Junction 3 of the M50 Motorway.

Newent is located in a basin surrounded by low hills and the majority of the surface water catchment areas drain into Newent Lake, via piped systems or Peacocks Brook both of which discharge to Ell Brook.

The catchment can be seen on Drawing 5075404-DWG-46 in Appendix M.

2.2 Surface Water System

The modelled surface water system consists of approximately 9800 metres of sewer ranging from 150mm up to 675mm in diameter. There are a number of outfalls discharging either into Peacocks Brook or to Newent Lake from the areas affected by flooding.

Highway gullies were identified within the study area and an assessment of their connection points was made using CCTV evidence where available and engineering judgement elsewhere. Some highways gullies connect to the storm system (identified in the CCTV survey), while others were assumed to connect to the combined sewerage system.

2.2.1 Watery Lane & Johnstone Road

There are three main lines of sewer (Drawing 5075404-DWG-46 in Appendix M) which serve Watery Lane and Johnstone Road; one runs along the top end of Watery Lane before cutting across the rear of the properties located between Watery Lane and Johnstone Road before discharging into Peacocks Brook. This system is linked by a high level overflow to the surface water sewer which serves Johnstone Road. The third runs from outside No. 17 Akermans Orchard at manhole SO71257701 before joining the SO71258603X on Watery lane down to Newent Lake.

2.2.2 Peacock Gardens

Peacock Gardens are served by a number of highway gullies which have been assumed to connect to short lengths of surface water sewer which discharges directly to Peacocks Brook. There are also a number of highway gullies which have been assumed to discharge direct to peacocks Brook.

2.2.3 Newent Town Centre

Newent Town Centre is served by a predominantly combined sewerage system. The assessment of which is outside the brief of this study.

2.3 Peacocks Brook

Peacocks Brook flows from the south of the catchment and runs parallel to Peacocks Gardens Watery Lane and Johnstone Road and drains into Ell Brook located at the north eastern extent of Newent Lake to the north of the Town Centre. Sections of the brook have been culverted between the High Street and Court Lane.

2.4 Newent Lake

Newent Lake covers an area of approximately 0.16Ha and outfalls north east into Ell Brook which runs south east. There are 4 known piped outfalls discharging into Newent Lake, one on the south bank and three on the north bank. One of the main surface water sewers serving Watery Lane discharges into Newent Lake.

3. Data Collection

3.1 Sources of Data

Document Title	Date	Doc. Ref.	Provided By	Comments
Historical Documents	02-12-08	5075404/47/DI-24 5075404/41/DI-17	FoDDC	Photographical evidence of flooding.
Unfiltered and Filtered LIDAR data	01-09-08	5075404/45/IR-15	Environment Agency	Data that allows interpolation of ground levels, and maps the terrain.
Rainfall data	16-10-08	N/A	Atkins	Created using FEH parameters.
Background Mapping Data	02-09-08	N/A	Gloucester Highways	
Sewer Record Plans	29-08-08	N/A	Severn Trent	Digital model built from plans held by FoDDC.
Newent DAP Model	05/12/08	N/A	Severn Trent	DAP model of combined sewer system.
FEH watercourse hydrographs	01-11-08	N/A	Atkins	Storm hydrographs for Watery Lane drainage ditch and Peacocks Brook.

Figure 1 – Sources of Data

3.2 Manhole Survey

A manhole survey was undertaken by Enviromontel in October 2008. The survey targeted eighteen manholes and five outfalls. Information from the survey was supplied in the form of hard copy manhole record cards (Manhole and Gully Surveys Newent October 2008 – M0810065. Atkins Ref: 5075404-41-DI-007). No digital data was supplied as part of the commission.

3.3 CCTV Survey

The CCTV survey was undertaken by Enviromontel during October 2008. The CCTV was undertaken to assess the general condition of the network, as well as identify any faults, blockages or build up of sedimentation. Approximately 1.4km of the pipe work was surveyed. Data was supplied in DVD format of the CCTV footage accompanied by a hard copy report (Newent CCTV Survey Report October 2008 – C0810010. Atkins Ref: 5075404-41-DI-006) detailing the grades along each section of surveyed sewer.

3.4 Topographic Survey (watercourse cross-sections)

Sixteen cross-sections were identified for survey on Peacocks Brook, however two sections could not be completed due to the brook being culverted in those locations. A detailed report (Newent Drainage Survey River Sections October 2008 – M0810065) of the cross-sections was issued with photographs of the sections (Atkins Ref: 5075404-41-DI-013).

3.5 Gully Surveys

The locations of 121 gullies were identified within the area of Watery Lane, Johnstone Road, Peacocks Gardens, High Street, Brookside and Craddock Road. The cover levels for these were then interpolated using LiDAR data. The LiDAR data supplied by the Environment Agency has a vertical accuracy of +/ – 0.15m. The connection points of the gullies were either identified based upon CCTV survey information or an assessment based upon engineering judgement. Gullies were found to connect to the storm system and assumed to connect to the combined system.

3.6 LiDAR

Supplied by the Environment Agency, LiDAR (Light Detection and Ranging) data is a mapping technique which uses a laser to measure the distance between an aircraft and the ground. The aircraft flies approximately 800 metres above the ground and surveys points on the ground at two metre intervals. The result is a map of the terrain that is suitable for assessing flood risk, and is supplied in a format that can be used with GIS applications.

The LiDAR data supplied by the Environment Agency has a vertical accuracy of +/ – 0.15m.

All LiDAR data used in the modelling of this report is subject to copyright the Environment Agency Geomatics Group 2008.

4. Hydraulic Model Construction

4.1 General

The Newent catchment was modelled using InfoWorks CS 9.5 2D, traditionally a sewer modelling package but with the capability of modelling complex river structures and overland flow paths. The following sections describe the process involved and the data used to model the various components of the catchment.

The level of detail required in the model needed to be sufficient to allow for an appropriate level of assessment to be made on the extent and cause of flooding within the catchment. Every known surface water manhole was included in the model, along with highway drainage manholes. Gullies were only identified in areas of known flooding and as such the model does not include all the gullies in the catchment.

The model was also required to produce outline options to resolve and or mitigate the impacts of the flooding observed and predicted.

4.2 Surface Water System

Surface water sewer data was sourced from the FoDDC. The data from paper plans was manually entered into the model and updated with targeted CCTV and manhole survey data. Where there was insufficient data regarding pipes sizes or invert levels these have been interpolated based upon the surrounding data.

The Newent Drainage Area Plan (DAP) model was supplied by Severn Trent Water; this was used to identify any missing information in the model that was not identified off the paper plans supplied by the FoDDC.

4.3 Watercourses

The watercourses were identified from Ordnance Survey (OS) background mapping data supplied by Gloucester Highways. A number of watercourse cross sections were identified for survey and upon receipt of the survey data were entered into the model.

Typical roughness co-efficient values were applied to the river sections, a Colebrook White value of 50mm for the bank sides and 15mm to 50mm for the watercourse bed was used.

Flow hydrographs for both the Watery Lane Drainage Ditch and Peacocks Brook drainage catchment upstream of the urban area were generated. There were based upon a rainfall runoff assessment undertaken using the Revitalised FSR/FEH Rainfall-Runoff Methodology (Centre for Ecology & Hydrology - December 2005). The implementation of this was employed using the spreadsheet developed by CEH. The flow hydrographs represent the flow from the rural catchment upstream of the inflow location at the head of each watercourse in the model.

4.4 Manholes

Manhole data was gathered from a number of sources including; historical plans, manhole survey and data from surface water system paper plans.

All manhole data has been entered into the model manually and as such the exact location cannot be guaranteed, however a good representation has been made.

4.5 Gullies

Gully positions were surveyed as part of the topographical survey in the catchment. The survey identified the positions of the gullies, and then the locations were uploaded into MapInfo, renamed and imported into InfoWorks. Gully cover levels were interpolated using LiDAR data.

A generic headloss curve was applied to all gullies in the catchment which accounts for the inflow and outflow restrictions associated with the gullies.

All gully data has been entered into the model manually and as such the exact location cannot be guaranteed, however a good representation has been made.

4.6 Subcatchment Generation

Surface water subcatchments were manually created in InfoWorks based upon the extent and location of the surface water sewer network. The Severn Trent Newent DAP model was used to identify areas where the combined sewerage system drained so that the surface water subcatchments did not overlap the combined subcatchments. Subcatchments draining to the foul and combined system were not re-drawn as part of this study, those supplied by Severn Trent were used.

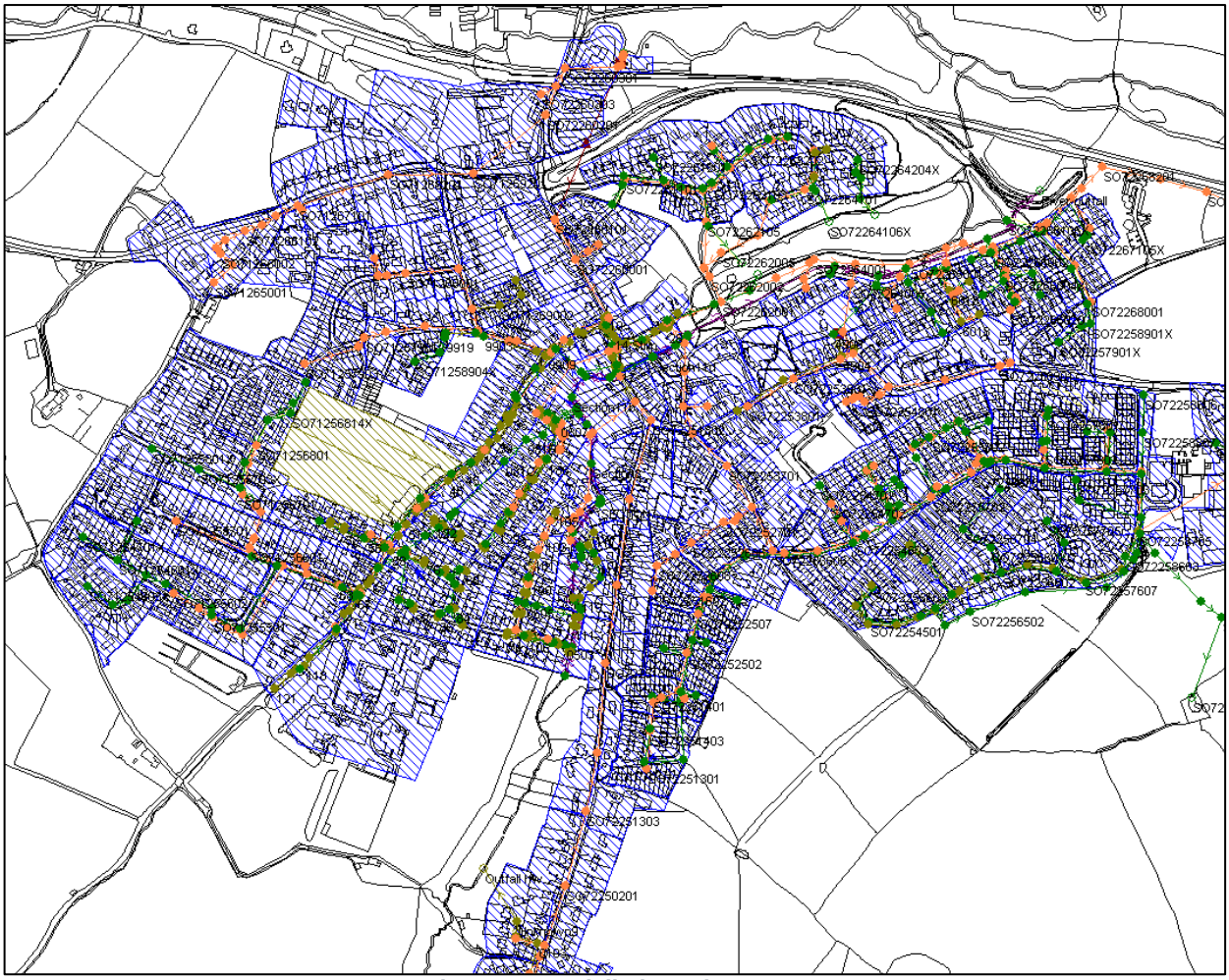

Figure 2 – Modelled Catchment Extents

4.6.1 Urban Subcatchment Generation

Urban subcatchments had to take into account; gullies, culverts and surface water sewers. The Severn Trent DAP model was used to identify areas which drained to the combined sewerage system. These areas could then be discounted from the surface water system and so the appropriate level of contributing area has been applied to the surface water system.

Runoff surface areas were based upon an assessment of roads, roofs and permeable areas.

4.6.2 Rural Subcatchment Generation

Two main rural catchment areas were identified which provided flow into the model. One covered the catchment area for Peacock Brook, and other covered the catchment area for the Watery Lane Drainage Ditch. The flows from these catchments were generated using the methodology described in section 4.3 of this report.

4.6.3 Contributing Area

An assessment of contributing area for the modelled subcatchments was made based upon roads, roofs and the permeable areas. Total contributing areas were adjusted during the calibration process to give an appropriate level for the catchment.

4.7 2D and Overland Flow

A 2D catchment boundary was created around the known flooding areas and Peacocks Brook. The purpose of including this is to identify overland flow paths from flooding manholes and gullies. During this process the model takes into account buildings, walls, and ground elevation.

Walls were entered into the model to indicate structures which blocked particular overland flow paths thus diverting flood waters in a more realistic route. Such structures can be solid brick walls, fences, sand bag barriers and any other impermeable barrier. The location of the walls was identified from photographic evidence and aerial photography. Walls were also used to represent the sand bags used (where the locations were identified by local residents and photographic evidence) during the flood events of summer 2007.

4.8 Rainfall Data

Design rainfall data was generated using FEH parameters were obtained from FEH Version 2.0. They were taken from the co-ordinates SO7255026100. Figure 3 shows the parameters used to generate the design rainfall.

Parameter	Value
SAAR	726
C (1km)	-0.028
D1 (1km)	0.368
D2 (1km)	0.435
D3 (1km)	0.272
E (1km)	0.289
F (1km)	2.33

Figure 3 – FEH parameters

4.9 Urban Catchment Wetness

Urban Catchment Wetness Index (UCWI) values were calculated using the Stochastic Average Annual Rainfall (SAAR) values were taken from the FEH parameters (see figure 3 above. UCWI is a measurement of how wet a catchment is prior to an event, when using design rainfall two UCWI values can be generated for winter and summer storms. Figure 4, taken from Wallingford Software InfoWorks CS shows the design values for UCWI based upon SAAR figures.

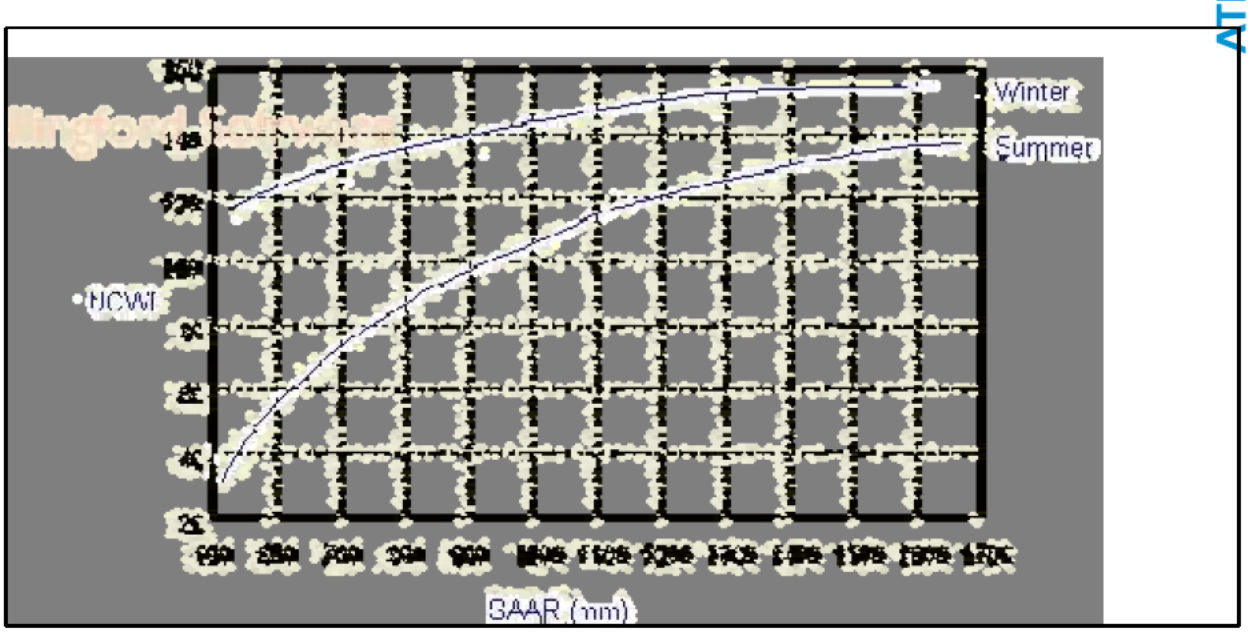

Figure 4 – UCWI Calculations

The final UCWI values used were 77 the summer simulations and 136 for winter.

4.10 Pipe Roughness

Pipe roughness was defined using Colebrook White. Depending on the material of the sewer and its condition, differing values were applies. These values are shown in Figure 5. The material and condition of the sewer was judged form manhole and CCTV surveys. In the case of the sewers that have not be surveyed the default roughness was set at 1.5, this was also applied to pipes receiving flows from gullies.

Sewer Material or Condition	Roughness (mm)
Default	1.5
Mild silt/ rubble	10-25
Sizable debris	25-50

Figure 5 – Roughness Co-efficient values

In the case of minor blockages, and reduced surface area, sediment was modelled, and in extreme cases of reduction in cross-sectional areas, orifices were used to replicate them.

5. Calibration

5.1 General

The Newent surface water model was calibrated using photographic evidence and drawings provided by FoDDC and Newent Town Council. Engineering judgement has been used where little or no other evidence was made available.

5.2 Flooding Locations

Newent has four main areas of known flooding; Watery Lane, Johnstone Road, Peacock Gardens and the Town Centre.

The storms of summer 2007 resulted in significant flooding throughout Newent. Photos and drawings provided by residents were used to identify areas of flooding. Flood locations and the assumed depths (taken from photographic evidence and drawings provided) were used to calibrate the model, these can be seen in Table 6. (It should be noted that the pictures provided may have not been taken at the peak of the flooding).

Location	Observed Flooding (mm)
Watery Lane	200 approximately
Johnstone Road	150 approximately
Peacocks Gardens	No data provided
Town Centre	No data provided

Figure 6 – Observed Flooding

5.3 Rainfall Data

Real time historical rainfall data was not available for this particular study so alternative methods of calibration have been used for this study. Design rainfall has been used to calibrate the model. The return period of the event which caused the flooding in the summer 2007 event has not been accurately identified, however from other studies in the area it has been assumed that the return period was in the region of a 30 year event. Therefore, a suite of 30 year return period events was used to replicate the known flooding conditions from the summer 2007 event.

5.4 Rural Inflows

No flow data is available for either Peacock Brook or the Watery Lane Drainage Ditch. As such, design hydrographs (using the method previously identified) have been generated for the same suite of 30 year rainfall events and applied to the model for calibration purposes.

5.5 Historical Evidence

Photos and verbal accounts by the residents provided records of the flooding in some areas in and around Newent. Although these photos may not have been taken at the peak of the flooding they are considered suitable enough to be used in the calibration of the model. Photos where the depth of water can be estimated were used to ensure the model was predicting flooding correctly. By comparing the depth in the photographs to the depth of flooding predicted by the overland modelling an acceptable level of calibration has been achieved.

Figures 7 to 11 show the observed flow paths and areas of known flooding from the summer 2007 flooding event

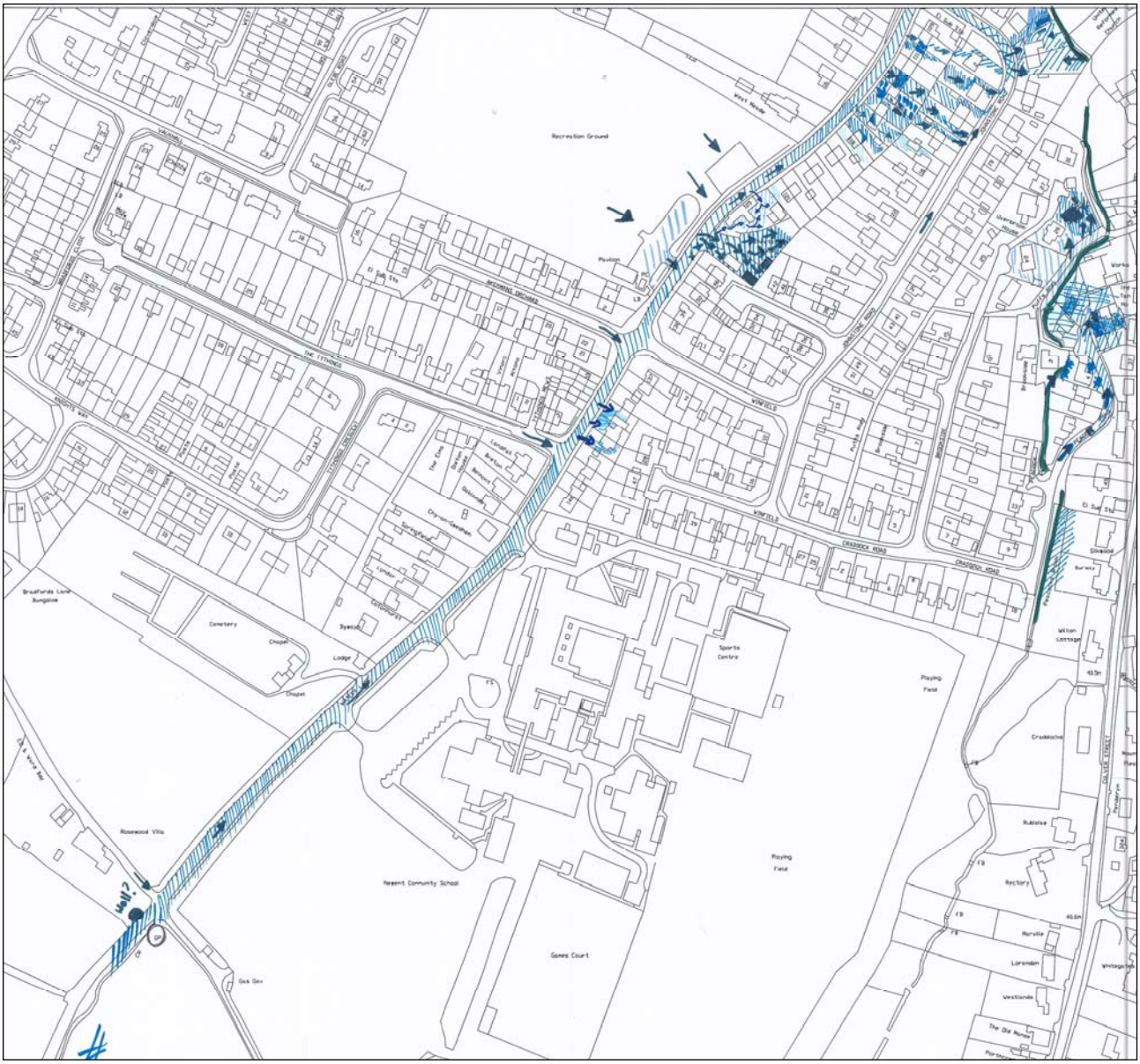

Figure 7 – Catchment Wide Observed Flooding

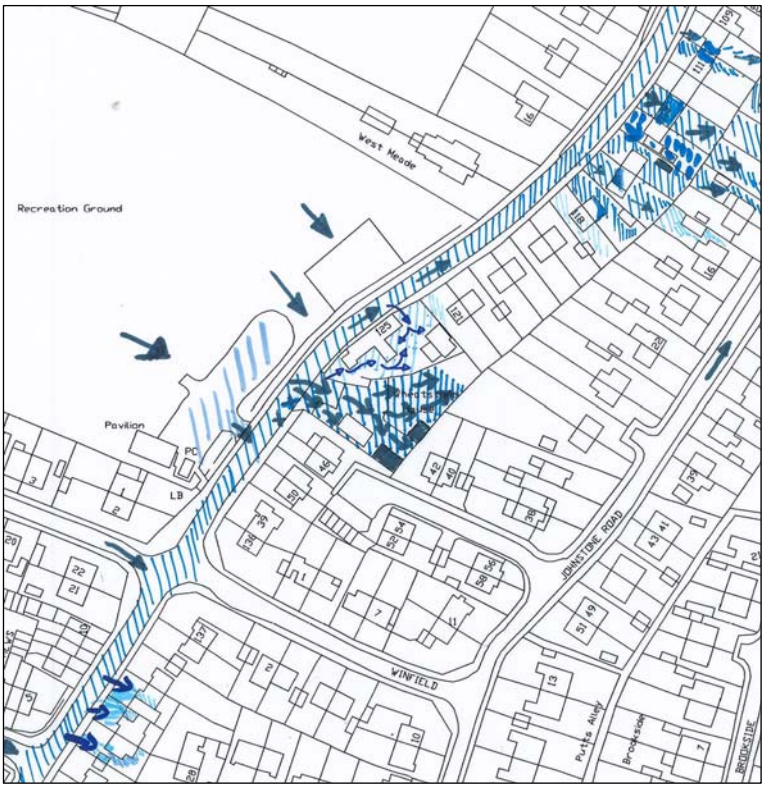

Figure 8 – Observed Flooding - Watery Lane

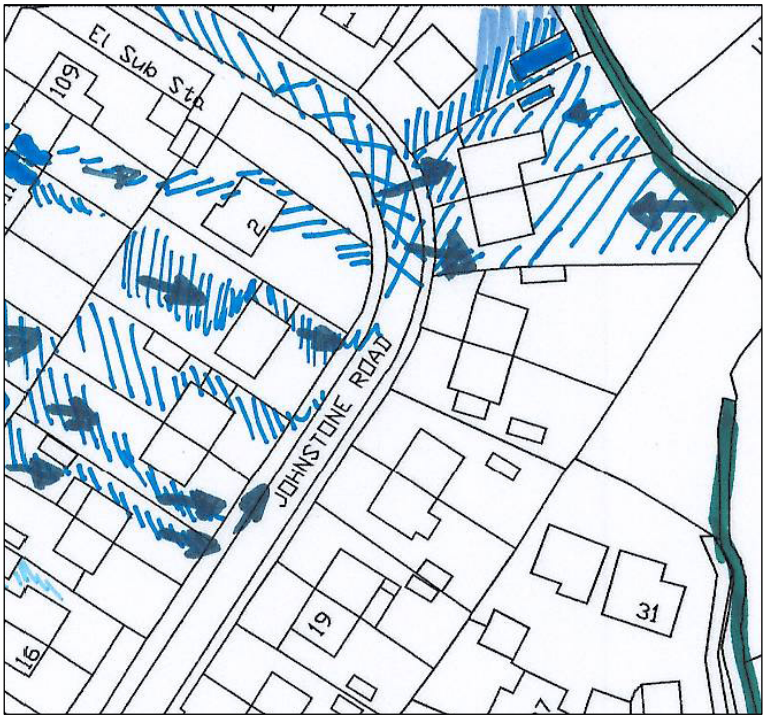

Figure 9 – Observed Flooding - Johnstone Road

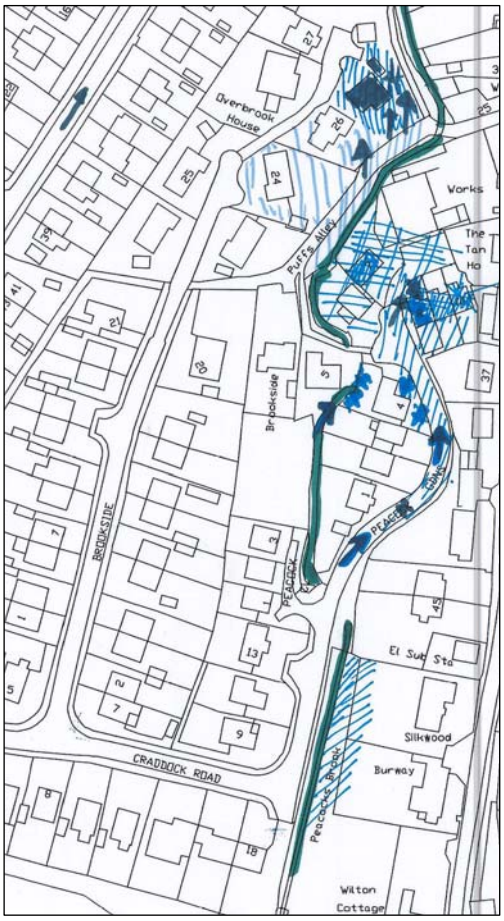

Figure 10 – Observed Flooding - Peacock Gardens

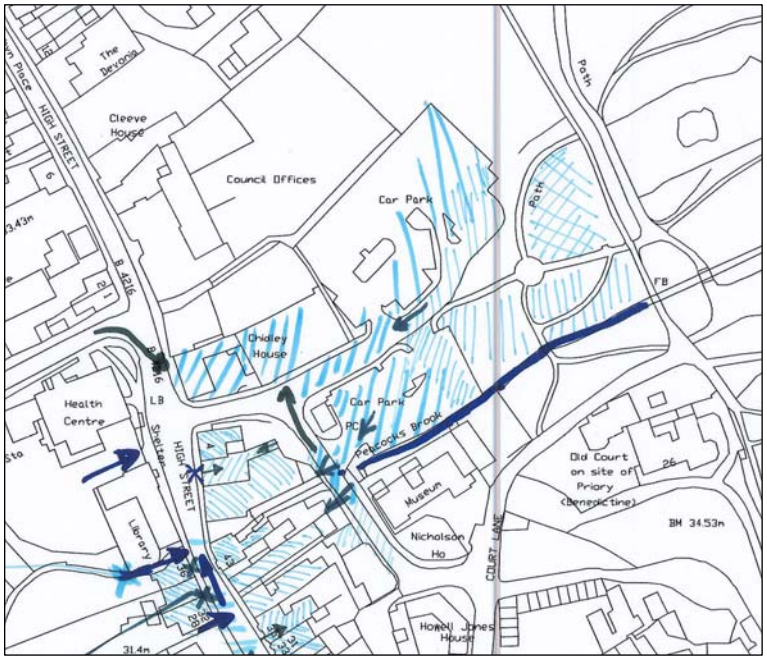

Figure 11 – Observed Flooding - Town Centre

5.6 2D Overland Flow Modelling

2D flood routing was used to calibrate the model. From discussions with local residents and Newent Town Council it became apparent that overland flow was the cause of some of the flooding.

Out of sewer flooding was occurring and flowing down the roads and ponding in the known flood locations. By applying 2D flood routing methodology we were able to better replicate this known flood mechanism.

5.7 Model Predicted Flooding

Figure 12 shows the model predicted flood depths for the different areas affected by the summer 2007 flooding events. Figure 13 shows the extent of flooding predicted in the catchment for the 30 year design calibration event. Figures 14 to 17 show the model predicted flooding for each of the known flood locations.

Location	Observed Flooding (mm)	Predicted Flooding (mm)
Watery Lane	200 approximately	240 -290
Johnstone Road	150 approximately	70 - 140
Peacocks Gardens	No data provided	0
Town Centre	No data provided	0

Figure 12– Model Predicted and Observed Flood Depths

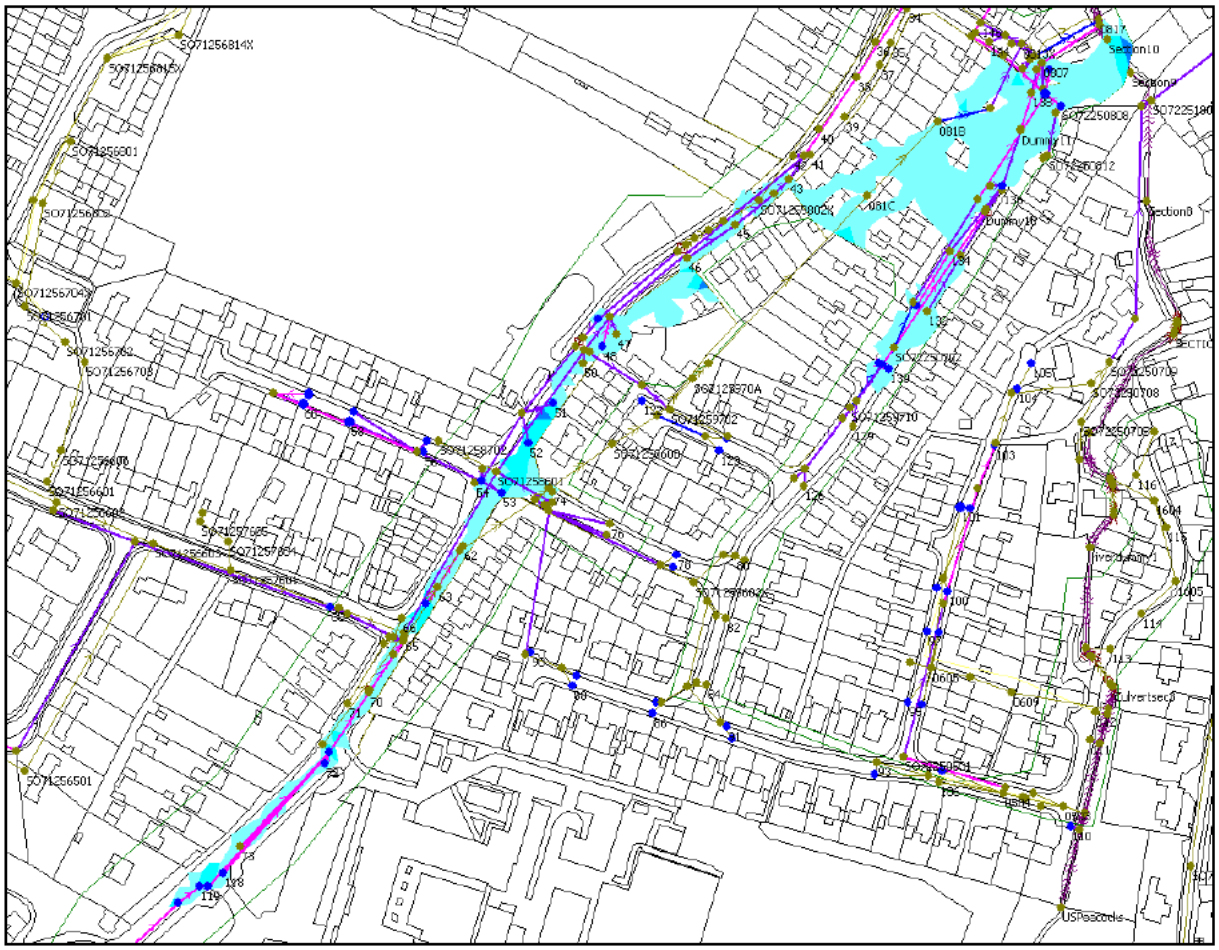

Figure 13 – Predicted Flooding

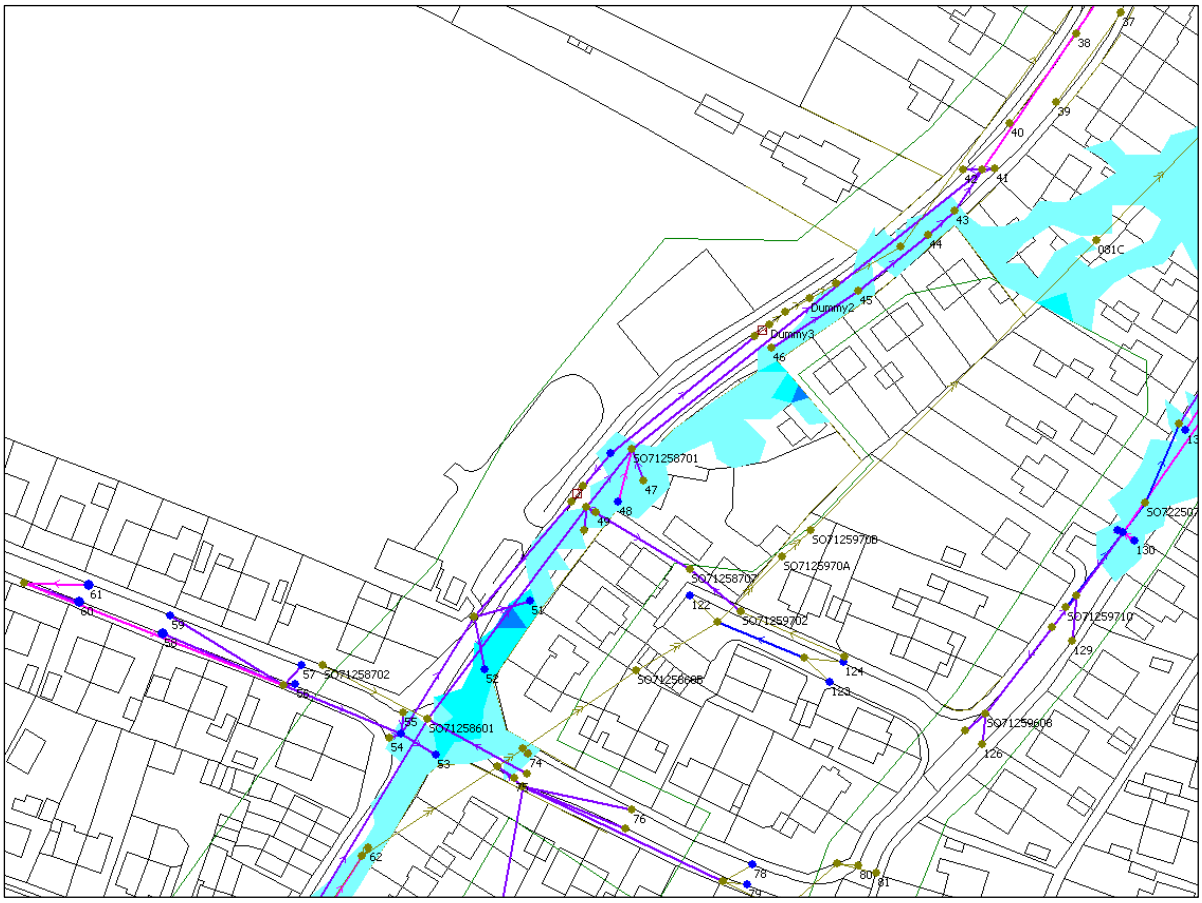

Figure 14 – Watery Lane Predicted Flooding

Figure 14 shows the extent of flooding along Watery Lane. The model predicted flooding differs slightly from that shown in Figure 8 (as identified by the local residents). The model does not predict flooding along Watery Lane after No. 16 (flows are not conveyed any further down Watery Lane to the north east). It is not possible to replicate the precise location and height of sand bag barriers laid down to protect the properties by the local residents.

The model does predict the overland flow path round the backs of the properties on Watery Lane to the properties along the northern side of Johnstone Road. It would be possible to replicate the flows along Watery Lane although the model would then not predict the flooding though the property.

Figure 15 shows the extent of the flooding along Johnstone Road. The model predicts out of sewer flooding from the surface water system at the south western extend of Johnstone Road which then flows in a north easterly direction down the road before pooling on the corner outside No.'s 5 and 7. The flood waters then flow round No. 7 Johnstone Road into Peacock Brook. The model may not be predicting the exact flood path correctly in this location as the garage/shed at No. 7 is known to divert the flows slightly differently.

The model predicted depths may vary from those observed on the corner of Johnstone Road as the extent and layout of sandbags laid down by local residents is not known which would significantly affect the depths in the model.

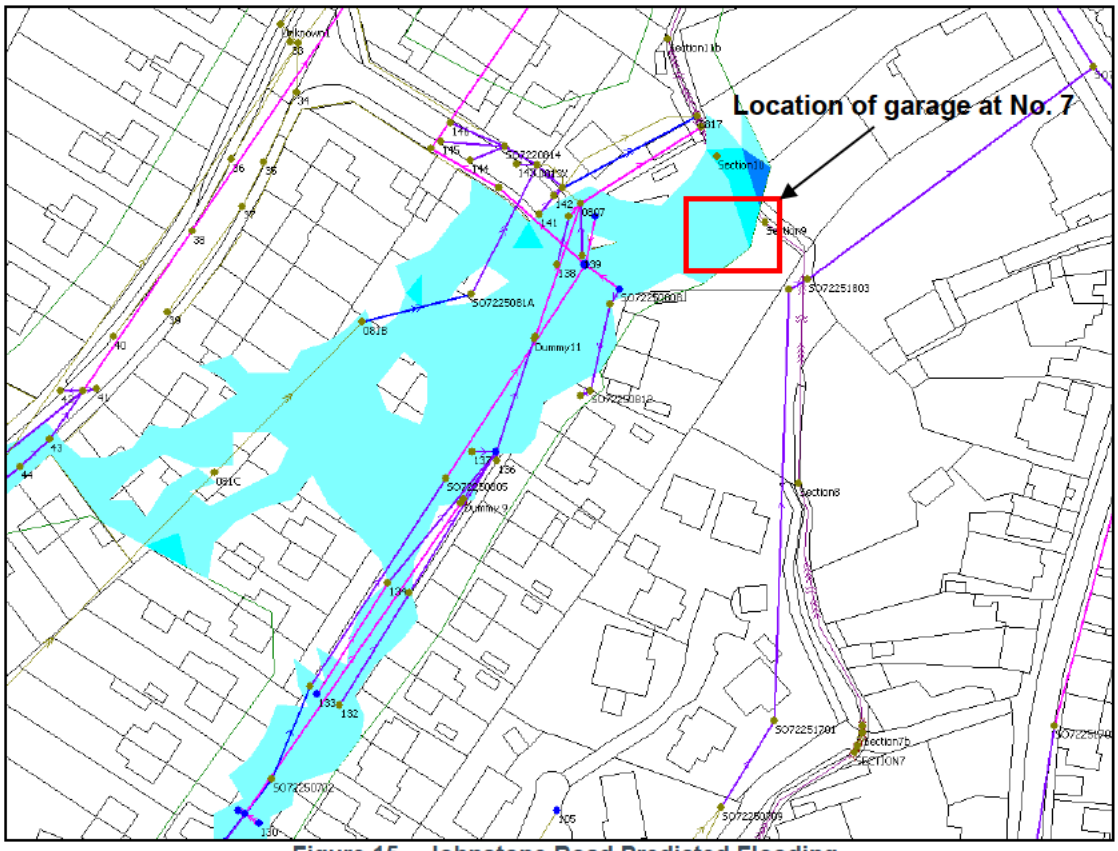

Figure 15 – Johnstone Road Predicted Flooding

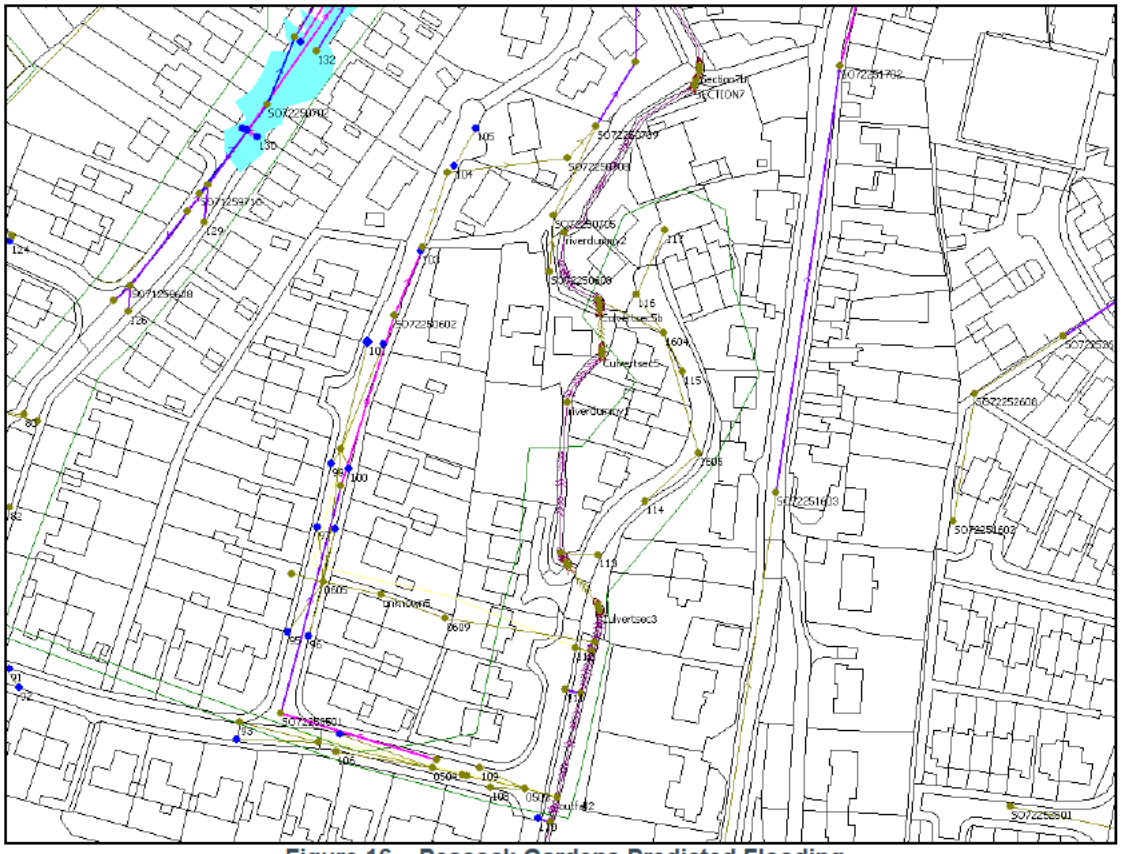

Figure 16 – Peacock Gardens Predicted Flooding

Figure 16 shows the extent of the model predicted flooding in the region of Peacock Gardens. It is clear that there is no flooding predicated from the surface water system in the area. The observed flooding in the area is likely to be from either insufficient number of highway gullies or poorly maintained existing road gullies. If this is the case neither would be identified as a source of flooding in the model. In addition to this there does not appear to be any flap valves on the outlets to Peacock Brook and as such the flow may back up the system thus reducing the capacity.

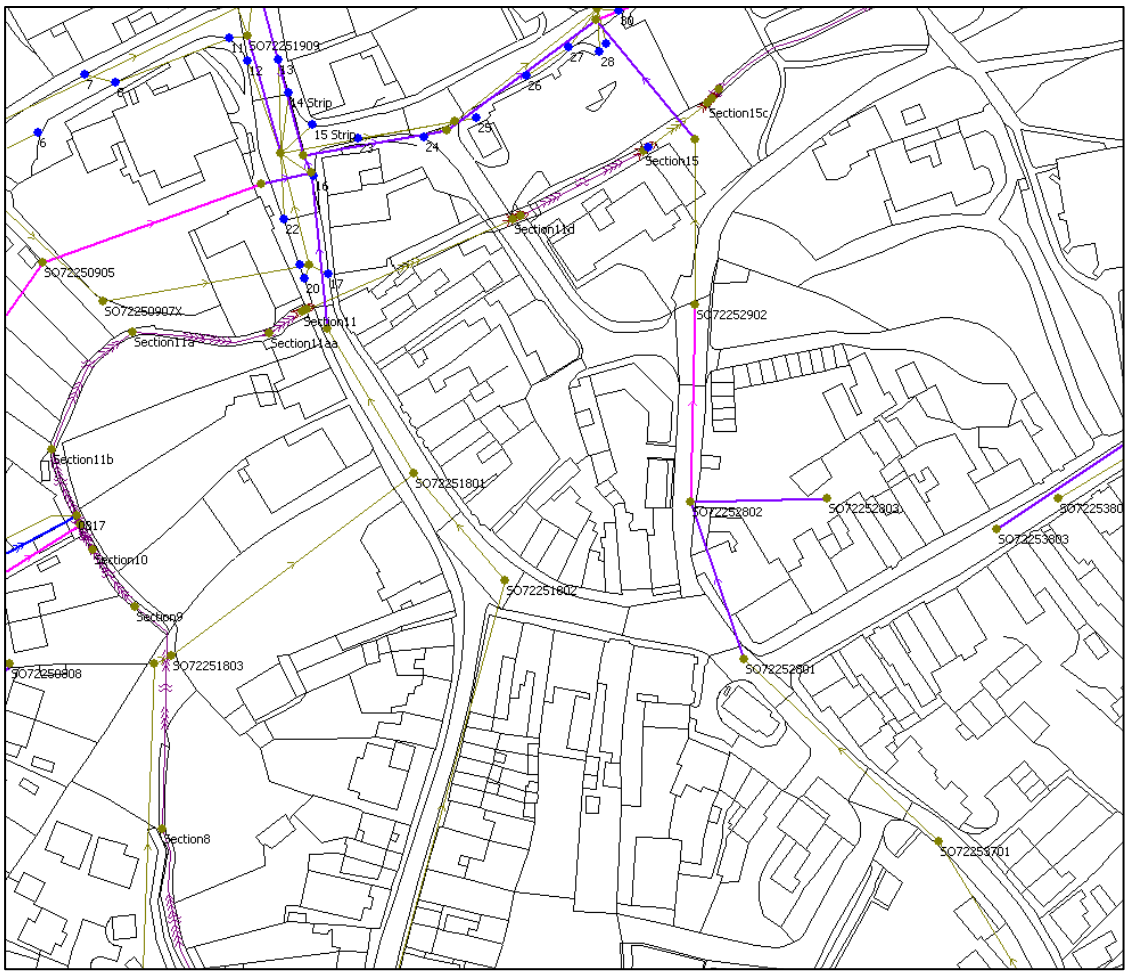

Figure 17– Town Centre Predicted Flooding

Figure 17 shows the town centre. No surface water flooding is predicted in the area. However, the observed flooding may be as a result of poorly maintained or insufficient number of gullies in the catchment, neither of which can be replicated in the model. The town centre is served by a combined sewerage system. These are no identified surface water sewers serving the town centre and the investigation of the combined system falls outside the brief of this study.

5.8 Model Changes during Calibration

The changes to the model for calibration purposes were limited to the altering of subcatchment contributing areas and changes made to the modelled serviceability issues. Subcatchment contributing areas were only adjusted slightly as the model was considered to be under predicting runoff. As such contributing areas were increased. In addition to this two subcatchments were included to represent the playing fields off Watery Lane. Reports from residents suggested that there was significant overland flow coming off the fields onto Watery Lane.

The CCTV survey identified a number of obstructions in the surface water system which were included in the model. The level at which these impact upon flows in the system can vary and as such is somewhat subjective. The modelled obstructions were changed slightly along Johnstone Road and Watery Lane which reduced the capacity of the system to induce flooding or reduce the predicts flooding in line with the observations made by local residents.

5.9 Level of Calibration Achieved

Due to the methods used to calibrate the Newent surface water model, the level of calibration was considered satisfactory. The model predicts the observed flooding to a suitable level in line with the pictures and reports from the local residents based upon a 30 year design event.

It is suggested that a flow survey be carried out in the catchment to further increase the confidence in the model.

5.10 Assumptions

- Gully Invert levels were estimated to be 500mm below ground level. If this created situations such as negative gradients, engineering judgement was used to interpolate revised values.
- The information about the connecting conduits between gullies was obtained from surveys, if this information was not available, a diameter of 150mm was assumed. If a pipe received flow from a number of gullies the pipe diameter was then interpolated as appropriate.
- There is no information on the sewerage records regarding the system upstream of manhole SO72250814 (a 640mm x 790mm brick sewer), only a picture taken from the manhole survey. It not known where this system originates or its purpose.

5.11 Recommendations

- We would recommend the installation of a number of flow monitors, river level gauges and rain gauges in the catchment to increase the level of confidence in the calibration. Whilst the model is considered calibrated and suitable for producing outline options it is not recommended that detailed design for any structures be based upon the results found in the report.
- Further investigation is required on the 640mm x 790mm system located upstream of manhole SO72250814. It could be a culverted part of the redundant Watery Lane Brook. If this system conveys substantial flows the model would require additional calibration and further improvement works may be required to the local surface water system located in Johnstone Road.

6. Hydraulic Analysis

6.1 Hydraulic Problems Identified

The hydraulic problems identified in this project are as follows:

- Overland flow from urban runoff.
- Flooding from surface water systems.
- Flooding from the urban watercourse

6.2 Hydraulic Analysis – Existing System

6.2.1 Flooding Analysis

Flooding analysis is undertaken to identify the duration of event which causes the most significant flood volumes within the surface water catchment. The critical duration in terms of flood water volumes is the 240 minute event for the 2 year return period while it is 480 minute for the 5 and 30 year events.

Figure 19 highlights total volume of flood water from the surface water system for different duration events and return periods.

Return Period (yrs)	Predicted Total Flood Volume (m^3) for Storm Duration					
	60min	120 min	180 min	240 min	480 min	720 min
2	59	68	69	70	61	50
5	163	167	197	300	472	365
30	989	1436	1828	2258	2952	2855

Figure 18 – Flooding Analysis

Flooding analysis was also undertaken for Peacocks Brook. This identified one area affected by flooding for a 100 year event. The car park opposite Chidley House on the north bank of Peacocks Brook is predicted to flood.

Quantifying the volume of flooding from a river is not as reliable using InfoWorks CS as quantifying that from a sewer system as rivers don't flood from one particular location but usually along a stretch of river bank. As such no flood volumes have been included for Peacocks Brook.

7. Catchment Needs

7.1 General

No known capital schemes have been undertaken in the catchment, some serviceability work has been carried out, although the exact location of this work is not known. The catchment structural, serviceability and hydraulic needs, sewers of poor condition or causing hydraulic restriction, are detailed in this section.

Where serviceability work has already been carried out by Gloucestershire Highways since this study was commissioned it has not been accounted for in this section (i.e. the lengths of sewers may have already been cleaned but they have still been identified for work in this section).

It is recommended that a complete list of all work undertaken in the catchment in the last 5 years is obtained from the highways authority so that any duplication of required works is not schedules or carried out.

7.2 Structural and Serviceability Needs

The CCTV footage revealed that the surface water system contained a number of structural and serviceability issues. These issues were graded from 1 to 5, 5 being the most severe. The definition for each grade is included in figure 20. Some of the issues were possible to incorporate into the model, such as sediment and blockages, however some of the more severe structural issue could not be modelled, for example deformation, and cracks.

Grade	Level
1	Occurrences without damage: for example joints. No defects were detected
2	Constructional deficiencies: for example wide joints. Rehabilitation can be scheduled long-term
3	Constructional deficiencies diminishing static, hydraulic and tightness: or example open joints Rehabilitation is necessary medium term with 3 to 5 years.
4	Constructional damages: for example pipe bursts. Rehabilitation procedure is urgent and has to be complete within 1 to 2 years. Necessity for emergency operations has to be examined
5	Pipe is already or will shortly be impermeable: for example collapsed pipe. Rehabilitation is urgent and short-term. In order to prevent further damage, necessary temporary spot repair has to be conducted on emergency level.

Figure 19 – Defect Grade Description

Typical serviceability issues in the Newent surface water system relate to root ingress and a build up of silt. Typical structural deficiencies in the system relate to; holes, poor connections and cracks. Figure 21 details the more severe structural and serviceability issues, listing only those graded as three to five. Those lengths of surface water sewer requiring maintenance or replacement/relining have been identified in the drawings listed in the Appendices B to M.

Manhole Reference	Grade	Pipe Lengths (m)	Fault
SO71259802 – SO71259701	5	26.5	3 grade 5 mass roots and debris ranging from 15% to 25% cross sectional area lost.
SO71259701 – SO71258706	3, 5	18.9	1 grade 5 mass roots with an 85% cross sectional area loss, 2 grade 3 circumferential and longitudinal fractures.
SO71258706 – SO71258705	5	55.3	5 grade 5 sections with mass moots ranging from cross sectional area losses of 25% to 35%.
SO71258705 – SO71258603	5, 4, 3	36.8	1 grade 5 root mass with a cross sectional area lost of 20%, 2 grade 4 defective connections, 1 grade 3 with tap roots at joint.
SO72251906 – SO72251907	4	40.5	3 grade 4 defective connections.
SO72251906 – SO72252903	4	22.9	1 grade 4 defective connection, survey abandoned due to debris.
SO72252903 – SO72252903	4	19.7	2 grade 4 defective connections.
SO72252903 – SO72262004	4	67	1 grade 4 defective connection, survey abandoned due to debris.
SO71257502 – SO71257503	3	77.3	4 grade 3 longitudinal fractures.
SO71258606 – SO71258610	4	38.5	1 grade 4 defective connection.
SO71258606 – SO7125860A	3	6.8	3 grade 3 longitudinal fractures.
SO71259703 – SO7125970A	4	23.6	1 grade 4 defective connection - 200mm intrusion.
SO71259710 – SO71250806	5	1.8	Survey abandoned due too much debris.
SO71250806 – SO71259710	5	11.3	Survey abandoned due too much debris.
SO71250806 – SO71250807	4,5	24.6	1 grade 4 defective connection, 1 grade 5 mass roots with 50% area loss - survey abandoned.
SO71250807 – SO71250806	5	7.3	Survey abandoned due too much debris.
SO71250807 – SO71250807A	4	34	2 grade 4 'encrustation at joint' with a 20% area loss.
SO71250807A – SO72250813	4	27.7	1 grade 4 hole in sewer at 5 o'clock.
081B – 081C	4	43.3	1 grade 4 hole in sewer at 12 o'clock.
SO7125703 – SO71257621	3, 4, 5	31.2	1 grade 3 tap roots at joint, 1 grade 4 defective connection, survey abandoned due to obstruction.
SO71257609 – SO71258603	4	27.5	1 grade 4 defective connection 100mm intrusion.
SO71250504 – Unknown6	4, 5	30.7	1 grade 4 broken sewer from 7 – 11 o'clock, 1 grade 5 deformed sewer.
SO72250906 – SO72250820	3,4,5	94.3	2 grade 3 tap roots at joints, 1 grade 4 defective connection 25mm intrusion, 3 grade 5 mass roots ranging from 20% to 25% cross sectional area lost.
SO72250906 – SO72550907	5	47.3	1 grade 5 mass roots at joint - 25% cross section area loss.
SO72251908 – SO7220907	4	48.9	1 grade 4 defective connection 100mm intrusion.
Unknown – SO72250909	5	28.9	Survey abandoned due to structural damage.
Unknown – SO72250609	3	27.4	1 grade 3 circumferential fractures from 04 – 09 o'clock.
SO72251604 – Outfall	5	3.8	Survey abandoned due to debris.
SO72251605 – SO72251604	5	12.9	Survey abandoned due to debris.

Figure 20 – Structural and Serviceability Grades

7.3 Hydraulic Needs

7.3.1 General

The locations listed below cover the areas known to flood within the catchment; Watery Lane, Johnstone Road, Peacocks Gardens and the Town Centre. The model was run using design rainfall with a 1 in 1 and a 1 in 5 year probability. The Design Manual for Roads and Bridges (DMRB) states that there should be no surcharge in the surface water system for a 1 in 1 event of critical duration while there should be no out of sewer flooding for a 1 in 5 year event of critical duration.

The capacity of the Peacock Brook was also assessed for 100 year return period events of different durations. It is the level of standard that the Environment Agency work to for their main water courses.

The impacts of climate change have also been assessed by increasing the intensity of the storms by 20%.

7.3.2 Watery Lane

Flooding occurs at manhole SO71257503 on Watery Lane (southern end) for a 5 year event. The cause of the flooding can be attributed to the partial blockages located between manholes SO71257503 and SO71257621 which cause a hydraulic restriction. Flooding occurs at gullies 51 and 52 on Watery Lane (northern) for a five year event. The cause of the flooding can be attributed to the major blockages located between manholes SO71258705 and SO71257621 which cause a hydraulic restriction resulting in the system surcharging.

Flooding is also predicted in Akermans Orchard (located off Watery Lane), at manhole SO71257701. This sewer will require surveying to confirm actual pipe diameter (currently interpolated as 150mm diameter), however as it stands it currently does not have the capacity to convey flows to the main sewer in Watery Lane.

The sewers in Watery Lane are in a poor condition, significant blockages and debris were noted along the whole length of Watery Lane.

There are a number of areas that could benefit from additional gullies to receive runoff either from a particular area or prior to flooding a particular area. These are:

- The car park entrance to the Recreation Ground – to collect overland flow off the grounds.
- The footpath exit from the Recreation Ground (adjacent to West Meade) – to collect overland flow off the grounds.
- The entrance to Wheatstone House.
- On the southern side of Watery Lane in front of properties No.'s 118 – 113.

These have been mentioned based upon observation made by local residents and by looking at the flood paths identified during the modelling.

7.3.3 Johnstone Road

Flooding occurs at manhole SO72250806 on Johnstone Road for a five year event. The cause of the flooding can be attributed to the major blockages located between manholes SO72250806 and SO72250807 which cause a hydraulic restriction. There are also partial blockages located between manholes SO71259711 and SO72250806 which further adds to the hydraulic restriction.

The sewers in Johnston Road are in a poor condition, significant blockages and debris were noted along the whole length of Johnston Road.

7.3.4 Town Centre

The model does not predict flooding in the town centre for a 1 in 5 year event. There is no surface water system located in the town centre and as such all highway drainage is connected to the public combined sewerage system. Observed flooding may be resulting from poorly maintained gullies.

7.3.5 Peacocks Gardens

The model does not predict flooding in Peacocks Gardens for a 1 in 5 year event. The surface water system is in a poor condition and it is thought that observed flooding may be as a result of poorly maintained gullies.

7.3.6 Peacocks Brook

An assessment of flooding has been made for Peacocks Brook for a 100 year return period event of critical duration. The brook has insufficient capacity to cope with a 100 year design event at one point. The general capacity of the brook is considered to have adequate capacity. The stretch of brook to the south of the car park located opposite Chidley House off the High Street is predicted to flood the car park.

The predicted flooding for a 100 year event exceeds the channel capacity and spills out onto the carpark before flowing towards Newent Lake. The flooding could be exacerbated by any gullies draining the car park directly to the watercourse. The presence and location of any such gullies is not known at this stage.

General observations of the watercourse suggest that it could do with some channel maintenance. The removal of overhanging branches and vegetation from the channel would increase its conveyance capacity as would the removal of non-transient silt build up. Discussions with local residents also suggested that there were significant partial blockages of some culverted sections (large branches etc). These have not been modelled as their location is not known but will impact upon the flooding in the catchment.

The channel capacity has not been modelled beyond where it runs adjacent to Newent Lake as this was considered to be out of the scope of the study area.

7.4 Summary of Needs

7.4.1 General

The whole system requires the gullies and the surface water sewers to be cleaned and a schedule of maintenance to be implemented to ensure the systems conveys the flows more efficiently downstream.

7.4.2 Watery Lane

The system located in Watery Lane requires jetting to ensure the mass roots (up to 85%), large concrete obstructions and debris are removed from the system in order for the flows to be conveyed more efficiently down to Newent Lake. There is one section requiring replacement due to collapse and several structural recommendations regarding future replacement, relining and repairing. The catchment along Watery Lane could benefit from additional gullies. Existing gullies require cleaning.

7.4.3 Johnstone Road

The system located in Johnstone Road requires jetting to remove obstructions (brick), debris and roots to ensure the system conveys the flows more efficiently to Peacocks Brook. The 675mm system located between Watery Lane and Johnstone Road requires some replacement or relining due to holes. Gullies require cleaning.

7.4.4 Peacocks Gardens

The system located in Peacocks Gardens (starting at Craddock Road, Brookside) requires jetting to remove the heavy debris located within the three systems to ensure the system conveys the flows more efficiently down to the outfalls located on Peacocks Brook. There is also one fracture which requires repairing/replacing. Gullies require cleaning.

7.4.5 Peacocks Brook

Peacock Brooks requires removal of debris, bush/tree intrusion and heavy non-transient silt along the whole length, in particular the culvert section 15 losing approximately 25mm of the culvert height to heavy silt build up.

Pictures showing the extent of the silt build up highlighted in Appendix K.

The location of any gullies draining the car park opposite Chidley House should be confirmed and their discharge point noted. If any discharge directly to Peacocks Brook then these will increase the amount of flooding this occurs in this car park.

8. Outline Option Requirements

8.1 General

The outline option development for Newent is based upon highway flooding guidance of no surcharge for a 1 in 1 year event and no out of sewer flooding for a 1 in 5year event. The capacity of peacocks brook has been assessed based upon a 1 in 100 year event.

An assessment of climate change has been made on the catchment by increasing the rainfall intensity by 20% in line with standard procedures. The work required below is considered adequate to cope with the additional impact of climate change.

8.2 Line of sewer along Watery Lane through to Newent Lake

Outlined below are the key restrictions in the system which requires removal or replacement:

- SO71250806 - SO71250807: (150) sewer does not have adequate capacity requires upsize to 225mm diameter (approximately 67m upsize required at an average depth of 1.37m).
- SO71257609 – SO71258603: (225mm diameter) roots, silt and debris build up requires removal.
- SO71258603 – SO71258705: (450mm diameter) mass roots, encrustation, silt and debris build up requires removal.
- SO71258705 - SO71258705: (450mm diameter) significant mass roots, silt and debris build up requires removal. (May require relining).
- SO71258705 - SO71258701: (450mm diameter) significant mass roots (85% partial blockage), silt and debris build up requires removal. (May require relining).
- SO71258701 – SO71259802: (450mm diameter) significant mass roots, silt and debris build up requires removal.
- SO71259802 - SO71250820: (450mm diameter) silt and debris build up requires removal.
- SO721250909 – Unknown MH ref. outside No.2 Watery Lane: (450mm diameter) complete blockage 2m d/s of manhole SO721250909. New manhole and approximately 2m of new 450mm diameter sewer required.
- Unknown MH ref. outside No.2 Watery Lane - Unknown MH ref. outside No.7 Watery Lane: (450mm diameter) silt and debris build up requires removal.
- Unknown MH ref. outside No.7 Watery Lane – SO72250820: (450mm diameter) silt and debris build up requires removal.
- SO72250820 – SO72250906: (450mm diameter) mass roots, silt and debris build up requires removal.
- SO72250906 - SO72250907: (450mm diameter) mass roots, silt and debris build up requires removal.
- SO72250907 – SO72251908: (675mm diameter) silt and debris build up requires removal.
- SO72251908 - SO72251907: (675mm diameter) silt and debris build up requires removal.
- SO72251909 - SO72251907: (300mm diameter) silt and debris build up requires removal.
- SO72251907 - SO72251906: (675mm diameter) silt and debris build up requires removal.
- SO72251906 - SO72252903: (675mm diameter) silt and debris build up requires removal.

- SO72252903 – SO72262004: (675mm diameter) silt and debris build up requires removal.
- SO72262004 – SO72263003 (outfall to Newent Lake): (675mm diameter) silt and debris build up requires removal.

The structural and serviceability issues which require addressing have been highlighted in Drawings 5075404-DWG-38 Appendix A, 5075404-DWG-39 Appendix B, 5075404-DWG-40 Appendix C, 5075404-DWG-41 Appendix D.

The following structural recommendations have been highlighted for replacement/relining/repair as they may be subject to future collapse or increasing headloss due to defective connections. However, they are not thought to have a significant impact in the short term (i.e. the next 5 years):

- SO71257609 – SO71258603: (225mm diameter) defective connections intruding 1m u/s of manhole SO71258603. It is recommended that work is carried out to improve this defective connection point.
- SO71258603 – SO71258705: (450mm diameter) two defective connections 13.5m and 30m u/s of SO71258705. It is recommended that work is carried out to improve these defective connection points.
- SO71258705 - SO71258701: (450mm diameter) circumferential and longitudinal fractures. It is recommended that this is replaced or relined in the same diameter.
- SO72250820 – SO72250906: (450mm diameter) defective connections intruding 38m u/s of manhole SO72250906. It is recommended that work is carried out to improve this defective connection point.
- SO72250907 – SO72251908: (675mm diameter) defective connections intruding 15m u/s of manhole SO72251908. It is recommended that work is carried out to improve this defective connection point.
- SO72251907 - SO72251906: (675mm diameter) three defective connections 4m, 14m and 33m u/s of SO72251907. It is recommended that work is carried out to improve these defective connection points.
- SO72251906 - SO72252903: (675mm diameter) two defective connections intruding 23m and 35 d/s of manhole SO72251906. It is recommended that work is carried out to improve these defective connection points.
- SO72252903 – SO72262004: (675mm diameter) defective connections intruding 4m u/s of manhole SO72252903. It is recommended that work is carried out to improve this defective connection point.

The highways gullies located along Watery Lane should be cleaned and a regular maintenance schedule put in place to prevent any further build up of silt and debris in both the gullies and the surface water sewers.

The surface water sewers long Watery Lane are considered to have adequate capacity to retain follows for a 1 in 5 year event. However, it was noted at a number of locations there appeared to be insufficient highway drainage gullies to capture overland flow. It is recommended that additional gullies are located at the following locations:

- The car park entrance to the Recreation Ground – to collect overland flow off the grounds.
- The footpath exit from the Recreation Ground (adjacent to West Meade) – to collect overland flow off the grounds.
- The entrance to Wheatstone House.
- On the southern side of Watery Lane in front of properties No.s 118 – 113.

The exact location and number of gullies is to be confirmed during detailed design. They should connect to the surface water system.

The location of the additional gully requirements can be seen in 5075404-DWG-39 shown in Appendix B.

8.3 Line of sewer from southern end of Watery Lane through to Johnstone Road

Outlined below are the key restrictions in the system which requires removal or replacement:

- SO71257502 – SO71257503: (450mm diameter) up to 10% in cross-sectional area is lost to debris, fine roots and encrustation. These partial blockages require removal.
- SO71257503 – SO71257621: (450mm diameter) lump of concrete requires removal in the system due to the defective connection listed below. Silt and debris build up requires removal.
- SO71257621 – SO71258610: (450mm diameter) silt and debris build up requires removal.
- SO71257503 – SO71258606: (450mm diameter) silt and debris build up requires removal.
- SO71257607 – SO71257608: (300mm diameter) silt and debris build up requires removal.
- SO7125860A - SO7125860B: (675mm diameter) silt and debris build up requires removal.
- SO7125860B - SO71259703: (675mm diameter) silt and debris build up requires removal.
- SO71259703 – SO7125970A: (675mm diameter) silt and debris build up requires removal.
- SO7125970A - SO7125970B: (675mm diameter) silt and debris build up requires removal.
- SO7125970B – SO7125081C: (675mm diameter) silt and debris build up requires removal.
- SO7125081C – SO7125081B: (675mm diameter) hole in sewer 25m u/s of manhole SO7125081B. This hole requires fixing as it allow excess infiltration into the network and is structurally unsound and may collapse in the future.
- SO7125081B - SO7125081A: (675mm diameter) silt and debris build up requires removal.
- SO7125081A – SO71250813: (675mm diameter) hole in sewer 10m u/s of manhole SO71250813. This hole requires fixing as it allows excess infiltration into the network and is structurally unsound and may collapse in the future.

The structural and serviceability issues which require addressing have been highlighted in Drawings 5075404-DWG-38 Appendix A, 5075404-DWG-39 Appendix B, 5075404-DWG-40 Appendix C, 5075404-DWG-41 Appendix D.

The following structural recommendations have been highlighted for replacement/relining/repair as they may be subject to future collapse or increasing headloss due to defective connections. However, they are not thought to have a significant impact in the short term (i.e. the next 5 years):

- SO71257502 – SO71257503: (450mm diameter) this length of sewer has longitudinal factures (grade 3) and it is suggested that this is replaced or relined in the same diameter. (it has also been highlighted for silt/debris removal).
- SO71257503 – SO71257621: (450mm diameter) defective connection 31m d/s of manhole SO71257503. It is recommended that work is carried out to improve this defective connection point.
- SO71257621 – SO71258610: (450mm diameter) defective connections intruding 14m u/s of manhole SO71258610. It is recommended that work is carried out to improve this defective connection point.
- SO71257503X – SO71258606: (450mm diameter) defective connections intruding 3m d/s of manhole SO71258610. It is recommended that work is carried out to improve this defective connection point.
- SO51258606 – SO7125860A: (675mm diameter) this length has longitudinal fractures. It is recommended that this is replaced or relined in the same diameter.
- SO71259703 – SO7125970A: (675mm diameter) defective connections intruding 6.6m d/s of manhole SO71259703. It is recommended that work is carried out to improve this defective connection point.

The highways gullies located along the southerly end of Watery lane should be cleaned and a regular maintenance schedule put in place to prevent any further build up of silt and debris in both the gullies and the surface water sewers.

It is also recommended that a new silt trap be constructed at the transition between the Watery Lane Drainage Ditch and the surface water sewer which conveys flows to Peacocks Brook. The location of the proposed silt trap can be seen on Drawing 5075404-DWG-38 in Appendix A.

8.4 Johnstone Road

Outlined below are the key restrictions in the system which requires removal or replacement:

- SO71259602 – Unknown MH ref. outside No.32 Johnstone Road: (225mm) silt and debris build up requires removal.
- Unknown MH ref. outside No.32 Johnstone Road - SO712599711: (225mm) silt and debris build up requires removal.
- SO712599711 – SO71250806: (225mm) silt and debris build up requires removal along with large cement obstruction.
- SO71250806 - SO71250807: (225) significant mass roots (45% partial blockage), silt and debris build up requires removal..
- SO72250807 – SO7220187 (outfall to Peacocks Brook): (225mm diameter) silt, encrustation and debris build up requires removal. Outfall requires new flap valve to stop river ingress into the system.
- Unknown MH ref. Outside No. 3 Johnstone Road - SO7220187 (outfall to Peacocks Brook): (600mm and 225mm) silt, encrustation and debris build up requires removal. Outfalls require new flap valves to stop river ingress into the system.
- SO7220813 - Unknown MH ref. Outside No. 3 Johnstone Road: (600mm and 300mm diameter) silt and debris build up requires removal.

The three outfalls in the same headwall SO7220817 (225mm, 225mm and 600mm) located to the rear of No. 3 Johnstone Road require flap valves to be retrofitted as described above. It is recommended a site visit to identify if a new headwall is required.

The highways gullies located along Johnstone Road should be cleaned and a regular maintenance schedule put in place to prevent any further build up of silt and debris in both the gullies and the surface water sewers.

It is recommended that further investigation is done into the 640x790mm arch incoming pipe into manhole SO72250814, the upstream system from this point is not known and should be clarified.

The structural and serviceability issues which require addressing have been highlighted in Drawings 5075404-DWG- 42 Appendix F and 5075404-DWG-43 Appendix G.

The location of the flap valve retrofits can be seen in Drawing 5075404-DWG-43 shown in Appendix G.

8.5 Peacock Gardens

Outlined below are the key restrictions in the system which requires removal or replacement:

- Unknown MH ref. outside No.10 Craddock Road – SO72250504: (225mm diameter) this section of sewer is broken 21.5m u/s of SO72250504 and requires replacing/repairing.
- Unknown MH ref. outside No.11 Brookside – SO72250605: (225mm diameter) silt and debris build up requires removal.
- SO72251605 - SO72251604: (225mm diameter) silt and debris build up requires removal.
- SO72251604 – Outfall: (225mm diameter) silt and debris build up requires removal.

The structural and serviceability issues which require addressing have been highlighted in Drawing 5075404-DWG-44 Appendix I.

The following structural recommendations have been highlighted for replacement/relining/repair as they may be subject to future collapse or increasing headloss due to defective connections. However, they are not thought to have a significant impact in the short term (i.e. the next 5 years):

- Unknown MH ref. in garden of No.6 Brookside – SO72250609: (225mm diameter) this length of sewer has circumferential factures (grade 3) and it is suggested that this is replaced or relined in the same diameter.

It is recommended that all the surface water sewers around Peacock Gardens are cleaned to remove all the silt and debris. All gullies require cleaning to remove the build up of silt.

The structural and serviceability issues which require addressing have been highlighted in Drawing 5075404-DWG-44 Appendix I.

It is recommended that all outfalls from surface water sewers and gullies to Peacocks Brook have flap valves retrofitted to prevent the brook backing up the system and potentially causing flooding. The location of the flap valve retrofits can be seen in Drawing 5075404-DWG-44 shown in Appendix I.

8.6 Town Centre

The model does not predict surface water flooding in the town centre. The drainage records highlight that the town centre is served by a combined sewerage system. It is suggested that the most likely cause of flooding in the town centre is from poorly maintained gullies, as such all gullies in the town centre should be cleaned and a suitable schedule of maintenance set up to prevent further blockage.

8.7 Peacock Brook

Flooding for a 100 year event is predicted for Peacocks Brook between the Museum and the car park opposite Chidley House. There is a large amount of silt build up through the culvert which reduces its capacity.

Outlined below are the key restrictions in the system which requires removal or replacement:

- Culvert Section 15 – Culvert Section 15D between the north east of the Museum and the car park opposite Chidley House. (2100mm x 1100mm box culvert) this section of culvert requires removal of heavy silt build up.
- The entire urbanised stretch of watercourse should be maintained to a higher standard. Vegetation and the heavy build up of non-transient silt should be removed which will increase the conveyance capacity of the channel.
- All significant partial blockages in culverted sections should be removed.

The location of any gullies draining the car park opposite Chidley House should be confirmed and their discharge point noted. If any gullies discharge directly to Peacocks Brook from the car park then it is recommended that these be fitted with flap valves to stop the flow in the brook backing up into the system.

The specific serviceability issues which require addressing have been highlighted in Drawing 5075404-DWG-45 Appendix L.

9. Mitigation Measures

9.1 Raising Awareness

Local residents should be informed that the level of protection for highway flooding is to resolve out of sewer flooding for a 1 in 5 year event. The flooding experienced in the summer of 2007 was much more significant than this and as such it is not reasonable to expect the FoDDC or Gloucestershire Highways to resolve flooding for such severe events. The outline options suggested in the report meet the requirements of The Design Manual for Roads and Bridges (DMRB).

The use of sandbags provided free of charge by the Forest of Dean District Council should be used in times of extreme rainfall to direct flows along the highway to an area where there is available capacity.

9.2 Individual Property Protection

It is recommended that individual properties owners become aware of the extra measures they can go to help mitigate or stop the flooding of their properties for the more severe events.

9.3 Environment Agency Floodline

It is recommended that all residents that fall within the flood plain of Peacock Brook or other historically known flooding locations sign up to the Environment Agency Floodline which can give an early warning to future flooding events.

9.4 Maintenance schedule

It is recommended that the Gloucestershire Highways Authority in conjunction with the FoDDC set up a suitable maintenance schedule for the catchment to prevent further build up of silt, debris and root masses.

10. Conclusions & Recommendations

10.1 Conclusions

The surface water model for Newent has been calibrated against a 30 year design event, which it has been assumed to have occurred during the summer 2007. The level of calibration achieved is considered suitable for assessing the hydraulic conditions of the system.

Overland flow paths have been well replicated along Watery Lane and Johnstone Road. No flooding has been predicted for the Town Centre which is served by a public combined sewerage system and is outside the scope of this investigation. No flooding for Peacocks Garden was predicted. It thought that poor gully condition could be contributing to the impacts of flooding in these locations which cannot be replicated by modelling techniques.

The surface water systems located within Watery Lane, Johnstone Road and Peacock Gardens are in a poor operational state which leads to backing up/flooding within these areas. Overland flow conveys flood waters to other parts of the catchment.

The options outlined in this report and the mitigation measures that could be put in place would afford the Highways Authority and residents of Newent a much improved level of service from the system and thus better protection.

10.2 Modelling Limitations

It should be noted that a hydraulic model is only as accurate as the data used to build it. The InfoWorks model for Newent provides a good representation of flooding observed in the Newent catchment despite the lack of suitable gauged flow or rainfall data. Assumptions have been made to the return period of the event which caused the flooding photographed during the summer of 2007. As such it is recommended that further survey work is undertaken to confirm the modelling already undertaken and improve the level of confidence in the model

10.3 Recommendations

It is recommended that the outline options identified in this report be progressed so that the level of protection to the highways and local residents in Newent can be increased and brought into line with the current drainage standards.

A short term flow survey consisting of flow monitors, river gauges and rain gauges would add significant confidence to the model. It is not recommended that the model be used to design large capital schemes unless a flow survey is undertaken. In addition to this it is recommended that additional topographical survey work is undertaken at key locations in the catchment prior to undertaking design work.

Those residents who have previously been flooded and those which have properties in the Peacocks Brook floodplain should sign up to the Environment Agencies Floodline as an early warning measure.

It is important to raise awareness with the local residents of the level of service that highway drainage provides. They should be made aware that the Highways Authority and FODDC are not to be expected to resolve flooding from highways drains for more severe events. They should also be invited to look into their own individual property protection.

It is recommended that the schedule of works undertaken in the last 2 years is obtained from the highways Authority and that those areas identified for works are not duplicated (depending upon dates of maintenance and CCTV). In general a comprehensive schedule of maintenance should be set up and adhered to so that future build up of silt and root masses does not occur.

It is recommended that further investigation is done into the 640x790mm arch incoming pipe into manhole SO72250814, the upstream system from this point is not known and should be clarified.

Appendix A

A.1 Watery Lane Options (Section 1)

Appendix B

B.1 Watery Lane Options (Section 2)

Appendix C

C.1 Watery Lane Options (Section 3)

Appendix D

D.1 Watery Lane Options (Section 4)

Appendix E

E.1 Watery Lane Gully Maintenance

Appendix F

F.1 Johnstone Road Options (Section 1)

Appendix G

G.1 Johnstone Road Options (Section 2)

Appendix H

H.1 Johnstone Road Gully Maintenance

Appendix I

I.1 Peacock Gardens Options (Section 1)

Appendix J

J.1 Peacock Gardens Gully Maintenance

Appendix K

K.1 Peacock Brook

Appendix L

L.1 Peacock Brook Maintenance

Appendix M

M.1 Catchment plan

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