Caterham-on-the-Hill
Surface Water Management Study
Surrey County Council

April 2016

ATKINS

Plan Design Enable

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Glossary

AEP	Annual Exceedance Probability
BGS	British Geological Survey
CPI	Consumer Price Index
FRA	Flood Risk Assessment
FEH	Flood Estimation Handbook
IMD	Index of Multiple Depravation
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
mAOD	Metres Above Ordnance Datum
MCM	Multi-Coloured Manual
NRD	National Receptor Database
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PV	Present Value
SCC	Surrey County Council
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SWMP	Surface Water Management Plan
SuDS	Sustainable Drainage System
uFMfSW	Updated Flood Map for Surface Water
WAAD	Weighted Annual Average Damages

1. Introduction

1.1. Project Scope

Atkins has been commissioned by Surrey County Council to undertake an assessment to investigate surface water flooding in Caterham-on-the-Hill and to develop conceptual designs for options which would improve drainage asset performance and reduce flood risk. The following tasks have been undertaken as part of the assessment:

1. **Drainage Asset Data review and scoping**
   The availability of data relevant to drainage assets in Caterham-on-the-Hill was checked and reviewed. This enabled identification of gaps in information and hence helped determine the scope for additional survey work.

2. **Highway drainage survey**
   Three scopes of works for surveying the highway drainage system were produced including:
   - Survey of the "Money Pit" to assess dimensions, connectivity and condition;
   - Condition survey of the Coulsdon Common soakaway; and
   - CCTV survey of specific lengths of the main storm drain.

   These surveys were commissioned as part of this project and a review of the survey results is provided in this report.

3. **Flood risk review and economic appraisal**
   The availability of data relevant to flood risk in Caterham-on-the-Hill has been checked and reviewed. This included a review of both the historical and anecdotal flooding evidence and the modelled data. The flood economics tool Flood DamaGIS was used to make a baseline assessment of flood damages using the Environment Agency Updated Flood Map for Surface Water (uFMfSW) and the weighted annual average damages approach.

4. **Conceptual option development**
   Conceptual options for flood alleviation and drainage asset performance in Caterham-on-the-Hill have been developed using data obtained during the review, high level constraint information and common sense design principles.

1.2. Data Sources

To inform this study, data and information have been obtained from the following sources:

- Information obtained from Surrey County Council including:
  - Light Detection and Ranging (LiDAR) data at a 1m resolution;
  - SCC Master Property Flooding Database;
  - SCC Wetspots Database;
  - City of London incident reports for flooding of Stites Hill Road and Coulsdon Common;
  - Environment Agency Updated Flood Map for Surface Water (uFMfSW)
  - National Receptor Database (NRD);
  - Ordnance Survey (OS) Master Map;
  - SCC's drainage asset GIS layers;
  - CCTV survey of SCC's storm drain (AB Pipeline Services Limited, March 2013);
  - Money Pit inspection (SCC, 1992)
  - Additional survey data commissioned as part of this study (Dene-Tech Services Limited May 2015 - see Section 2.3);
  - SCC gully cleaning records; and
  - Thames Water sewer network GIS layers (available for review as part of the study but cannot be published).

- Publically available information including:
  - Environment Agency Website;
  - British Geological Survey (BGS) website; and

- The Cranfield Soil and Agrifood Institute Soilscapes website.

- A site visit to Caterham-on-the-Hill undertaken on the 27th October 2014 with staff from Atkins and Surrey County Council.

1.3. Catchment Description

Caterham-on-the-Hill is located in Surrey, between Croydon to the North and the M25 to the south. There are no surface watercourses (either main rivers, ordinary watercourses or drainage ditches) within the study area as defined in Figure 1-1. There is however one main surface water flow path and the study area boundaries are based on the topographic catchment of this flow path. The catchment is 1.2km^2 in area, with further details of the drainage system given in Section 2.

Caterham-on-the-Hill is a predominantly residential area with some shops and businesses along the High Street and the Westway. There are five main areas of open space, namely Queens Park recreation ground, Hillcroft Primary School playing field, Westway Common, Town End recreation ground and Coulsdon Common.

There are large areas of recent development to the west of Coulsdon Road. These are served by a Thames Water surface water system that includes pipes, gullies, soakaways and a storm wetland, draining water in a westerly direction away from the study area. Runoff from these developments does not drain towards the main surface water flow path through Caterham-on-the-Hill; the area is thus excluded from this study.

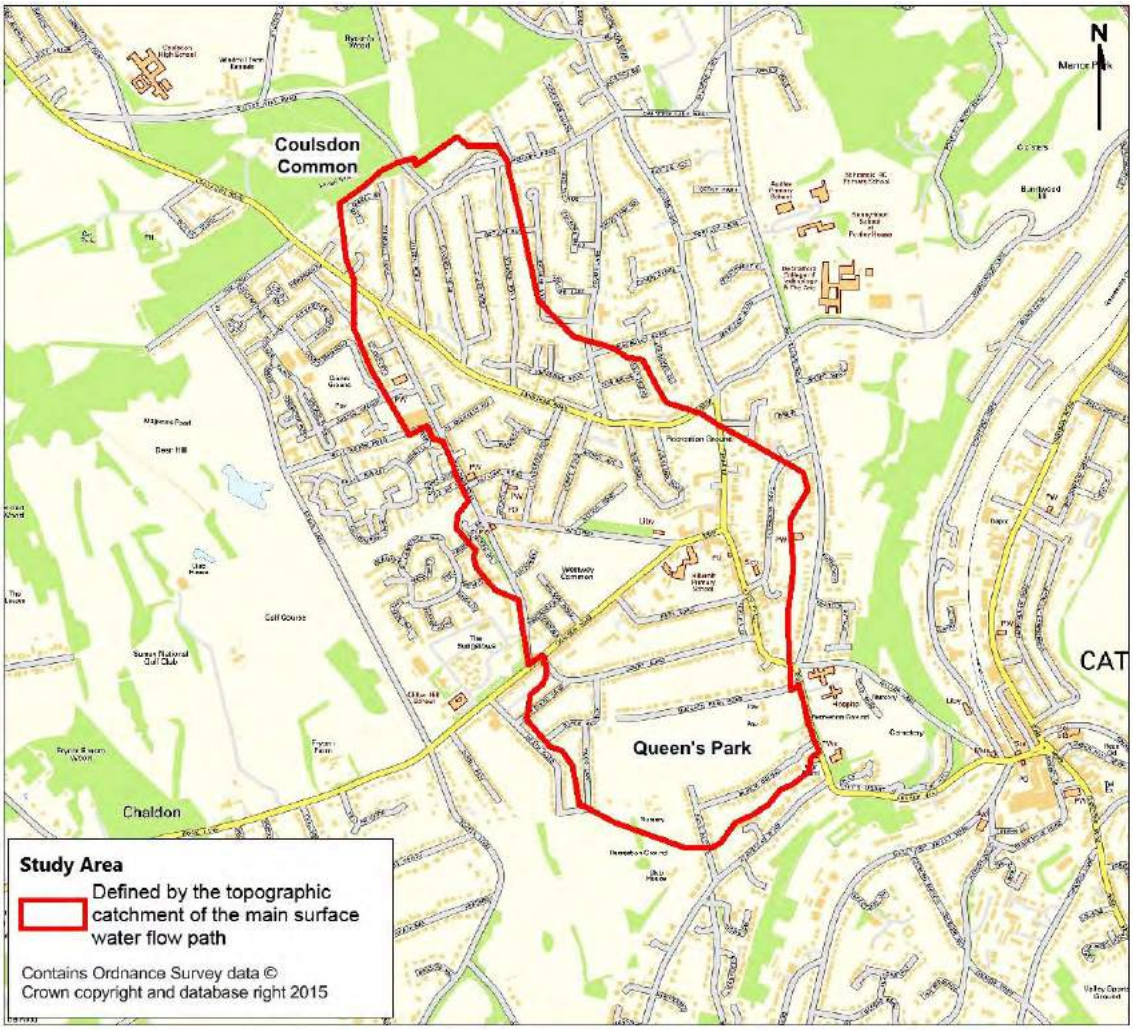


Figure 1-1 Study area location

Light Detection and Ranging (LiDAR) data has been obtained for the Caterham-on-the-Hill catchment. It is evident that the catchment is small and relatively steep sided with gradients in the range of 1 in 50, sloping northwards towards Coulsdon Common. Within the catchment, levels range from a maximum 196mAOD and a minimum of 152mAOD.

The underlying geology of the site is the Lewes Nodular Chalk Formation, overlain with superficial deposits of clay, silt , sand and gravel (British Geological Survey (BGS), 2015). The chalk is a 'principal' aquifer, with a high permeability and capable of providing a high level of water storage. The superficial deposits are defined as a 'Secondary A' aquifer; permeable layers that are capable in supporting water supplies at a local rather than regional scale. The whole of the study area is located within a Groundwater Source Protection Outer Zone (Environment Agency maps, 2015). The soils of the catchment are recorded as being "slightly acid loamy and clayey soils with impeded drainage" (Soilscapes, Cranfield Soil and Agrifood Institute, 2015).

2. Drainage System

2.1. Review of Existing Information

2.1.1. Thames Water Assets

Caterham-on-the-Hill is served by two separate sewer systems, one that conveys the foul flow and another that conveys the surface water flow. There are no combined sewer systems within the area. Both the foul and surface water sewers generally drain northwards, following the decline in the topography.

2.1.2. SCC Assets

Asset Database

Provided within the SCC asset database are drainage gullies, catchpits, covers, manholes, soakaways and surface water drains. One storm drain is shown within the database, which is also the main surface water drain in Caterham-on-the-Hill. Generally only location information is provided with the assets, information such as pipe diameters or invert levels are not provided.

Soakaways

The underlying chalk geology means that the Caterham-on-the-Hill surface water drainage was designed to discharge to soakaways. There are numerous soakaways in the study area, a majority of which provide very localised drainage for small clusters of road gullies. The main storm drain terminates in a soakaway located on the south-eastern edge of Coulsdon Common, with other soakaway structures located along the drain's length (see Table 2-1).

The efficiency of each soakaway will depend on the infiltration capacity of the ground and the soakaway design. Over time, soakaways can also become silted / blocked and ongoing maintenance and debris clearance is required to maintain drainage efficiency. In 2014 all the soakaways in the Queen's Park ward and along the Stites Hill route system were classified by SCC as "high priority" for cleaning. A good soakaway needs to be able to discharge stored water quickly such that capacity is available to receive runoff from a subsequent storm.

Money Pit

"The Money Pit" is a SCC-owned asset located under a concrete slab in a fenced-off area of open ground between St. Michaels Road and Banstead Road (B2030). Access is provided via seven inspection access covers in the concrete slab. At the start of this study, the exact purpose of the Money Pit asset was unknown, but it was believed to be connected to the main storm drain to provide a storage and/or a soakaway function. Details of the connectivity were not known. The only information received pertaining to the asset was an inspection report from 1992. This provided indicative asset dimensions of "length 37m, width 18.5m and depth 15m" (SCC, 1992). These dimensions have now been superceded by the findings of a recent survey (see Section 2.2).

Surface Water Drain

A CCTV survey of the main storm drain was commissioned by SCC and undertaken in March 2013 by AB Pipeline Services Limited. This survey covered the storm drain between Queens Park Road in the South and Stites Hill Road in the North. The survey provided information relating to the dimensions, condition and connectivity of each length of pipe. Connectivity with soakaways was identified, as summarised in Table 2-1. Photographs of some of these soakaways (from the CCTV survey) are provided in Appendix B. Locations of blockage issues (caused by siltation, collapse or root growth) were also identified, and a severity score allocated, with 0 being not an issue and 5 being a very severe issue.

A summary table containing information about all 68 surveyed pipe lengths is available in Appendix B. The ID column within this table relates to the pipe locations as illustrated on the map in Appendix B. A summary of the pipe lengths that were allocated the maximum severity score are shown in Table 2-2. Of significant interest are pipe lengths 63 and 66, both of which are located in between Queens Park Road and Court Road, an area that is known to flood (see Section 3). These pipes are in a poor condition, with cracks and roots, and two collapsed sections. There are reported blockages of up to 50% in what are relatively small pipes (150mm in

the upstream reach), significantly reducing the capacity of the pipe to convey surface water flows downstream. This increases the risk of surcharging and flooding in this area.

Also of interest is the pipe just downstream of Money Avenue (no. 41). Money Avenue is also an area highlighted by SCC as an area that has experienced flooding, verified by the SCC Wetspots and the Environment Agency uFMfSW. Pipe 41 has also been allocated the highest severity ranking, which in this location relates to cracks and siltation.

Table 2-1 Soakaways on the main storm drain

Number (u/s to d/s)	CCTV Reference	SCC Reference	Location*	Overflow Pipe?	Construction Material	Photograph
1	SOAKAWAY	SSo857	Queen's Park	No	Unknown	No
2	Soakaway 6	Not on database	Money Avenue	Yes	Concrete	Figure B-1
3	Soakaway 2	SSo2735	Junction of Campbell Road & Banstead Road	No	Brick	Figure B-2
4	Soakaway 4	SSo2736	Junction of Milton Road & Banstead Road	Yes	Concrete rings	Figure B-3
5	Soakaway 1	SSo3473	Milton Road	Yes	Concrete rings	No
6	Soakaway	SSo3480	Coulsdon Common	No	Concrete rings	Figure 2-9

* The location of the soakaways is illustrated on Figure 2-11 using the first (upstream to downstream) referencing number.

Table 2-2 Lengths of pipe allocated the highest severity ranking

Id	Location	Pipe diameter (mm)	Max % blockage	Cracks	Roots	Silt	No. of incoming connections	Max Severity	Comments
63	Downstream of Queen's Park Road	225	50	Y	Y	N	3	5	Significant collapses and broken pipes. Connections at 11.1m, 16.4m, 26.3m with 100mm, 150mm, 100mm respective diameters.
66	Court Road (near junction with Poplar Way)	150	30	Y	Y	N	0	5	S61 is surcharged - unable to unblock. Suspected collapse.
54	The Raglan Precinct	450	20	N	Y	N	0	5	
56		450	20	N	Y	N	0	5	Broken joint 10.6m down including missing pipework
41	Between Money Road and Livingstone Road	450	5	N	Y	Y	2	5	Connection at 42m and 42.8m down both diameter 150mm
33	Banstead Road (near St. Michael's Road)	450	20	N	Y	N	1	5	Connection intruding at 9.3m down diameter 150mm with 150mm intrusion (severity 4)
28	Junction of Banstead Road and Campbell Road	450	0	Y	Y	N	0	5	
32		225	10	Y	N	N	0	5	Two pipes - Pipe B. Part collapsed and deformations.
22	Between Campbell Road and Milton Road	450	30	N	Y	N	0	5	
23		450	30	N	Y	N	0	5	
14	Banstead Road (upstream of Milton Road)	375	5	Y	Y	N	0	5	
21	Immediately upstream of Coulsdon Common soakaway	450	10	Y	N	N	0	5	Deformed pipe and part collapse

Listed from upstream to downstream, Y = Yes, N = No

Gully Cleaning

The SCC Operations team organise annual cleaning of the gullies in Caterham-on-the-Hill in accordance with their routine gully cleansing schedule. The SCC gully cleaning records from July / August 2014 have been provided and consist of 140 records within the study area. These records include a percentage silt level, which provides an indication of gully blockage. The gullies along Chaldon Road, Avenue Road, Money Road, Money Avenue and Banstead Road were highlighted as being at a “medium risk”. Only Milton Road gullies were highlighted as being at “high risk”, with four gullies recorded as having a 100% silt level.

SCC have reported ongoing issues of cars parking over gullies, preventing cleaning from taking place. If a blocked gully cannot be cleaned, road drainage is impeded, increasing the risk of surface water flooding. This is particularly true in Park Road. Advanced signing and letter drops already takes place, but it is recommended that a more robust noticing and planning procedure is developed to improve gully access, with potential involvement of local residents where appropriate.

2.2. Additional Survey

2.2.1. Scope of Works

The review of existing data identified gaps in information which in conjunction with the findings of the flood risk review (see Section 3) determined the scope for additional survey work. Three scopes of works for surveying the highway drainage system were produced and are included in full in Appendix A. In summary, the work commissioned and undertaken by Dene-Tech Services Limited in April 2015 included:

- Survey of the Money Pit to assess dimensions, connectivity and condition;
- Condition survey of the Coulsdon Common soakaway; and
- CCTV survey of specific lengths of the main storm drain.

2.2.2. Survey Results

Money Pit

Construction, Dimensions and Function

The Money Pit is a brick structure covered with a concrete block and beam slab. The slab is supported by brick piers (55 mm x 470 mm x 470 mm) at 2.6m spacing. Its dimensions were surveyed as 36.1m x 17.9m x 1.5m deep (from soffit to invert), thus providing a volumetric storage of 967m³. The top most level of the Money Pit cover was measured at 167.86m AOD; with the invert of the Money Pit measured at 166.12mAOD.

The Money Pit was found to have a gravel base, and hence it is assumed to have been designed to provide a soakaway function. The gravel is however compacted and heavily silted, and so current rates of infiltration to ground are assumed to be very low. This is supported by the areas of standing water which were found inside the Money Pit at the time of the survey, during what had been a week of dry weather.

Access

There are seven inspection covers at random intervals in the slab. There are no means of entering (such as ladders or step-irons) to allow persons to enter the chamber from these access covers. Figure 2-1 illustrates the location of the inspection covers and the surveyed cover level.

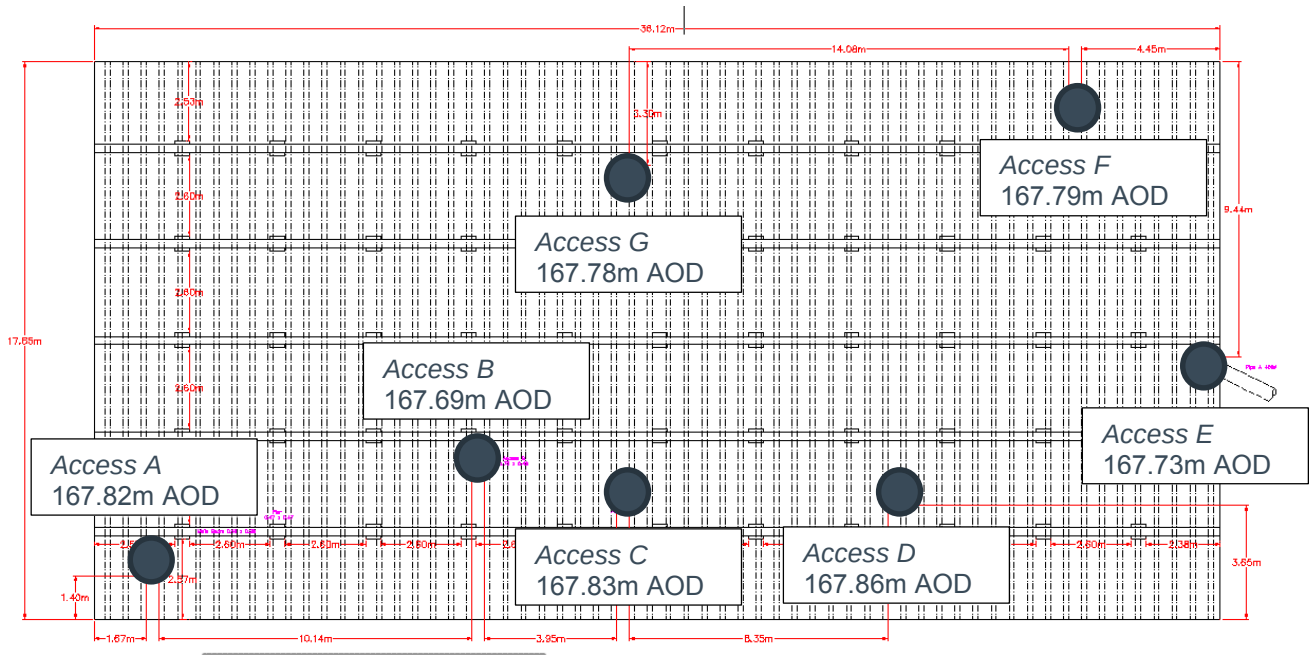


Figure 2-1 Plan view of the Money Pit showing access locations and levels

Condition

Access covers were found to be rusted, although not to a dangerous state. At the time of the survey, approximately 80% of the slab over the Money Pit was covered with vegetation, including brambles and small shrubs and trees. Soil and roots had to be cleared to access the covers. The vegetation growth meant that the survey team was unable to assess the condition of the slab surface. There was evidence of root ingress into the chamber from the stab above, as illustrated in Figure 2-2. The chamber wall and brick piers all seemed structurally sound with no evidence of cracking or displaced brickwork. The mortar joints seemed in good condition.

Figure 2-2 Root ingress through the Money Pit slab and onto one of the chamber's piers

There was an average of 400mm of silt at the base of the Money Pit (see Figure 2-3), though in some areas this was considerably more, particularly in the northern corner of the asset where silt was seen to be piled up against the chamber wall (see Figure 2-4). Due to the levels of siltation, the survey team were unable to leave the base of the inspection chamber area to assess the wider condition of the asset.

Figure 2-3 Silt levels at base area of access cover D

Figure 2-4 Photo from Access A showing area of considerable sedimentation and standing water

Connectivity

The 2015 survey of the Money Pit found only two incoming connections:

- A mid-level (0.4m from base) 450mm conduit with an invert level of 166.5m AOD along the south-eastern side of the chamber, close to Access E (see Figure 2-5 and 2-6); and
- A high-level (1m from base) 150mm conduit with an invert level of 167.1m AOD along the north-western of the chamber, close to Access A (Figure 2-5).

The mid-level 450mm incoming conduit is the main storm drain. The high-level 150mm incoming conduit is believed to be a private connection.

Figure 2-5 Money Pit incoming pipes (450mm on left and 150mm on right)

Figure 2-6 2013 CCTV survey of 450mm pipe outfalling into the Money Pit chamber

As part of the survey, a manhole cover in St. Michaels Road was lifted. This was found to provide access to a small soakaway taking local road drainage. Runoff from St. Michaels Road is therefore not discharged into the Money Pit.

No outgoing connections were found. Since the surveyors were only able to survey the area immediately surrounding the base of the access chambers, there is a possibility that an outgoing connection is present in the northern corner of the asset which was not covered in the survey, as shown in Figure 2-7. It is also noted that any low-level incoming or outgoing pipes could not have been observed because they would have been buried beneath the 400mm of silt.

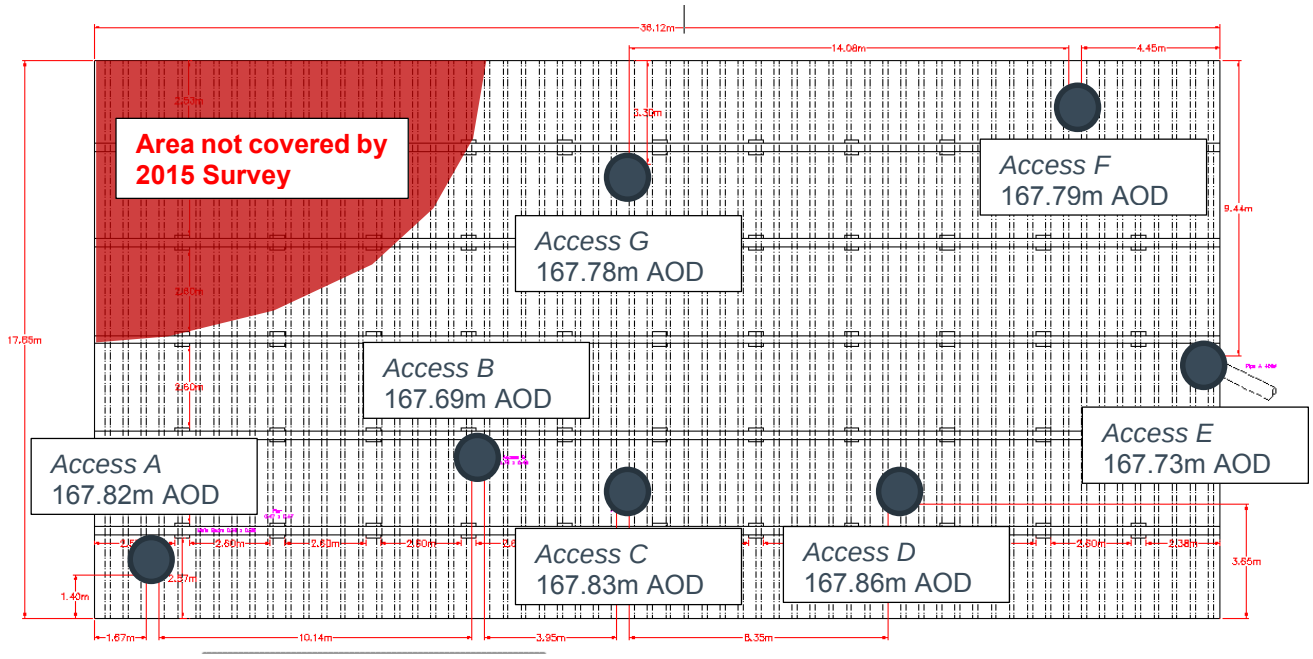


Figure 2-7 Coverage of the 2015 Money Pit survey

A previous CCTV survey (AB Pipeline Services Limited, March 2013) surveyed a length of sewer on the main storm drain just downstream of the Money Pit. The upstream end of the survey was a manhole chamber in the garden of 99 / 101 Banstead Road, to the north-west of the Money Pit. Looking upstream, the 2013 CCTV survey image (see Figure 2-8) clearly slows a large conduit (approximately 450mm) running from the manhole chamber in the road, towards the Money Pit. Access to this manhole chamber was not available and hence it was not possible to confirm connectivity.

Figure 2-8 2013 CCTV survey showing manhole downstream of The Money Pit

Although there is no direct evidence of an outgoing connection from the Money Pit chamber, the available evidence, including the 450mm diameter conduit found in the 2013 CCTV survey, suggests that there is an outgoing conduit from the Money Pit which is part of the main storm drain and can convey flows downstream. The invert of this conduit connection is unknown.

Coulsdon Common Soakaway

Construction, Dimensions and Function

The soakaway on Coulsdon Common consists of 6 precast concrete rings, with a concrete slab and single access opening. Surveyed dimensions of the soakaway chamber were 1.5m diameter x 6.2m deep, providing a storage volume of 11m^3. The cover level of the Soakaway was surveyed at 152.40m AOD.

There are 50mm diameter soak holes, spread at roughly 400mm intervals in the base rings of the chamber up to 1.65m above the base of the soakaway. No soak holes were found above this level. No solid base for the soakaway was found; the entire base of the soakaway could thus have a soakaway function, or alternatively a solid base exists but could not be found beneath the heavy siltation.

A drop test was carried out at the site to calculate the existing performance efficiency of the soakaway. Water was artificially discharged into the chamber via a tanker to a depth of 1m above the silt level. The drop in water level was timed, giving an average soak-away / discharge rate of 0.24l/s (0.00025m^3/s).

Access

There is a single access cover in the slab with step irons down into the asset.

Condition

The slab is covered with vegetation. The cover and frame were found to be rusted although not to a dangerous state. The chamber rings and slab appeared to be structurally sound with no evidence of cracking or spalling. The base of the chamber is heavily silted with approximately 150mm of sediment and trash, including plastic drinks bottles, crisp packets and plastic bags. This is illustrated in the photograph in Figure 2-9.

Figure 2-9 Image into soakaway chamber showing trash covering the base

Connectivity

There is a single incoming circular concrete culvert with a diameter of 450mm and an invert level of 150.11m AOD. This is the main storm drain. The CCTV survey (AB Pipeline Services Limited, March 2013) found this pipe to be fractured and deformed, as illustrated on Figure 2-10. No other pipes were located in the chamber, and hence with soakaway has no formal overflow mechanism.

Figure 2-10 2013 CCTV survey showing fractured and deformed pipe, ending in the soakaway

Surface Water Drain CCTV

A total of 270m of the main storm drain was surveyed, out of a required length of 530m. The lengths which could not be surveyed were due to an intruding incoming connection (pipe) or lack of access to an entry manhole. This included the length of sewer between Court Road and Park Road, the length of sewer between the northern edge of Hillcroft Primary School playing field and Chaldon Road, and the length of sewer around the Raglan Precinct. Appendix B shows a location map of the surveyed and unsurveyed sewer lengths, including the manhole references.

Table 2-3 summarises the output from the survey using the same manhole referencing system and listed by surveyed maximum severity score. The three lengths with a surveyed maximum severity score of 5 were as follows:

- Length under Hillcroft Primary School playing fields immediately downstream of Park Road – collapsed sewer;
- Length downstream of Chaldon Road – loss of area because of roots; and
- Length in back-gardens between Auckland Road and Oak Road – loss of area because of roots.

Of particular note is the collapsed pipe downstream of Park Road, as this road has historically been affected by surface water flooding.

Table 2-3 Output from 2015 CCTV survey

US M/H	DS M/H	Location	Pipe diameter (mm)	Max % blockage	Cracks	Roots	Silt	No. of incoming connections	Max Severity	Comments
S51E	S51A	Hillcroft Primary School, immediately d/s of Park Road	300	0%	Y	Y	N	0	5	Collapsed drain d/s of Park Road
S49	S49 A	D/s of Chaldon Road	80	20%	Y	Y	Y	0	5	Loss of area because of roots
S45 A	S45	Between Auckland Road and Oak Road	450	30%	N	Y	N	0	5	Loss of area because of roots
S48	S45 A	Between Auckland Road and Oak Road	450	0%	Y	N	N	2	4	Broken pipe and displaced joint
S59	-	Court Road	300	10%	Y	Y	N	1	3	Cracks and roots. Survey incomplete due to intruding connection 0.5m from u/s MH.
S51 A	S51 B	Hillcroft Primary School	300	0%	Y	Y	N	0	3	Cracks
S51C	S51D	Hillcroft Primary School	300	10%	N	Y	N	0	3	Roots
S51 B	S51 C	Hillcroft Primary School	300	0%	N	Y	N	0	2	
S51D	S51	Hillcroft Primary School	300	0%	Y	Y	N	0	2	Survey abandoned unable to pass bend in pipe
S39	S38	Oak Road	450	5%	Y	Y	N	3	2	

Listed in severity order and then from upstream to downstream, Y = Yes, N = No

2.3. Drainage Catchment Conceptualisation

The information collated on the surface water drainage system has been used in conjunction with ground level information from LiDAR data to divide the study area into drainage sub-catchments. These are illustrated on Figure 2-11. Table 2-3 provides a description of the land-use and drainage in each of these sub-catchments as well as a description of conveyance in the main storm drain. In the absence of full surface water modelling, this information is useful to better understand the sources of surface water runoff and relative contributing catchment areas.

Table 2-4 Caterham-on-the-Hill Drainage Sub-Catchments

Catchment Reference	Catchment Name	Catchment Size (ha)	Main Surface Water Drain	Catchment and Drainage Description
C1	Manor Avenue	2.9	Not located in this catchment.	Residential urban sub-catchment. Road slopes to gullies which drain to 2 soakaways. Any runoff exceeding the drainage capacity can flows north into Queen's Park recreation ground.
C2	Queen's Park Recreation Ground	11.8	Not located in this catchment.	Catchment mostly comprises of the grassed recreation ground. There are two surface water flow routes north across the recreation ground, with a swale, filter drain, some drainage gullies and a soakaway located along the northern boundary. A small mound along the hedgeline prevents very shallow water from flowing directly onto Queen's Park Road.
C3	Queen's Park Road to Court Road	6.2	Conveys flow N in 225mm diameter pipes.	Ground slopes north-easterly and north-westerly towards the main surface water flow path. Low density residential area, predominantly comprised of large gardens.
C4	Birch Avenue	6.1	Not located in this catchment.	Residential urban sub-catchment. Road slopes to gullies which drain to 2 soakaways located on the junction between Birch Avenue and Court Road. Any runoff exceeding the drainage capacity is likely to flow in a north-easterly direction towards the main surface water flow path.
C5	Court Road to Park Road	5.5	Conveys flow W and N in 225mm dia. pipes.	Ground slopes north-easterly and north-westerly towards the main surface water flow path. Low density residential area, predominantly comprised of large gardens.
C6 west	Park Road to Chaldon Road	16.6	Conveys flow N in mostly 300mm dia. pipes.	Residential urban sub-catchment which includes Hillcroft Primary School building and playing field. There are 3 soakaways on Park Road and 1 on Chaldon Road. Runoff flows towards the main surface water flow path.
C6 east	Essendene Road and High Street			Urban sub-catchment. Runoff drains in a north-westerly and south-westerly direction, with 5 soakaways collecting road drainage from Essendene Road and 1 on Poplar Way. Any runoff exceeding the drainage capacity reaches the main surface water flow path at the junction between the High Street and Chaldon Road.
C7 south	Westway Common	11.0	Conveys flows NW (450mm dia. pipes) towards soakaway 2 on Money Avenue.	Open grass area and allotments. Runoff drains in a northerly direction towards the main surface water flow path and the SCC surface water drain (450mm diameter).

Catchment Reference	Catchment Name	Catchment Size (ha)	Main Surface Water Drain	Catchment and Drainage Description
C7 north	Town End recreation ground and Auckland Road		The soakaway only operates when flow depth in the main drain exceeds a spill level.	Runoff drains in a south-westerly direction from the Town End recreation ground, with 4 soakaways collecting road drainage from Auckland Road.
C8 south	Money Road	9.3	Conveys flows NW (450mm dia. pipes).	Soakaway takes drainage from Westway Common. Runoff from the residential area drains in a northerly direction towards the main surface water flow path.
C8 north	Banstead Road east			Residential urban sub-catchment. Runoff drains in a westerly direction with 3 soakaways along Banstead Road.
C9 south	Chaldon Road west to Banstead Road	15.2	Conveys flows NW (450mm dia. pipes) into the Money Pit.	Residential urban sub-catchment with clusters of road gullies draining to soakaways. Runoff drains in a northerly and north-easterly direction towards the main surface water flow path and the SCC surface water drain.
C9 north	Elm Grove			Residential urban sub-catchment with clusters of road gullies draining to soakaways. Any runoff exceeding the drainage capacity reaches the main surface water flow path at the junction between Banstead Road and Livingstone Road.
C10 west	Coulsdon Road and St. Michaels Road	8.4	Assumed outflow from the Money Pit. 450mm dia. pipes convey flow NW. The drain terminates in a soakaway (no. 3) located at the junction of Banstead Road and Campbell Road.	Residential urban sub-catchment. Runoff drains in a northerly and north-easterly direction towards the main surface water flow path.
C10 east	Le Personne Road			Residential urban sub-catchment with clusters of road gullies draining to soakaways. Any runoff exceeding the drainage capacity reaches the main surface water flow path at the junction between Banstead Road and St. Michaels Road.
C11 west	Coulsdon Road (north)	9.1	375mm dia. pipes under Banstead Road convey flow SW, terminating in soakaway (no. 3) at downstream end of catchment C10. Two overflow pipes on this route. First into Milton Road, conveying flows N via two soakaways (no. 4 & 5, with overflow pipes). Second into 450mm pipe route between Milton Road and Campbell Road, connecting back into the main route at the downstream end of the catchment.	Residential urban sub-catchment including supermarket development. Runoff drains in a north-easterly direction towards the main flow path at Banstead Road.
C11 east	East of Banstead Road			Residential urban sub-catchment with little formal drainage. Sub-catchment falls in a westerly direction towards Banstead Road.

Catchment Reference	Catchment Name	Catchment Size (ha)	Main Surface Water Drain	Catchment and Drainage Description
C12	Downstream to Coulsdon Common	17.2	Receives overflow from Milton Road soakaway (no. 5) and flows from the Milton Road / Campbell Road pipe route. 450mm drain conveys flows N, terminating in the Coulsdon Common soakaway (no. 6).	Residential urban sub-catchment with clusters of road gullies draining to soakaways. Runoff is in a predominantly northern direction with the main flow path through the centre of the sub-catchment.

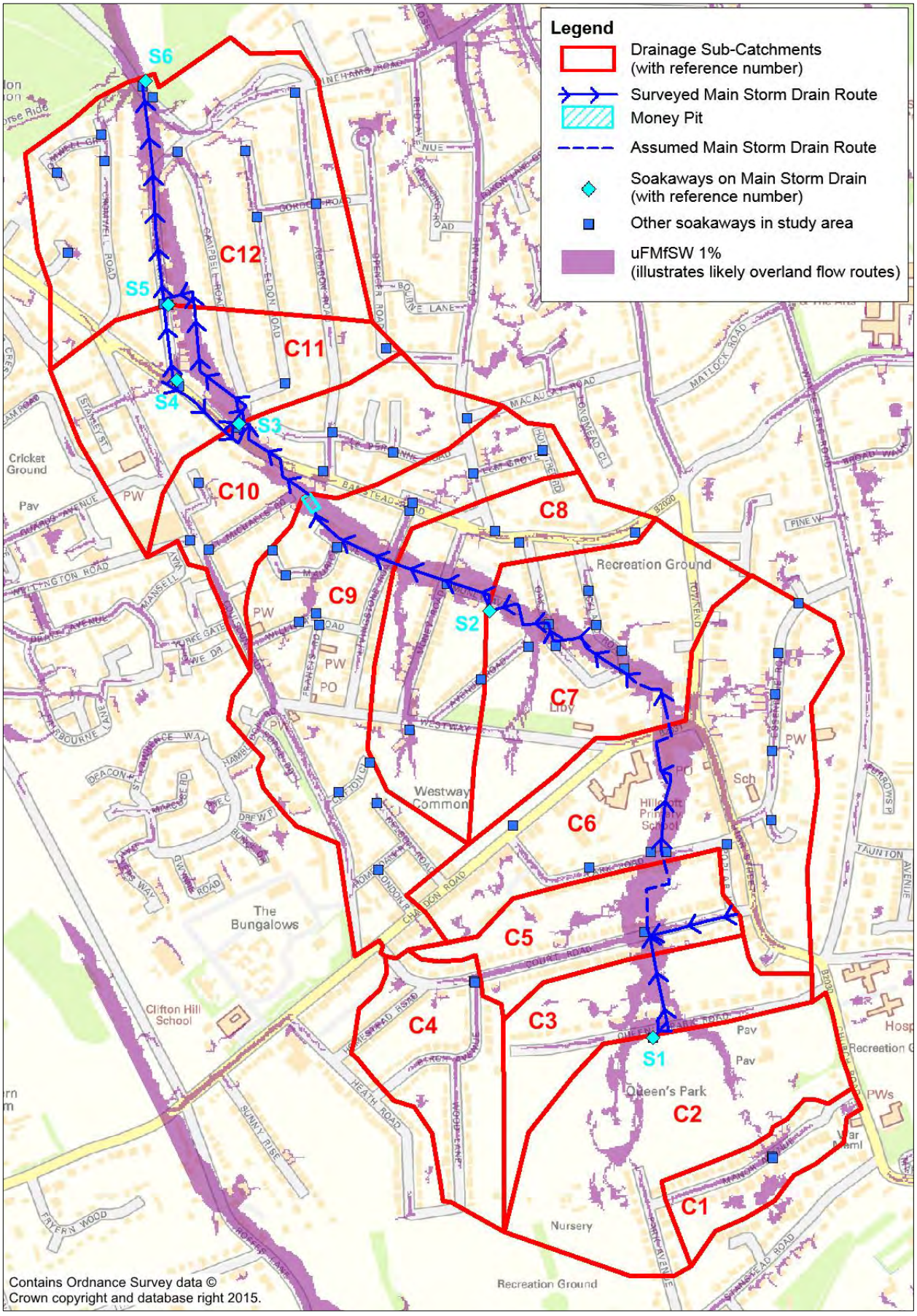


Figure 2-11 Caterham-on-the-Hill Drainage Sub-Catchments

3. Flood Risk Review

3.1. Historical and Anecdotal Flooding Evidence

SCC Records

The Surrey County Council Master Property Flooding Database contains two reported locations of property flooding in Caterham-on-the-Hill. Both of these are from the 2013/14 winter, with internal flooding recorded as affecting a total of 11 properties on Court Road and Park Road. It was noted on a site visit that many properties along Park Road have notably low thresholds. It is also reported that at least one property flooded in Queens Park Road. Anecdotal information suggests that the properties were affected by surface water flooding, which in the case of Queen's Park Road originated from runoff from the Queens Park recreation ground, which then flowed down the hill through residential gardens and combined with urban runoff to flood the properties in Court Road and Park Road.

There are four wetspots within the study area as summarised in Table 3-1. There are an additional three wetspots (Ninehams Road, Buxton Lane and Roffes Lane) which are adjacent but outside of the study area. The areas which have been reported as flooded are illustrated on Figure 3-2.

Table 3-1 Surrey Wetspot Data

Road	Reported Flooding	Identified Issues & Suggested Actions	Possible Cause & Owner
Queen's Park Road	No reports of property flooding Flooded road with stranded vehicles	Pipes from Queens Park soakaway surcharge	Unknown cause LLFA
Money Road	1 report of internal property flooding Flooded road with stranded vehicles	Drains have been checked, possible capacity issues	Highway system Surrey Highways
Banstead Road	1 report of internal property flooding 1 report of external property flooding Flooded road with stranded vehicles		Unknown cause LLFA
Ninehams Road / Stites Hill Road	No property flooding Flooding on Coulsdon Common and Stites Hill Road	Surface water system through Caterham-on-the-Hill terminates with 2 soakaways, which surcharge. Clean soakaways Increase storage capacity upstream	Highway system Surrey Highways

City of London Records

The City of London owns and manages Coulsdon Common. As described in Section 2, the main storm drain terminates in a soakaway located on the south-eastern edge of the Common. Over the last year this soakaway has surcharged on numerous occasions following heavy rainfall. The number of reported incidents is listed in Table 3-2. The pressure of the water lifts the manhole cover (and in some cases removes it completely), allowing the water to then flow down the grass verge and onto Stites Road, flooding the road. There is a drainage ditch which then conveys the water through Rydons wood and out onto Caterham Drive. The City of London records suggest that a lot of litter and debris is subsequently left on the Common and the surcharging can be accompanied by a "foul smell".

Table 3-2 Flooding Incidents on Coulsdon Common

Month	No. of Reported Incidents	Month	No. of Reported Incidents
December 2013	1	June 2014	1
January 2014	3	July 2014	1
February 2014	2	August 2014	1
May 2014	1	November 2014	1

3.2. Groundwater Levels

The National Hydrological Monitoring programme provides monthly hydrological summaries which can be downloaded from the CEH website. These summaries include data from the groundwater level index wells, the closest of which is Well House Inn gauge, located on Chipstead Lane (Kingswood), approximately 6km to the west of Coulsdon Common. The gauged record provides a measure of groundwater level in the North Downs chalk, which includes the Lewes Nodular Chalk Formation; the bedrock geology underlying Caterham-on-the-Hill. Table 3-3 lists the monthly average groundwater level and a single recorded groundwater level at the well for the last 18 months. This data is illustrated on a graph in Figure 3-1.

Table 3-3 Recorded Groundwater Levels at Well House Inn

Month	In-Month Average Groundwater Level (m AOD)	Date	Groundwater Level (m AOD)
Sep-13	93.91	01/10/2013	93.99
Oct-13	93.05	31/10/2013	92.34
Nov-13	93.05	30/11/2013	93.77
Dec-13	93.49	31/12/2013	100.8
Jan-14	94.87	05/02/2014	105.24
Feb-14	96.87	05/03/2014	104.52
Mar-14	96.88	31/03/2014	101.76
Apr-14	97.07	01/05/2014	100.2
May-14	96.95	31/05/2014	99.17
Jun-14	96.38	30/06/2014	98.12
Jul-14	95.74	31/07/2014	97.23
Aug-14	94.85	31/08/2014	95.47
Sep-14	93.92	30/09/2014	93.85
Oct-14	92.88	31/10/2014	92.9
Nov-14	92.88	30/11/2014	92.5
Dec-14	93.52	31/12/2014	94.77
Jan-15	94.99	31/01/2015	97.69

Following the period of prolonged rainfall, groundwater levels across south-east England were notably high during winter 2013/14 and spring 2014. This is illustrated in the data from Well House Inn, with a maximum recorded level exceeding 105m AOD. High groundwater levels were also recorded at Environment Agency gauges including Bughill (Warlingham, 3km away) and Woldingham (2.5km away), both of which experienced levels exceeding 110m AOD.

High groundwater levels can contribute to flooding either directly when groundwater reaches the surface, or indirectly by reducing the capacity of the surface water drainage system. The latter occurs because groundwater can infiltrate into drainage assets (for example, through cracks in pipes) and / or prevent infiltration in soakaways. Although the data from the nearby monitoring wells indicates high groundwater levels

in the chalk bedrock, these are still over 40m below the ground surface at Caterham-on-the-Hill (152m AOD at the Coulsdon Common soakaway and 167m AOD at the money pit), suggesting that groundwater infiltration into the drainage assets is unlikely to have contributed to the flooding experienced over winter 2013/14.

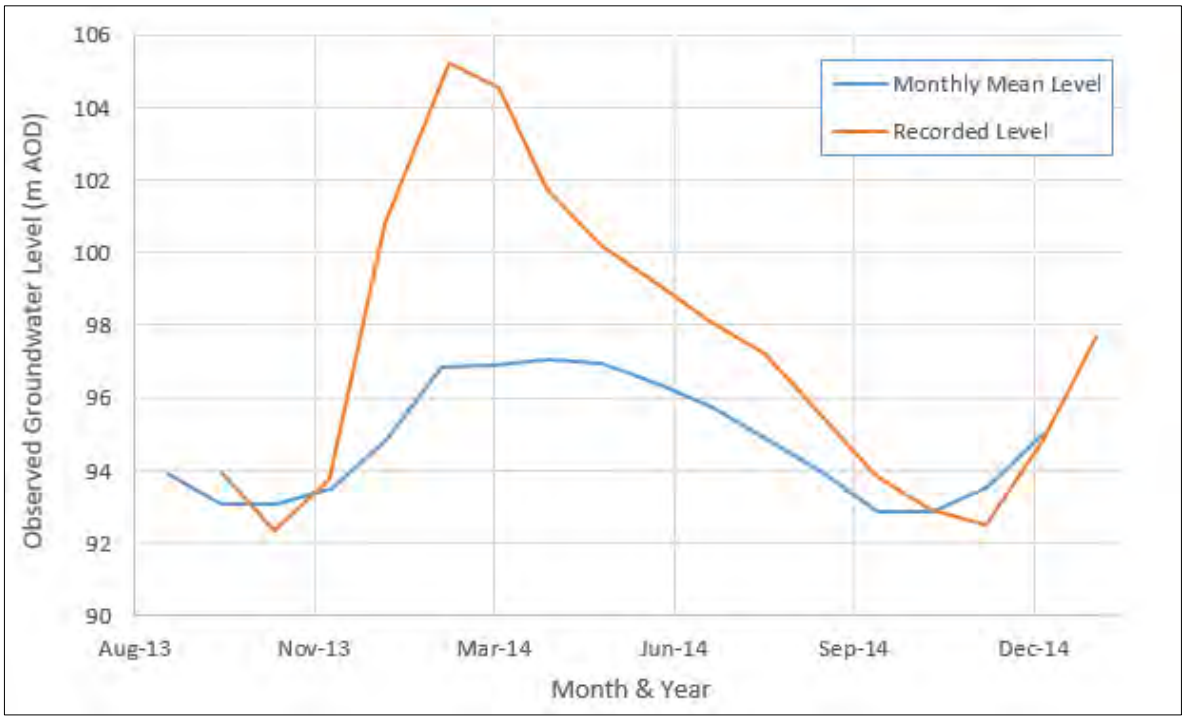


Figure 3-1 Recorded Groundwater Levels at Well House Inn

3.3. Modelled Flood Risk

Surface Water Flood Risk

The Environment Agency Updated Flood Maps for Surface Water (uFMfSW) provided in Figure 3-2 clearly illustrate the main surface water flow path through Caterham-on-the-Hill, suggesting that roads and properties are at risk of flooding with an annual probability of 3.3%. This is likely to be caused by urban runoff, with contributions from rural surfaces depending on the severity of the event and antecedent catchment conditions.

The uFMfSW gives an indication of the areas likely to be at risk of surface water flooding. The extents were produced from 2D models which were built using a national digital terrain model to represent the surface of the land, over which water can flow and pond. The uFMfSW improved on the previous surface water modelling by taking account of local models (where available) and information provided by the LLFAs. There are limitations with the surface water flood model, notably:

- The model does not represent flooding that occurs from overflowing watercourses, drainage systems or public sewers caused by catchment-wide rainfall events or river flow; and
- The model can only give an indication of flooding which could be caused by local rainfall.

Comparing the modelled flood risk with the historical and anecdotal flood records reveals that all of the reported flooding in Caterham-on-the-Hill is located within the area susceptible to surface water flooding as defined by the Environment Agency maps. It is therefore considered that the Environment Agency uFMfSW is sufficient in providing a baseline overview of the risk of flooding from surface water in Caterham-on-the-Hill.

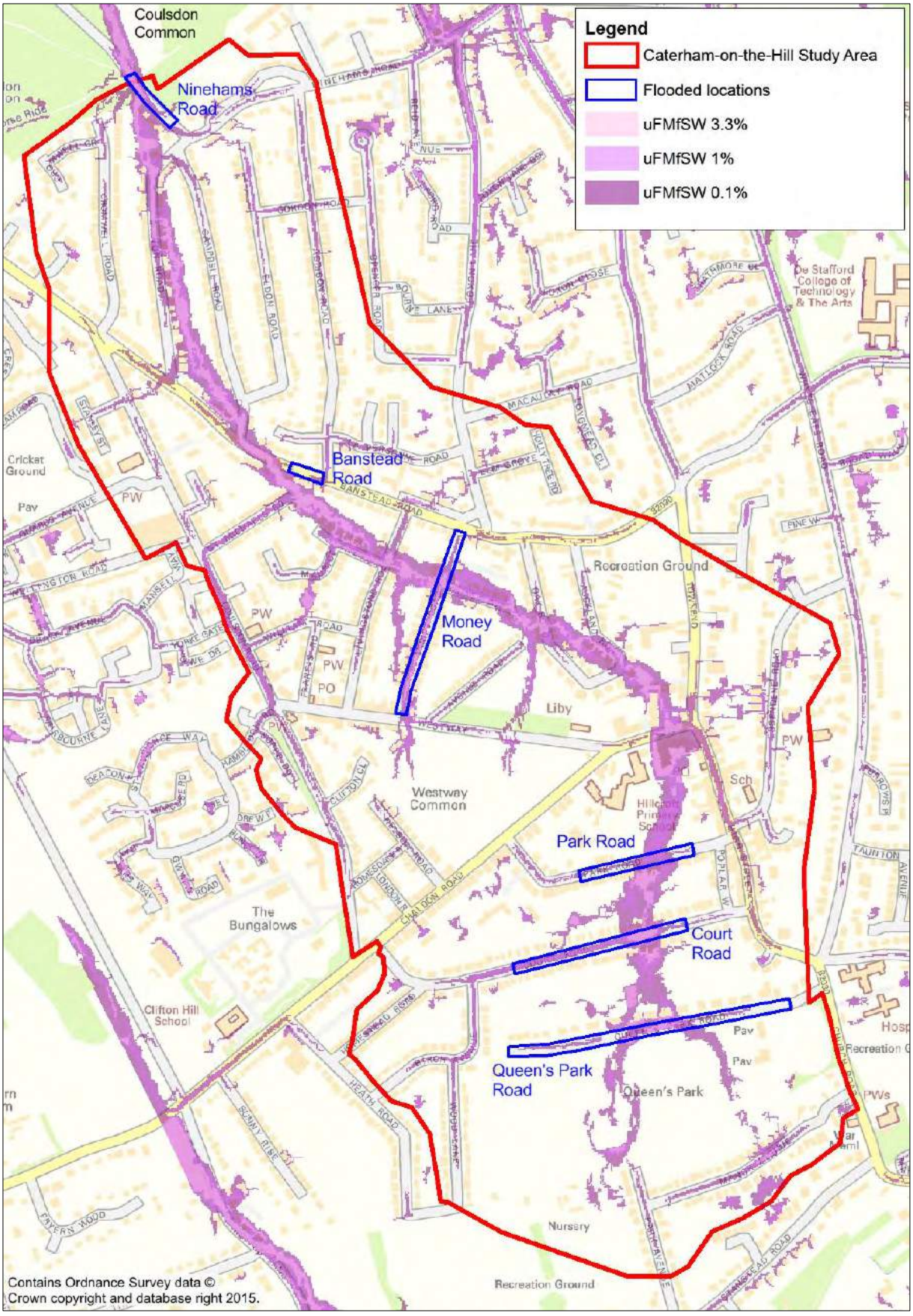


Figure 3-2 Modelled and historic surface water flood risk

Groundwater Flood Risk

The British Geological Survey (BGS) Susceptibility to Groundwater flooding dataset shows where groundwater flooding could occur; it does not indicate the level of risk or probability. The data is also indicative only and was developed by combining two conceptual models (permeable superficial deposits and clearwater flooding). The dataset indicates that the southern part of Caterham-on-the-Hill (south of Westway and Chaldon Road) has a “very low” susceptibility to groundwater flooding. In contrast, the area to the north of Banstead Road, between Foxon Lane and Coulsdon Common has a “very high” susceptibility to groundwater flooding.

An understanding of the predicted flood risk estimated by numerical models, combined with historic information has enabled calculation of the economic damages caused by a surface water flood event. The method and results of these calculations are outlined in the section below.

3.4. Economic Appraisal

An economic assessment has been undertaken to calculate potential level of economic damage to properties as a result of surface water flooding in Caterham-on-the-Hill, using the Environment Agency uFMfSW only. Damages caused from other sources of flooding are not considered in this assessment.

The area assessed was restricted to the main surface water flow path from Queens Park to Coulsdon Common. This approach has been taken because the properties within the smaller catchment area are most likely to benefit from any proposed scheme to reduce flood risk along this main flow path.

3.4.1. Existing Properties at Risk

Buildings located within the Environment Agency 1 in 30 Annual Probability (AP), 1 in 100 AP and 1 in 1,000 flood outline were identified and counted. The resulting property counts, broken down by road, are documented in Table 3-4 and are illustrated on Figure 3-3. There are an estimated 94 properties at risk in the 1 in 30 AP event, all but one of which is residential. There are an additional 65 properties at risk in the 1 in 100 AP event. The uFMfSW is un-calibrated and the number of properties at risk presented here should therefore be used with an appropriate level of caution to reflect the level of uncertainty in the dataset.

Table 3-4 Count of Buildings located within the Environment Agency uFMfSW Outlines

Road	Number of Buildings at risk of Surface Water Flooding					
	1 in 30 AP		1 in 100 AP		1 in 1,000 AP	
	Res.	Non-Res.	Res.	Non-Res.	Res.	Non-Res.
Queen's Park Road	2	0	3	1	3	1
Court Road	5	0	8	0	13	0
Park Road	8	0	16	0	19	0
B2031	14	1	15	4	15	7
Auckland Road & Oak Road	14	0	23	0	30	0
Money Avenue & Money Road	6	0	19	0	29	0
Livingstone Road & Maurice Avenue	13	0	17	0	21	0
St. Michael's Road & Banstead Road	14	0	20	0	38	0
Milton Road & Stites Hill Road	17	0	33	0	64	0
Total (main flow path route)	**93**	**1**	**154**	**5**	**232**	**8**

Note that the numbers presented here ‘overlap’ with each other such that 154 residential buildings are at risk in a 1 in 100 AP event, but this includes the 93 residential buildings which are at risk in a 1 in 30 AP event.

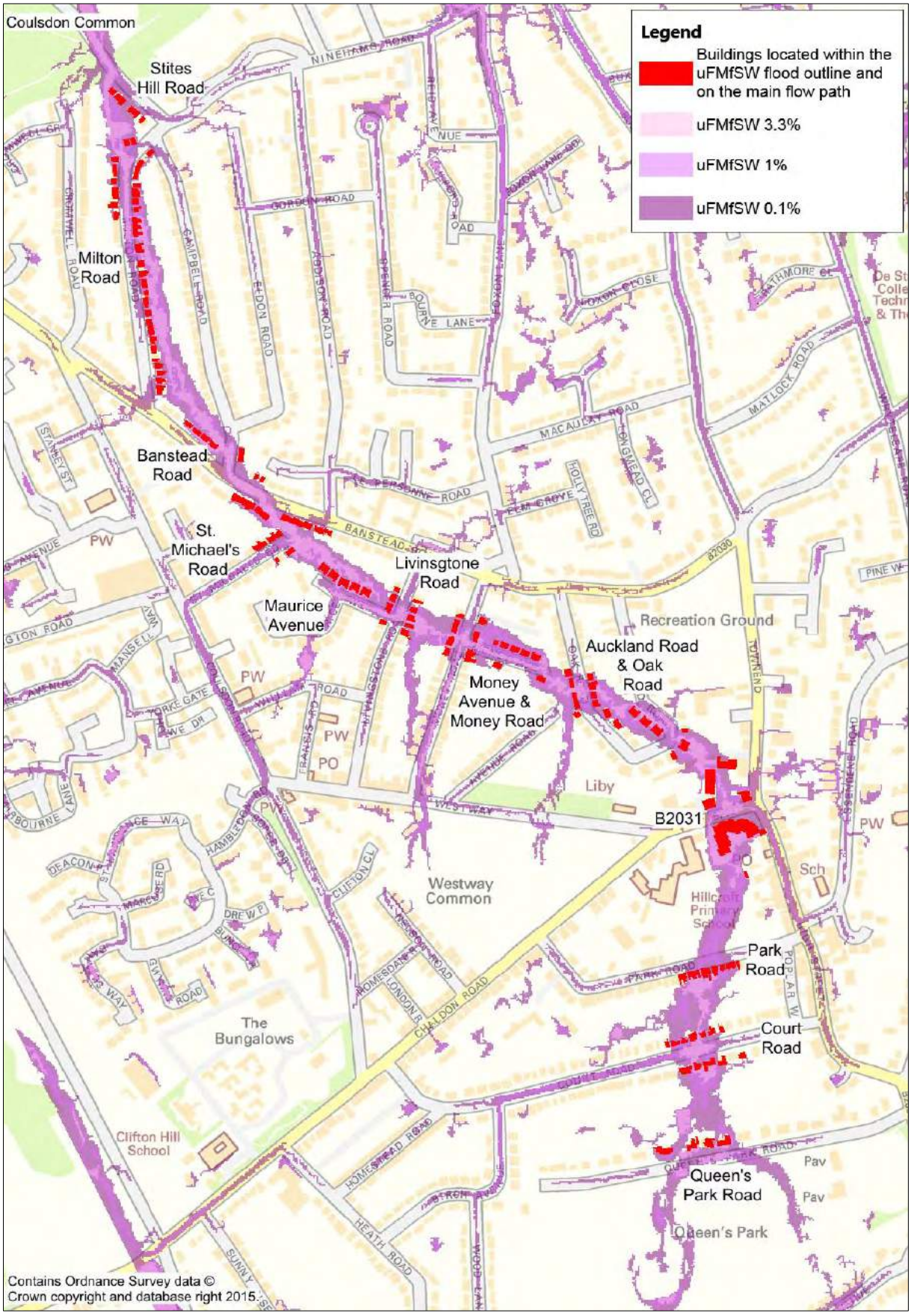


Figure 3-3 Properties at risk of surface water flooding on the route of the main flow path

3.4.2. Baseline Economic Damages

The baseline Weighted Annual Average Damage (WAAD) values for residential and non-residential properties were taken from the MCM (Flood Hazard Research Centre, 2014) and updated to an April 2015 price date using the Consumer Price Index (CPI). Annual Average Damages are the average amount of damage likely to be incurred in each statistical year. This is a long term average, and represents an annual rate, based on a defined scenario. The WAAD values have been generated from national historic flood data, considering a range of flood events and locations. These WAADs are suitable for high level assessments and vary with the probability of flooding at each property. Note that the 1 in 1,000 AP damages are effectively zero for non-residential properties. This is because the probability of flooding is so rare.

The sum of the WAAD for each property type and road area has then been discounted using the standard HM Treasury rate to give a Present Value damage (PVd) over 100 years assuming no increase in surface water flood extent due to climate change. The results are provided in Table 3-5. The total baseline PVd is £6,026k.

Table 3-5 Baseline Economic Flood Damages

	AAD			PVd (over 100 years)	% of Total PVd
	Res.	Non-Res.	Total		
Queen's Park Road	£4,100	£1,800	£5,900	£174,900	3
Court Road	£10,500	£0	£10,500	£313,400	5
Park Road	£17,800	£0	£17,800	£530,900	9
B2031	£26,300	£3,500	£29,700	£886,400	15
Auckland Road & Oak Road	£29,400	£0	£29,400	£876,800	15
Money Avenue & Money Road	£16,200	£0	£16,200	£481,600	8
Livingstone Road & Maurice Avenue	£25,600	£0	£25,600	£764,500	13
St. Michael's Road & Banstead Road	£28,700	£0	£28,700	£855,500	14
Milton Road & Stites Hill Road	£38,300	£0	£38,300	£1,142,200	19
Totals			**£202,100**	**£6,026,200**	

3.4.3. Economic Benefits of a Potential Scheme

The WAAD approach described above was used to calculate the PVd for option scenarios, with a scheme in place to provide an assumed Standard of Protection (SoP) to properties along the main surface water flow path in Caterham-on-the-Hill. The difference between the option PVd and the baseline PVd is referred to as the scheme benefits (PVb). Table 3-6 provides a broad indication of the scale of benefits which could be achieved if a scheme could be designed to provide a certain SoP to all the properties at risk considered in this assessment.

Table 3-6 Present Value Damages and Benefits of a Potential Scheme

	Damages (PVd)	Benefits (PVb)
Baseline	£6,026,000	-
With scheme to provide a 1 in 30 SoP	£2,426,000	£3,600,000
With scheme to provide a 1 in 75 SoP	£914,000	£5,112,000
With scheme to provide a 1 in 100 SoP	£403,000	£5,623,000

It is noted here that the economic damages and benefits are based on direct damages measured economically as a cost to the nation, as required by any applications to the Environment Agency for Flood Defence Grant in Aid (FDGiA). Other authorities / organisations (for example local councils and Local Enterprise Partnerships, LEPs) are regionally focused and not always limited by these restrictions. The local economic impact can be

vital to understand the value of flood defence capital works to the community, and calculation of these local economic damages / benefits can potentially provide further justification and funding sources for a proposed scheme. For Caterham-on-the-Hill there are very few non-residential properties located on the main surface water flow path. Calculation of the local damage associated with business disruption is therefore unlikely to significantly change the PV damage, and thus the PV benefit of any potential scheme.

4. Conceptual Option Development

The previous sections of this report have discussed the risks, sources and mechanisms of flooding, and known information about drainage asset performance in Caterham-on-the-Hill. An assessment of economic damages has also been undertaken to quantify the impact of flooding and to enable an understanding of the potential economic benefits of any flood risk management scheme. In this section potential flood risk management options are identified, starting with a long list of options. A high level appraisal of the benefits, opportunities and constraints of these options has led to identification of a short list of the most feasible options for flood alleviation and drainage asset performance. These are then discussed in further detail.

4.1. Long List of Options

Table 4-1 documents the high level appraisal of the long list of options identified for managing drainage assets and flood risk in Caterham-on-the-Hill.

Table 4-1 Options Long List

Option Type	Option	Benefits	Constraints	Short Listed?
Survey	Further survey / investigation to address remaining uncertainties associated with storm drainage assets in the catchment.	Better understanding of asset condition, connectivity and potential causes of flooding issues.	Access constraints for survey work.	Yes
Maintenance of existing assets	Re-instate broken pipes and clear root masses and silt along main storm drain, as identified on the CCTV surveys.	Sewers kept in operational service, with improved flow conveyance. Broken pipes could be a source of silt and debris.	Likely closure of roads while work takes place. Access to residential property gardens may be required.	Yes
	Clean soakaways	Improved discharge capacity, with reduced risk of surcharging.	Can be difficult to clear / clean deep soakaways. Regular inspection and maintenance required to keep assets clean.	Yes
	More robust noticing and planning procedure for gully cleaning.	Reduced risk of parked cars preventing access to gullies. Opportunity for community engagement.	Not possible to guarantee access to gullies, especially in roads where off-street parking is not available.	Yes
	Clean Money Pit	Increase storage capacity. Improved discharge capacity / restore soakaway function. Would enable a more complete survey of the asset.	Very high cost. Ongoing maintenance would be required to keep asset clear.	No
	Review existing practice and implement a more proactive and regular maintenance regime of the storm water drainage assets.	Improved asset operation to design capacity / level of service, with reduced risk of flooding. Opportunities to identify maintenance efficiencies.		Yes

Option Type	Option	Benefits	Constraints	Short Listed?
Manage debris	Installation of silt traps downstream of Queen's Park.	Captures and removes silt before it enters the drainage system, reducing the risk of siltation of pipes and soakaways and hence improving conveyance and asset performance.	Siltation not identified as a major issue in the catchment with limited sources of silt.	No
	Litter campaign	Reduce quantity of litter which gets into the drainage system, reducing the risk of soakaway blockage and public health issues associated with soakaway surcharge.	Difficult to determine effectiveness.	Yes
	Installation of silt trap in manhole chambers upstream of the Money Pit and the Coulsdon Common soakaway	Traps silt before it reaches and blocks the Money Pit / soakaway. Easier, safer and cheaper to clear compared with clearing assets.	Silt traps require a regular maintenance regime to prevent blockage.	Yes
Improve existing assets	Upsizing of existing pipe network or installation of additional pipes.	Improve flow conveyance, potentially reducing flooding that occurs as a result of system surcharging.	Risk of increasing downstream flood risk. Likely to be prohibitively expensive. Likely closure of roads while construction takes place.	No
	Excavate Coulsdon Common soakaway and re-build.	Design new soakaway to have a higher discharge capacity, reducing the risk of surcharge.	Capital cost. Coulsdon Common is outside of SCC boundaries.	Yes
Flood storage	Create flood storage area at Queen's Park recreation ground	Stores runoff with reduced discharge downstream, reducing risk of property flooding. Location is immediately upstream of three roads known to be at risk of flooding.	Additional work required to determine option feasibility. Capital and ongoing maintenance costs. Location is in upper catchment and only accounts for 12% of the whole catchment.	Yes
	Create flood storage area using the Hillcroft Primary School playing field.	Stores runoff with reduced discharge downstream, reducing risk of property flooding.	Additional work required to determine option feasibility. Capital and ongoing maintenance costs. H&S implications when flood storage is in use. Located downstream of the main residential risk areas.	No

Option Type	Option	Benefits	Constraints	Short Listed?
	Replace Money Pit with above ground detention basin.	Cheaper, easier and safer to maintain. Potential to create a community asset. Environmental / biodiversity benefits.	Capital and ongoing maintenance costs.	Yes
	Create flood storage area on Coulsdon Common.	Stores runoff with reduced discharge downstream, reducing risk of property flooding along Caterham Drive and Rydon's Wood Close. Potential opportunities for landscaping enhancement as part of the works.	Capital and ongoing maintenance costs. Coulsdon Common is outside of SCC boundaries.	Yes
Green infrastructure	Local measures to reduce the volume of surface water runoff in the piped network e.g. rainwater gardens and water-butts.	Reduced risk of system surcharging. Opportunity for environmental, biodiversity and aesthetic benefits.	Individual measures will have a negligible impact and so needs to be applied across the whole area in combination with other management options to be most effective.	Yes
Design for exceedence	Bolt down manhole cover on Coulsdon Common soakaway.	Reduced risk of manhole cover lifting when soakaway is surcharged.	If inflow is greater than soakaway discharge capacity, water pressure would build, and resulting surcharge would ultimately be more dangerous than in the existing situation.	No
	Install overflow on Coulsdon Common soakaway	Overflow would allow excess water to be safely conveyed downstream without lifting of the manhole cover, reducing the H&S risk associated with surcharging. Drainage ditch already exists, to which a formal connection could be constructed.	Option in isolation (without addressing soakaway discharge capacity issues) could increase risk of flooding downstream.	Yes
	Build bund along east side of Stites Road.	Reduces risk of road flooding if the Coulsdon Common soakaway surcharges by conveying water parallel to the road and into the ditch, without flooding onto the road.	Residual risk of flooding should the new bund overtop or breach / fail. Coulsdon Common is outside of SCC boundaries. Need to maintain public access and ensure H&S. Helps to design for exceedence but should be considered in combination with options to reduce the risk of exceedence.	Yes

Option Type	Option	Benefits	Constraints	Short Listed?
	Kerb Raising (especially along roads in upstream part of the catchment).	Reduced risk of surface water inundation of properties as low depths of flood water would be confined to the road.	Access considerations for cars onto drives, wheelchairs and buggies. Court Road (south side) and Park Road properties at risk of flooding from back gardens, not just the road.	Yes

4.2. Short-Listed Options

This section provides additional information on the short-listed options recommended by this study for further investigation / consideration. At the request of SCC, some indicative costs have been provided. These are for guidance only and based on previous projects and engineering judgement. The costs relate to capital expenditure and exclude any allowance for design, supervision, planning permission (if required) and consultation. Capital expenditure would also be subject to site survey, receipt of more detailed information and contractor quotations.

4.2.1. Further survey / investigation

This report provides a detailed review of the information available about the surface water drainage assets in Caterham-on-the-Hill. There remain some areas of uncertainty, specifically:

- The route and condition of the main storm drain between Court Road and Park Road;
- The size and condition of the soakaways located part-way along the main storm drain; and
- The connectivity of the Money Pit with the downstream storm drain.

Further survey or investigations could be undertaken to address these areas of uncertainty. The survey previously undertaken (2015) was unable to confirm the presence (or not) of an outfall from the money pit. It is suggested that jet washing and a CCTV survey from the downstream manhole, upstream towards the money pit would be the best way of determining connectivity. At the time this report was finalised, this was left with SCC to arrange. Further survey from within the money pit would require de-silting of the asset to ensure a safe working environment, as the depth of silt means that it is not safe for a surveyor to currently leave the access chamber ladders and “walk around” the asset.

4.2.2. Maintenance of existing assets (including litter management)

Maintenance of existing assets should be undertaken to maintain flow conveyance and reduce the risk of flooding cause by blockage. Maintenance recommendations include addressing the issues identified by the CCTV survey of the main storm drain (re-instating broken pipes, clearing root masses and removing silt), and cleaning soakaways. It is also recommended that a review of existing practice is undertaken to identify whether a more proactive and efficient approach to maintenance could be undertaken. Amongst other things, this should include consideration of a more robust noticing and planning procedure to improve access for gully cleaning. This study has identified an issue with litter getting into the drainage system. One option to address this would be a litter campaign, which could be organised by the local community, school or Parish Council.

4.2.3. Green infrastructure

There are a number of ways that surface water can be managed locally, including rainwater gardens, water butts and encouraging the use of SuDS (Sustainable Drainage Systems). Removing surface water from the surface of the ground and from the Thames Water combined sewer system could reduce the risk of flooding from both the Thames Water sewers and from surface water runoff. This option could also provide environmental, ecological and educational benefits to the community. Improved surface water management in isolated parts of Caterham-on-the-Hill is not however likely to be as effective as a single solution; instead this option would need to be implemented across the wider catchment and combined with other measures in order to realise any flood risk benefits.

4.2.4. Kerb raising

Raising the kerbs along roads where property is known to be at risk of flooding (including Queen's Park Road, Court Road and Park Road) would allow more water to be stored on the road, potentially reducing the risk of internal property flooding. Consideration of the access requirements of residents and the safety during times of flooding would be required, as flooding on the road may be deeper as a result of this option. Whilst this option may provide a small flood risk benefit, it would need to be considered alongside other options as part of a holistic solution to flooding in this part of Caterham-on-the-Hill. This is particularly true given that the flood water affecting many of the properties in this area originates not from the roads, but from upstream areas via property back gardens.

4.2.5. Queen's Park flood storage area

Creation of a flood storage area at Queen's Park recreation ground could be achieved by construction of a flood bund to the south of Queen's Park Road. This would retain surface water runoff and reduce the risk of flooding to properties downstream, principally those on Queen's Park Road, Court Road and Park Road. The recreation ground is located in the upper catchment, accounting for only 12% of the total catchment area to Coulsdon Common. It does however account for 45% of the catchment area to Park Road, which covers many of the Caterham-on-the-Hill flood risk areas. The suggested location of the flood bund and the drainage catchments are illustrated on Figure 4-1.

Additional work would be required to determine option feasibility. This would likely to entail use of a hydraulic model to inform the design of the new structures. The two main constraints that are currently envisaged for this option are that it could be expensive (depending on the scale of the works). Depending on the storage volume, consideration would also need to be given to reservoir safety obligations under the Reservoirs Act (1975) and the Flood and Water Management Act (2010).

Figure 4-1 Queen's Park Option

4.2.6. Money Pit detention basin

The Money Pit is currently difficult and costly to access for inspections and maintenance. Replacing the underground structure with an above-ground detention basin would make it cheaper, easier and safer to maintain. This option also provides an opportunity to create a community asset as well as having wider environmental and biodiversity benefits in a part of Caterham-on-the-Hill which is predominantly residential.

Replacement of the money pit with an above-ground detention basin is likely to involve break-up of the existing concrete structure, profiling and landscaping, with a very high-level indicative cost of £150k. This however excludes the cost of material disposal, design and supervision, and planning fees, which would all be expected to add significant cost. It is noted here that the above-ground detention basin would provide a reduced storage (and soakaway) capacity compared with the existing money pit because of the likely need to profile the sides and provide access around the edge of the basin. There is also a risk that this option would increase the real or perceived risk of flooding to residential properties in this area. Further work would therefore be required to determine the feasibility of this option and to inform a design such that flood risk to neighbouring areas is not increased and sufficient attenuation and/or soakaway function can be maintained.

4.2.7. Coulsdon Common

The following options have been short-listed for managing the risk of flooding to Stites Hill Road on Coulsdon Common:

- Clean soakaway including removal of litter and silt. This would temporarily improve discharge capacity and hence reduce the risk of surcharging. In time however, litter and silt would accumulate, and therefore, for this option to be effective, the maintenance work would need to be regular and ongoing.

- Install a silt trap in the manhole chamber upstream of the soakaway. This would trap silt before it reaches the soakaway, reducing the risk of blockage. Installing a silt trap would entail excavating out the manhole or creating a new manhole on the line if there is space, making it deeper and wider than the existing to create a catch pit, and possibly including a baffle board to slow flows through the chamber. There are also 'off the shelf' silt trap units that can be installed in a network. On the basis that the pipe is 450mm diameter and assuming a 1.5m deep manhole chamber, the rough cost for excavation of the existing chamber and reconstruction including a silt trap would be £2.5-4k. This would need to be maintained to remain effective, and so consideration of maintenance costs should be included when making a decision about this option. Installation of a trash screen is not recommended because of the very regular maintenance that would be required to prevent debris collecting and causing blockage. If unmaintained, this could therefore actually increase flood risk. Trash screens can be installed in open channels, attached to a culvert inlet headwall, but in Caterham-on-the-Hill this would require the culvert to be daylighted. If daylighting were to be possible, the rough cost of a trash screen assuming a 450mm culvert, if the channel was open and the headwall and baseplate needed to be cast in situ, would be in the region of £4-6k.

- Excavate the existing soakaway and re-build. The design of the existing soakaway, with small perforations only in the lower part of the asset means that the discharge rate is low and the asset is prone to blockage because of siltation.

- Install an overflow on the Coulsdon Common soakaway. At present, when the incoming flow exceeds the discharge capacity, the soakaway chamber fills with water and the water pressure lifts the manhole cover. An overflow would allow the excess water to be safely conveyed downstream without lifting of the manhole cover. The ditch on Coulsdon Common is about 30m from the soakaway. A high level overflow in the soakaway chamber could outfall via an open ditch or a pipe. The preference would be for an open ditch as this provides additional capacity, and without knowledge of likely peak flows and volumes, it would be difficult to select an appropriate pipe size. The rough cost for excavating and profiling a 30m-length ditch line and installing a high level overflow on the soakaway chamber is £5-7k. The costs for a bolt down cover to be installed on the Coulsdon Common soakaway manhole would be in the region of 0.5k.

- Raise the grass verge along the east side of Stites Hill Road, creating a small bund (similar to that which already exists on the west side of the road). Should surcharging still occur, this would provide an overland conveyance route for the water from the soakaway to the drainage ditch without flooding the road. Cousldon Common is located within the London Borough of Croydon and is owned and managed by the City of London Corporation, and hence consultation and agreement would be required before any works could be undertaken.

- Re-landscape the area of Rydon's Wood to the south of The Pipe Track to provide an area of depressional surface water storage at the end of the existing drainage ditch. As with the previous option, this will require consent from the London Borough of Croydon and the City of London Corporation. There would also be capital and ongoing maintenance costs. The option provides opportunities for landscaping enhancement and biodiversity benefits as well as surface water attenuation.

A map and photos of the Coulsdon Common area are provided in Figure 4-2.

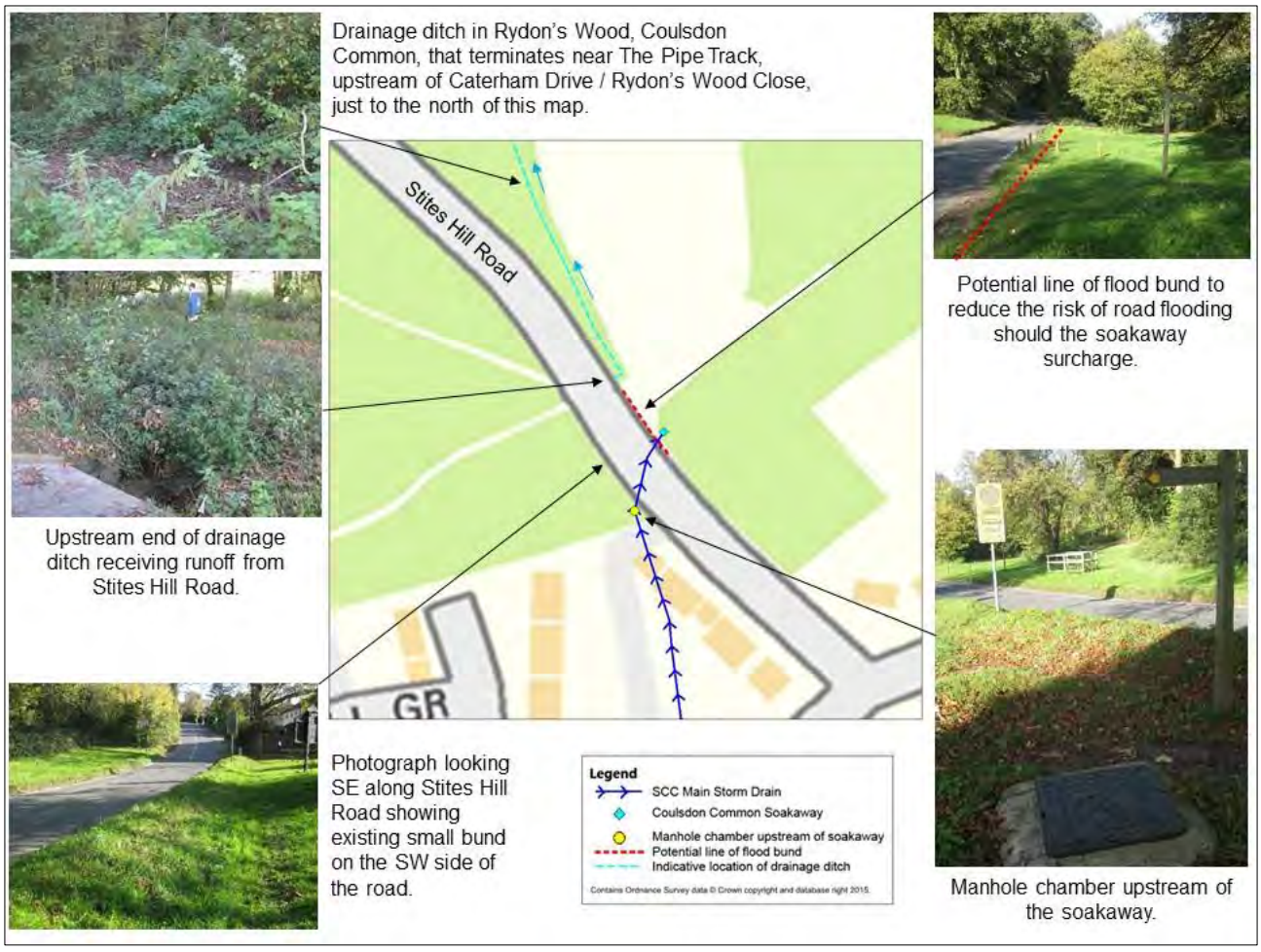


Figure 4-2 Coulsdon Common Options

5. Summary and Recommendations

A review of the existing drainage asset information for Caterham-on-the-Hill identified several gaps in information which were subsequently addressed by survey of the Money Pit, the Coulsdon Common soakaway and sections of the main storm drain. This report has set out the current understanding of the storm drainage system, which comprises of a main drain from Queen's Park to Coulsdon Common, with soakaways located both on the route of the main drain and in neighbouring areas providing local road drainage. The Money Pit is a large underground asset thought to have both a storage and soakaway function, although the latter is severely impeded by the current levels of siltation / blockage.

Flood risk areas and mechanisms have been investigated following a review of both the historical and anecdotal flooding evidence and the modelled data. There is a history of property flooding in the upstream catchment along Queen's Park Road, Court Road and Park Road. There have also been numerous reports of surcharging of the Coulsdon Common soakaway, leading to flooding of Stites Hill Road. There are just under 100 properties located along the main flow path thought to be at risk of flooding from surface water in Caterham-on-the-Hill up to an annual risk level of 1 in 30 (3.3%). The estimated Present Value damages (over a 100 year period) are estimated to be in the order of £6million.

A long list of conceptual options which would improve drainage asset performance and reduce flood risk has been developed. These options have been appraised at a high level for their technical viability, and refined into a short list of options which could be considered further. The short-listed options include:

- Further survey / investigation;
- Maintenance of existing assets, including litter management;
- Improved surface water management making use of green infrastructure;
- Kerb raising in flood risk areas;
- Creation of a flood storage area in Queen's Park;
- Replacement of the Money Pit underground asset with an above-ground detention basin; and
- Various options for Coulson Common including soakaway clearance, installation of a silt trap, soakaway re-build and measures to better manage exceedence (including installation of an overflow pipe, construction of a flood bund and / or landscaping to create a storage area).

As this is a high-level appraisal it is recommended that further work is carried out on these options to determine which options are most suitable and/or achievable. Some could be undertaken by SCC immediately. Others will require further work to confirm option feasibility and to inform design, as well as consultation with relevant stakeholders and landowners.

6. References

AB Pipeline Services Limited (March 2013). CCTV survey of SCC's surface water pipe

British Geological Survey (BGS) website: http://www.bgs.ac.uk/data/mapViewers/home.html (Last accessed April 2015).

City of London (2014). Incident reports for flooding of Stites Hill Road and Coulsdon Common

Cranfield Soil and Agrifood Institute Soilscapes website: http://www.landis.org.uk/soilscapes/ (Last accessed April 2015).

Dene-Tech (May 2015). Caterham-on-the-Hill survey reports and data

Environment Agency Website – Interactive Maps: http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e (Last accessed April 2015)

Surrey County Council (1992). Money Pit Inspection Report

Appendices

Appendix A Survey Scopes

Appendix B Survey Reports and Data

Appendix A. Survey Scopes

Caterham-on-the-Hill CCTV Survey Scope

Caterham-on-the-Hill Coulsdon Common Soakaway Survey Scope

Caterham-on-the-Hill Money Pit Survey Scope

CCTV Survey Scope

To:	Survey Company		
From:	William Rust, Atkins	**Email:**	william.rust@atkinsglobal.com
Phone:	01372 754 246	**Date:**	16 Jan 2015
Ref:	5135062_CCTV survey	**cc:**	Clare Grout, Atkins Owen Lee, Surrey County Council
Subject:	Caterham-on-the-Hill Drainage System survey - pipe network CCTV		

Survey Purpose

Atkins are working with Surrey County Council to better understand surface water drainage in Caterham-on-the-Hill. As part of this project, several asset surveys are required. A CCTV survey of the drainage system in this area has previously been undertaken. There are however several missing lengths from this original survey, hence necessitating additional survey work.

Survey Scope

CCTV survey of surface water sewer lengths near Westway Common in Caterham-on-the-Hill, Surrey. This CCTV survey should be accompanied by a report which provides as a minimum: pipe dimensions, pipe invert levels, pipe condition and description of connectivity to upstream and downstream pipes.

Required Survey Lengths

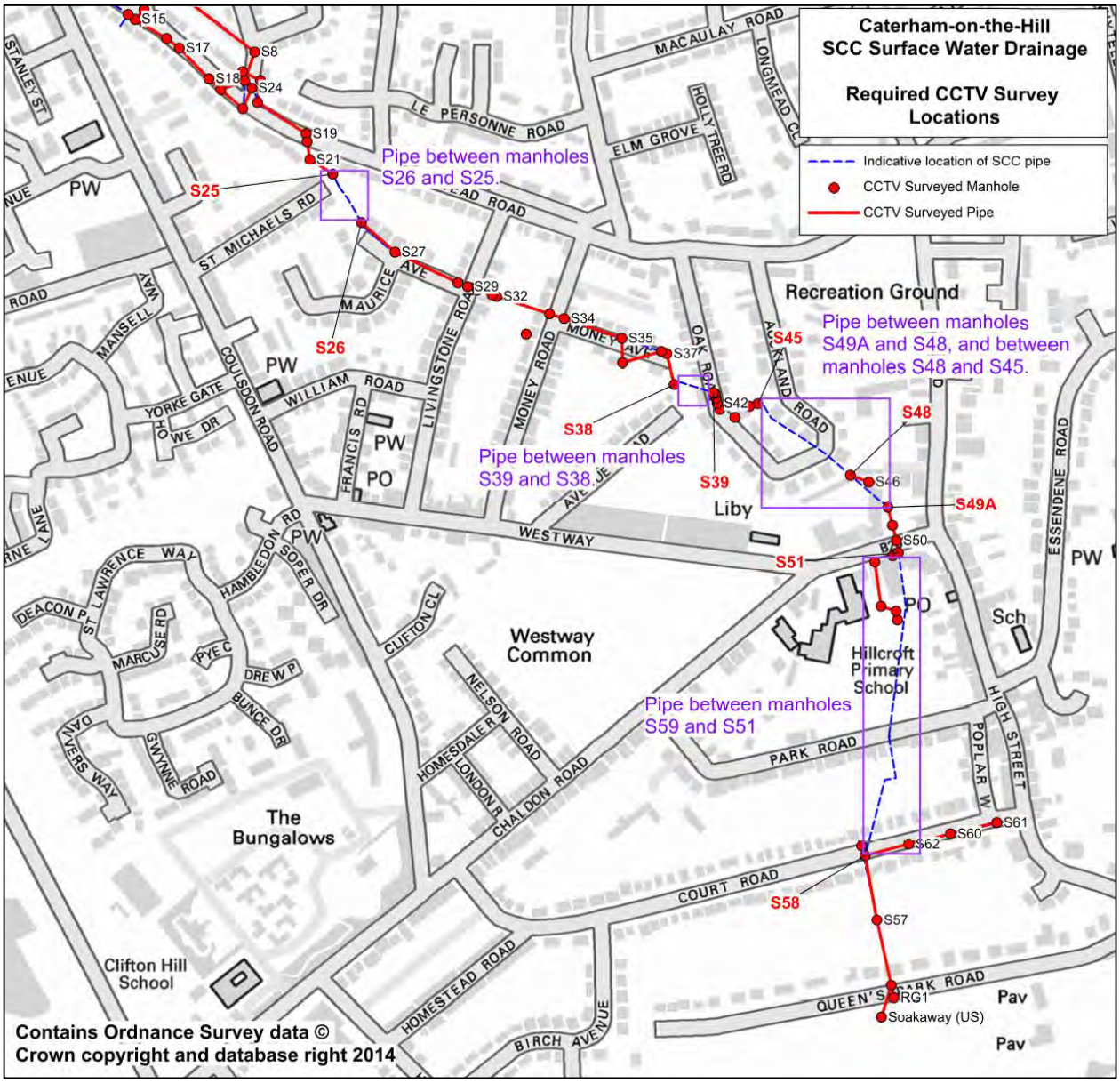
1. Between manholes S58 (Court Road) and S51 (Chaldon Road) – approx. chainage: 320m
2. Between manholes S49A (Nr. Chaldon Road) and S45 (Nr. Oak Road) – approx. chainage: 170m
3. Manholes S39 (Oak Road) and S38 (Nr. Money Avenue) – approx. chainage: 40m

Approximate total chainage: 530m
(Note that survey is not required between S26 and S25 as this is the location of the “Money Pit” asset).

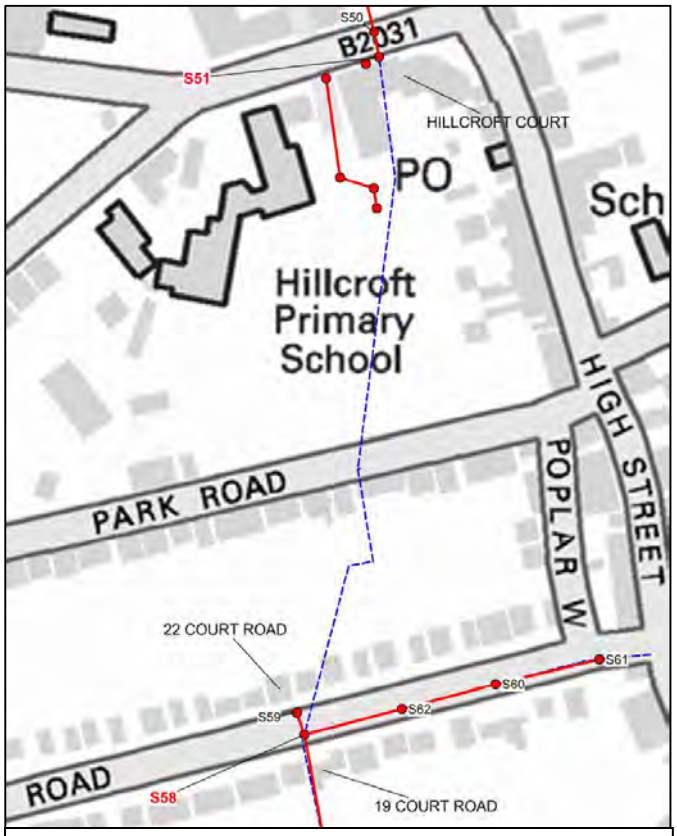
Health and Safety

Any contractor will be required to submit their risk assessment before undertaking the survey work detailing measures to ensure the health and safety of their surveying staff.

CCTV Survey Scope



CCTV Survey Scope

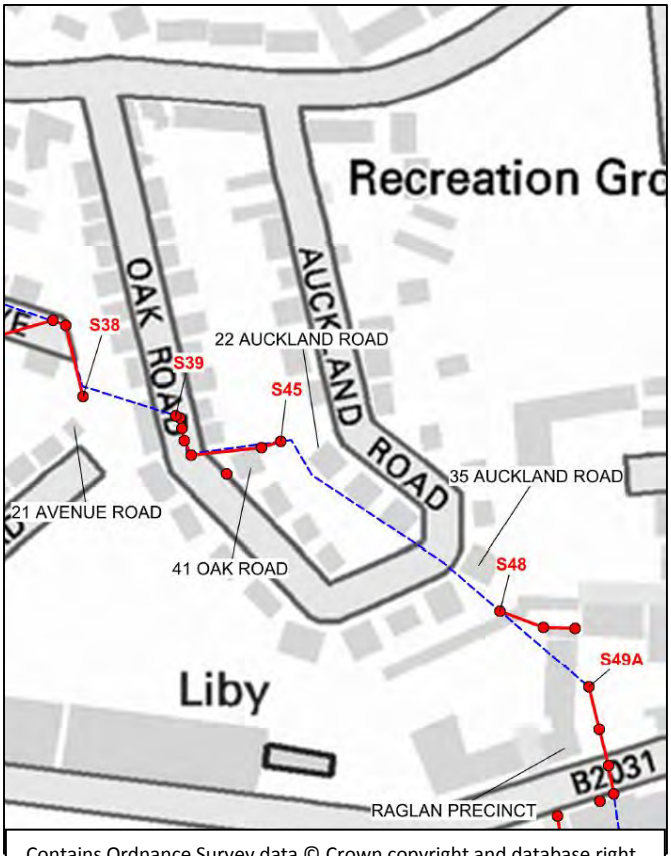


Survey Section 1

Manhole S58 in the highway outside 19 Court Road.
BNG Reference:
***X** 533,269 : **Y** 155,681.*

To

Manhole S51 to the north of Hillcroft Court on the corner of B2031 and High Street.
BNG Reference:
***X** 533,302 : **Y** 155,986.*



Survey Section 2

Manhole S49A in the courtyard of Raglan Precinct.
BNG Reference:
***X** 533,292 : **Y** 156,032.*

To

Manhole S45 near 41 Oak Road.
BNG Reference:
***X** 533,160 : **Y** 156,136.*

Survey Section 3

Manhole S39 in the highway outside 44 Oak Road.
BNG Reference:
***X** 533,115 : **Y** 156,147.*

To

Manhole S38 in the curtilage of 21 Avenue Road.
BNG Reference:
***X** 533,076 : **Y** 156,155.*

Soakaway Survey Scope

To:	Survey Company		
From:	William Rust, Atkins	**Email:**	william.rust@atkinsglobal.com
Phone:	01372 754 246	**Date:**	16 Jan 2015
Ref:	5135062_Soakaway survey	**cc:**	Clare Grout, Atkins Owen Lee, Surrey County Council
Subject:	Caterham-on-the-Hill Drainage System Survey – Coulsdon Common Soakaway		

Survey Purpose

Atkins are working with Surrey County Council to better understand surface water drainage in Caterham-on-the-Hill. As part of this project, several asset surveys are required.

Location

Soakaway Manhole:

Soakaway on Coulson Common located to the north-west of Stites Hill Road.
BNG Reference: ***X*** *532,501****: Y*** *156,985*
See map and photograph below.
The soakaway is located on publically-accessible land adjacent to the road. A temporary wooden fence has been constructed around the soakaway by Surrey County Council.

Pre-Survey Scope (if a pre-survey is required)

It is not known whether a pre-survey will be required. If so, an initial survey should be undertaken to ascertain access to soakaway and feasibility of a drop test/infiltration test within the soakaway. Any pre-survey (where necessary) should also include measurement of internal dimensions.

Survey Scope

Soakaway inspection and Infiltration Test.

Survey Output Requirements:

- Dimensions (including internal surface area)
- Soil Infiltration rate drop test
    - If access is sufficient, to be conducted within the soakaway
    - If access is not sufficient, a trail pit to be dug adjacent to the soakaway to measure infiltration.
- Fill Material details.
- Asset condition (i.e. levels of siltation / temporary or permanent blockage and cracks) and concluding comments about whether the soakaway is still an effective drainage asset.

Health and Safety

Any contractor will be required to submit their risk assessment before undertaking the survey work detailing measures to ensure the health and safety of their surveying staff.

Soakaway Survey Scope

Contains Ordnance Survey data © Crown copyright and database right 2015.

Contains Google Street view imagery ©

Soakaway Survey Scope

Photograph of the soakaway manhole

Money Pit Survey Scope

To:	Survey Company		
From:	William Rust, Atkins	**Email:**	william.rust@atkinsglobal.com
Phone:	01372 754 246	**Date:**	16 Jan 2015
Ref:	5135062_Money Pit survey	**cc:**	Clare Grout, Atkins Owen Lee, Surrey County Council
Subject:	Caterham-on-the-Hill Drainage System Survey – The Money Pit		

Survey Purpose

Atkins are working with Surrey County Council to better understand surface water drainage in Caterham-on-the-Hill. As part of this project, several asset surveys are required.

Asset Location and Information

"The Money Pit" is a Surrey County Council owned asset located under a concrete slab in a fenced-off area of open ground between St. Michaels Road and Banstead Road (B2030) in Caterham-on-the-Hill, Surrey. There is a small alley which runs between the two roads. The fenced off compound is accessed through a padlocked pedestrian gate, the key for which is held by Surrey County Council.

*BNG Reference: **X** 532746 : **Y** 156347.*

Maps and photographs are provided below.

There are 7 inspection access covers in the concrete slab which provide access to the Money Pit. These are all within the fenced-off compound. The compound area is currently partially overgrown.

In addition to the Money Pit inspection access covers located within the compound, there is a manhole on the surface water network upstream of the Money Pit, as follows:

Manhole S26 in the green space West of 41 Maurice Avenue.
*BNG Reference: **X** 156,318 **: Y** 156,318.*

It is not known whether there is an outflow from the Money Pit. There is a downstream manhole on the main surface water pipe system located as follows:

Manhole S25 in the curtilage of 99 Banstead Road.
*BNG Reference: **X** 532,733 : **Y** 156,367.*

The exact purpose of the Money Pit asset is unknown, but it is believed to be connected to the surface water drainage system in Caterham-on-the-Hill and provides a storage and/or a soakaway function. Details of the connectivity are however not known.

An inspection undertaken in 1992 described the asset as follows: "A large rainwater soakaway constructed of concrete culverts. English bond brick retaining walls and beam and block soffit covered by a concrete slab. The secondary beams supporting the blocks and concrete slab are supported by larger transverse beams which in turn are supported by brick piers." The same inspection report provides indicative asset dimensions of: "Length 37m, width 18.5m and depth 15m".

Asset Condition Survey Scope

Asset condition survey of the "Money Pit".

Survey Output Requirements:

- Asset construction material and function (whether it has a soakaway function or is just storage)
    - If it is believed to have a soakaway function; details of any fill material and condition of this to determine whether the soakaway is able to still function effectively.
- Asset condition (i.e. levels of siltation / blockage and cracks).

Money Pit Survey Scope

More Detailed Asset Survey Scope

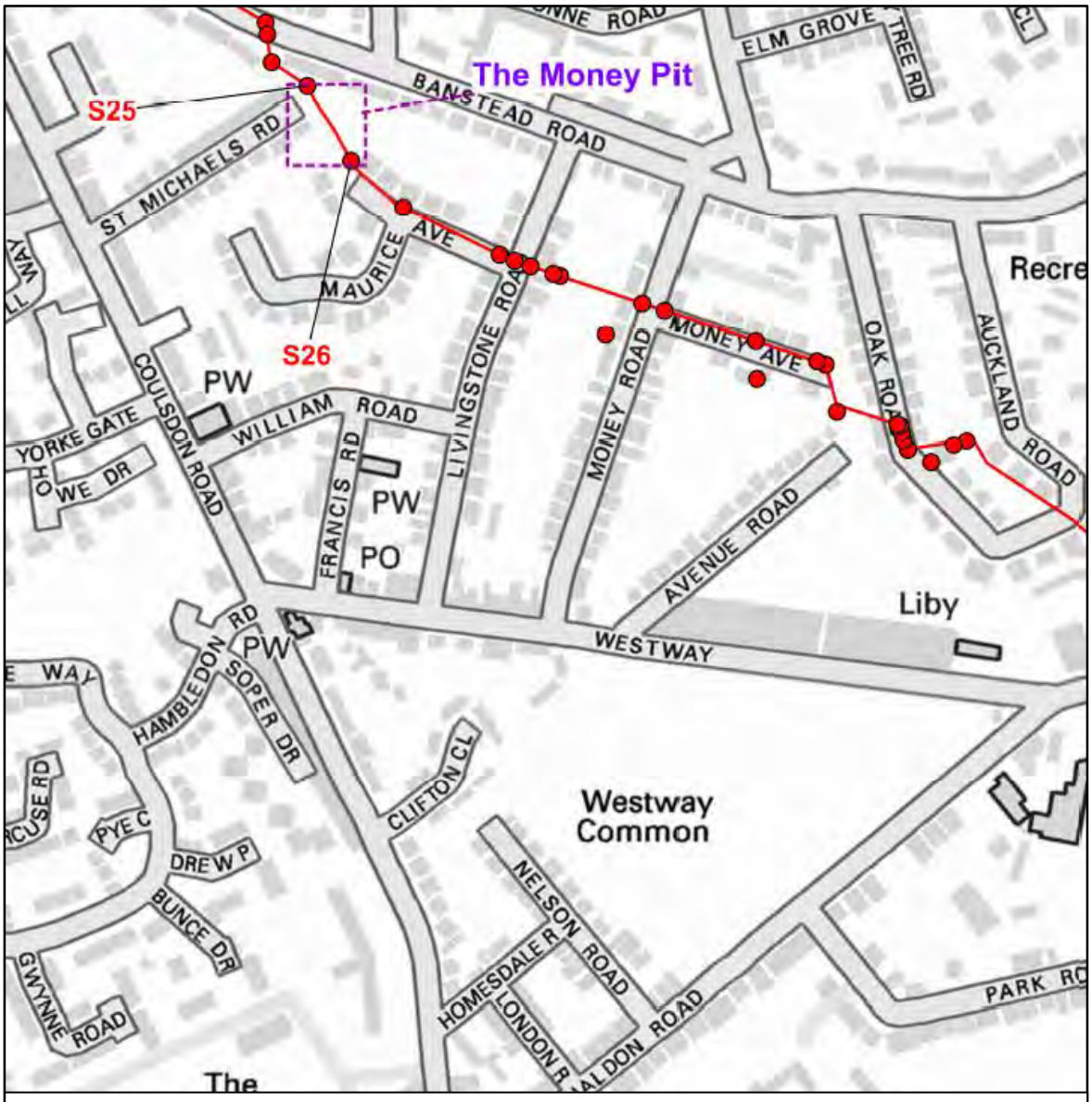
As well as a quote for the asset condition survey, we potentially require a more detailed survey of the asset.

Survey Output Requirements:

- Dimensions of the Money Pit (length, width, depth).
- Dimensions and locations of any incoming or outgoing pipes.
- Invert levels (if necessary can be provided as a depth below ground level) of any pipe inlet and outlets.
- Connectivity of any pipes with the surrounding surface water drainage system.

Health and Safety

Any contractor will be required to submit their risk assessment before undertaking the survey work detailing measures to ensure the health and safety of their surveying staff.



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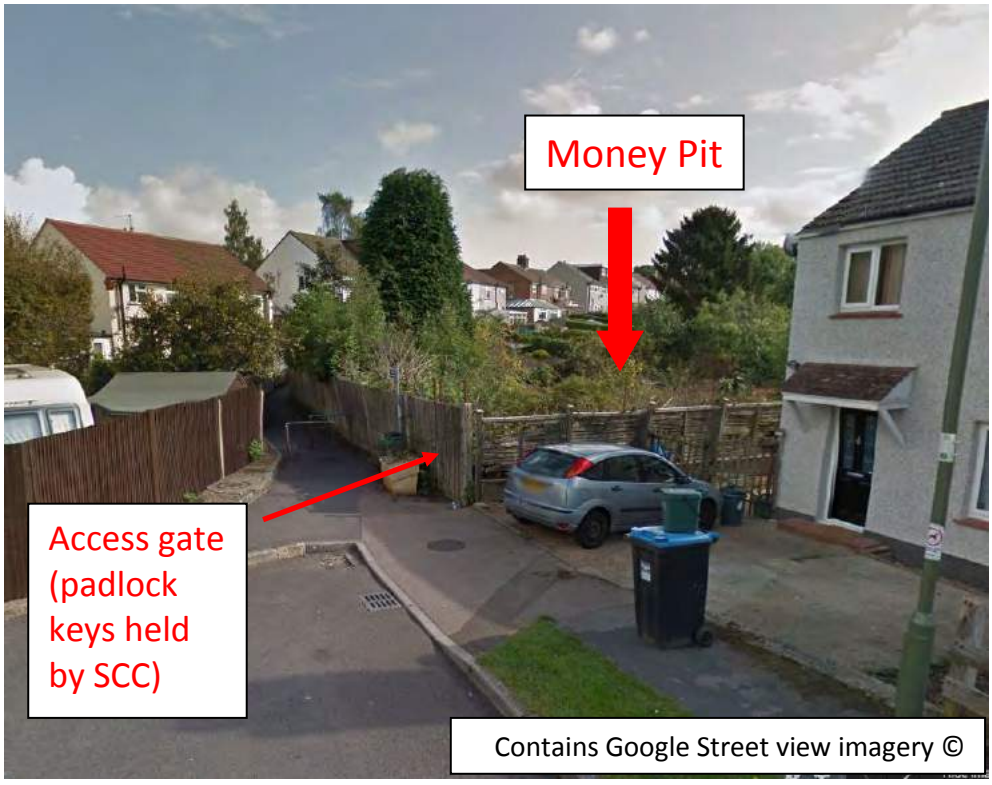
Money Pit Survey Scope



Money Pit Survey Scope

Photograph looking into the Money Pit compound area

CCTV survey (2013) – image from the surface water pipe looking downstream into the Money Pit.

Appendix B. Survey Reports and Data

CCTV survey (AB Pipeline Services, March 2013)

CCTV survey (Dene-Tech, May 2015)

Coulsdon Common Soakaway survey (Dene-Tech, May 2015)

Money Pit survey (Dene-Tech, May 2015)

B.1. CCTV survey (AB Pipeline Services, March 2013)

A CCTV survey of the main surface water drain in Caterham-on-the-Hill was commissioned by SCC and undertaken in March 2013 by AB Pipeline Services Limited. This survey covered the surface water drain between Queens Park Road in the South and Stites Hill Road in the North. The survey provided information relating to the dimensions and condition of each length of pipe. Locations of blockage issues (caused by siltation, collapse or root growth) were identified, and a severity score allocated, with 0 being not an issue and 5 being a very severe issue. Table B-1 below contains information about all 68 surveyed pipe lengths.

Table B-1 Summary 2013 CCTV survey results

Id	Pipe diameter (mm)	Max % blockage	Cracks	Roots	Silt	No. of incoming connections	Max Severity	Comments
1	450	0	N	N	N	0	2	Encrustation Light at Joint from 12 to 12 o'clock (2m)
2	450	0	N	N	N	0	0	
3	450	0	N	N	N	1	0	Connection at 0.3m down diameter 150mm
4	450	10	Y	N	Y	1	4	Connection at 30.4m down diameter 150mm
5	450	0	Y	N	N	1	3	Connection at 83m down diameter 300mm
6	450	0	N	N	N	0	0	
7	450	0	N	N	N	1	1	Connection at 69.7m down diameter 150mm
8	450	0	N	N	N	0	0	
9	375	0	N	N	N	0	1	
10	375	0	N	N	N	0	0	
11	375	0	Y	N	N	0	4	
12	375	0	Y	N	N	0	3	
13	375	0	N	N	N	0	0	
14	375	5	Y	Y	N	0	5	
15	225	0	N	N	N	0	1	Joints displaced Medium
16	450	0	N	N	N	0	0	
17	375	10	N	N	Y	0	1	Debris and silt
18	375	20	N	N	Y	0	1	Debris and silt
19	450	0	N	N	N	0	0	
20	225	0	N	N	N	0	0	
21	450	10	Y	N	N	0	5	Deformed pipe and part collapse
22	450	30	N	Y	N	0	5	
23	450	30	N	Y	N	0	5	
24	375	0	N	N	N	0	0	Survey abandoned at 17m due to water level
25	450	0	N	N	N	0	0	
26	450	0	N	N	N	0	0	
27	450	0	N	Y	N	0	1	High water levels up to 40% diameter loss

Id	Pipe diameter (mm)	Max % blockage	Cracks	Roots	Silt	No. of incoming connections	Max Severity	Comments
28	450	0	Y	Y	N	0	5	
29	450	0	N	N	N	0	0	Sharp line deviations
30	375	0	Y	N	N	0	2	
31	225	0	Y	N	N	0	4	TWO PIPES - Pipe A. Broken joints
32	225	10	Y	N	N	0	5	TWO PIPES - Pipe B. Part collapsed and deformations.
33	450	20	N	Y	N	1	5	Connection intruding at 9.3m down diameter 150mm with 150mm intrusion (severity 4)
34	450	0	N	Y	N	0	1	NOTE: Random polyline - Pipe connects from S26 to 'Money Pit', there is no location provided for 'Money Pit'
35	450	0	Y	N	N	1	4	Connection intruding at 19.2m down diameter 150mm with 50 intrusion. High water levels up to 30% diameter loss.
36	450	15	N	N	Y	2	1	Connection at 32.2m down and 53.8m down, both diameter 150mm
37	450	0	N	N	N	0	1	
38	450	0	Y	N	N	3	3	Connection at 0.3m down, 5.3m down and 5.7m down, all diameter 150mm
39	450	0	N	N	N	0	0	
40	450	0	N	N	N	0	0	
41	450	5	N	Y	Y	2	5	Connection at 42m and 42.8m down both diameter 150mm
42	450	0	N	N	N	1	0	Connection at 4.7m down diameter 150mm
43	450	0	N	N	N	0	0	
44	450	0	N	N	N	0	0	
45	450	0	N	N	N	0	0	
46	450	0	N	N	N	0	0	
47	450	0	N	N	N	0	0	
48	450	0	Y	N	N	0	3	
49	450	0	N	N	N	0	0	
50	400	0	Y	N	N	0	3	
51	450	0	Y	N	N	0	2	
52	450	0	N	N	N	0	0	
53	450	0	N	N	N	0	0	
54	450	20	N	Y	N	0	5	
55	450	0	N	N	N	0	0	
56	450	20	N	Y	N	0	5	Broken joint 10.6m down including missing pipework
57	375	0	N	N	N	0	3	Displaced brick, positions vary
58	675	5	N	N	Y	0	1	Debris and silt

Id	Pipe diameter (mm)	Max % blockage	Cracks	Roots	Silt	No. of incoming connections	Max Severity	Comments
59	675	5	N	N	Y	0	1	Debris and silt
60	300	0	N	N	N	0	0	
61	225	0	Y	N	N	0	4	Multiple fractures
62	225	0	N	N	N	0	0	Survey abandoned due to water level (20% diameter loss)
63	225	50	Y	Y	N	3	5	Significant collapses and broken pipes. Connections at 11.1m, 16.4m, 26.3m with 100mm, 150mm, 100mm respective diameters.
64	225	0	N	N	N	3	3	Open Joint Medium. Connections at 23.9m, 28m and 38.2m down, all diameter 100mm
65	225	0	Y	Y	N	0	3	
66	150	30	Y	Y	N	0	5	S61 is surcharged - unable to unblock. Suspected collapse.
67	150	0	Y	Y	N	0	4	Hole in pipe, broken pipe at several locations
68	150	0	Y	N	N	0	3	

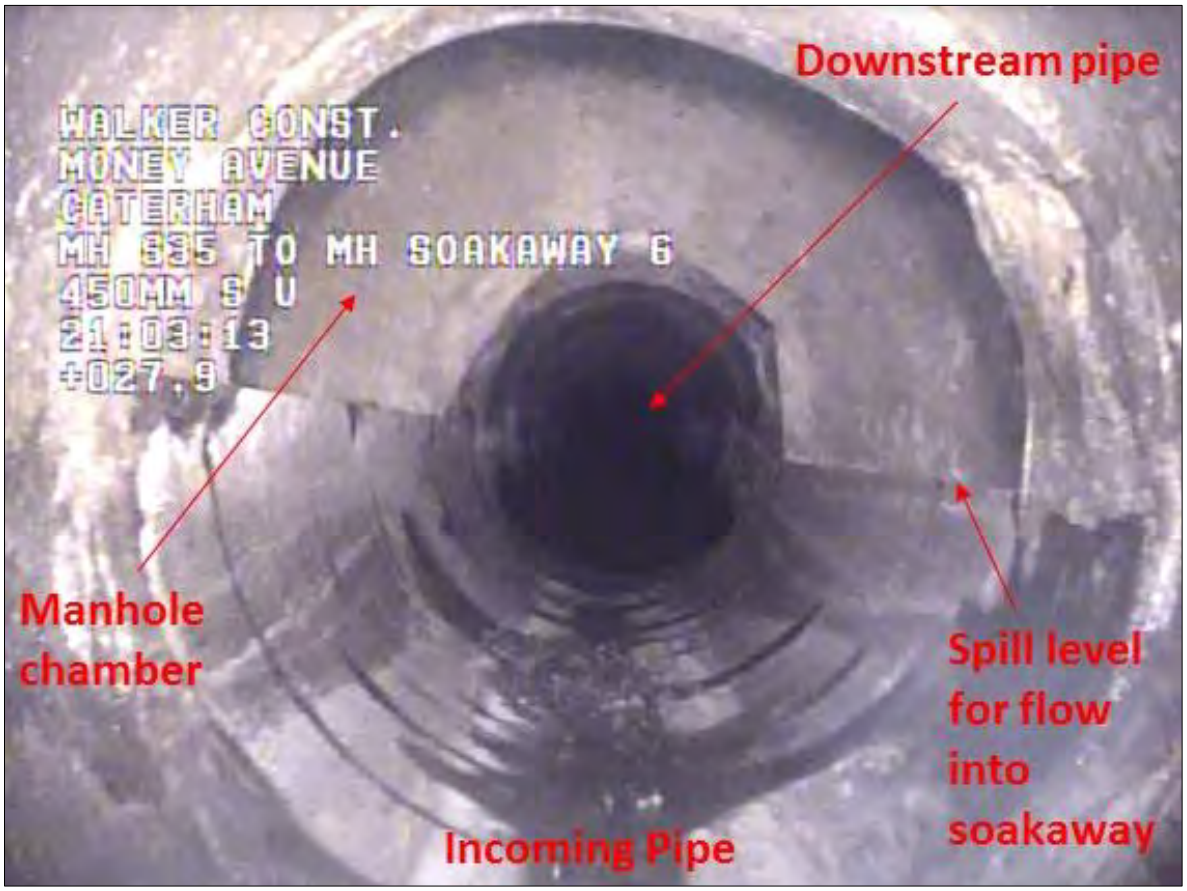


Figure B-1 CCTV photo of soakaway 2 (Money Avenue)

Figure B-2 CCTV photo of soakaway 3 (Junction of Campbell Road and Banstead Road)

Figure B-3 CCTV photo of soakaway 4 (Junction of Milton Road and Banstead Road)

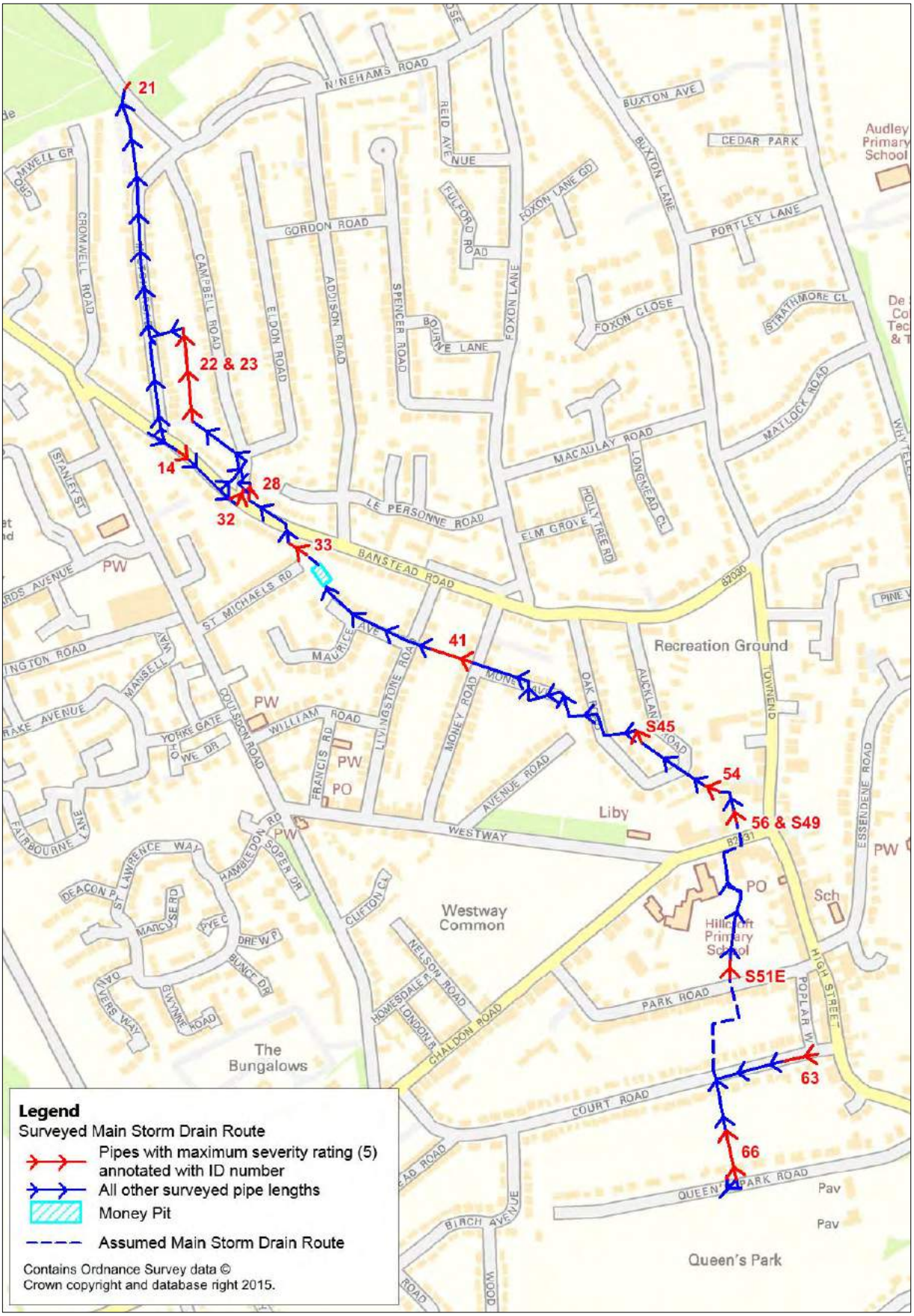
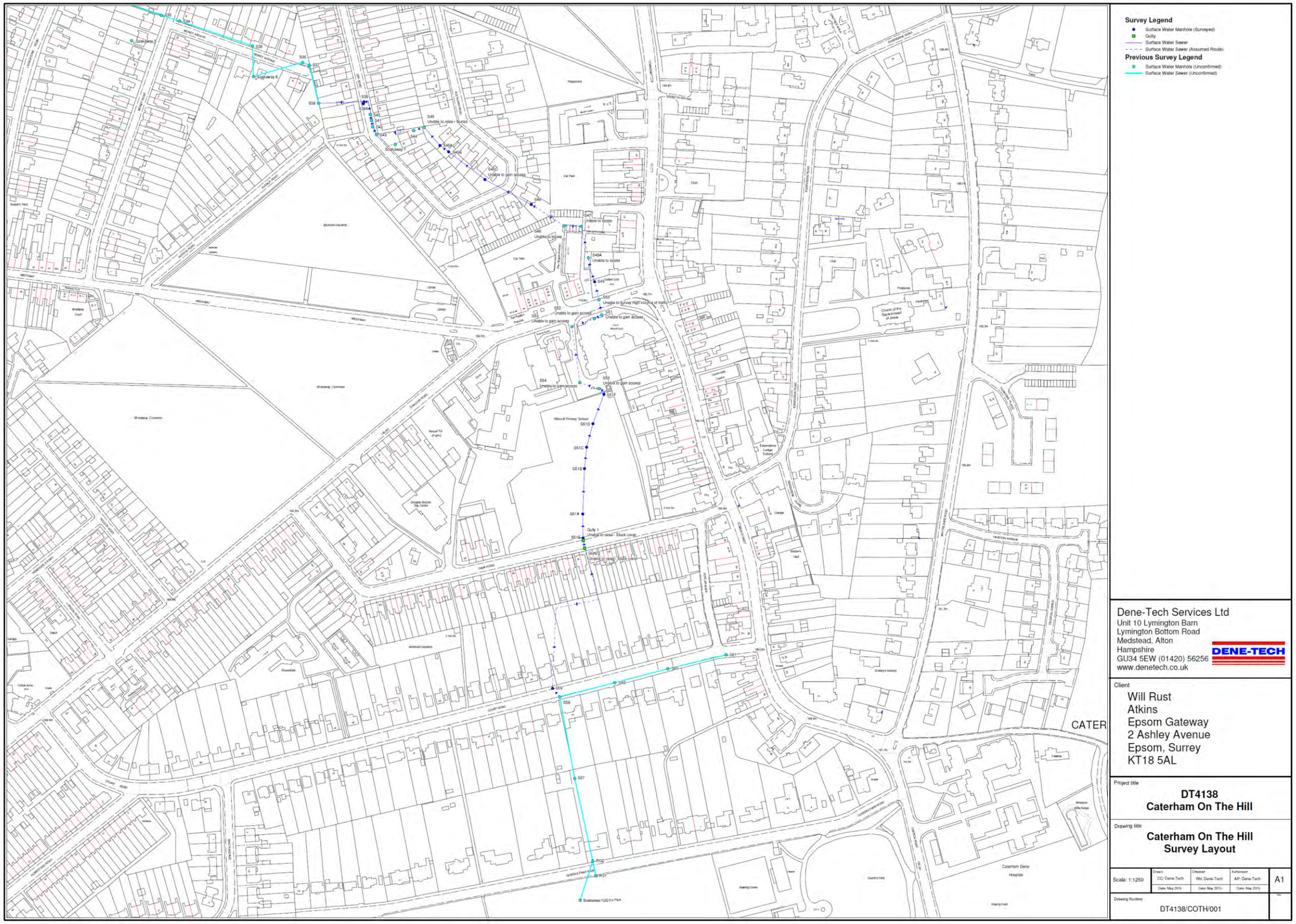


Figure B-4 Map of CCTV-surveyed pipe lengths

B.2. CCTV Survey (Dene-Tech, May 2015)



B.3. Coulsdon Common Soakaway Survey (Dene-Tech, May 2015)

Survey and Inspection of Stites Hill Soakaway Chamber Caterham

Survey Date – 01.05.15
Location – Opposite Number 124 Stites Hill Road, Caterham
Grid Coordinates – 532502, 156986
Surveyor – Richard Worman

Stites Hill Soakaway Chamber is at the end of a surface water culvert that runs through Caterham. Its approximate size is 1.5m diameter and over 6m deep.
It is a concrete ring structure covered with a concrete slab and single access opening. The cover and frame were found to have rust issues although not to a dangerous state.
The slab is covered with vegetation with small trees growing on top.

Access was made into the chamber and measurements and assessments were made from the base.
The chamber has a silt base at 6.05m and no solid base to the structure was located.
Only 1 pipe was surveyed entering the chamber, a 450mm concrete culvert connection at a depth of 2.29m. No other pipes were located in the chamber. There is evidence of surcharge in the chamber to the slab level.

The chamber rings and slab appeared to be structurally sound with no evidence of cracking or spalling. There are 50mm soak holes in the base rings of the chamber up to 1.5m above the silt level. The holes are spread randomly roughly at 400mm intervals. No soak holes are above this level.

A drop test was carried out at the site to calculate how efficient the soakaway was performing. Water was artificially discharged into the chamber via a tanker to a depth of 1m above the silt level. The water level was timed dropping every 10cm to give an average soak away rate of 0.25L/S.

DENE-TECH SERVICES

Manhole Data (STC25)

NODE REF: SOAKAWAY.

NGR:

Drainage area code

(1)

Location: STITES HILL ROAD IN VERGE OPPOSITE FOOTPATH

	Year laid	2	Status	PJ	Function	S	Node type	M	Survey Date		
COVER	Shape	D	Hinge?	N	Lock?	N	Duty	H	Size	610 x 610	Toxic? N
SHAFT	S/E?	N			Depth	520			Size	520 Ø	Vermin? N
CHAMBER	Soffit	S	Steps	15	Ladders	0	Landings	0	Size	1500 Ø	Constr P

Flow Depth (mm): 0

Silt Depth (mm):

Surch Depth (m): 0.65

COVER LEVEL: 152.395

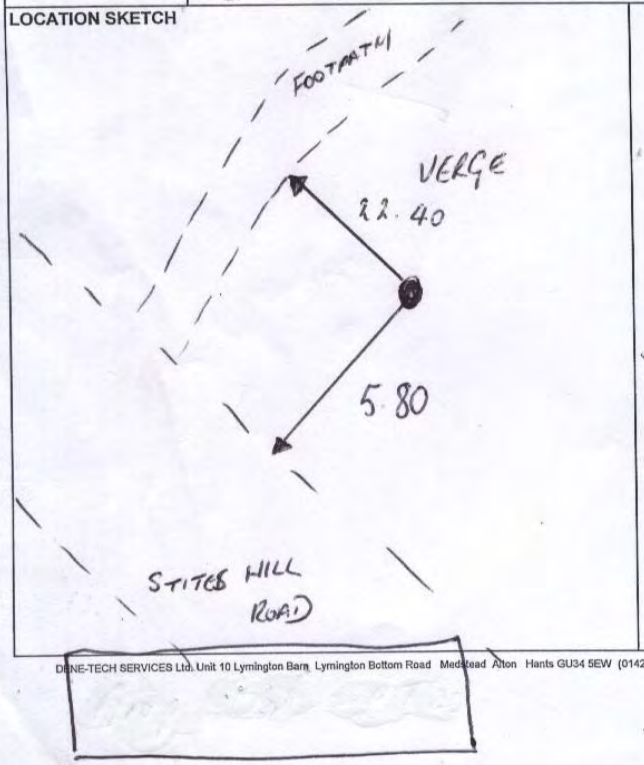
IN	clock time	Upstream MH Ref.	Pipe Size		Pipe shape	Backdrop dia.	Pipe mat.	Lin. Mat.	Depth from cover	INVERT LEVEL
A	8	SWA.	450	x	C		C.O		2.29.	150.105
B				x						
C				x						
D				x						
E				x						
F				x						

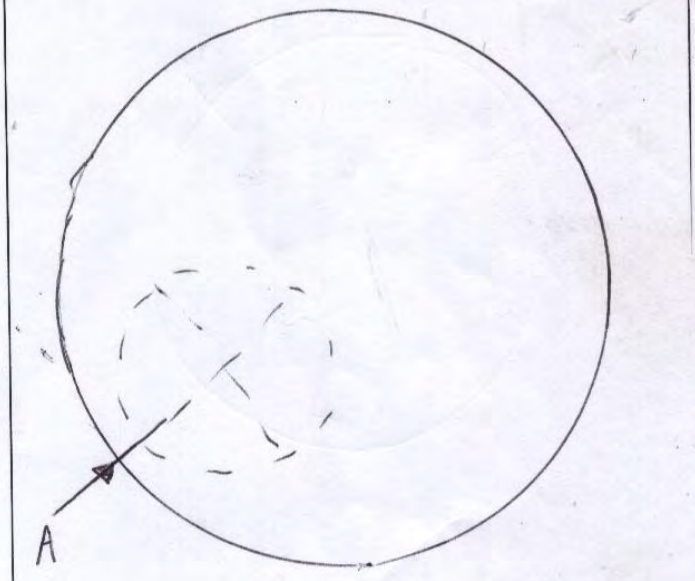
OUT	clock time	Downstream MH Ref.			Pipe Shape	Crit				
X				x						
Y				x						
Z				x						

Condition (Y if attn req'd): Cover | Irons/lad | Shaft | Chamber | Benching | Other

REMARKS: * THIS IS A SOAKAWAY HOLE'S IN CHAMBER WALL. UNABLE TO PROBE THROUGH SILT DEPTH TO TOP OF SILT of SOAKAWAY. 6.05m Surcharge of 0.65 m.

LOCATION SKETCH





Stites Hill Soakaway

Drop Test Survey

DENE-TECH

DENE-TECH SERVICES LIMITED

UNIT 10, LYMINGTON BARN, LYMINGTON BOTTOM ROAD, MEDSTEAD, Nr. ALTON, HANTS GU34 5EW
Telephone/Fax: 01 420 562 569
E-mail: denetech@globalnet.co.uk

GENERAL INFORMATION

WTW Catchment :	**Caterham**		
Catchment Code :	**N/A**		
Name :	**Stites Hill**		
Eastings :	**532501**	**Northings:**	**156985**
Sewer Record ID :	**N/A**		
Operational Control :	**N/A**		
Date of Survey :	**1st May 2015**		
Surveyed by :-	**Company Name :**	**Dene-Tech Services Limited**	
	Name of Surveyor :	**Richard Worman**	

OVERFLOW DETAILS

Provided (Yes/No) :	**No**
Type (EO/CSO) :	
Location :	
Screen (Yes/No) :	
Screen Type :	
Bar Spacing (mm) :	
Condition :	
Evidence of Pollution/Use (Yes/No) :	

Number of Pumps :	**N/A**

RISING MAIN DETAILS

Length (m) :	**N/A**
Diameter (mm) :	**N/A**
Material :	**N/A**

SURGE PROTECTION (Yes/No)	**N/A**
Type :	

PUMP DROP TESTS

Soakaway size	**1.50m Diameter**
Test Area (m^2)	**1.77**
Test Volume (m^3)	**0.177**

Soakaway filled with tanker water and tests taken over 100mm to monitor rate of drop

	Test Start Level m(AOD)	Test Stop Level m(AOD)	Test No	Drop		Fill		Net Output
				(secs)	(l/s)	(secs)	(l/s)	(l/s)
	150.30	150.20	1	712	0.25	N/A		0.25
	150.30	150.20	2	746	0.24	N/A		0.24
	150.30	150.20	3	780	0.23	N/A		0.23
				Average Output (l/s)				**0.24**
				Average Output (l/s)				
				Average Output (l/s)				
				Average Output (l/s)				
				Average Output (l/s)				
				Average Output (l/s)				

B.4. Money Pit Survey (Dene-Tech, May 2015)

Survey and Inspection of The Money Pit Storage Chamber Caterham

Survey Date – 30.04.15
Location – Adjacent Number 29 St Michaels Road, Caterham
Grid Coordinates – 532733, 156353
Surveyor – Richard Worman

The Money Pit is a large storage / Soakaway Chamber on a surface water culvert that runs through Caterham. Its approximate size is 36.12m x 17.85m and 1.5m deep.
It is a brick structure covered with a concrete block and beam slab. The slab is supported by 55 x 470mm x 470mm brick piers at 2.60m spacing's. There are 7 access inspection access covers at random intervals in the slab to enter the chamber. These covers and frames were found to have rust issues although not to a dangerous state.
The slab is covered with 80% vegetation with small trees growing on top. Soil and roots had to be cleared to access the covers. Due to the growth we were unable to assess the condition of the slab surface.

Access was made into the chamber from various cover openings. Measurements and assessments were made from each site.
The chamber was noted to have large silt deposits in most areas, averaging about 400mm in depth. Due to this we were unable to leave the base of the opening area.
Only 2 pipes were surveyed entering the chamber, a 450mm concrete culvert and a 150mm private connection. No pipes were spotted leaving the chamber. It is assumed all other pipes are under the silt level. There is evidence of surcharge in the chamber to the slab level.

The chamber wall and brick piers all seemed structurally sound with no evidence of cracking or displaced brickwork. The mortar joints seemed in good condition. It was noted the mass roots were growing through the chamber slab from the vegetation on the surface. These roots had spread across the under surface of the slab and are growing down the brick piers and into the silt at the base of the chamber.

It is recommended that the surface slab is cleared of all vegetation and the roots treated to avoid further ingress into the chamber. Also suggested would be to clear silt at the base of the chamber to open up any pipes that may be entering or leaving.

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