# 3. Sewerage Infrastructure Requirements and Costings

The assessment of growth on the sewerage infrastructure has been based on the use of AWS Infoworks sewer network models to determine the impact of growth scenarios on the hydraulic capacity of the sewer network and the magnitude and frequency of intermittent discharges.

## 3.1 Downham Market

The Downham Market model incorporates Downham Market town centre and the villages of Crimplesham and Wimbotsham. These drain to Downham Market WWTW. The catchment has a population of approximately 10,000 and the foul/combined system has a total of seven pumping stations (four with overflows), four combined sewer overflows (CSOs) and five bifurcations.

The available model was a model enhancement completed in October 2007. This model was updated to include schemes (Dennis Sneezum CSO) and developments (two modelled locations, 510 population) completed since October 2007, and amendments to the flow to full treatment at the WwTW (orifice control set to reduce the flow to full treatment from 85l/s to 80l/s), with a number of major blockages removed (blockages being assumed to be addressed as part of any ongoing or future maintenance).

A Base Future Model was derived from the Existing Model. This included known future developments (12 modelled locations, 2,644 population), and future schemes (an upgrade at the WwTW, upsizing of the existing sewers through the Hayfields Development Site, online storage downstream of the Railway Road Site, and storage at Fairfields Pumping Station).

A number of limitations of the model should be considered. There was a blockage at Elizabeth Avenue causing a varied spill level at the bifurcation which changed between verification events. There is a lack of hydraulic correlation between the level in the balancing tank and the flows leaving the balancing tank for full treatment (the WwTW balancing tank levels and flood volumes should be treated with some caution). There was a significant surcharge response across the network, based on 3 pumping stations switching off for 2-3hrs after the rainfall had finished during Event E. There is a lack of as built or survey data for the area around the Dennis Sneezum CSO. There is some uncertainty in the accuracy of sources of data in some areas, due to using data in the original model that was flagged as ‘old plans’, and conflicts with AWS network data in some areas. There are discrepancies between observed and modelled pump rates, and also between verification Events C and D.

Apart from the future developments added to the model as described above, the impact of an additional 500 proposed properties at one of four possible locations around the perimeter of the catchment was investigated. Five year and 30 year return period design storms were set up to assess flooding and hydraulic detriment. A fully stochastic 10 year time series was generated within STORMPAC and used in the assessment of the proposed development on spills.

The measures described in the following sections would be required to avoid any increase in sewer flooding and changes in discharges to CSOs. If these measures are carried out there would be no need to apply for changes in the consents.

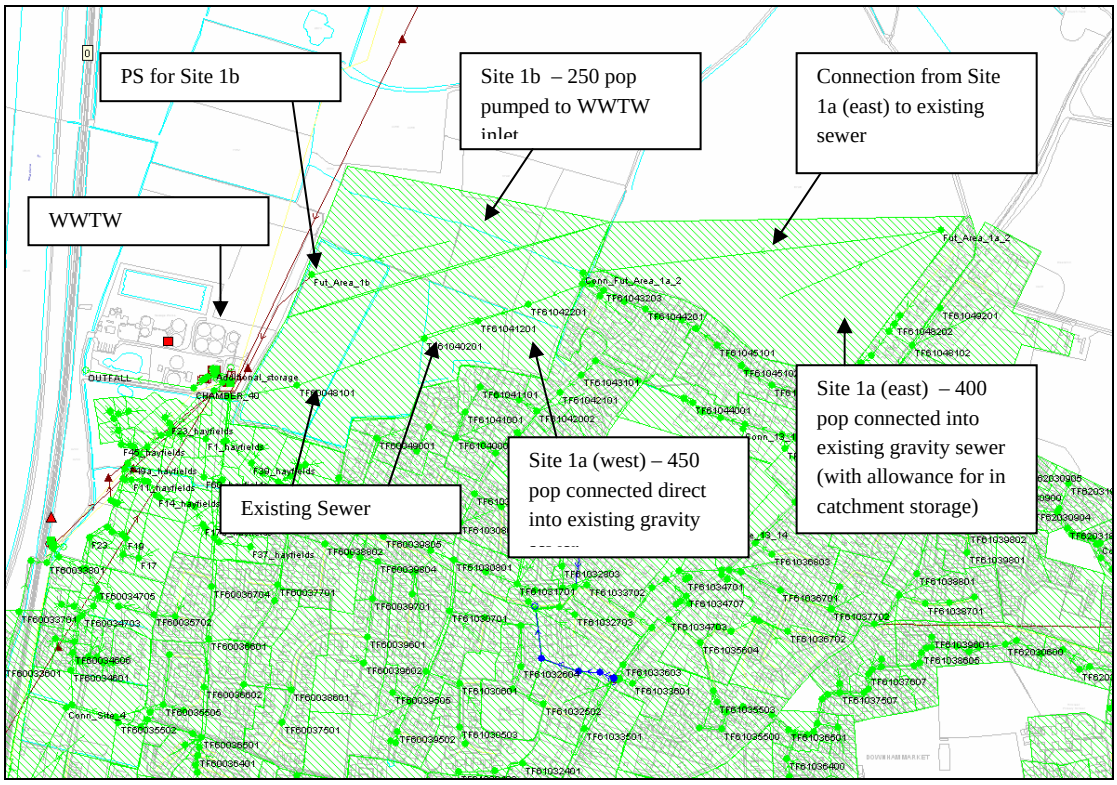
### 3.1.1 Development Site 1

Development Site 1 is situated to the north of the town of Downham Market on rural/ agricultural land. Downham Market WWTW is situated a short distance to the west of the proposed development site. Land availability around the WwTW is an issue and Anglian Water has informed us that they would object to this site on ground of proximity to the sewage works. Downham Market WwTW is likely to require process extensions to meet growth and it is important that adequate space is allowed.

The site is split into two areas: 1a and 1b. Area 1a is to the south and adjoins the town of Downham Market. Ground levels from Digital Terrain Data suggest that it should be possible to drain this area into the existing sewer which crosses the open land from east to west before draining into the WwTW. However, area 1b to the north is more remote from this sewer and also at a lower ground level. The ground levels here are typically at the level of the WwTW inlet. Given that the WwTW inlet is only around 1m deep it is unlikely that area 1b can be drained by gravity. Thus, it will be necessary to pump flows from this part of the site to the WWTW inlet.

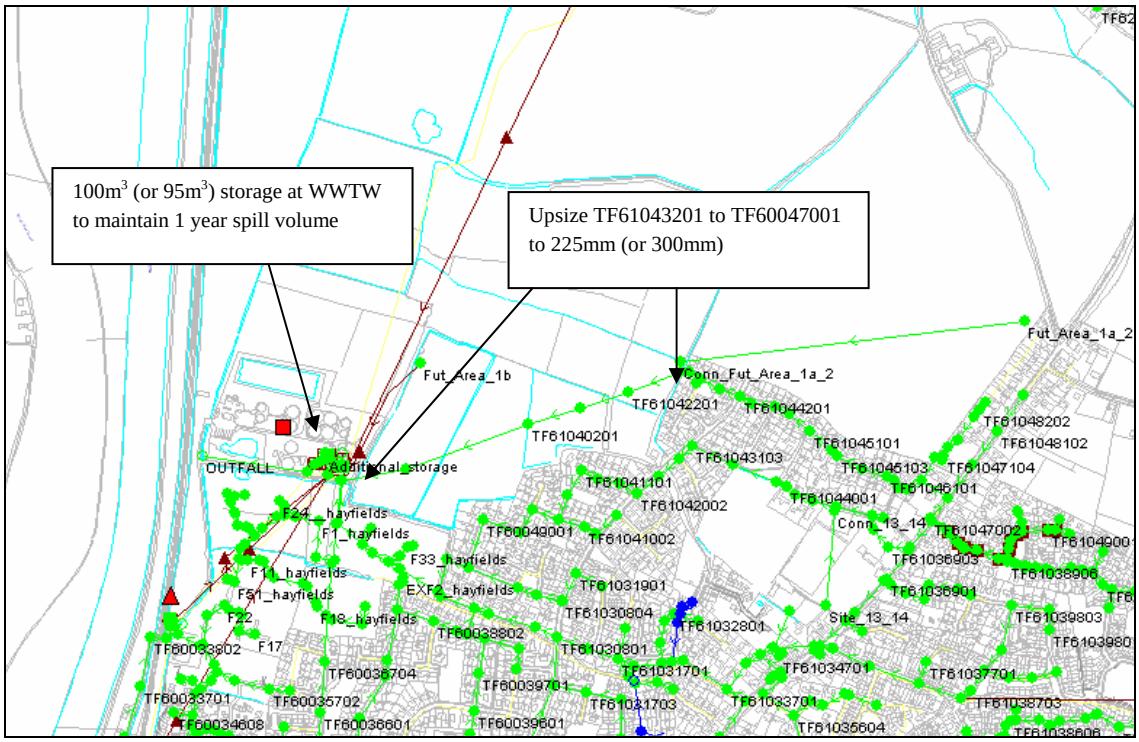
Since Area 1a can be drained by gravity into an existing sewer it is likely that this part of the site would be developed in preference to Area 1b. Thus, the 500 houses have been apportioned across the two sites with as much as possible at Area 1a (which has been subdivided into east and west). The proposed breakdown of development is shown in Figure 3.1 below.

**Figure 3.1 Proposed Development at Site 1 in Downham Market**



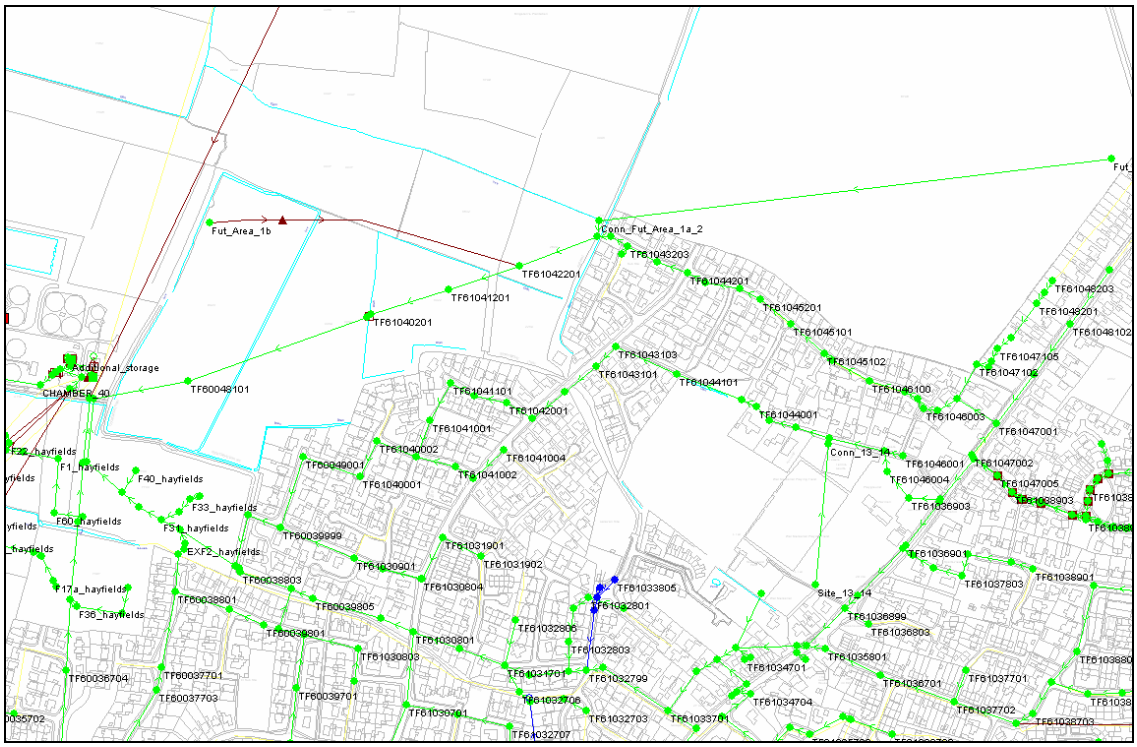

In order to produce no hydraulic detriment it is necessary to upsize the existing 150mm pipe between manholes TF61043201 and TF60047001 to 225mm. This reduces the flooding compared with the Base Future Model, but there is a slight worsening of surcharge levels at some locations with this option. However, there is still over 1m freeboard at the worst affected location. In order to completely alleviate the modelled flooding for a 30 year event at node TF61043201 it is necessary to upsize the existing 150mm pipe between manholes TF61043201 and TF60047001 to 300mm. Additional storage is required at the works to maintain the Base Future Model spills. Based on this it has been determined that for the no hydraulic detriment option a storage volume of 100m$^3$ is required at the WwTW and for the flooding removal option a storage volume of 95m$^3$ is required at the WwTW to maintain the Base Future Model spills.

**Figure 3.2 Upgrading Proposals for Development Site 1 - Option 1**




Option 2 for Site 1 consists of 186.3m of 750mm diameter on line storage upstream of the WwTW. The rising main from the north part of the development site (area 1b) discharges upstream of the on line storage so that flows to the WwTW are maintained as in the Base Future Model. For no hydraulic detriment it is also necessary to regrade 99.4m of 150mm sewer upstream of the proposed on line storage. There is no worsening of surcharge levels with this option. In order to alleviate all modelled flooding for a 30 year event it is necessary to regrade and upsize the same 99.4m length to 225mm.

**Figure 3.3 Upgrading Proposals for Development Site 1 - Option 2**



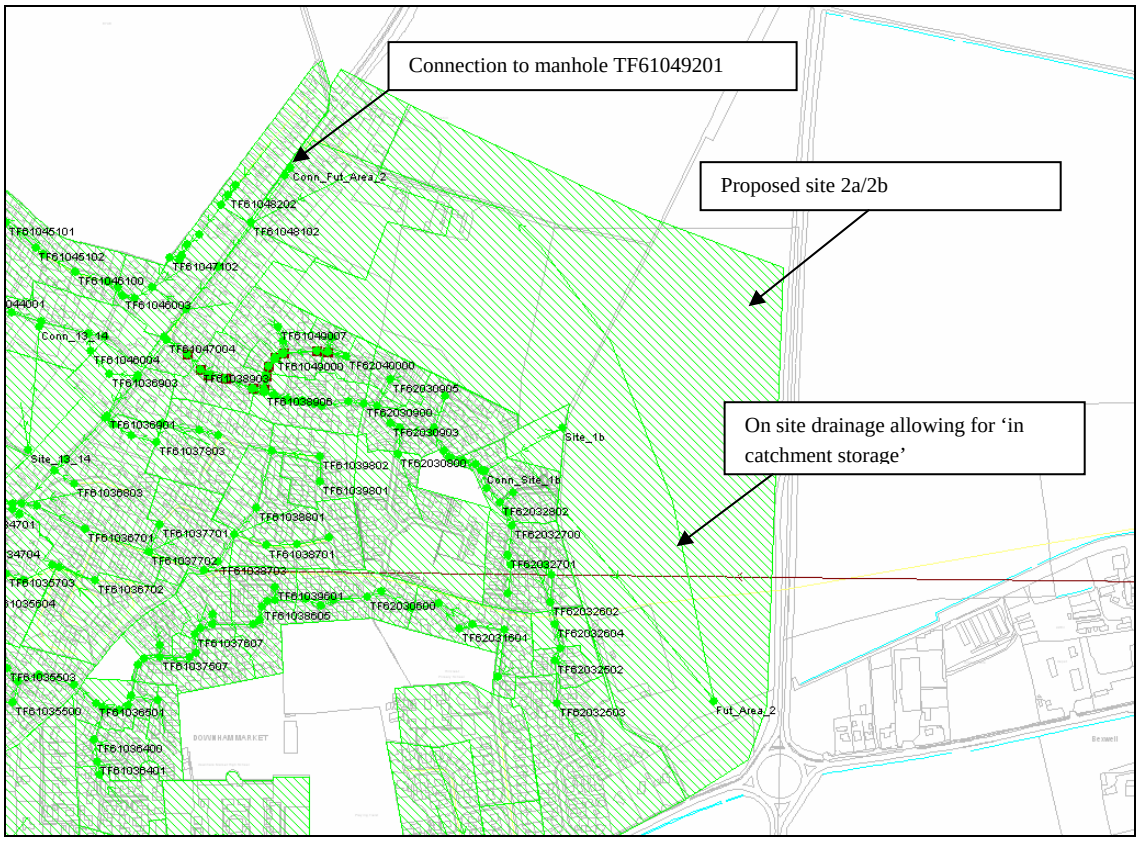

## 3.1.2 Development Site 2

Development Site 2 is situated to the north east of the town of Downham Market on rural/agricultural land. The site is actually split into two areas: 2a and 2b. Area 2a is to the south and adjoins the town of Downham Market. Ground levels from Digital Terrain Data suggest that the site generally slopes from south east to north west. As a result, it should be possible to drain the site by gravity and there are a couple of potential locations at which the site could connect into the existing system.

The first means by which the site could be drained is to connect to the same point as for Site 1 before discharging by gravity to the WwTW. However, this would require approximately 750m of sewer across open rural/agricultural land (across the fields considered as part of Site 1); on top of the on site drainage and whatever upgrades would be required to the existing network to mitigate against deterioration in hydraulic performance. As a result, this is not likely to be a cost effective solution and has not been considered further.

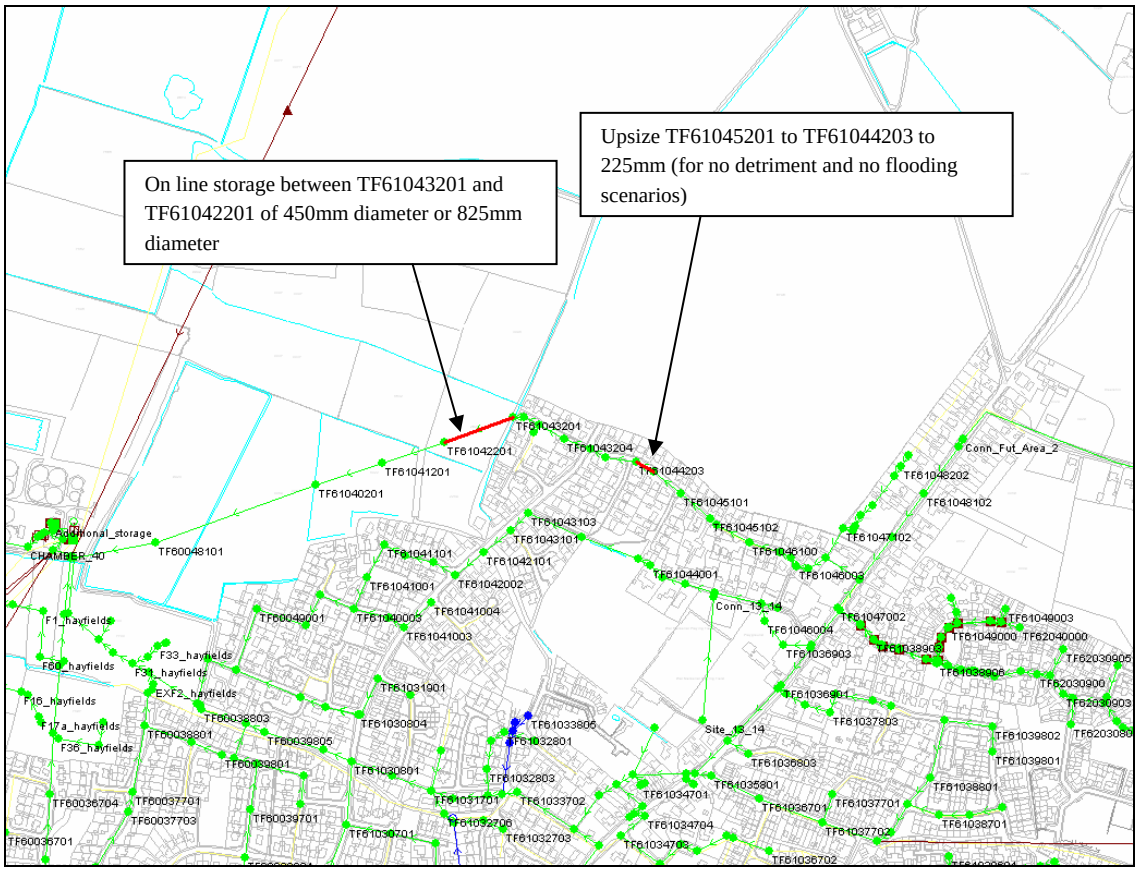
The first option considered in detail for Site 2 is to drain the site by gravity and connect into manhole TF61049201 on Lynn Road to the west of the site. It is likely that Area 2a would be developed in preference to Area 2b, given its proximity to existing properties. The proposed layout of development is shown in Figure 3.4 below.

**Figure 3.4 Proposed Development at Site 2 in Downham Market - Option 1**



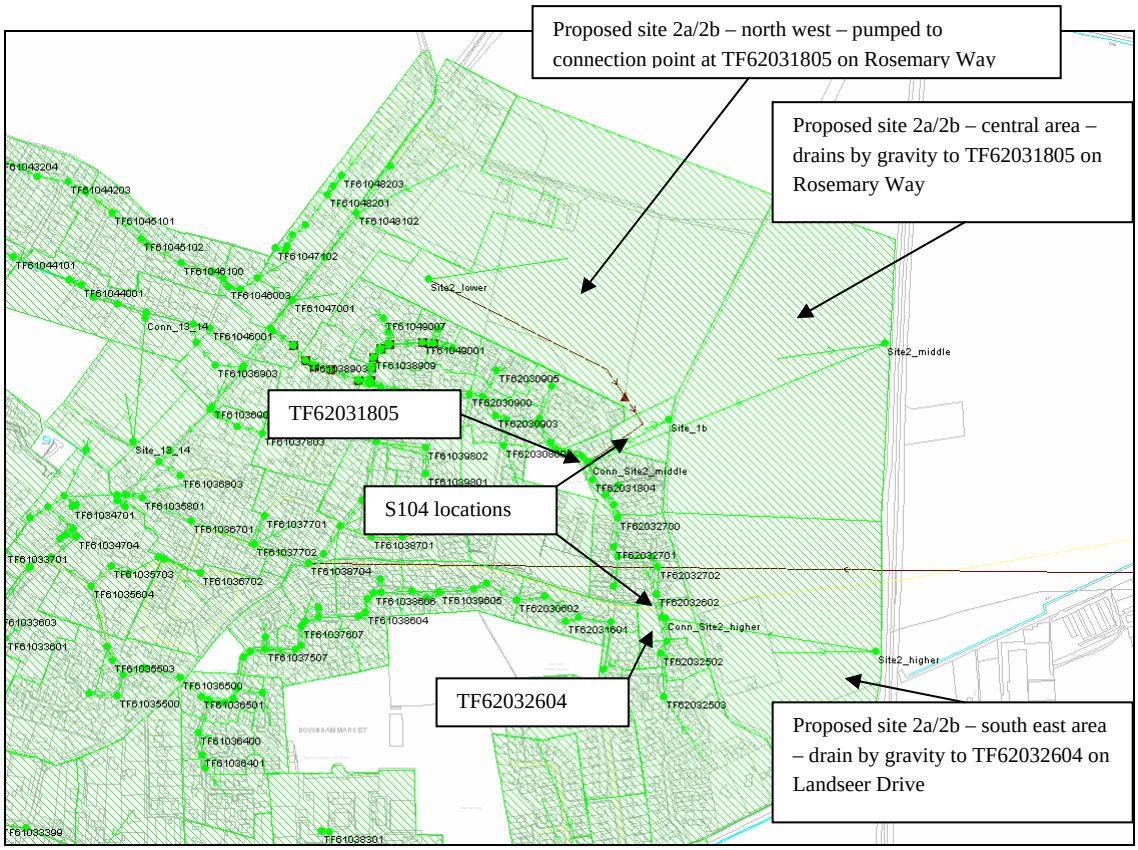

In order to provide no hydraulic detriment from the development it is necessary to upsize 27.3m of 150mm pipe between manholes TF61045201 and TF61044203 to 225mm and to provide 99.4m of 450mm diameter on line storage between manholes TF61043201 and TF61042201 (giving 15.8m$^3$ of storage). There are some increases in surcharge levels with this option. However, there is still a freeboard of approximately 1.2m at the worst location. In order to completely remove the modelled flooding at nodes TF61043201 and TF61046100 as part of the development of 500 houses it is still necessary to carry out an upgrade of the same 27.3m of pipe from 150mm to 225mm. On line storage also has to be provided between the same two manholes (99.4m in length) however, the storage diameter has to be increased to 825mm diameter, giving a storage volume of 53.1m$^3$.

**Figure 3.5 Upgrading Proposals for Development Site 2 - Option 1**



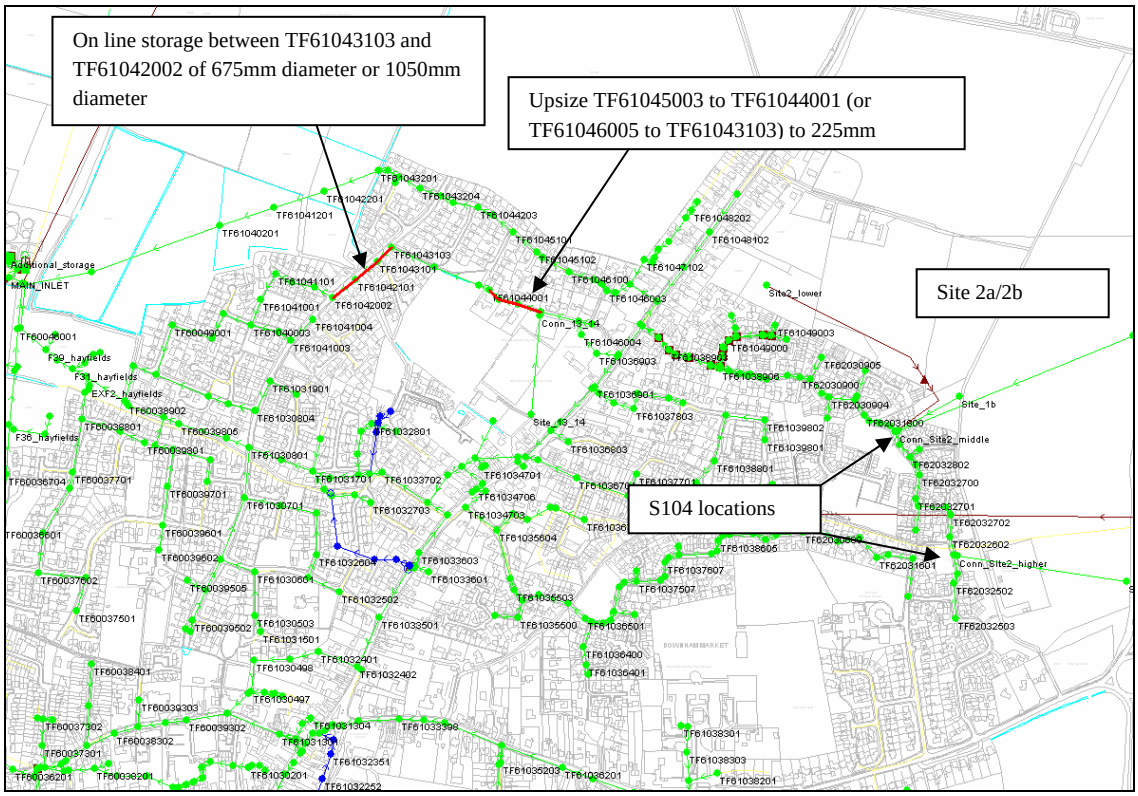

There are Section 104 agreements to develop two relatively small areas on the east side of Downham Market. Option 2 for Areas 2a/2b is to connect the flows from 2a/2b through the section 104 sites into the existing sewers. This has the potential advantage that the connections from the 2a/2b site could be included within the section 104 agreements. The most north western part of Site 2a/2b is at a lower ground level than at the proposed connection point for this option. Flows from this area would, therefore, need to be pumped with this option. The proposed breakdown of development is shown in Figure 3.6 below.

**Figure 3.6 Proposed Development at Site 2 in Downham Market - Option 2**




In order to provide no hydraulic detriment from the development it is necessary to upsize 97.6m of 150mm pipes between TF61045003 and TF61044001 to 225mm and provide 131.9m of 675mm diameter on line storage between TF61043103 and TF61042002, giving a storage volume of 47.2m$^3$. There are some minor increases in surcharge with this option in place for the 30 year storm. However, there is still a freeboard of over 1m at the worst location. In order to completely remove the modelled flooding between manholes TF61046004 and TF61041101 as part of the development of 500 houses it is necessary to upsize 346.2m of 150mm pipes between TF61046005 and TF61043103 to 225mm and provide 131.9m of 1,050mm diameter on line storage between TF61043103 and TF61042002, giving a storage volume of 114.2m$^3$.

**Figure 3.7 Upgrading Proposals for Development Site 2 - Option 2**




### 3.1.3 Development Site 3

Development Site 3 is situated to the south east of the town of Downham Market on rural/ agricultural land. The site is actually split into two areas: 3a and 3b. Area 3a is to the west and adjoins the town of Downham Market. Ground levels from the Digital Terrain Data suggest that the site generally slopes from north (at around 36m) to south (at around 26m). Given that the ground level at the adjacent sewers on the west side of Downham Market are at around 30 to 34m it is clear that it will be necessary to pump flows from all or part of the site to connect into the existing system.

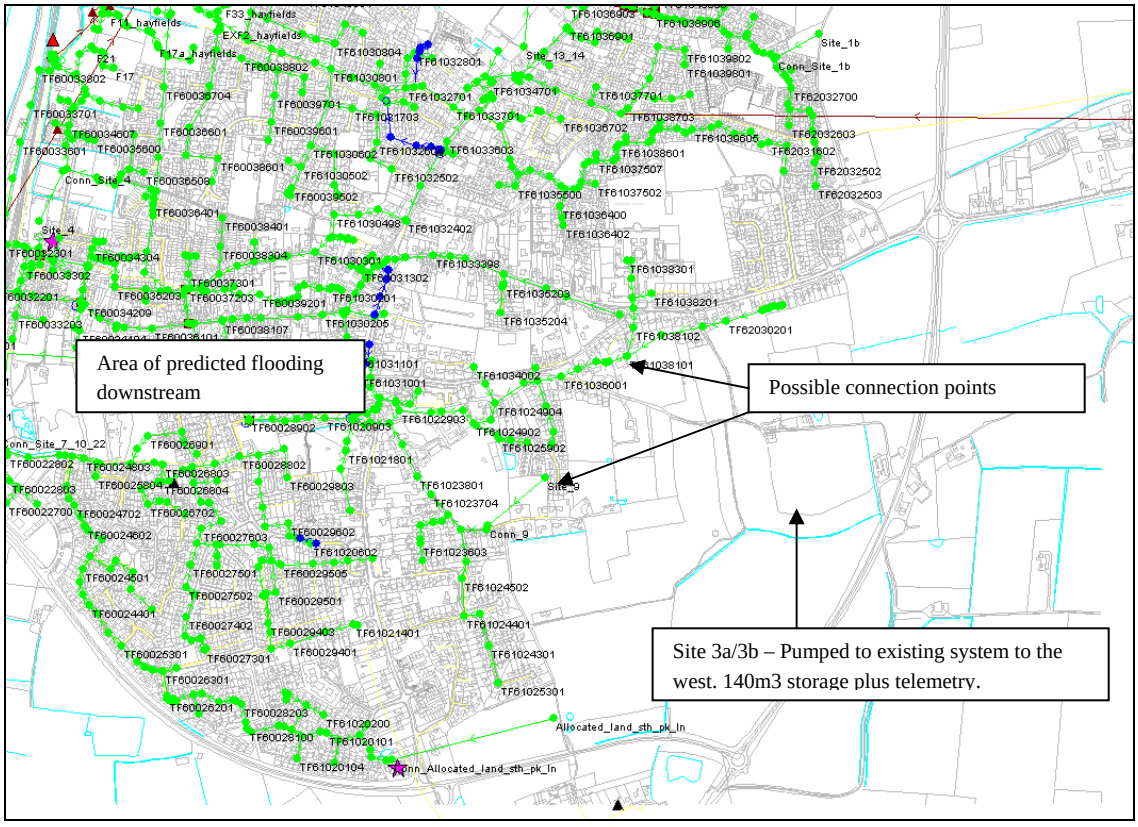
One option for location 3 is to pump flows to the north to the same connection points as for Site 2. However, this will require at least 1.7km of rising main in addition to the various upgrades to mitigate against deterioration in hydraulic performance detailed from Site 2. This is unlikely to be cost effective and has not been considered further.

The first option considered in detail for location 3 is to pump flows from the development site to the adjacent existing sewer system to the west. This would mean that flows from the site would then drain through the centre of Downham Market. This is an issue as there is a considerable amount of predicted flooding in and around the town centre. The amount of upgrade work that would be required to the existing system to mitigate against deterioration in hydraulic performance caused by the additional flows is likely to be prohibitive. However, an option is to store flows at the development site with telemetry linked to the existing system. Flows would only be pumped from the development site when levels within the existing system indicated that there was sufficient spare capacity. It has

been determined that a storage volume of 140m$^3$ is required at the development site for this option. The detention time within the proposed storage is determined to be in excess of six hours; therefore it would be necessary to provide stirrer pumps to avoid septicity issues.

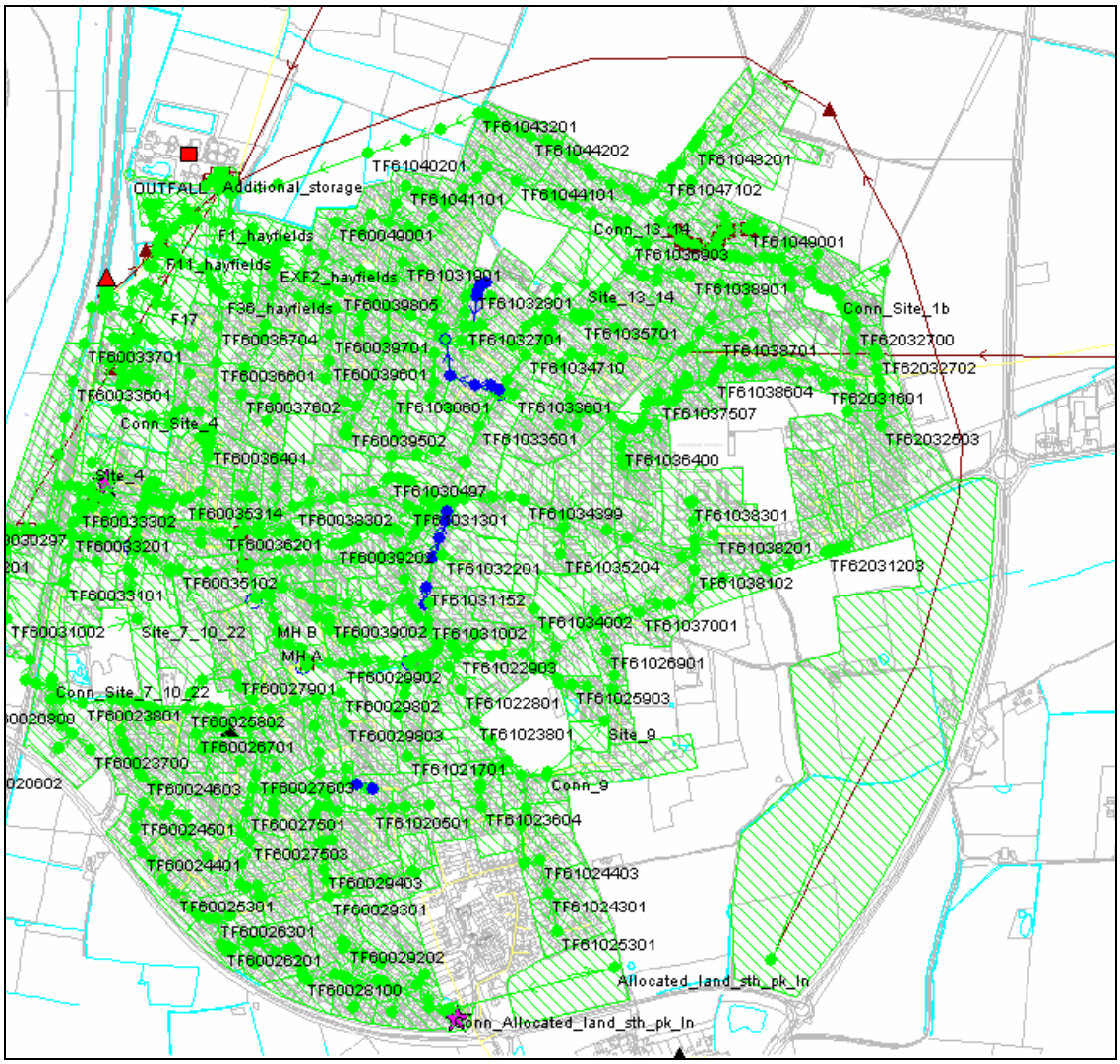
The option of storing foul flows and pumping at night would not be acceptable to Anglian Water. This would also need control to prevent pumping during heavy rain which would inevitably lead to either extremely complex control philosophies or flooding with foul sewage.

**Figure 3.8 Upgrading Proposals for Development Site 3 - Option 1**




The second option for Site 3 is to pump flows all the way to the treatment works. This has the advantage that there is no detriment to the sewer system but it does require a long rising main of approximately 3.8km. However, a storage volume of 610m$^3$ is required to maintain the Base Future Model spills at the WwTW. Anglian Water has indicated that the option of pumping to WwTW is probably unsustainable due to septicity and power. There are already houses very close to WwTW inlet and pumping septic sewage there will cause unacceptable odour.

**Figure 3.9 Upgrading Proposals for Development Site 3 - Option 2**

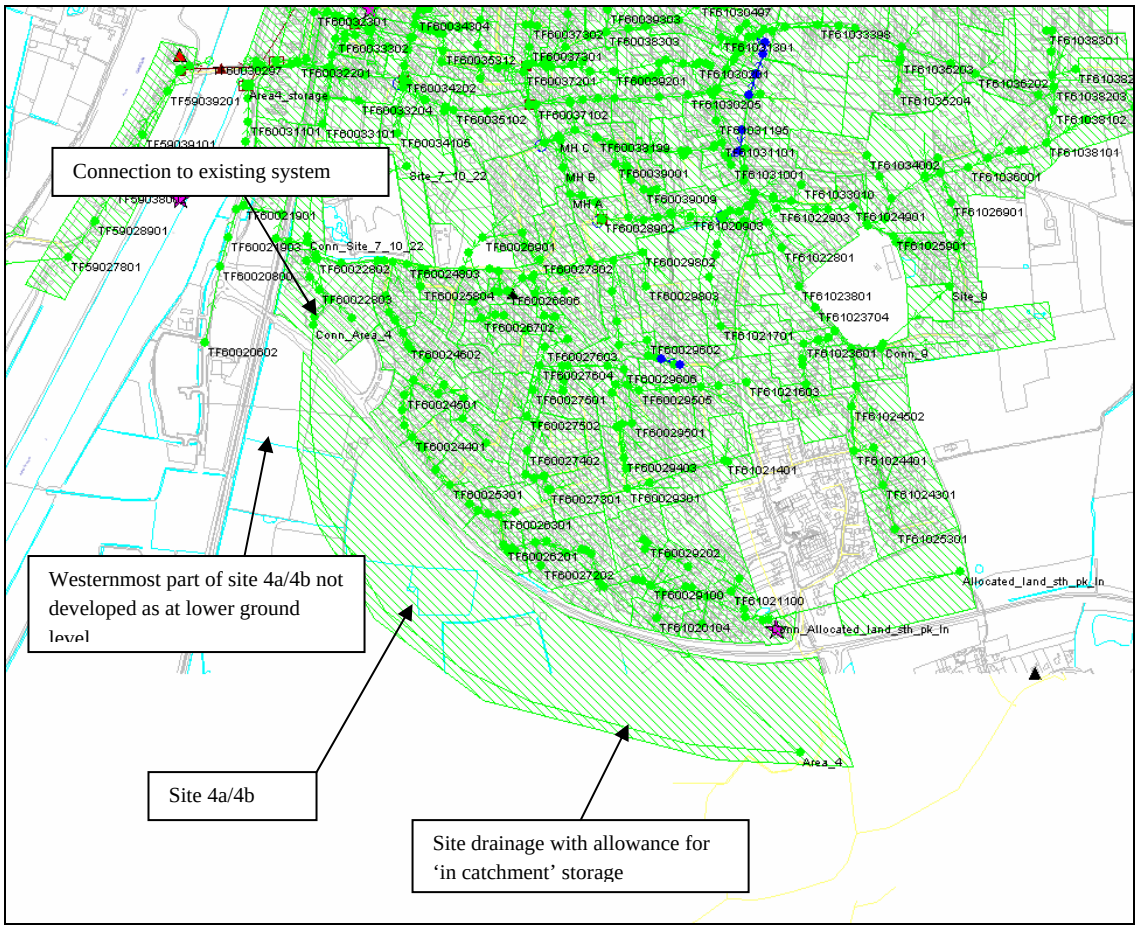



## 3.1.4 Development Site 4

Development Site 4 is situated to the south west of the town of Downham Market on rural/agricultural land. The site is actually split into two areas: 4a and 4b. Area 4a is to the north and adjoins the town of Downham Market. Ground levels from Digital Terrain Data suggest that the site generally slopes from north east to south west.

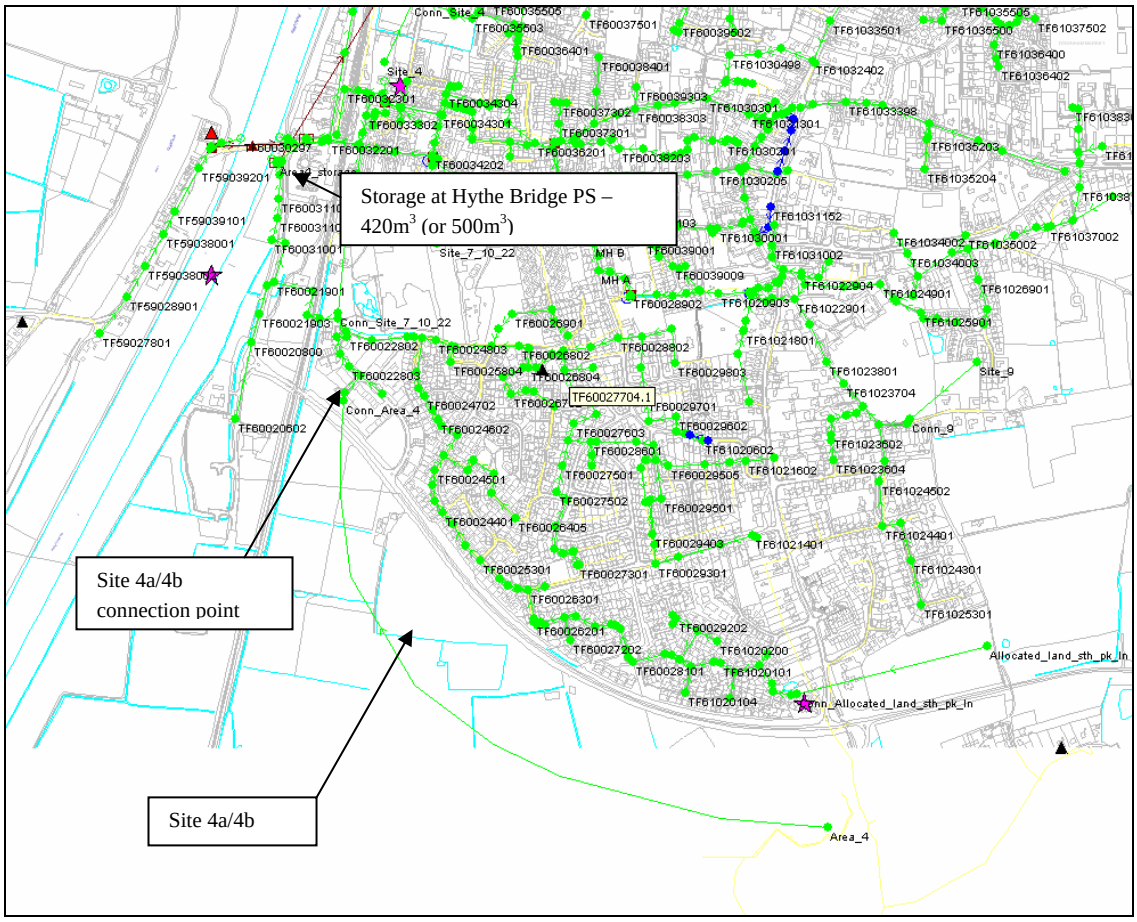
The first option for location 4 is to drain the site by gravity and connect into manhole TF60022700 (or a suitable nearby manhole). It would not be possible to drain the westernmost part of the site, adjacent to the railway line, by gravity as it is at a lower level than the connection point. Therefore, for Option 1 it is assumed that this part of the site will not be developed. The proposed breakdown of development for Option 1 is shown below.

**Figure 3.10 Proposed Development at Site 4 in Downham Market - Option 1**




An option is to increase the pump rate at Hythe Bridge but this will lead to increased spills (and hence the need for storage) at the WwTW. Thus, the preferred option is to provide storage at Hythe Bridge. In order to provide no deterioration in hydraulic performance, compared with the base future model, a storage volume of 420m$^3$ is required. There is some increase in peak surcharge level with this option in place. However, there is still a freeboard of around 1m for this event at the worst location. In order to alleviate all the modelled flooding downstream for a 30 year event a storage volume of 500m$^3$ is required.

**Figure 3.11 Upgrading Proposals for Development Site 4 - Option 1**




Option 1 for Site 4 only works if storage is included at the Railway Road development site. If the development were to take place at Railway Road with no mitigation measures the storage volume required at Hythe Bridge to alleviate all flooding downstream with the 500 houses in place at Site 4 would increase to 690m$^3$.

The second option for location 4 is to pump flows directly to the works. As with Site 3 Option 2 this has the benefit that there is no hydraulic detriment to the sewer network. However, it does require a long rising main - in this instance 1.7km. With Site 4 there would be the additional difficulty of where to locate the rising main. The west side of Downham Market is bounded by the railway line and the River Great Ouse. Crossing and re-crossing these would obviously be problematical. The only other realistic alternative would be to lay the rising main through the western part of the town. This is likely to be expensive and give rise to significant disruption. Notwithstanding this issue the storage volume required at the WwTW to maintain spill performance compared with the Base Future Model would be identical to Site 3 Option 2, i.e. 610m$^3$.

### 3.1.5 Costs

Generated costs (see Table 3.1, Section 3.5) generally do not include the drainage within the site where the 500 houses are to be developed, only the required upgrades to the existing sewer system. However, on site pumping stations and rising mains to connect to the existing system are included as this is infrastructure that would be

required above the usual laterals and gravity connection to the existing sewer. Costs also include feasibility and design, land purchase and compensation, site investigation and site supervision.

## 3.2 Hunstanton

The Hunstanton model includes the villages of Thornham, Holme-next-the-Sea and Old Hunstanton, and the whole catchment area extends across approximately 350ha. The network has a connected winter population of approximately 5,300, increasing in the summer to 15,000. The modelled area is pumped to Heacham WwTW.

The existing model was built and verified in 2002. It was necessary to update the model as follows to represent the current (and future proposed) network(s). Sub-catchments were added to include additional housing areas, including the village of Titchwell and the housing development to the east of the Hunstanton city centre. The population was revised from 5,313 in the original model to 8,594 in the updated model. Two large caravan parks were represented in the model to account for most of the influx summer population, estimated in the Drainage Area Plan (DAP) to be around 15,000. The remaining summer population was distributed in the city centre where the highest proportion of local hotels was assumed to be. The flooding representation of manholes was checked and corrected. Two small trade flows were put back into the model. A recent survey of Southend Road TPS was input into the model, with revised values for pump on/off levels and a reduction in the total pumping rate.

Two growth scenarios were modelled. Both development site areas are significantly larger than normal for the quoted number of properties. Development Site 1 and Development Site 2 are split into areas ‘a’ and ‘b’, so confirmation of the total number of properties, and whether there are any additional properties above the numbers quoted, should be sought. The development sites are located at a high point in the area. The ground elevation suggests that there is a potential need for pumping if the development site extends too far to the east. A detailed engineering assessment will be needed for this. 10 year and 30 year return period storms were setup using FEH catchment descriptors. The catchment model uses both the Fixed (Wallingford) and NewUK (Variable PR) runoff models. Design storms with summer and winter profiles were setup, with wastewater generation files matching the seasonal population types (holiday population). A second set of design storms were setup for climate change sensitivity runs with 20% uplift in the rainfall.

**Figure 3.12 Location of Development Site 1 in Hunstanton**

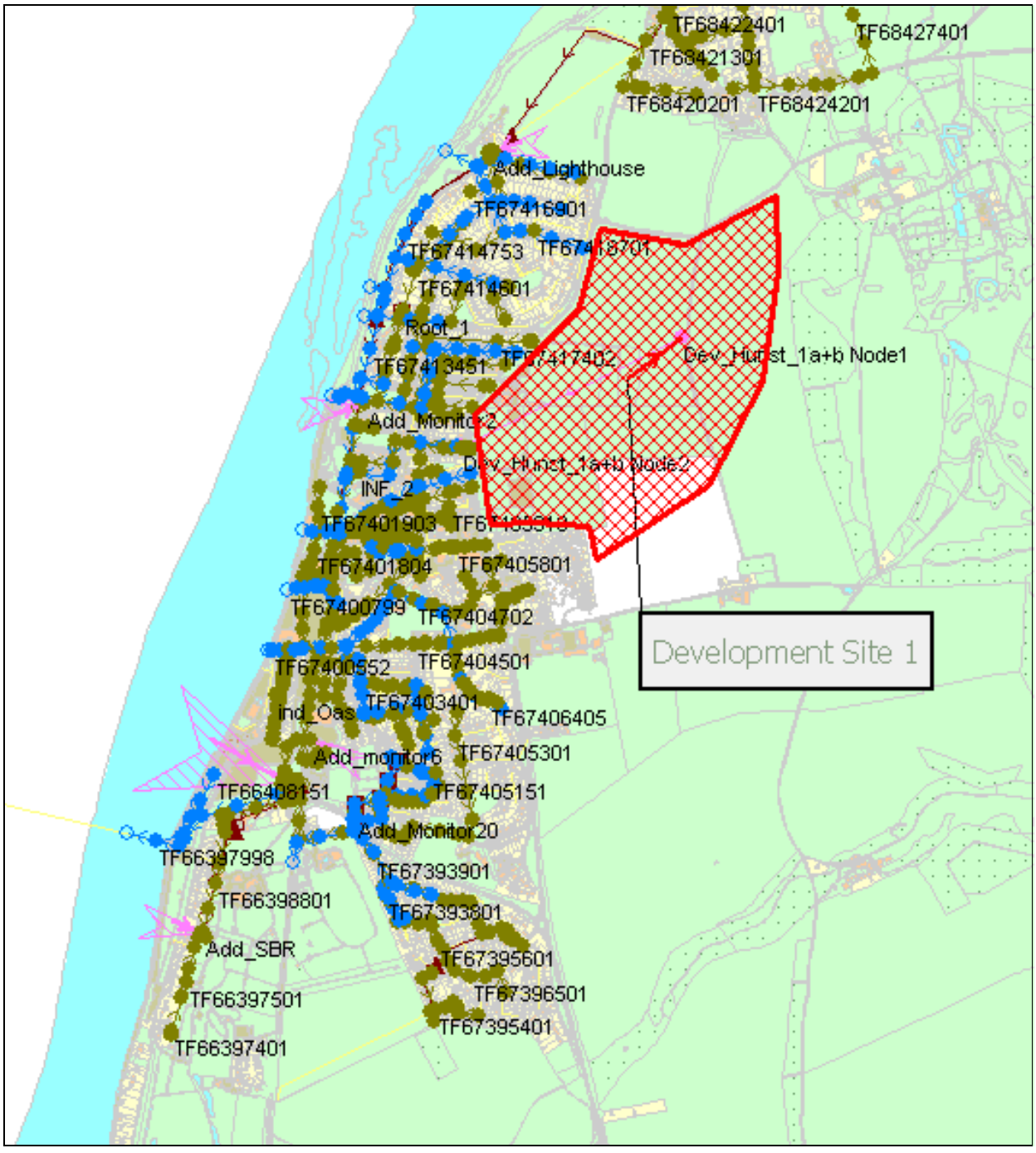
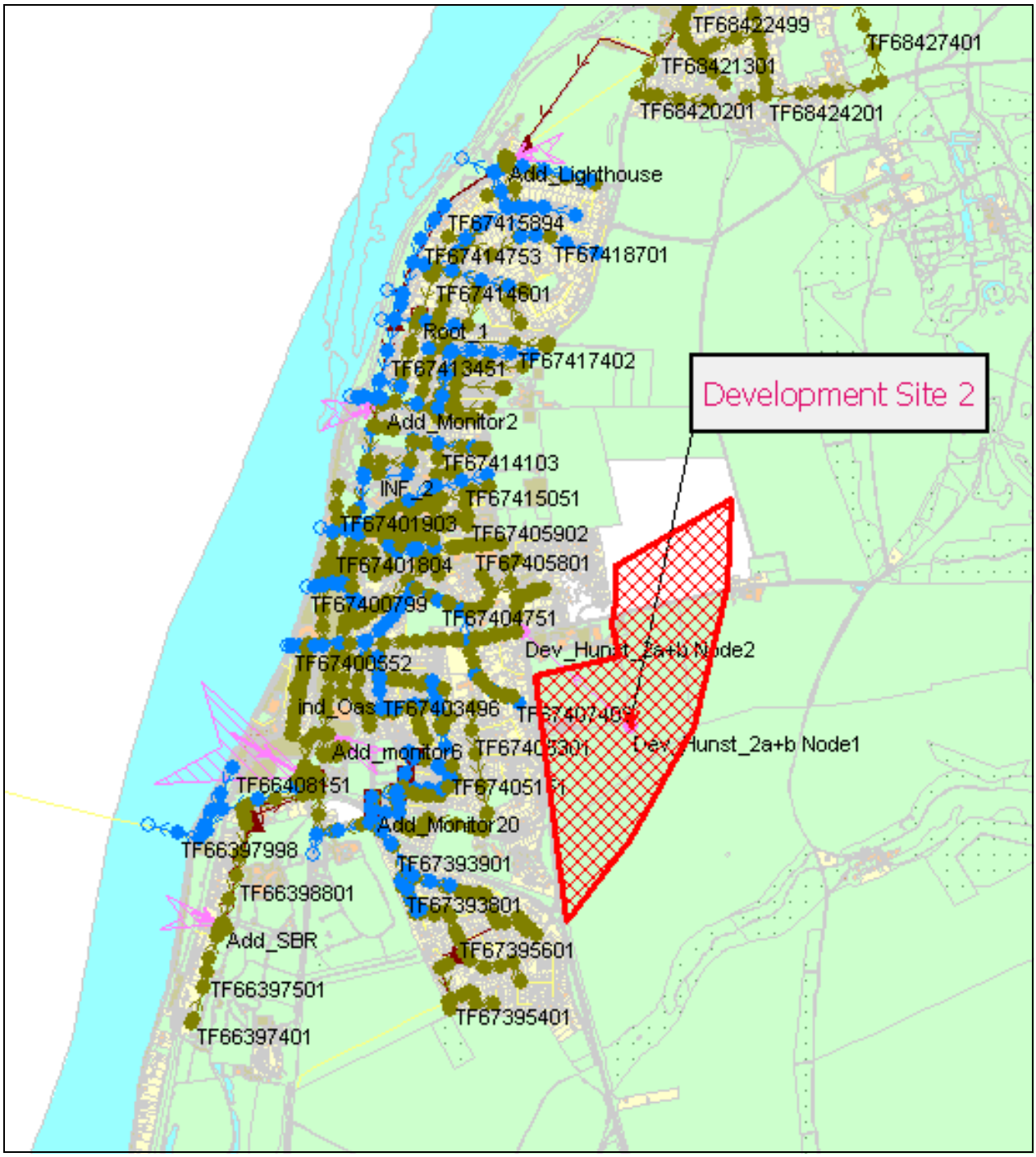


**Figure 3.13 Location of Development Site 2 in Hunstanton**




The flood risk sensitivity was carried out using the version of the model with the holiday population as this was the most conservative base line. Accordingly, only summer storms were used. The flood risk analysis revealed there is no significant increase in flood risk to the catchment with the introduction of the Development at either Site 1 or

Site 2. Additionally, the climate changes sensitivity runs suggested that there is no increase in flood risk for either development site for short duration storms.

A Time Series Rainfall (TSR) run was performed for the current system and for both possible development sites. The summer population flows were used in the TSR as a conservative representation of flows in the catchment. For both development sites there is an increase in CSO spill frequency and volume at Smugglers Lane PS CSO and South End Road TPS EO compared with the current situation, but these are not significant increases.

### 3.2.1 Costs

As the development sites have no significant impact on the hydraulic performance of the network, no additional infrastructure is foreseen.

## 3.3 Wisbech

AWS are completing their modelling of the Wisbech sewerage network and it has been agreed that a report will be issued separately in the future.

## 3.4 King's Lynn

The King's Lynn model includes nine towns/ villages, namely: King's Lynn; Clenchwarton; Terrington St Clement; West Winch; Setchey; Castle Rising; North Wootton; South Wootton; and West Lynn, and the catchment extends over 1,748ha. The catchment has a population of 49,452 (2009).

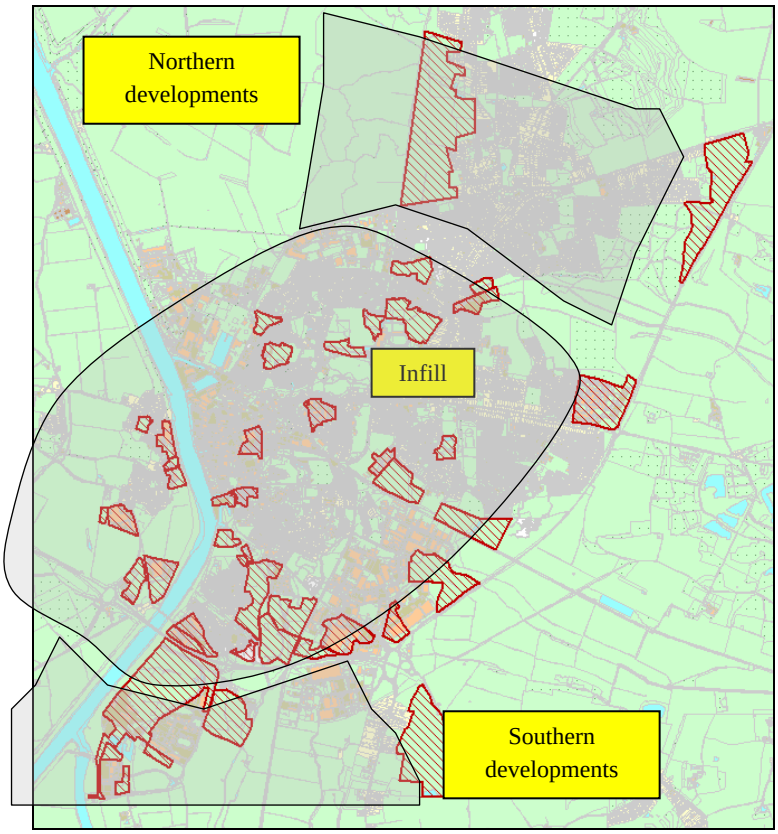
The available King's Lynn model from 2004 was updated to include 2009 trade flows and housing developments between 2004 and 2009. Changes to the 2004 model included a survey of the Gaywood TPS to determine pump on/off levels, a review of all trade flow representation in the model, incorporation of any additional population changes in the catchment from new developments up to 2009 (South Fairstead 45/14a - 168 properties, South Fairstead - 45/14b - 104 properties, King's Lynn NORA 45/33 Phase 1 - 109 properties, King's Lynn West Lynn 45/40 - 136 properties), incorporation of the @One Alliance AMP4 sub-model for West Winch together with capital solutions for DG5 properties, a review of foul flows reaching the WWTW to determine if there have been significant changes to DWF (this identified a reducing trend in DWF which was consistent with the reduction in trade flows), and a review of storm overflow locations to ensure the effect on spills is properly analysed. The Future model was then derived to include future developments to 2025.

FEH design rainfall was used. The majority of the model uses Wallingford runoff, but the West Winch part of the model uses the New UK runoff model. For CSO spill analysis a time series was created using Stormpac 4.1, and following analysis a typical year was chosen. To also assess the effects of climate change, the design rainfall was uplifted by 20% for additional simulations.

For modelling analysis King's Lynn the allocated development sites were separated into three areas of development: the Northern area (2,000 dwellings); the Infill (central) area (4,768 dwellings); and the Southern area

(1,400 to 4,000 dwellings) which were added separately to the existing model to run scenarios of their impact individually and in combination.

**Figure 3.14 Growth Areas in King's Lynn**



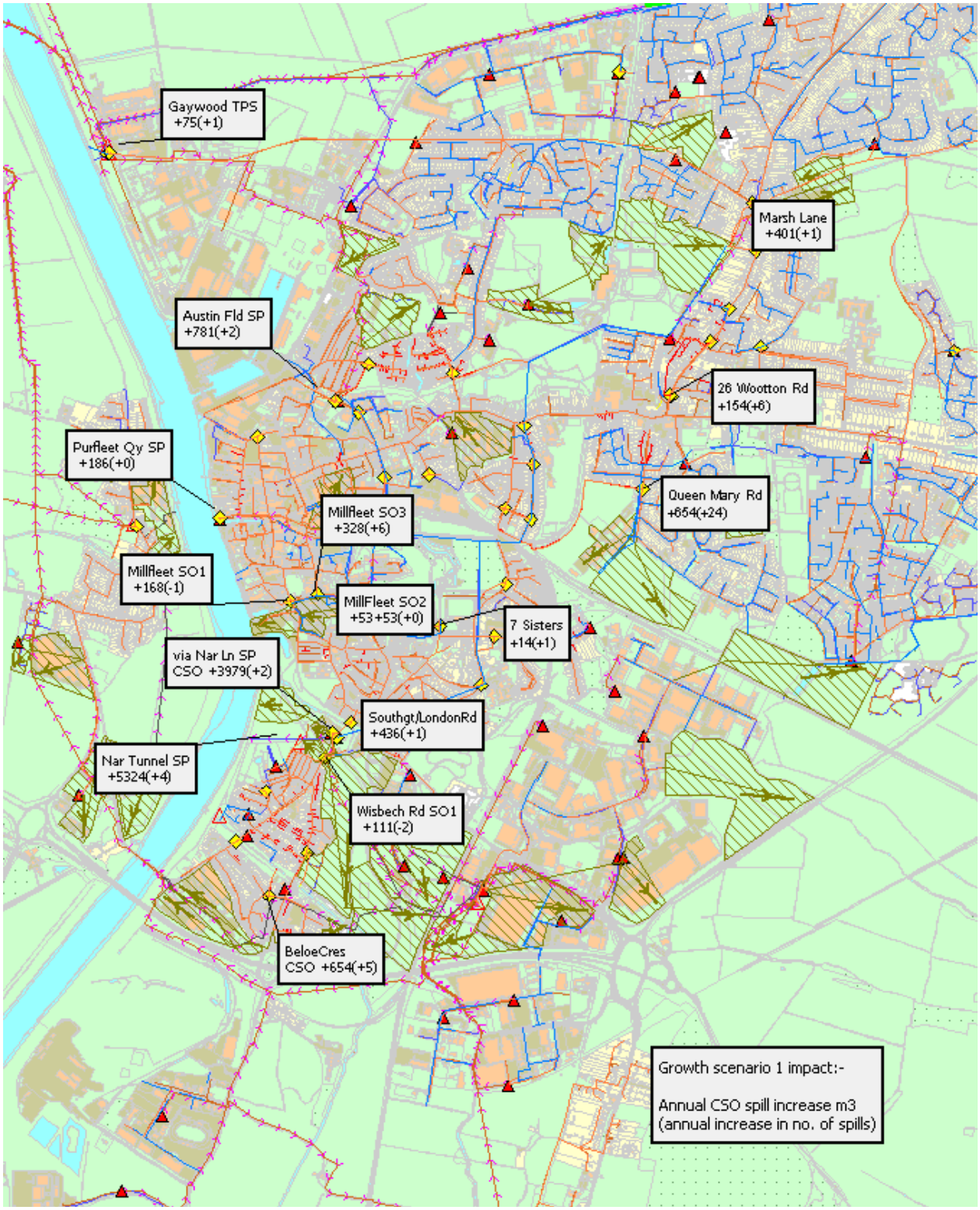

Design events were run for 10 and 30 year return periods, and also the typical year of time series rainfall, for four scenarios.

### 3.4.1 Scenario 1

Scenario 1 consists of the infill developments only (4,768 dwellings). Connection was generally made to the largest available sewer in the immediate vicinity, with obvious engineering difficulties such as railway crossings also avoided. Most of these connections were made at the boundary of or within the development site. However, for some developments connections were made a distance away from the site boundary (Lynnsport East ND07 connected to Greenpark Avenue PS 3-400m off-site, Edma Street ND05 connected to a manhole on Burkitt Street 130m from the southwest corner of the site, Wisbech Road ND32 connected to a manhole in Saddlebow Road 100m from the east edge of the site, Wisbech Road ND33 connected to a manhole in Saddlebow Road 200m from the east edge of the site via ND32, NORA - new COWA site ND37 connected to a manhole in Saddlebow Road 100m from the west edge of the site, NORA Phase 1a ND34 connected downstream of Wisbech Road overflow 70m from the north edge of the site, NORA Phase 1c ND36 connected downstream of Wisbech Road overflow 5-700m from the east edge of the site via ND34, Marina ND37 connected to Nar Lane PS 150m from the south east corner of the site, and Tesco ND40 connected to a manhole 100m off-site). The impact on the existing network

showed no significant flooding increase, but increased CSO spills at 17 locations. Figure 3.15 shows this impact, with the increased spill volumes and frequencies highlighted at each overflow location.

**Figure 3.15 Impact of Scenario 1 in King's Lynn**

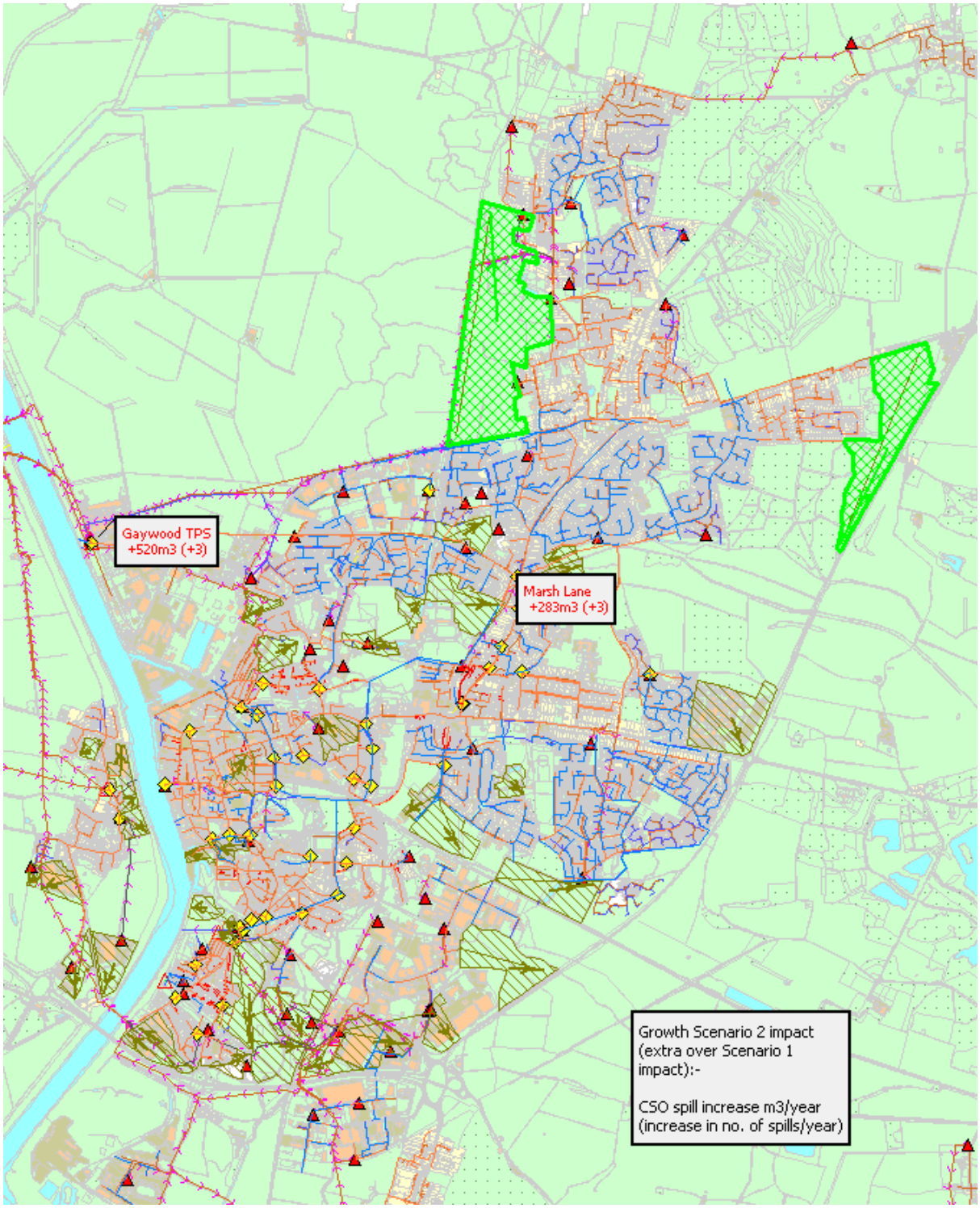


To mitigate against the increased spills, the inline PSs were uprated and overflow weirs raised. Marsh Lane PS was reduced to 14l/s and 0l/s to utilise storage, Gaywood TPS was uprated to 460l/s, Marsh Lane overflow weir crest level was raised to 2.2m and sediment removed, 95 Wootton Road overflow weir crest level was raised to 3.2m, 26 Wootton Road overflow weir crest levels was raised to 3.5m, Gaywood Park PS was uprated to 28l/s with 12m of rising main upgraded to 150mm, Queen Mary Road overflow weir crest level was raised to 1.1m, Purfleet Quay PS was uprated to 21l/s, Austin Field PS was uprated to 205l/s, Millfleet PS was uprated to 45l/s, the sediment depth was reduced at Wisbech Road overflow, and Nar Lane PS was uprated to 85l/s.

### 3.4.2 Scenario 2

Scenario 2 consists of the infill developments plus northern developments (4,768 dwellings plus 2,000 dwellings). For King's Lynn Northeast development ND02 there were three options for connection to the network. Option N1 and Option N2 both pump the sewage from the development 2km to the southwest of the site, with Option N1 improving/ re-laying 400m of 600mm dia sewer and Option N2 including 800m$^3$ of storage (or 900m$^3$ of storage to account for climate change) with the Marsh Lane overflow weir crest level being raised to 2.47m. Option N3 pumps 2.9km along Grimston Road to the north of the site then includes 2.9km of new c450mm dia gravity sewer to Gaywood TPS shared with King's Lane North development ND01. The King's Lane North development ND01 is located 2km from Gaywood PS and can be connected directly by gravity sewer or rising main (gravity sewer if shared with Option N3 from ND02). The impact on the existing network over and above Scenario 1 showed no significant flooding increase, but further increased spills at Gaywood TPS and Marsh Lane overflow. Figure 3.16 shows this impact, with the increased spill volumes and frequencies highlighted at each overflow location.

**Figure 3.16 Impact of Scenario 2 in King's Lynn**



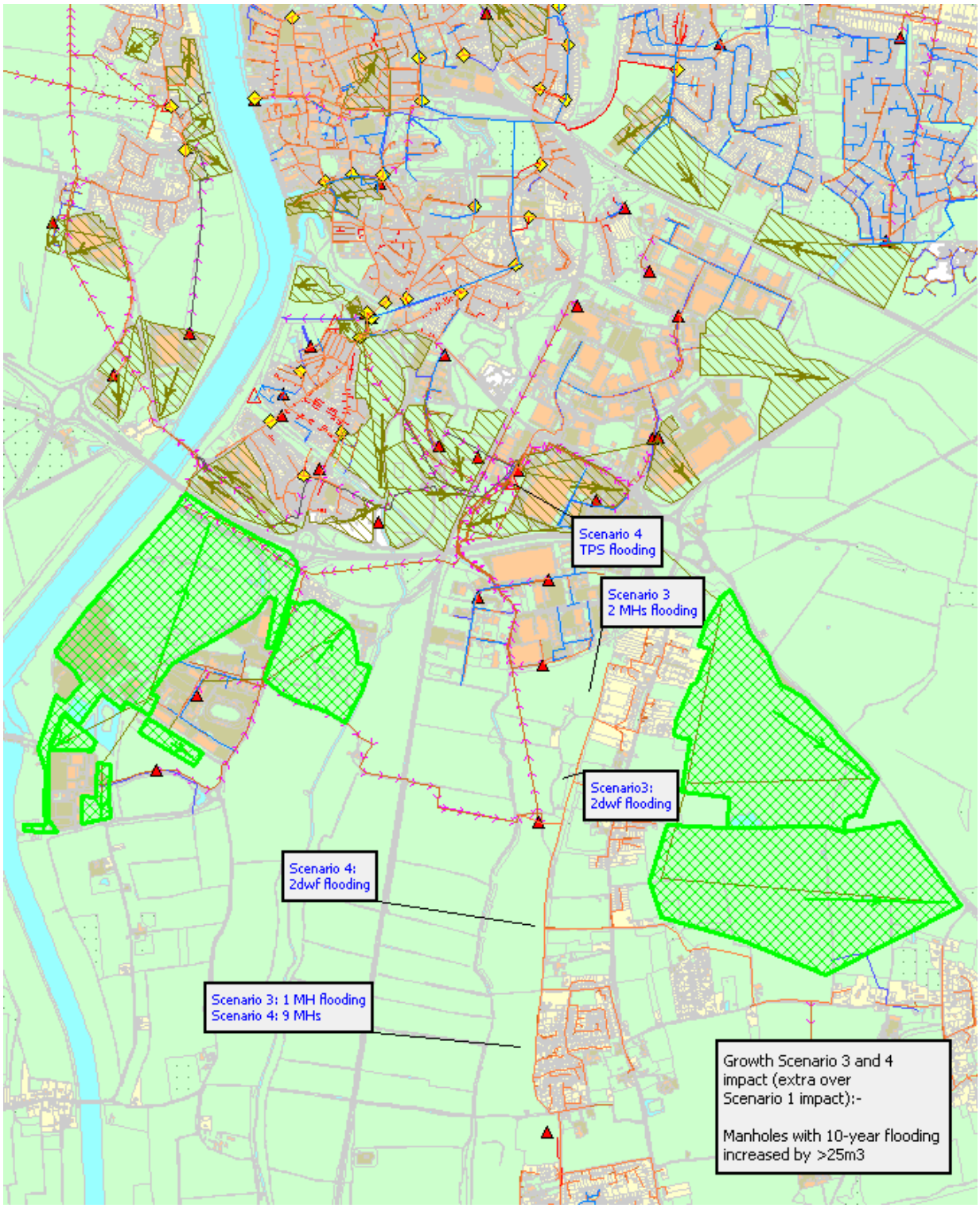

In addition to the mitigation measures in Scenario 1, Gaywood TPS was uprated to 520l/s for Option N1, to 490l/s for Option N2 and to 500l/s for Option N3.

Anglian Water has commented that the increase in discharge from Gaywood is likely to require duplication of the rising main under the estuary and improvements at the STW.

### 3.4.3 Scenario 3

Scenario 3 consists of the infill developments plus southern developments, which only includes parts A and B of development number 44 (4,768 dwellings plus 1,400 dwellings). There are two options for the King's Lynn South East development sites (ND44). For Option S1 areas 44a and 44b are connected to West Winch PS 1km off-site and for Option S2 areas they are connected to Hardwick TPS. The impact on the existing network over and above Scenario 1 showed flooding at and upstream of West Winch PS, with no additional CSO impact, as shown in Figure 3.17.

**Figure 3.17 Impact of Scenarios 3 and 4 in King's Lynn**



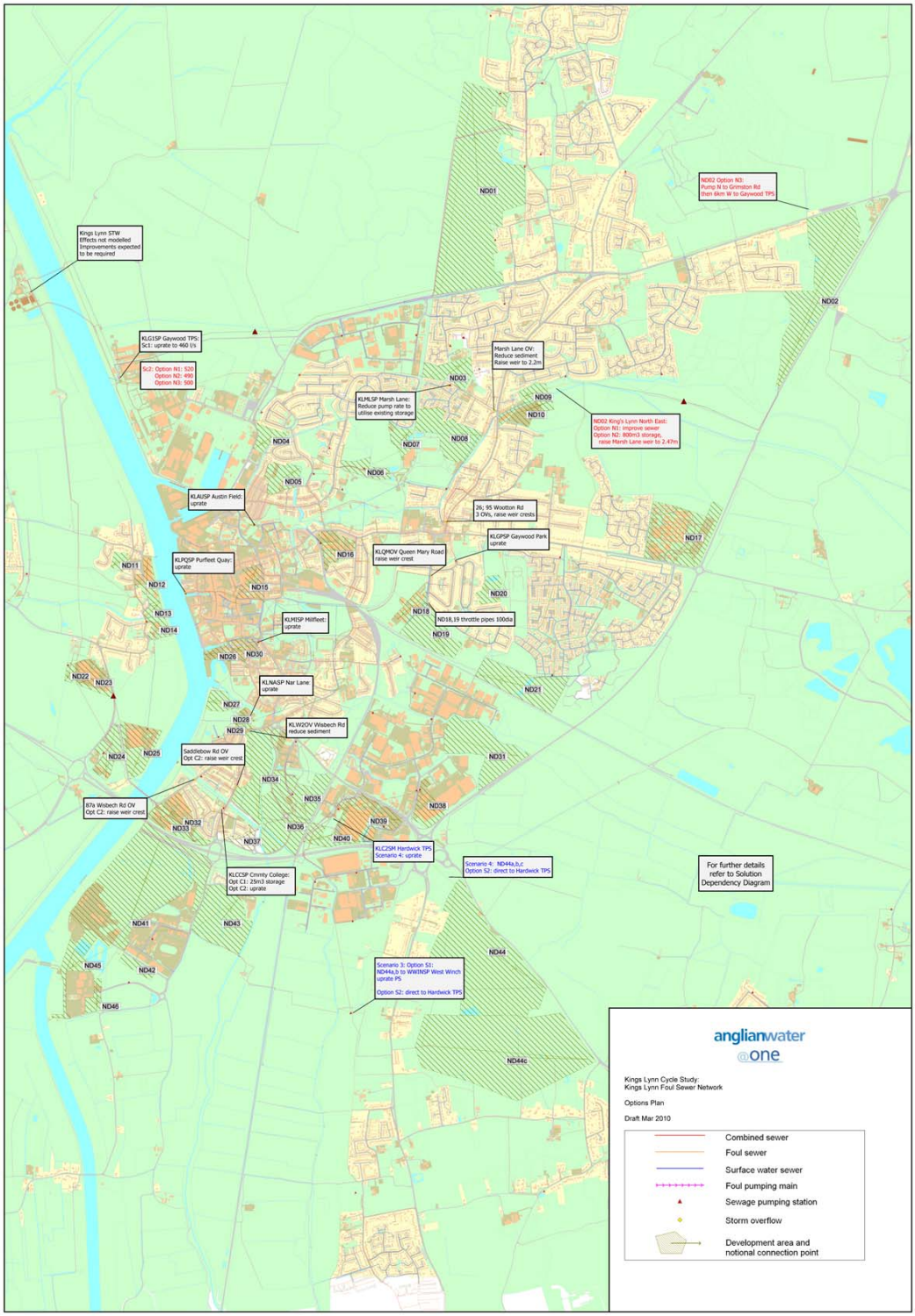
In addition to the mitigation measures in Scenario 1; for Option S1 25m$^3$ of storage was added at the Community College PS, and West Winch PS was uprated to 112l/s (this may require a new 1km length of rising main); for Option S2 Community College PS was uprated to 25l/s with 62m of rising main uprated to 150mm, Saddlebow Road overflow weir crest level was raised to 2.4m, and 87a Wisbech Road overflow weir crest level was raised to 2.5m.

### 3.4.4 Scenario 4

Scenario 4 consists of the infill developments plus all of development 44 (4,768 dwellings plus 4,000 dwellings), with the connection for development 44 to Hardwick TPS. The impact on the existing network over and above Scenario 1 showed minor flooding at Hardwick TPS, with no additional CSO impact, as shown in Figure 3.17. Minor uprating to 400l/s (or 410l/s to account for the effects of climate change) would be required to account for this.

The measures described in the preceding sections would be required to avoid any increase in sewer flooding and changes in discharges to CSOs. If these measures are carried out there would be no need to apply for changes in the consents.

**Figure 3.18 Options Plan for King's Lynn**



## 3.5 Summary of Infrastructure Options and Costs

### 3.5.1 Basis of Costings

The cost estimates were calculated to allow for both the Construction Costs and Other Project Cost (e.g. project management, construction management) to provide comparison between the site options (it was agreed that detailed costs would not be provided in this report). The calculated costs were based on lengths, diameters and depth categories taken from the AWS modelling reports. Normal ground conditions were assumed with no contaminated material and an allowance has been made of 10% for unmeasured items (e.g. fencing). Excluded from these costs are hard dig and soft ground, utility diversions, service crossings and ground water (rates allow for a 2" pump for keeping trenches dry).

Table 3.1 provides indicative costs to show the relative expenditure required for the options.

**Table 3.1 Upgrading Costs for Downham Market Proposal Options (Cost Category 1 = 25K-100K, category 2 = 100K – 250K, category 3 = 250K – 500K, category 4 - >500K)**

| Site | Upgrading Proposals | Cost Category | Rank Order |
|---|---|---|---|
| Site 1a/1b - Option 1 - no hydraulic detriment | Upsize 632.8m of sewer to 225mm and 100m3 storage at WWTW. | 3 | 7 |
| Site 1a/1b - Option 1 - alleviate flooding downstream of development site | Upsize 632.8m of sewer to 300mm and 95m3 storage at WWTW. | 3 | 8 |
| Site 1a/1b - Option 2 - no hydraulic detriment | 186.3m of 750mm dia on line storage, re-grade 99.4m of 150mm sewer. | 3 | 5 |
| Site 1a/1b - Option 2 - alleviate flooding downstream of development site | 186.3m of 750mm dia on line storage, re-grade and upsize 99.4m of sewer to 225mm. | 2 | 4 |
| Site 2a/2b - Option 1 - no hydraulic detriment | Upsize 27.3m of sewer to 225mm and 99.4m of 450mm dia on line storage. | 1 | 2 |
| Site 2a/2b - Option 1 - alleviate flooding downstream of development site | Upsize 27.3m of sewer to 225mm and 99.4m of 825mm dia on line storage. | 1 | 3 |
| Site 2a/2b - Option 2 - no hydraulic detriment | Upsize 97.6m of sewer to 225mm and 131.9m of 675mm dia on line storage. | 1 | 1 |
| Site 2a/2b - Option 2 - alleviate flooding downstream of development site | Upsize 346.2m of sewer to 225mm and 131.9m of 1,050mm dia on line storage. | 3 | 9 |

**Table 3.1 (continued) Upgrading Costs for Downham Market Proposal Options (Cost Category 1 = 25K-100K, category 2 = 100K – 250K, category 3 = 250K – 500K, category 4 - >500K)**

| Site | Upgrading Proposals | Cost Category | Rank Order |
|---|---|---|---|
| Site 3a/3b - Option 1 | Store 140m3, pump flows to existing system. Stirrer pumps and telemetry. | 3 | 6 |
| Site 3a/3b - Option 2 | Pump flows to WWTW. Storage of 610m$^3$ at the WWTW. | 4 | 13 |
| Site 4a/4b - Option 1 - no hydraulic detriment | 420m$^3$ storage at Hythe Bridge PS. | 3 | 10 |
| Site 4a/4b - Option 1 - alleviate flooding downstream of development site | 500m3 storage at Hythe Bridge PS. | 3 | 11 |
| Site 4a/4b - Option 2 | Pump flows to WWTW. 610m3 storage at WWTW. | 4 | 12 |

From a comparison of the costs of development at the various sites it can be seen that developments at locations 1a/1b (Option 2) and 2a/2b (Option 1 and no hydraulic detriment for Option 2) are the lowest cost alternatives in terms of the required upgrades to the system. This is to be expected as Sites 3a/3b and 4a/4b are more remote from the treatment works. These sites consequently require a significant amount of storage to avoid detriment to the downstream network or lengthy rising mains and storage at the treatment works. It is recommended that Sites 1a/1b and 2a/2b are examined in more detail as potential development locations. The availability of land and suitability of connection points for these locations will need to be considered further. Once a more in depth view of the potential developments at these locations has been determined, with a proposed site layout, a more detailed analysis of the required upgrades to the sewer network can be carried out.

**Table 3.2 Upgrading Costs for King's Lynn Proposal Options (Cost Category 1 = < 1 million, category 2 = 1 -2 million, category 3 = > 2 Million)**

| Site | Upgrading Proposals | Cost Category | Rank Order |
|---|---|---|---|
| Scenario 1 - Infill development in King's Lynn Town only (4,768 dwellings) | In line pumping stations uprated and overflow weirs raised. Sediment removal at Marsh Lane. | 1 | 1 |
| Scenario 2 - Infill development in town centre and northern development site 6,768 dwellings | Option N1 - pump sewerage 2km to the southwest of the site; 400m of 600mm sewer improved; in addition to Scenario 1 improvements. | 2 | 5 |
| Scenario 2 - Infill development in town centre and northern development site 6,768 dwellings | Option N2 - pump sewerage 2km to the southwest of the site; 900 m$^3$ of storage required; ; in addition to Scenario 1 improvements. | 3 | 7 |
| Scenario 2 - Infill development in town centre and northern development site 6,768 dwellings | Option N3 - sewerage pumped 2.9km to Gaywood TPS, requires 2.9km of new rising main; ; in addition to Scenario 1 improvements. | 3 | 6 |

**Table 3.2 (continued) Upgrading Costs for King's Lynn Proposal Options (Cost Category 1 = < 1 million, category 2 = 1 -2 million, category 3 = > 2 Million)**

| Site | Upgrading Proposals | Cost Category | Rank Order |
|---|---|---|---|
| Scenario 3 - Infill development in town centre and southern development site (parts A and B of development 44)<br>6,168 dwellings | Option S1 - connection to West Winch PS; 25m$^3$ storage required at Community College PS and possible 1km length of new rising main; uprating of West Winch PS. | 2 | 2 |
| Scenario 3 - Infill development in town centre and southern development site (parts A and B of development 44)<br>6,168 dwellings | Option S2 - connection to Hardwick TPS; Community College PS uprated, 62m rising main uprated, weir creats raised at Saddlebow Road and Wisbech Road. | 2 | 3 |
| Scenario 4 - Infill development in town centre and southern development site (all of development 44)<br>8,768 dwellings | Option 1 - Connection to Hardwick TPS. Minor uprating at Hardwick TPS in addition to Scenario 1 upgrading. | 2 | 4 |

From a comparison of the costs of development at the various sites it can be seen that for Scenario 2 Option 1 is the lowest cost while Option 2 is the highest cost of the three. For Scenario 3 costs for Option 1 are lower than for Option 2.

## 3.6 Summary and Conclusions

### 3.6.1 Downham Market

At Downham Market options at four alternative development sites were considered for the additional allocation of 500 dwellings. The solutions considered and the infrastructure upgrades required to produce are shown in Table 3.1.

At Development Site 1 Area 1a could be drained by gravity to connect with the existing sewer, whereas Area 1b would require pumping and is also a further distance from a suitable connection point to the existing sewer. The proposed model was run with the majority of the new housing allocation located at Site 1a, and a smaller number at Site 2a (850 and 250 population respectively). Two options were considered for configuring the sewerage system; both require pipeline upgrades and storage. However option 1 is for storage at the WwTW while Option 2 incorporates online storage. There are space constraints at the WwTW site which may limit the options for incorporating storage there.

At Development Site 2 Option 1 would involve gravity drainage while Option 2 would require a small area to be pumped. Sites 3 and 4 are located more remotely from the WwTW; for Site 3, sewerage from all or part of the site would need to be pumped, and at Site 4 part of the site would require pumping. For the development of Site 4 there is an option to provide storage at Hythe Pumping Station instead of Downham Market WWTW.

Estimated capital costs for each option are provided to determine the most cost-effective option.

### 3.6.2 Hunstanton

At Hunstanton the modelling for both Sites 1 and 2 showed there were no system capacity constraints with the proposed growth scenarios, therefore no upgrading will be required. Local concerns about historical flooding are currently being addressed by Anglian Water.

### 3.6.3 King's Lynn

At King's Lynn four development configurations (scenarios) were considered, combining infill housing within King's Lynn itself (4,768 dwellings) and development to the northeast and/or the south of the town. Only Scenario 4 incorporated all of the proposed growth to 2026. All scenarios required uprating of several Pumping Stations (at Gaywood, Gaywood Park, Purfleet Quay, Austin Field, Millfleet and Nar Lane), upgrading of pipelines, and several weir crests would need raising.

Estimated capital costs for each option are provided to determine the most cost-effective option.

### 3.6.4 Wisbech

AWS are completing their modelling of the Wisbech sewerage network and a report on infrastructure requirements and costs will be issued separately in the future.

The measures to upgrade the sewerage system described for each settlement would be required to avoid any increase in sewer flooding and changes in discharges to CSOs. If these measures are carried out there would be no need to apply for changes in the consents.