Tolney Lane Flood Alleviation Options Appraisal

Final Report (Stage 3)

A111780

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Prepared on behalf of N&SDC

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1.0 Executive Summary

There are significant flood risk issues at the Tolney Lane Gypsy and Traveller Community (G&TC) Site given its location within the flood plain of the River Trent. In summary, the flood risk impacts on access and egress from the site given that Tolney Lane is the only means of vehicular access; furthermore, most of the G&TC site is at a risk of flooding with parts exposed to a very high level of risk; and finally, it should be noted, climate change will only exacerbate this situation.

This project seeks to identify three feasible options to alleviate the above flood risks.

The project commenced with a review of the site and the local issues that would influence likely solutions (Stage 1). Key to this preliminary assessment was to modify the existing River Trent model to give it a degree of granularity that would allow detailed examination of how water moves across the flood plain in the vicinity of the site, and to provide a tool by which the alleviation options could be assessed.

Five initial options were identified and considered in the light of the site context and the emerging more detailed understanding of the flood risks. This allowed the selection of three options to be tested using the refined river model; the selection process was undertaken with N&SDC Officers at the conclusion of Stage 2 of the Project.

Stage 3 of the project has involved the development of the outline detail of the three options, allowing the basic elements to be both costed and inserted into the river model. The options are as follows; Option 1: Raising of a length of Tolney Lane up to its junction with the Great North Road together with the defence of most of the individual G&TC plots at greatest risk of flooding (preliminary cost estimate £2,850K); Option 2: the provision of an emergency access from the south western end of the G&TC site to an existing agricultural access onto the A46. This scheme does not provide any defences to the G&TC site (preliminary estimated cost £1,700K); and Option 3, a scheme to improve the defence of almost the entire site, taking account of climate change and provision of the emergency access as described under Option 2 (preliminary estimated cost £3,150K). For all three options two basic mitigations were provided: (a) a new flood relief channel (including a new culvert under Tolney Lane) to link to an existing bridge under the railway and (b) lowering of land in the park area to the south of Tolney Lane.

This report concludes that it would be feasible to develop a scheme to improve the flood resilience of Tolney Lane and improve the standard of protection to most of the highest risk locations within the G&TC site. In order to establish if Flood Defence Grant in Aid (FDGiA)

funding for such a scheme could be provided, it will be important that the eligible properties for cost benefit calculations are established and their locations identified.

On balance it seems likely that Option 1 is the most advantageous as it defends a large proportion of areas at greatest risk (and may therefore attract some FDGiA funding); it also appears to have limited adverse impacts on flood risk to adjacent areas. As a scheme it is also less reliant on third party co-operation than is the case in respect of options 2 and 3.

2.0 Introduction

2.1 Overview

WYG have been appointed by Newark and Sherwood District Council (N&SDC) to undertake an options study to improve the flood protection and resilience of the Gypsy and Traveller Community (G&TC) located on Tolney Lane in Newark. Tolney Lane is the only vehicular access to the site and joins the Great North Road just to the north-west of Trent Bridge, where the Great North Road crosses the River Trent and links into the town centre.

The extensive and growing G&TC are located on various plots off Tolney Lane. Land levels in the G&TC Plots are higher to the south-west, being generally at or above the 12.0 metre (m) above Ordnance Datum (AOD) contour; the plots and Tolney Lane itself at the north-eastern end of the site are lower being at or around 11.0m AOD.

The 1 in 100 year flood (Q100) level in the vicinity of the site is approximately 12.1m AOD upstream of the weir at the Longstone Bridge and 11.6m AOD at the Trent Bridge. Consequently, most of Tolney Lane is in flood zone 3, according to the EA Flood Map for Planning, with the land approximately above the 12.0m AOD contour being depicted as in Flood Zone 2.

As a result the G&TC in Tolney are exposed to significant flood risks: (a) actual fluvial flooding of site areas, this risk being greatest in the north east part of the site and adjacent to the railway; and (b) access/egress issues that affect the entirety of the site, given that Tolney Lane, which provides the only vehicular access route to the site has a high level of flood risk exposure where it runs in close proximity to the River Trent (Newark Branch).

The properties in the G&TC vary widely in type from mobile homes to substantial permanent properties. The survey in July 2018 identified 259 caravans, 42 bricked in caravans and 30 dwellings, a total of 331 accommodation units. It is concluded that the majority of the properties are and will continue to be classified as 'Highly vulnerable' 'caravans, mobile homes and park homes intended for permanent residential use' according to Table 2 of the Flood Risk and Coastal Change Planning Practice Guide (PPG). This situation will only be

exacerbated by the impacts of climate change as flood levels are predicted to increase significantly over the next 100 years.

This project is a preliminary feasibility study to consider how this situation can be mitigated.

2.2 Scope of the Report

WYG were appointed to undertake this commission following a tendering process in which the scope of the study was defined and qualified in response to the specific requirements of N&SDC as set out in the tender documents.

The project has been undertaken in three stages with a preliminary report issued at the end of Stage 2. The Stage 2 report has been used to form the basis of the final report, issued following Stage 3 (detailed modelling of three defence options).

It has been agreed with N&SDC that initially five preliminary flood defence and resilience options (listed below) would be considered as set out below:

1. Provision of improved emergency access/egress north-eastwards along Tolney Lane to the Great North Road. Initial considerations suggest that the improvement might include physically raising of the level of Tolney Road or the use of Bailey Bridges as a temporary measure to be installed on notification of a flood event.
2. Provision of an emergency exit onto the A46 (subject to Highways England (HE) approval) from the land above the 12.0m AOD contour should be a reasonably practical proposition. If this were to run along the edge of the railway before meeting the A46 embankment, it would not of itself result in the displacement of a large amount of flood water and should therefore not significantly exacerbate flood risk elsewhere; there would still remain a risk to the site in the event of a very large event; some of the lower parts of the site will still be at significant risk of flooding; There are a number of potential route options for this road. This proposal deals primarily with the access/egress issue.
3. Provision of an embankment along the River Trent between the Great North Road in the north-east and the A46 in the south-west, set back as far as possible from the River Trent to minimise the loss of flood plain. It is likely to be necessary to investigate the possibility of lowering some of the land between the defence and the river so that it becomes 'functional flood plain' or other land to provide 'compensatory storage'.
4. A scheme of land raising, using materials gained from lowering land alongside the river to raise land up against the railway and A46 or at the north eastern end of the site may be worth investigating.

5. Opportunities to improve the flood resilience of the site: e.g use of floatable units, property level protection or both;

At the conclusion of Stage 2, following consultation with N&SDC, three options will be selected (or a combination of options from the above list) to be taken forwards for more detailed examination using the River Trent model that was used to provide the N&SDC Strategic Flood Risk Assessment update published in 2017 in Stage 3.

2.3 Limitations

This report has been prepared by WYG Engineering on behalf of N&SDC with the scope of the report as described in Section 2.2 above and takes into account the particular instructions and requirements. It is not intended for and should not be relied on by any third party and no responsibility is undertaken to any third party.

WYG Engineering accepts no duty or responsibility (including in negligence) to any party other than to N&SDC and disclaims all liability of any nature whatsoever to any such party in respect of this report.

2.4 Structure of the Report

Section 3 of the report provides a description of the site and the specific constraints in providing a scheme to improve the flood defence and resilience of the G&TC. Section 4 of the report provides an overview of how the River Trent model has been modified to provide a tool to allow a better assessment of the existing flood risk and to provide a means for testing the options selected from more detailed investigation at Stage 3 of the project. Section 5 provides a brief description of the five options considered in Stage 2 and the relative merits of these. It concludes by setting out how three options were selected in conjunction with N&SDC for more detailed investigation by river modelling in Stage 3 of the project.

Section 6 of the report briefly describes the elements of the three options taken forward for assessment by modelling and provides some very preliminary cost estimates for each option. A detailed description of the modelling methodology and the model mapping for the three options is provided in the Model Report which is provided in full in Appendix D. Section 7 summarises the option model results and set out the report's conclusions and recommendations.

3.0 Tolney Lane: Issues, Constraints and Opportunities

3.1 Section Introduction

The general area to be considered by the project has been agreed as being defined as follows: the land bounded by the railway on the north, the Great North Road on the east, the River Trent on the south and the A46 on the west. Although the area to the west of the Old Trent Dyke is unlikely to require defences, it should be included in the study as it provides (i) an alternative access to the A46 and (ii) could allow a shorter embankment on the Trent bank to tie back to the A46 embankment.

3.2 The Natural Environment

3.2.1 Introduction

The site lies in the large swathe of land that constitutes the flood plain of the River Trent. The flood plain at this location is wide, it being approximately 7 km upstream of the tidal influence limit at Cromwell lock. Naturally, prior to human control introduced to facilitate agriculture, transport routes and settlements, the river would be subject to a braiding and meandering regime that would be subject to progressive and perpetual change over time in response to individual flood events and ongoing geomorphological processes. The confluence of the River Devon that enters the Trent from the south, occurs opposite the site.

At some point in time the current bifurcated channels of the River Trent (a northern channel running adjacent to Kelham) and a southern channel (The River Trent Newark Branch) running alongside Tolney Lane and Newark castle became embedded into the local land management system. A former remnant channel, now largely redundant in normal flows, known as the Old Trent Dyke, runs northwards from the Trent and near the western extremity of the Tolney Lane G&TC.

The Trent is a navigable river, and to enable navigation to negotiate the weir opposite the Tolney Lane site, a lock has been constructed on the left bank of the river. It is understood that the weir was introduced in association with a now demolished flour mill. The land between the canal and the river are effectively an island that is partially occupied with buildings, mostly associated with the canal. Vehicular access to these buildings from the rest of Newark is provided by a single road bridge upstream of the lock. This island is linked by

pedestrian bridges over the river to Tolney Lane by a stone arch bridge (Longstone Bridge), which is of historic interest and runs along the weir crest. A newer bridge crosses over the Trent into the Park that is located between Tolney Lane and the river, downstream of the lock.

3.2.2 River Flood levels

Based on the model used to inform the N&SDC SFRA update (2017) flood levels along the River Trent adjacent to the site are as follows:

(i) Where the Trent enters the area of immediate interest (see attached LIDAR plan);
(ii) Just upstream of the weir;
(iii) Just downstream of the weir;
(iv) The bridge where the Great North Road goes over the Trent.

Location	FMP Node Name	Maximum water level from model (mAOD)			
		Q20	Q100	Q100CC1 (30% CC)	Q100CC2 (50% CC)
i) Taken at NGR (E,N) 478650, 353475	403533990	11.74	12.17	12.45	12.59
ii) Taken at NGR (E,N) 479233, 353680	403533250-a	11.63	12.09	12.37	12.52
iii) Taken at NGR (E,N) 479207,353709	NewBr1d	11.52	12.02	12.29	12.41
iv) Taken just upstream of the bridge at NGR (E,N) 479635, 354125	403532620u	11.05	11.61	11.94	12.13

However, the modelling identifies movements of flood water across the flood plain that will need to be considered as part of any future flood defence scheme. The movements are:

1. The culvert under the A46 that maintains the continuity of the Old Trent Drain
2. The A46 bridge over the railway line which also includes bridging across a farm track to the south of the railway;
3. Two further culverts under the A46 to the south of the Old Trent Drain culvert;

4. A culvert under the railway approximately at the centre of the Tolney Site; and
5. A second culvert under the railway located adjacent to the car parks at the north-eastern end of Tolney Lane.

3.2.3 Topography

Detailed topographical surveys to support this study have not been undertaken. However, publicly available LIDAR data is provided in Appendix B. The LIDAR data provides the digital terrain model for the flood model. The key issues in relation to the topography are discussed in section 3 below.

3.3 The Built Environment

The Tolney Lane G&TC site is bounded by the Newark to Nottingham railway on its northern edge. It rises onto a low embankment running south-westwards from the level crossing on the Great North Road. As noted above, there are two culverts which allow the passage of flood water under the railway thus providing some limited linkage between the flood plains to the north and south of the railway.

Historic mapping (1884- see Appendix C) shows that a siding linked the former flour mill to the railway; this siding crossed Tolney Lane and the River Trent (Newark Branch). The point where the siding went across Tolney Lane represents the point where Tolney Lane is virtually adjacent to the river. This location is referred to as the Tolney Lane/River Trent 'pinch point' in this report. Although not specifically inspected during site visits, the road could be subject to risk from erosion at this location in the long term unless protective measures are maintained.

The A46, crosses the River Trent flood plain on an embankment just to the west of the site. The road crosses over the railway.

An element of flood plain connectivity is provided under the A46 by an underpass for farm traffic, a culvert for the Old Trent Drain and a bridge over the railway that also accommodates a farm road. Flood plain connectivity is maintained under the railway by a bridge adjacent to 'The Burrows' plot on the G&TC site and opposite the car park access to off Tolney Lane to the north and east of the G&TC site.

Access from the A46 embankment is provided by a sloping access road into the field located to the west of the Old Trent Drain and the north of the River Trent. This access is some 400m to the north of the A46 bridge over the River Trent (Newark Branch).

Tolney Lane itself is provided with footpaths on both sides up to the eastern boundary of the G&TC; thereafter, the footpath continues on the park side only up to the 'Old Slaughterhouse' plot of the G&TC site. Tolney Lane provides access to car parks at its north-eastern end and access to the series of individual G&TC sites. It is understood that Tolney Lane is an adopted highway up to the point where it divides into two branches; the northern branch providing access to 'the Burrows' plot and the southern branch terminating at the 'Hiram's paddock' plot. The plan in Appendix A, provided by N&SDC, identifies the individual G&TC plots within the wider site.

It is anticipated that most utilities will be present in the road and there appears to be a pumping station located in the park between the road and the river. A bank, approximately 1.5m in height separates the park from the road. This bank is discontinuous, so it clearly is not intended as a flood defence, although it will affect the movement of flood water around Tolney Lane.

Tolney Lane itself turns north eastwards away from the river towards the railway between the Shannon Falls and Hoes Farm elements of the G&TC wider site. A secondary road (also known as Tolney Lane on some documents), which appears to be the continuation of Tolney Lane maintains the north-east to south west alignment and continues along to the 'Hirams Paddock' site. It also provides access to several properties outside of the G&TC site. In this report, these two roads are referred to as the northern and southern branches of Tolney Lane.

3.4 Tolney Lane G&TC Sites

It has not been possible to undertake an internal inspection of the various G&TC sites on Tolney Lane. However, the following issues are evident from Tolney Lane and aerial photography:

1. Although there is a predominance of mobile homes within the G&TC sites, some of the mobile homes are more akin to 'Park Homes' and some are fully developed as traditional brick built residential properties.

2. The individual sites have a variety of boundary treatments. The sites at the north-eastern end of Tolney Lane are provided with good quality brick walls, some with ground level openings to permit the movement of flood water.
3. Analysis of the number of properties that regularly pay council tax has not been considered in this study; however, this will be a relevant factor when considering potential funding from Flood Defence Grant in Aid (FDGiA) for any future scheme.

3.5 Other Issues

3.5.1 Land use

The remainder of the land in the study area is as follows:

(i) The land around the periphery of the G&TC site west of the Tolney Lane/River Trent pinch point is in agricultural use, this being predominantly pasture, although a triangular area to the west of the Old Trent Dyke is used for arable agriculture.

(ii) A public right of way is shown on OS mapping running long the left bank of the Trent from Longstone Bridge although access along the full length is impeded due to an absence of stiles and the presence of chained and wired gates. A second public right of way runs from Longstone Bridge to Tolney Lane adjacent to Ropewalk Farm.

(iii) A relatively recently constructed car park is located to the north east of the G&TC site between Tolney Lane, the railway and the Great North Road. A number of buildings (including public conveniences) are located towards the Great North Road;

(iv) A public park is located between the river and Tolney Lane to the north east of the Tolney Lane/River Trent pinch point.

3.5.2 Geotechnical

Given the geomorphological history of the area it is anticipated that the superficial deposits in the area will be typical of a river flood plain; alluviums, silts, sands and gravels. Evidence of all of these deposits can be seen on exposed surfaces on the left bank of the Trent.

4.0 Baseline Model Outputs

4.1 Baseline Model Methodology

In conjunction with the SFRA update undertaken by WYG in 2016, the River Trent model was obtained from the Environment Agency (EA) and flows relevant to the new EA climate change allowances were simulated and flood extents and mapping outputs provided.

However, the River Trent model is based on a 20m grid size which is too 'coarse' to allow testing of defence options, which are likely to be of relatively small spatial extent. The current 20m grid EA multi domain hydraulic model has been assumed to be 'fit-for-purpose', including all required input data (LiDAR, model inflows & hydrographs, boundary conditions etc); it contains a single TUFLOW domain.

Following a review of the current model set up the current model has been truncated and combined into a single domain. This is to reduce model run times in the proposed option testing. The 2D grid size has been reduced from 20m to 5m.

Model sensitivity testing (ST) has been undertaken using the Q100CC1 and Q1000 events.

A full description of the modelling methodology is provided in the modelling report which forms Appendix D of this report.

4.2 Baseline Model Outputs.

Following resolution of the matters noted above, flood mapping covering flood depth and extent, flow velocities and resultant flood hazard for the present 'baseline' situation are provided for the following events in the Modelling Report provided in Appendix D:

(i) Q20 (1in 20 year flood) or 5% annual exceedance probability (AEP). This event is usually used to define the 'functional flood plain' which is significant in terms of planning policy.

(ii) Q100 (1 in 100 year event) or 1% AEP. This event defines the extent of Flood Zone 3 and is the typical aspirational standard of protection to be provided to residential

property (although, for new development, a further 'freeboard' allowance is added to cover flood level uncertainties and climate change).

(iii) Q100 plus Climate Change 1 (CC1) (1 in 100 year event plus 30% climate change allowance- the figure to be used in the Trent catchment);

(iv) Q100 plus (CC2) (1 in 100 year event plus 50% climate change allowance- the figure to be used in the Trent catchment);

(v) Q1000 (1 in 1000 year event) or 0.1% AEP. This event defines the extent of Flood Zone 2.

It should also be noted that the baseline model identifies some important linkages on the flood plain between areas separated by the A46 and railway embankments.

Simplistically, considering the Q20 event only, flood levels are highest in the quadrant to the south and west of the railway and A46, and lowest to the north of the railway, with no relative difference either side of the A46. However, in the quadrant in which the Tolney Lane G&TC site is located levels fall from south west to the north east (as would be expected). This set up dictates the direction of movement along the hydraulic linkages under the A46 and railway.

4.3 Baseline Model: Site Issues Identified

The modelling confirms the following:

(i) The Church View, Bowers, Old Slaughterhouse and Park View sites at the north east end of the G&TC site would be inundated during a Q20 event. The part of Tolney Lane adjacent to the above site elements would also flood. The Burrows and 2 Tolney Lane, adjacent to the railway line would also flood. As noted above, the Q20 flood outline is generally used to identify areas of 'functional flood plain' although land occupied by buildings would not normally be identified as functional flood plain. The level of hazard associated with this inundation is classified as 'Danger for Most' in Park View, and the Old Slaughterhouse sites and at The Burrow, which includes elements of 'danger for all' (due to flow movements under the adjacent railway culvert).

(ii) Approximately 150m of Tolney Lane centred around the Tolney Lane/River Trent pinch point is classified as 'Danger for Most' during this event, signifying the very real access/egress issue that would arise during a relatively low event, such as the Q20.

(iii) Whilst the flood extent increases on the Q100 event, most of the G&TC site to the west of the junction in Tolney Lane remains flood free. Parts of Hirams Paddock and Sandhills Sconce would be inundated from the south east and west, but the associated hazard is generally 'caution' or 'danger for some'.

(iv) During the Q100 event parts of Tolney Lane either side of the Tolney Lane/River Trent pinch point become 'danger for all' and almost the entire length up to the Great North Road are 'danger for most';

(v) The A46 and the Great North Road remain above the flood during the Q100 event.

(vi) As would be expected, the situation deteriorates further when the climate change scenarios are considered. The A46 remains flood free on all scenarios, although the Great North Road is inundated on the Q100 plus 35% climate change scenario (CC1).

(vii) The model includes links to represent location where water is conveyed across the flood plain under the A46 and the railway line; it is clear that interruption of these conveyance routes will have wider impacts on flood risk in areas within and adjacent to the flood plain.

The flood mapping is provided in the Modelling Report which is provided in Appendix D of this Report.

5.0 Preliminary Options Considered

5.1 Section Introduction

The preliminary options agreed with N&SDC are examined in turn below.

However, the investigations demonstrated that the most appropriate solutions are likely to combine elements of some of the option types considered and set out below.

As most of the options are likely to remove flood plain storage and/or alter flood plain linkage it will be necessary to demonstrate by the Stage 3 modelling that the proposals do not have unacceptably adverse flood risk impacts on neighbouring land and property.

To mitigate adverse impacts it may be necessary to lower ground level on the existing flood plains where this is likely to be feasible or maintain or enhance flood plain hydraulic linkages.

5.2 Preliminary Option 1a: Flood Resilient Exit to Great North Road: Raised Road

It would appear to be broadly feasible to raise the level of Tolney Lane along the length indicated on the plan in Appendix B such that it remains above the 1 in 100 year flood. However, it would be necessary to maintain vehicular access to the G&TC site during the raising works, and, how this might practically be achieved, and the approximate costs are provided in Section 6.3 below.

The raised road would form one side of a protection system for the lower parts of the G&TC site. To fully defend the site, a barrier would be required running along the eastern boundary of the G&TC site between Tolney Lane and the railway embankment.

The raising of Tolney Lane could continue along the full length of Tolney Lane up to its junction with the Great North Road.

The protected area of the G&TC would require a surface water pumping station to deal with water falling within the defended area during a period of flooding when gravity drainage will not be possible.

To minimise the loss of flood plain and to maintain hydraulic connectivity that currently exists under the railway it would be necessary to provide culverts under the road at intervals to allow the car parking area to continue to flood and flood water to continue to pass under the railway.

It may be necessary to enhance the flood plain elsewhere to mitigate the impact of the loss of flood storage through the introduction of the defences.

5.3 Preliminary Option 1b: Flood Resilient Exit to Great North Road: Use of Bailey Bridges

A key consideration for any form of temporary flood protection is the length of time needed to erect the system. Clearly any system needs to be capable of installation on receipt of a flood warning at a point where there is a reasonable level of certainty that the predicted flood is likely to occur. Therefore, because Newark is on the lower reaches of the Trent, one of England's largest rivers, the potential for a flood event to occur will become evident up to 12 hours before the onset of flood conditions. However, greater certainty as to the size of the flood peak in Newark is unlikely to be available until, say, 6 hours before the peak arrives, the predictability of the flood peak level increasing as the flood approaches.

Bailey bridges are modular steel bridges that can be used as temporary structures or installed in emergency situations. Typically, Bailey Bridges are used as temporary replacements to bridges that may be washed away in a flood or damaged otherwise; clearly, they also have obvious military applications where supply lines need to be established across rivers.

A company named Mabey manufactures and provides modular steel bridges in the UK that could be loosely categorised as 'Bailey Bridges'. Bridge units are available in a wide range of lengths and widths. The modular approach allows units to be selected for a wide range of situations; however, the designs are intended to 'bridge' a gap, which is a rather different concept to temporarily raising the level of a length of road.

The modelling identifies that a length of around 600m of road requires protection from flooding for dry access/egress to be available to the Tolney Lane G&TC site.

As an alternative to providing dry access to the Great North Road using Bailey Bridges, an alternative shorter route option is considered briefly below. The option considered assumes

dry access from the parts of Tolney Lane above the Q100 flood level to land that is above the Q100 flood level on the right bank of the Trent. Any such proposal would therefore need to get from the area in the vicinity of the point where Tolney Lane divides into a northern and southern branch to the higher land on the right bank where Mill Lane crosses the approach to the canal lock. As the crow flies this is approximately 300m (half the distance of following Tolney Lane down to the Great North Road).

However, although the distance is halved, this benefit is more than offset by the increased difficulty of having to provide a crossing of the main channel of the River Trent (Newark Branch) (required span approximately 30m). There is an existing bridge over the former mill race which would need to be investigated to establish its suitability for retention as part of a formal access/egress route. However, a 30m span over the Trent would be prohibitive for a temporary bridge solution, as such a bridge could not be stored off-site and brought in without the use of specialised vehicles. It would need very heavy duty cranage to lift the bridge into position onto prepared abutments. Such an operation is not sufficiently reactive to the lead in times associated with flooding at this location. It is concluded that this is not a practical proposition.

5.4 Preliminary Option 2: Emergency Exit to A46

An emergency egress option is possible, subject to Highways England (HE) agreement, from the western end of the G&TSC site onto the embankment of the A46. This road would only be available for use in the event of a flood predicted to flood Tolney Lane thereby severing the site from the rest of Newark.

As HE are proposing to upgrade the A46 to expressway standards, it may be possible as part of the HE upgrade to include for the new emergency exit within the design. Alternatively, it may be more acceptable to HE to modify the existing agricultural access from the A46 to the field to the west of the Old Trent Dyke.

There are four potential route options for the emergency exit; some of the southern options would sever an area of land from the flood plain that could conceivably be either defended or raised and used as potential future expansion space for the G&TC. However, as the baseline modelling has identified important flood plain linkages which may need to be retained to avoid adverse impacts elsewhere, there is a real danger that these linkages would be compromised by this proposal unless significant bridging structures are introduced.

This proposal does not address the current flood risk issues at the north-eastern end of the G&TC site. However, re-location of the sites to any new expansion area created may be a possibility.

5.5 Preliminary Option 3: Defences and Mitigation

The low-lying part of the G&TC site could be defended by a hard barrier (e.g either an embankment or wall or combinations of both) rather than by road raising; however, this, on its own would not address the emergency access/egress issue.

5.6 Option 4: Land Raising

This may be viable in conjunction with the creation of an emergency egress route to the A46; however, it would require the re-location of the low-lying eastern part of the C&TC site westwards.

5.7 Option 5: Flood Resilience Measures

Increasingly, flood resilience measures are used as a means of providing protection to property in the event of a flood. The intention of flood resilience measures is to allow the impact of a flood on a property to be minimised.

Ensuring all property owners in the at-risk area are signed up to EA flood warnings and that there are formal flood plans in place, provides a low level of flood resilience.

However, typically, flood resilience involves 'keeping the water' out of the property (using property level flood protection systems), or by adapting the property so that in the event of an internal flood clean-up operations can take place quickly and flood damage is minimised.

In the case of caravans and park homes, a strategy to exclude water is unlikely to be successful, because if any depth of water is excluded, it is likely to either precipitate the collapse of the caravan or park home walls or result in the structure floating. Although anchorage points can be provided relatively easily for a floating structure, as the structures are not designed to float, the benefit of the anchorage point is primarily limited to preventing the structure moving off-site and contributing to downstream blockages; the provision of an anchorage point alone would not ensure the safety of the occupants.

In the Netherlands, innovative floating properties have been constructed. The designs of such structures are sophisticated, the design enabling the contents of the floating structure to be secure, provision made for utilities connections to be maintained, and extensive foundations and guides to allow the unit to move safely on the varying water levels.

5.8 Option Comparison and Recommendations

5.8.1 Introduction

The options set out above were presented by WYG to technical officers from N&SDC on Thursday 7th March. The issues identified in the preliminary baseline modelling (see flood mapping contained in the modelling report in Appendix D of this report) are set out in Section 4 above and influence the option selection for further investigation by modelling.

5.8.2 Options Discounted

It was agreed that the proposal to use Bailey Bridges should not be pursued further for the following reasons:

(a) The length of Tolney Lane that requires raising temporarily is approximately 620m. Using a standard low loader, the length of bridge that could be easily transportable is approximately 12m. To raise this entire length would require 50 12m long bridge units. Even if 2 bridge units per loader were to be feasible, it would require 25 trips from the Bailey Bridge store area to bring the units to site.

(b) Assuming, each bridge could be successfully located and fixed in place in 2 hours, it still would require a period of 100 hours (5 days) to fully install the full length. Whilst it might be possible to reduce this time period, it seems unlikely that the system could be sufficiently reactive to the lead in times likely to be available via flood warnings resulting in the risk of failure to implement in time or the risk of prematurely over-reacting on numerous occasions.

It was also agreed that the use of flood resilience measures alone was not an appropriate solution for caravans and park homes as excluding water is likely to result in the structural failure of the unit; the development of provision of floating properties is a major undertaking that is not consistent with the typical accommodation on the Tolney Lane G&TC Site.

5.8.3 Option 1: Raising Tolney Lane and Defending Plots

It was agreed that the feasibility and impact of raising Tolney Lane to a level just above the Q100 flood be investigated by river modelling. This would provide a dry access/egress to the

Great North Road on all events up to the Q100. Further raising would be of limited benefit, as the Great North Road itself becomes inundated on the Q100 plus 30% climate change event. In conjunction with the improvements to Tolney Lane, given that the following plots flood on a Q20 event a flood barrier around these plots along Tolney Lane would be provided: Park View, Old Slaughterhouse Site, Bowers Site, Church View Site and Shannon Fall (Part). A further flood wall would be required from Tolney Lane to the railway embankment along the eastern side of the Park View site. The above measures will require mitigation to minimise adverse impacts elsewhere, and the following mitigations are available: lowering of parts of the parkland and removal of embankments from the south side of Tolney Lane and improvements in flood plain connectivity by the introduction of a culvert under the raised Tolney Lane linking to the bridge under the railway. The elements of Option A are shown on Dwg SK003 in Appendix E.

5.8.4 Option 2: Emergency Access Egress Route to A46; Defence to Plots as Proposed under Option 1 (with mitgations).

It was recognised that the proposed upgrade works on the A46 would provide the opportunity to raise the matter of an emergency access/egress route to the Tolney Lane G&TC site with Highways England (HE).

Given that the northern spur of Tolney Lane is very narrow in some locations and that the shortest route across the flood plain to the existing farm access point onto the A46 is from the south western end of the G&TC site (e.g the Hiram's Paddock and Green Park plots) it was agreed that the route option to be tested be as follows: (i) a perpendicular approach to the A46 from the Green Park plot and (ii) a route alongside the base of the A46 embankment. Culverts would need to be provided at all points where flood plain conveyance routes are crossed by the road.

The mitigation options associated with Option A, have been included in the Option B model.

5.8.5 Option 3: A Defence to the G&TC Site (except the Burrows Plot) plus Emergency Access Route to A46 and Mitigations as Option 2.

Although it was recognised that, the associated costs would be high and the adverse impacts potentially unacceptable, it was agreed that a defence scheme for the entire Tolney Lane G&TC site footprint (with the exception of the Burrows Plot) would be tested in the river

model. This option also included the emergency access route to the A46 and the mitigations tested with Options 1 and 2.

6.0 Options Taken Forward for Further Investigation

6.1 Section Introduction

The options to be investigated in the river model, as agreed with N&SDC Technical officers, are described in outline in Section 5 above. A fuller description of each option is provided in sub section 6.2 below, along with some very preliminary costing information.

6.2 Modelling Methodology

A detailed description of the modelling methodology is provided in the Model Report which is provided in Appendix D of this report.

6.3 Stage 3 Option 1 Description and Costing

The following items are the key elements of Option 1:

1. Raise Tolney Lane from the point where it splits into a northern and southern arm to the Great North Road to a road level of the existing 1% AEP maximum water level plus 100mm freeboard.

   (a) 250m raised by approximately 1.5m (£2000 x 250= £500,000)

   (b) 275m raised by approximately 1.0m (£1500 x 275 = £412,500)

   (c) 150m raised 0 – 0.5m (£1250 x 150 = £187,500)

2. Measures to maintain access to the G&TC site during the raising of the road. Over most of the length this could be achieved by means of a temporary road on the park side of Tolney Lane. At the pinch point where Tolney Lane is closest to the river, it may be necessary for the temporary road to be located on the opposite of

the road within the edge of the Shannon Falls site. Allowance for temporary road (£25,000)

3. 5 new access points (£25,000)
4. Allowance for utility diversions (£50,000)
5. New Flood Wall (60m) (Tolney Lane to Railway Embankment): £60,000
6. Amendments to walls (350m) alongside Tolney Lane Frontage including new flood gates: £350,000
7. Surface Water Pumping Station behind flood walls: £50,000
8. Mitigation: 1.5m high x 5m wide culvert under Tolney Lane and Footpaths: £50,000
9. Mitigation: New 5m wide flood relief channel (170m): £50,000
10. Mitigation: Removal of embankments and land lowering to 11.0m AOD in park to increase flood plain storage locally plus reinstatement of paths and landscaping: £80,000

The overall total of the above items is £1,840,000.

It is suggested that 30% should be added to this figure to cover, further investigations, design and procurement costs with a further allowance of 20% added to cover project contingencies giving a preliminary cost figure of £2,900,000 (rounded to the nearest £50K).

6.4 Stage 3 Option 2 Description and Costing

The following are the key items of Option 2:

1. Construction of a new emergency access/egress road from the G&TC site (leaving the site at the Green Park plot but extended to the southern arm of Tolney Lane through the Hirram's Paddock plot) to the existing agricultural access onto the A46. It is assumed that this road will be on an embankment (1 in 3 side slopes) and will be 3m wide with a basic metalled surface. (840m x £750 = £630,000)
2. Culvert 1: 10m wide, 3.1m high: £60,000
3. Culvert 2: 10m wide, 3.5m high: £60,000

4. Culvert 3: 5m wide, 2.25m high: £30,000

5. Culvert 4: 5m wide, 2.6m high: £30,000

The total of items 1 – 5 is £810,000

In addition, the mitigation elements of Option 1 would be required:

6. Mitigation: 1.5m high x 5m wide culvert under Tolney Lane and Footpaths: £50,000

7. Mitigation: New 5m wide flood relief channel (170m): £50,000

8. Mitigation: Removal of embankments and land lowering to 11.0m AOD in park to increase flood plain storage locally plus reinstatement of paths and landscaping: £80,000

9. Mitigation: localised raising of Tolney Lane over new culvert: £100,000

The total of items 6 – 9 is £280,000 giving a total for Option 2 of £1,090,000

It is suggested that 30% should be added to this figure to cover, further investigations, design and procurement costs with a further allowance of 20% added to cover project contingencies giving a preliminary cost figure of £1,700,000 (rounded to the nearest £50K)

6.5 Stage 3 Option 3 Description and Costing

Option 3 retains the mitigations proposed under Options 1 and 2 and the 'defence' provisions of Option 1. Tolney Lane, however, only requires raising to a point providing access to the adjacent G&TC plots and to cross over the proposed new culvert.

In addition, a new defensive bund (where required) is placed around the G&TC sites to the south and west of the point where Tolney Lane splits into two. The approximate line of the defence is shown on Plan SK005 which is provided in Appendix E. It has been assumed at this stage that the much longer southern defence (780m) would be provided by means of an earth embankment. However, the shorter defensive link between the higher ground in the G&TC site to the railway embankment has been assumed to be a wall (45m long). This wall would require a flood gate to allow access to agricultural land to the west. A wall has been assumed due to the lack of space and the need to incorporate the flood gate. The defence height would be set at approximately 13.2m AOD in order to defend the area against all

events up to the Q100 plus 50% CC. The defence is the same crest level as the proposed emergency access/egress route to the A46, so the road and defence can be of common construction along the south western edge of the G&TC site.

The defences would allow all parts of the G&TC site to be defended against the Q100 plus 50% climate change event except for the Burrows Plot. A number of private properties will also benefit from the defence.

The key elements are:

1. 780m of earth embankment: (780 x 700 = £546,000)
2. 45m of flood wall: (45 x 1000 = £45,000)
3. New Flood Gate: £10,000

The following 'defence' elements of Option 1:

4. Raising of Tolney Lane (approximately 40m) to a point to the north east of the culvert that links the River Trent (Newark Branch) with the railway bridge to a road level of the existing 1% AEP maximum water level plus 100mm freeboard.

   (a) 250m raised by approximately 1.5m (£2000 x 250= £500,000)

   (b) 100m raised by approximately 1.0m (£1500 x 100 = £150,000)

   (c) 50m raised 0 – 0.5m (£1250 x 50 = £62,500)

5. 4 new access points (£20,000)
6. Allowance for utility diversions (£30,000)
7. New Flood Wall (60m) (Tolney Lane to Railway Embankment): £60,000
8. Amendments to walls (350m) alongside Tolney Lane Frontage including new flood gates: £350,000
9. Surface Water Pumping Station behind flood walls: £50,000

   The following mitigation elements of Options 1 and 2

10. Mitigation: 1.5m high x 5m wide culvert under Tolney Lane and Footpaths: £50,000
11. Mitigation: New 5m wide flood relief channel (170m): £50,000

12. Mitigation: Removal of embankments and land lowering to 11.0m AOD in park to increase flood plain storage locally plus reinstatement of paths and landscaping: £80,000

The total for Option 3 is therefore £2,003,500

It is suggested that 30% should be added to this figure to cover, further investigations, design and procurement costs with a further allowance of 20% added to cover project contingencies giving a preliminary cost figure of £3,150,000 (rounded to the nearest £50K)

7.0 Conclusions and Recommendations

7.1 Section Introduction

The basics of the above schemes have been inserted into the River Trent Model, which was prepared for this purpose, by introducing an appropriately reduced model grid size. Some evolution of the designs has occurred between commissioning of the modelling and completion of the report. As a result, the modelling diverges from the option descriptions provided above in the following ways:

(i) Stage 3 Option 2: The Emergency access/egress route extends further southwards that shown in the modelling report;

(ii) Stage 3 Option 3: The modelling did not allow for raising of Tolney Lane from the point where it splits into a northern and southern route up to the north eastern edge of the G&TC.

Notwithstanding the above, it is considered that the accuracy of the modelling is commensurate with the purpose of this report and allows a reasonable assessment of the flood risk implications of the proposed interventions.

The flood mapping for each option is provided in the modelling report (see Appendix D of this report) and the implications of the results are drawn out below, including further mitigations which might be considered which may reduce some of the identified adverse impacts. The 'Depth Difference' maps show the impact of the proposals on flood risk in areas adjacent to the site; green depicts areas where the depth of flooding decreases, red, areas where flood depths increase.

7.2 Stage 3 Option 1: Performance and Commentary

Inasmuch as the Park View, Old Slaughterhouse Site, Bowers Site, Church View Site and Shannon Fall and Tolney Lane itself all remain flood free on the Q20 and Q100 events the option delivers its intended result.

It does, however, leave parts of the wider site still at risk of flooding on the Q100 event (including the Burrows and 2 Tolney Lane, against the railway line and parts of Hirams

Paddock and Sandhills Sconce). The hazard associated with this flooding is 'danger for all' at the Burrows.

When 30% climate change is considered on a Q100 event, water can begin to enter the Park View, Old Slaughterhouse Site, Bowers Site, Church View Site across the railway line, and the extent of inundation spreads in the larger south western portion of the G&TC. As would be expected, when 50% climate change is applied to the Q100 event this situation deteriorates further.

The depth difference maps show that up to and including the Q100 event the proposals (including the mitigation) actually reduce flood risk in areas to the south of the Great North Road; the areas of increase are largely located over the River Trent (Newark Branch) adjacent to the Great North Road bridge and a small area to the south of where Tolney Lane splits into two. However, once climate change is taken into account on the Q100 event, the effective squeezing of flows by the raising of Tolney Lane and the introduction of defences, holds water back to the south west of the site, causing a slight increase in flood depth over a wide area, with a corresponding decrease in flood risk in the area to the north of the railway line.

The above increases in flood depth are unlikely to be acceptable.

There are possible mitigations which could be considered:

(i) Lowering of land levels in the flood plains at selected locations between the G&TC site, the A46 and the River Trent (Newark Branch). Given that the depth increases

are generally in the range 20 - 50mm lowering of selected areas by 100 – 250mm may be sufficient to off-set the increases;

(ii) Improve further the flood connectivity across the railway line. This might be achieved by widening the culvert under Tolney Lane and the associated relief channel.

Defending the Park View, Old Slaughterhouse Site, Bowers Site, Church View Site and Shannon Fall sites against more severe events would require measures to prevent water crossing the railway line.

7.3 Stage 3 Option 2: Performance and Commentary

As would be expected, Option 2, provides a dry access/egress route on all the events tested.

However, although the mitigations at Tolney Lane are retained (i.e. the flood channel and culvert under Tolney Lane and the lowering of land in the park area) these mitigations are not sufficient to avoid increases in flood depth over a wide area to the south and west of the G&TC site.

The increases in flood depth are unlikely to be acceptable.

There are possible further mitigations which could be considered:

(i) Lowering of land levels in the flood plains at selected locations between the G&TC site, the A46 and the River Trent (Newark Branch). Given that the depth increases

are generally in the range 50 - 100mm lowering of extensive selected areas by 100 – 250mm may be sufficient to off-set the increases;

(ii) Improve the flood connectivity across the proposed new access/egress route. In particular, culverts 1 and 2 may need to be considerably increased in size to improve conveyance;

(iii) Improve further the flood connectivity across the railway line. This might be achieved by widening the culvert under Tolney Lane and the associated relief channel.

7.4 Stage 3 Option 3: Performance and Commentary

As would be expected, Option 3, provides a dry access/egress route to the A46 on all the events tested and defends the entirety of the G&TC site other than the Burrows Plot, up against the railway.

However, although the mitigations at Tolney Lane are retained (i.e. the flood channel and culvert under Tolney Lane and the lowering of land in the park area) these mitigations are not sufficient to avoid increases in flood depth over a wide area to the south and west of the G&TC site that commence even on the Q20 event and become extensive at depths 50 – 100mm to the south west of the site and at depths in excess of 100mm on the Q100 plus 50% climate change event in the area between the site, the A46 and the river; however, the area where flood depths increase by over 100mm extends into the urban areas on the left bank of the river.

Increasing flood depths significantly by proposals that require planning approval is contrary to the National Planning Policy Framework and would therefore be subject to objection by the EA who are statutory consultees in respect of proposals in Flood Zones 2 and 3. Furthermore, increasing the flood risk to existing urbanised area is likely to generate significant public opposition.

The further possible mitigations which could be considered are:

(i) Lowering of land levels in the flood plains at selected locations between the G&TC site, the A46 and the River Trent (Newark Branch). Given that the depth increases

are generally in the range 50 - 100mm lowering of extensive selected areas by 100 – 250mm may be sufficient to off-set the increases;

(ii) Improve the flood connectivity across the proposed new access/egress route. In particular, culverts 1 and 2 may need to be considerably increased in size to improve conveyance;

(iii) Improve further the flood connectivity across the railway line. This might be achieved by widening the culvert under Tolney Lane and the associated relief channel.

(iv) Mitigations associated with the proposed upgrade of the A46, which itself will interrupt flood plain conveyance; it is possible that the conveyance of water from west to east under the A46 corridor could be reviewed as part of the upgrade works and taken with the other mitigations identified above, a solution found that avoids any inacceptable increase in flood risk to properties external to the site.

However, the magnitude of the predicted increases in flood depth due to the significant loss of flood plain storage as a result of the extensive defended area strongly suggest that the adverse impacts of this option cannot be rendered acceptable through mitigation.

7.5 N&SDC Local Plan Review Implications

As part of the Local Plan Review it is relevant to consider if the study has identified any evidential justification for the expansion of the G&TC site at Tolney Lane.

This report has identified that it is feasible to improve the current situation by defending most of the areas at greatest risk of flooding and improving the access and egress issues to the entire site during flood events. The positive benefits of flood alleviation measures (a developed version of Option 1 or 2) is likely to be able to considerably improve the current situation and partially off-set the adverse impacts of climate change for some time for the current G&TC site. Therefore, consideration should be given to the development of a more detailed local policy for the Tolney Lane G&TC site that allows its continuance largely within the existing boundaries in conjunction with a scheme (a variant of either Option 1 or 2) to reduce the current level of flood risk exposure.

However, any expansion of the site onto the surrounding flood plain is unlikely to pass the sequential test of the National Planning Policy Framework, even if the Exception Test could be passed for the expansion area by the introduction of defences. As identified by the Option 3 modelling, defending new undeveloped flood plain areas in this location is unlikely to be

possible without creating unacceptable adverse impacts elsewhere. Therefore, even if a Sequential justification for expansion at Tolney were available, it is unlikely that the Exception Test could be passed for any further significant expansion beyond the current boundaries.

7.6 Funding Issues

Flood Defence Grant in Aid (FDGiA) is available for flood defence projects which meet the criteria set out on documents published by the Environment Agency and available on the GOV.UK website. Successful schemes are added to the 6 year programme of works. The EA indicated that funding is also available from the Regional Flood Defence Committee Local Levy fund for studies that are likely to result in the development of schemes for inclusion on the EA 6 year programme of Flood Alleviation Projects. Minutes of the meeting with the EA to discuss the project can be found in Appendix F.

Clearly, there are complicated rules associated with FDGiA funding. A critical issue in allocating funds is the cost benefit provided by the scheme in terms of the benefits to protected residential properties compared to the cost of the scheme. However, for inclusion in the cost benefit calculation, 'Park Homes' can be included, provided that there is an established history of council tax payment for the property concerned. A potential lack of properties with consistent council tax payments could mean that the cost benefits of a scheme to defend all or parts of the Tolney Lane G&TC will not be sufficient to secure sufficient FDGiA funding to allow the scheme to proceed.

It is not necessary to provide defences to a Q100 plus 50% climate change standard in order to attract the funding; however, it is necessary to improve the protection and the cost benefits of the protection level provided need to be carefully balanced against the cost of the project. It is also acceptable for schemes to be funded from multiple sources, so schemes

that score a low-cost benefit ratio and so attract a low FDGiA funding can still proceed if the funding shortfall can be obtained from other sources.

7.7 Conclusions and Recommendations

The modelling confirms that there is a significant flood risk issue at the Tolney Lane G&TC Site. There are three distinct aspects to this risk:

(a) The risk posed by flooding of Tolney Lane, which is the only means of access out of the site to higher land. Even on a Q20 event, significant and hazardous flooding occurs;

(b) Most of the G&TC site is at a significant risk of flooding. Park View, Old Slaughterhouse Site, Bowers Site, Church View Site, Shannon Falls (Part), The Burrows and No 2 Tolney Lane all lie on land that floods on a Q20 event. This is a high exposure to flood risk; most of the remainder of the site progressively becomes at risk as the event considered increases in severity.

(c) Increases in flooding attributable to climate change will further exacerbate this situation.

There are potential solutions to alleviate this situation and three options have been tested in this study. The options tested are not the only options available and each option could be

developed further with supporting mitigation. Elements of each option could be combined to provide an optimal solution.

The table below summarises the issues associated with the three options tested in the river model in Stage 3 of the project.

	Stg 3 Option 1	Stg 3 Option 2	Stg 3 Option 3
Key Elements	Improved Access/Egress on Tolney Lane; Defences to High Risk Sites	Emergency Access to A46	Emergency Access to A46 Defences to Most of Site (with climate change provision)
Cost Estimate	£2,900K	£1,700K	£3,150K
Advantages	Tolney Lane is an adopted road; Defends most high-risk areas; Least adverse impact on adjacent flood risk	Least cost	Largely complete solution;
Disadvantages	Limited Solution	Very Limited Solution Only; Reliant on third party access;	Most impact on adjacent flood risk (adverse impacts unlikely to be resolvable)

In order to establish the likelihood of securing FDGiA funding, it is important that the eligible properties for cost benefit calculations be established and their locations identified.

On balance it seems likely that Option 1 offers the least disadvantages as it defends a large proportion of areas at greatest risk (and may therefore attract some FDGiA funding); it also appears to have limited adverse impacts on flood risk to adjacent areas which may be

resolved by further refinement of the solution. As a scheme it is also less reliant on third party co-operation than is the case in respect of options 2 and 3.

Finally, the proposals to upgrade the A46 may result in measures that could alter the way in which flows move across the flood plain which could conceivably assist mitigations to support Options 2 or a variant of Option 2.

The significant adverse impacts of Option 3 are unlikely to be resolvable.

This report concludes that it would be feasible to develop a scheme as a development of either Option 1 or 2 to improve the flood resilience of Tolney Lane and improve the standard of protection to most of the highest risk locations within the G&TC site.

The report does not support any justification for any significant expansion of the G&TC site at Tolney Lane in conjunction with the provision of new defences, as such defences will almost certainly have detrimental impacts on flood risk elsewhere that cannot be mitigated. Therefore, it is concluded that the NPPF Exception Test could not be passed for any significant expansion even if sequential justification were available.

However, the positive benefits of flood alleviation measures (a developed version of Option 1 or 2) is likely to be able to partially off-set the adverse impacts of climate change for some time for the current G&TC site. Therefore, consideration should be given to the development of a more detailed local plan policy for the Tolney Lane G&TC site that allows its continuance largely within the existing boundaries in conjunction with a scheme (a variant of either Option 1 or 2) to reduce the current level of flood risk exposure.

8.0 Appendices.

Appendix A: G&TC at Tolney Lane: Site Plan

Appendix B: LIDAR Data

Appendix C: 1884 Historic OS Map

Appendix D: Modelling Report

Appendix E: Stage 3 Option Plans

Appendix F: EA Meeting Minutes