Nottingham City
Condition Projection Model

May 2021

Document Information

Title	*Carriageway Condition Projection Model 2021 to 2031*
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Document History

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01	Draft	JW	1st May 21	DRAFT
02	Draft	JW	14th June 21	DRAFT

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Contents

Executive Summary

The Carriageway Infrastructure asset in Nottingham is valued more than **£1.06 Billion**. This report discusses the affects of changing budgets on the management of infrastructure assets in the future.

Nottingham have employed XAIS Asset Management Ltd as most of their workforce have been heavily involved in pavement management since the early 90's. Senior XAIS members were directly involved in the creation of UKPMS and helped design the UKPMS framework which most systems are based upon in the UK. XAIS have been a specialist technical advisor to ALL the PFI's in the UK and several DBFO companies, creating working models for the lenders and banks in litigation and bidding for major works throughout the UK and Europe. These include:

- M6 DBFO
- M74 DBFO
- A417/A419 DBFO
- A1(M)
- D47 Czech Republic

The authority's approach to evaluating the condition of Carriageways uses an Annual Engineers Inspection (AEI) which has been successfully used over the last few years, delivering accurate scheme lengths for asset valuation and scheme appraisal.

The analysis shows over the next 10 years:

- Existing budget results in an increase in the maintenance need of **£87.7m**
- Significant investment is required, an additional **£5m** per annum (which has been modelled)

The report recommends that the members note:

1. The options available to Nottingham Council to optimise available funding to its most efficient use on the highway network i.e., adopt Life Cycle Planning.
2. The potential financial implications of not putting effective asset management in place

The reasons for the above recommendations are:

1. To safeguard available funding to Nottingham.
2. To manage the carriageway assets in a controlled manner, therefore minimising hazards and corporate risk to the council whilst maximising safety and journey reliability for users and stakeholders of the network
3. Taking an asset management approach has a positive impact on revenue funds, as it is expected this will reduce the revenue spend on reactive maintenance

1. Introduction

Nottingham Council has 774km of roads of footways. This is by far the Council's biggest property asset, which is worth over **£1.06 billion,**

A Roads –	75.5 km
B Roads –	23.3 km
C Roads –	41.5 km
U Roads –	634.0 km

Like all property assets, the condition of our roads and footways deteriorates over time, which causes a loss of value. In Nottingham, the value of the Carriageway infrastructure is currently reducing by **£4 million** per year (Annual Depreciation).

Deterioration will always occur but the aim of effective asset management is to target investment to slow the rate of deterioration or keep it in check. Keeping deterioration in check is commonly referred to as maintaining 'steady state'. The 20/21 allocation for highway maintenance funding is approximately **£1.4** million, which is **35%** of the annual depreciation and **ONLY 0.13%** of the asset value. It has been recognised for some time that this amount is insufficient to achieve a steady state, but by optimising our investment, we can and have slowed the decline as much as possible by using the maintenance tools available to us. There is a shortfall in annual spend of **£5 million.**

Whilst the Engineers have been slowing the network decline there is an initial accumulated maintenance need for the carriageway asset in the region of **£57 million** (5.4% of the asset value), which will bring the network up to a standard where steady state maintenance can be introduced.

This report sets out the long-term consequences of continuing to under invest at present levels, by modelling the continued deterioration of our roads and footways and understanding future funding needs through Lifecycle Planning.

The Department for Transport have made it clear to local authorities that to secure current indicative capital funding levels, we must actively be seeking to adopt asset management principles, i.e. provide effective and efficient delivery of services and maximise the return on funding.

The report also sets out the alternate options available to Nottingham to secure funding to remove the accumulated maintenance need and deliver a steady state network.

2. Process

2.1. Data Loading into XA ©

In order to populate the model, it is essential that we use accurate and complete data from the surveys undertaken on the network. The accuracy of the model is totally dependent on the quality and quantity of data being supplied and hence particular effort has been expended ensuring that the data has been audited and that gaps in network data are logged or backfilled where necessary.

2.2. Configuring XA ©

Once the data is in the correct format and of the right quality within XA, configuration of XA is required to ensure the output and results are based on "real" scenarios, therefore the council has a reliable output for decision making etc.

This process requires skill and care and due to the requirements for the output, this process can become lengthy. This tailoring of the system makes it bespoke to the network in question and totally user defined (i.e. the engineer sets all rules and parameters for decision making).

- **Treatment Definition**

  What treatments will be used for the respective conditions

- **Treatment Selection Rules**

  Uses a decision tree to identify which sections will be treated and with which solution.

- **Scheme Parameters**

  This defines the rules on which maintenance schemes will be selected.

- **Condition Projection**

  Is used to estimate the future levels of deterioration on the network based on current condition factors. This is linked to the lifecycle of the asset.

2.2.1. Treatment Definitions

There is a requirement to establish how the schemes will be treated with regard to maintenance, this is done within Treatment Definitions. These are minimal treatment options for modelling; however, they can be set against different carriageway types such as bituminous or concrete.

Treatments are also defined here against each of the route hierarchies (i.e. Urban or Rural, M101 or M102 etc.

In treatment definitions it is critical for model accuracy that unit rates for maintenance reflect truly what is happening on the network. XAIS have therefore taken a detailed approach to this function working with the Authority to develop accurate pricing schedules. Data was gathered from the authority to provide

- Scheme costs broken down into £ per m²
- Surface or treatment types undertaken
- Longevity/life span of products used

(costs are inclusive of design/drainage/materials etc)

There are various treatments setup within the system but for budgeting purposes they were collated under the following treatment types:

Treatment Types	
A	Planned Works Structural Maintenance
B	Planned Works Preventative Maintenance
C	Planned Patching Maintenance

Table 5.3 - Treatment Types

The following table shows some of the treatments set up within XA and is referenced to the treatment type

Treatment Recorded	Colour Band
Resurface Binder	Reconstruction
Resurface	
Junction Deterioration	Resurface
Resurface 3 - 5 Years	
Micro Asphalt >10% Patch	Preventative Maintenance
Micro-Asphalt <10% Patch	
S Dress >10% Patch	
S Dress <10% Patch	
Patching Required	Patching Maintenance
S Dress 3 - 5 Years	
Up To Standard	Up to standard As New
As New	

2.2.2. Treatment Decision Trees

Future treatment selection in the model is based on a decision tree process to apply one of the pre-defined treatments. The decision tree is established by the engineer and uses the defects and Investigatory levels to apply the treatment. The example below shows a decision process for maintenance hierarchy M101.

The treatment decision trees have been populated for all the maintenance hierarchies with all environments

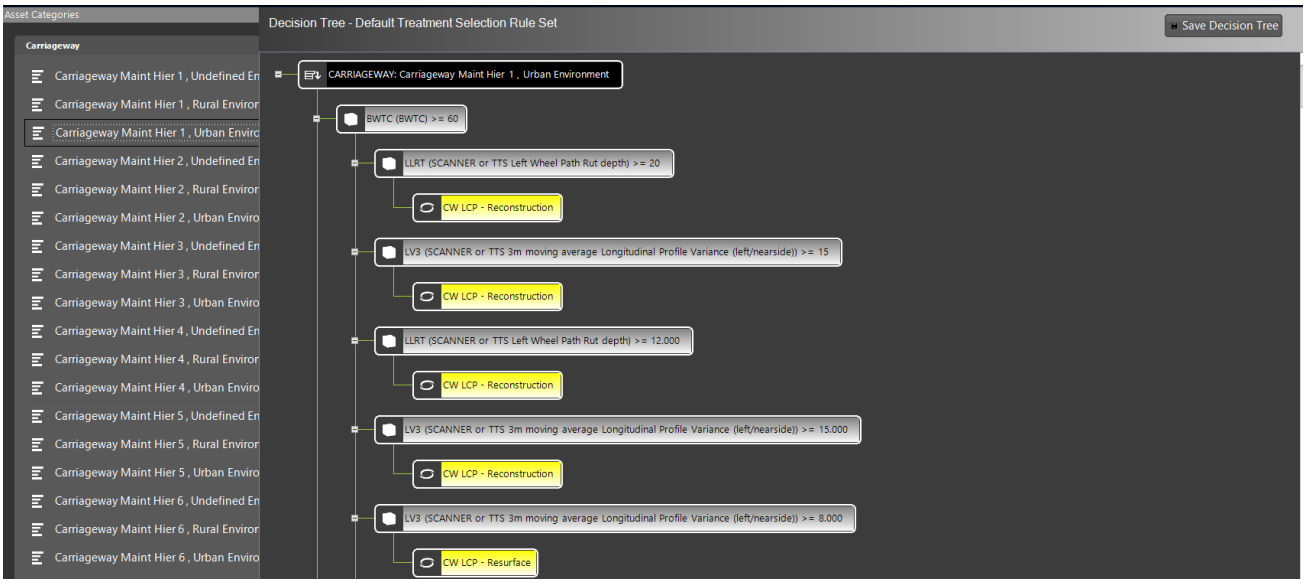


Figure 5.8 – Example Treatment Decision Tree

2.2.3. Scheme Parameters

The scheme creation parameters are used to determine how future schemes or hot spots will be identified on the network. The parameters are set against threshold levels to ensure that schemes are chosen efficiently. Criteria is set against the minimum scheme length, merge buffer length (i.e. how far back and forth the system will look to find section data of the same levels) or the minimum percentage of a section to be included and the scheme efficiency. The extract below from the model shows the parameters used within XA.

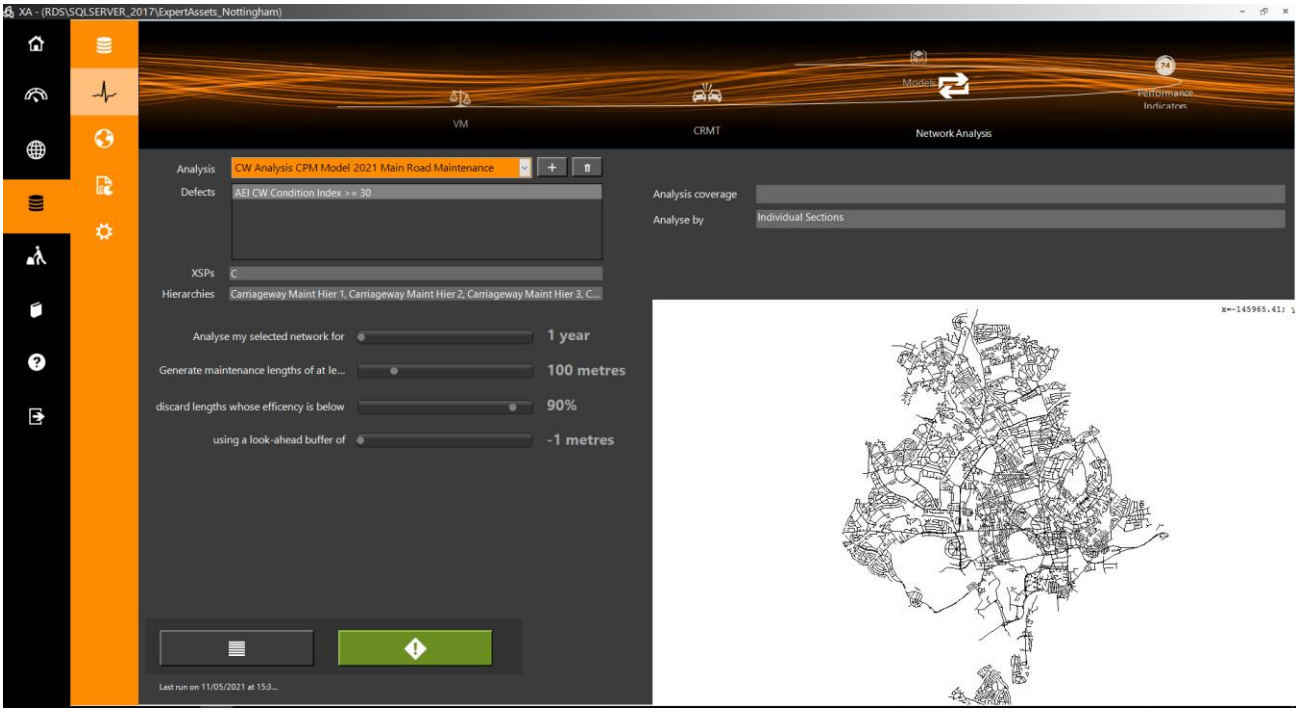


Figure 5.9 – Example Scheme Creation Parameter Set

2.2.4. Condition Projection

To enable the authority to develop a forward works programme and test investment strategies, there is a requirement to develop a robust method for condition projection. Several options are available for consideration and have been trialled.

- UKPMS condition Projection – ''Use with caution'' has been issued from the PCIS support contract. Our consultants are part of the PCIS support team and have evaluated this process. It was decided that information was not available to ensure this methodology would work on the Nottingham Network

- Straight Line Condition Projection – This method uses an absolute value for the defects or percentage increase for the condition index. This is appropriate for some parts of the network but does not work when a section is up to standard in the first year.

- Deterioration curves – This method is the most appropriate method for long term condition projection and follows the similar methodology to the UKPMS deterioration model. This methodology has been developed for the authority, but requires re-iteration and validation in future years following an annual review.

During workshops held with the authority a lot of time and effort was undertaken in ensuring the lifecycle planning models are correct. Therefore, the condition projection should match the expected lifecycle as shown below:

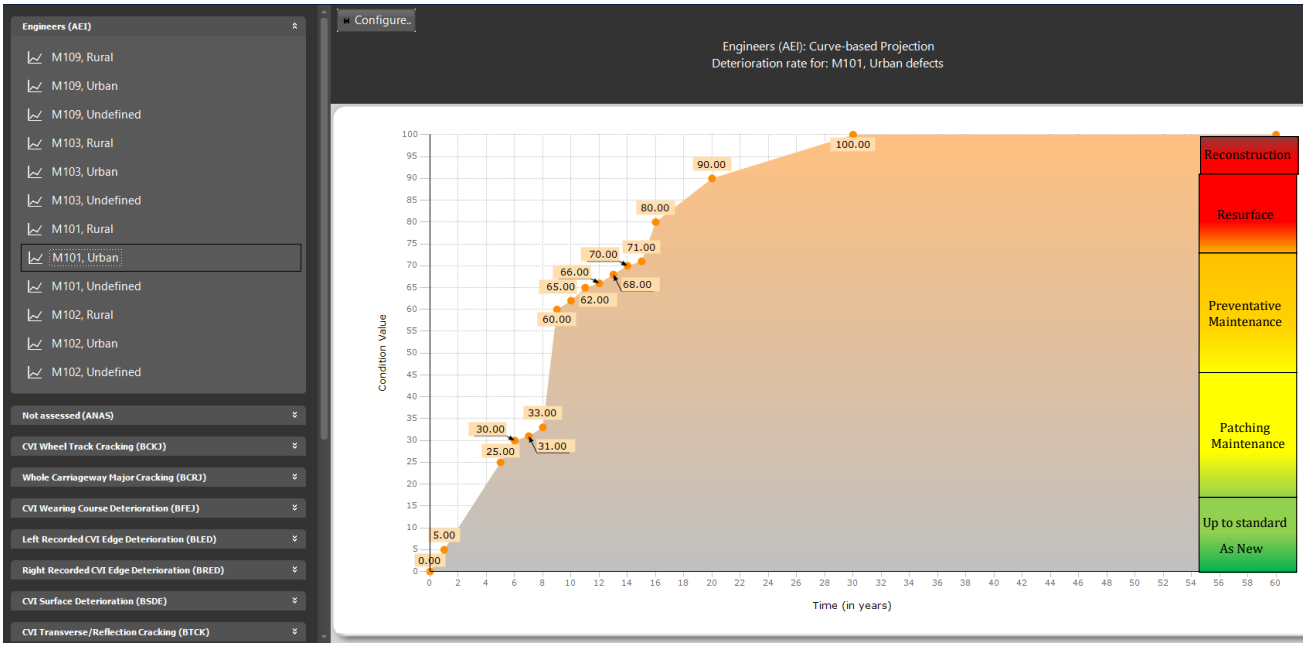
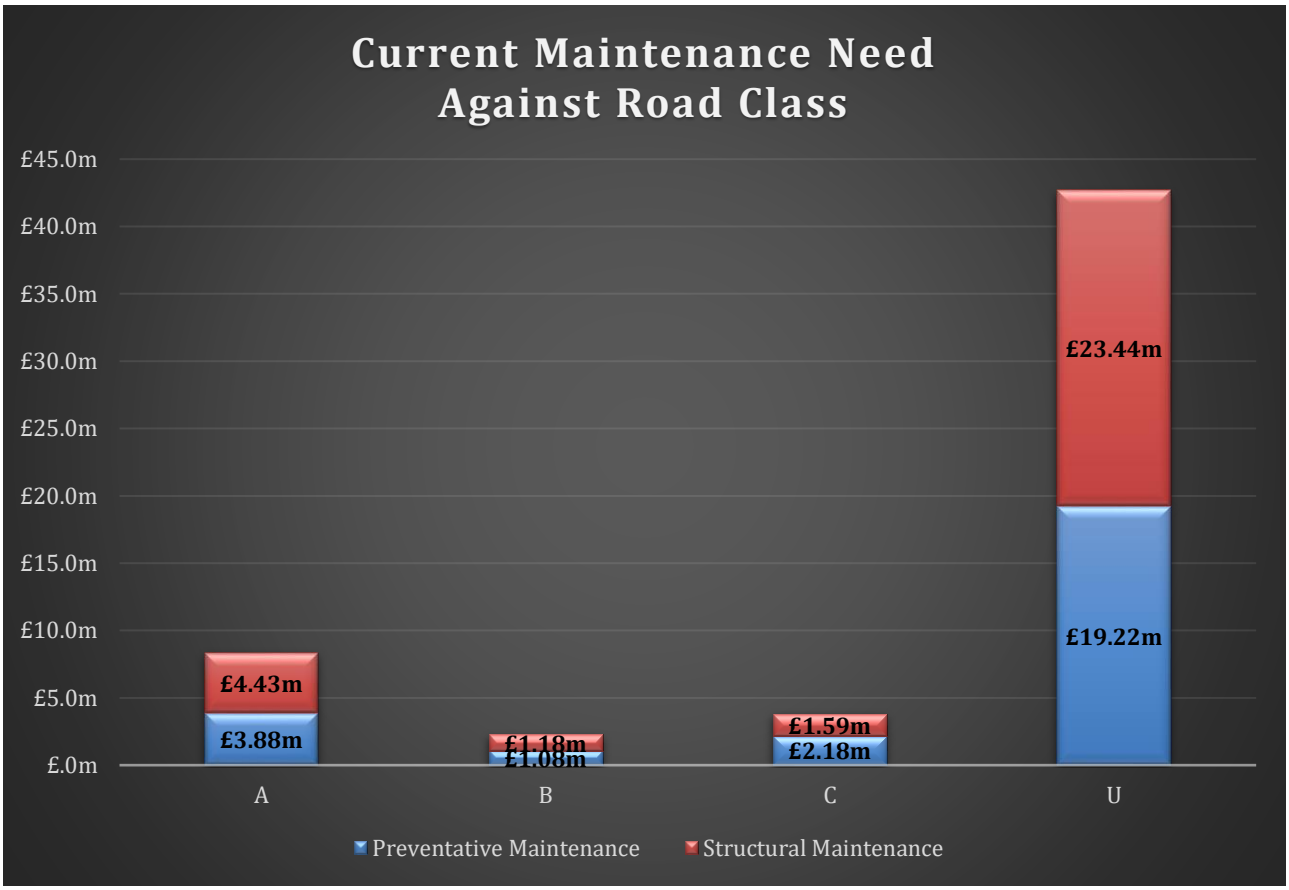


Figure 5.10 – Example Condition Projection Curve

3. Current Condition

The Council undertakes UKPMS Best Practice Guide AEI condition surveys. These UKPMS surveys deliver a number of condition indices and Treatments which are processed within XA ©. This data was pre-processed to deliver an overall condition index directly related to a treatment. The original data was reset if a treatment length could be funded and the appropriate UKPMS CI and RCI would be reset to zero and condition projected accordingly.

The graph below shows the current condition and respective cost to maintain against the Road Class:



Maintenance Need by Road Class:

The graph above shows that there is a current carriageway maintenance need across the network of

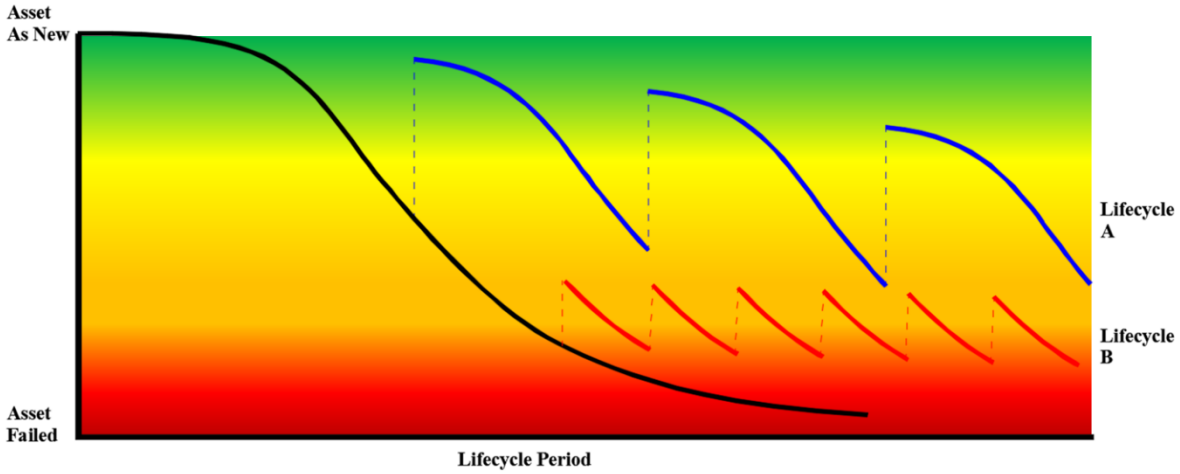
£57 Million

4. Life cycle planning

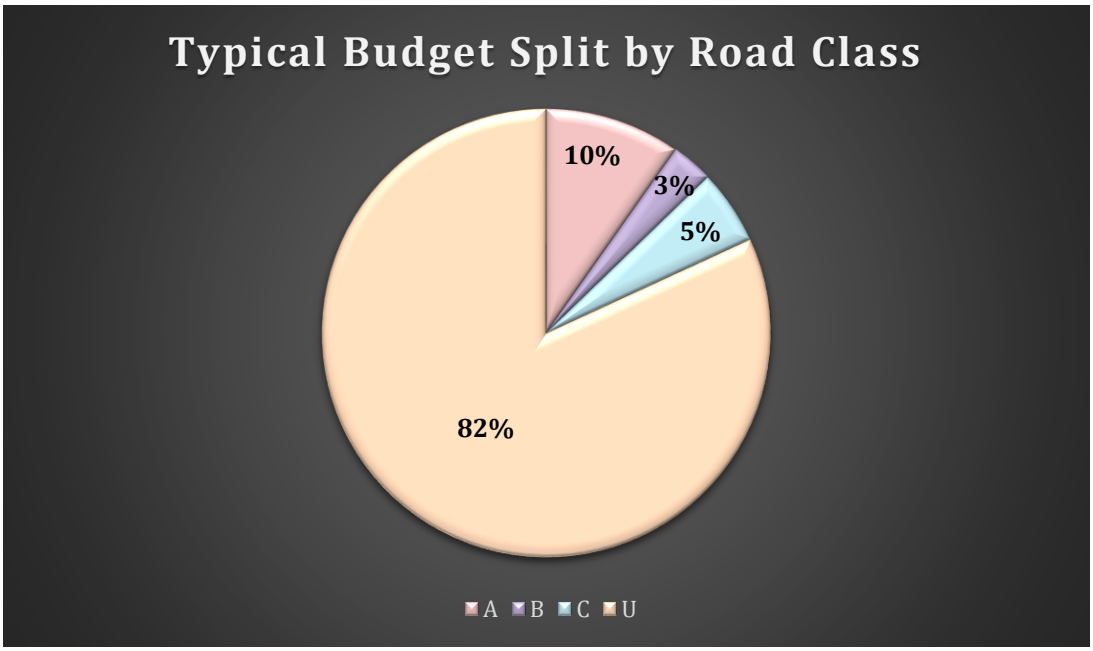
Nottingham engaged XAIS Asset Management to undertake lifecycle planning to identify the best strategy for maintaining our key assets which is also value for money. This provides a business case to determine the budget required to effectively manage these assets in the future. The full technical report detailing this process is available. Using XA© which is XAIS's Asset Management system, Nottingham have produced a robust model which can deliver demonstrable results.

The "Well Managed Highway Infrastructure: A Code of Practice" released by DfT recommends that a functional hierarchy is adopted by councils to enable effective asset management. Nottingham have been one of the first Authorities to adopt this and will be updating this model to reflect the different maintenance hierarchies in the future as it is recognised that the duration between maintenance interventions would change by road use and hierarchy. The lifecycles to be modelled in all the budget scenarios was one of Engineering logic as this is the most cost-effective lifecycle plan for the council to invest in, as it has the lowest Net Present Value (NPV). Meaning the amount of money required by the council to maintain the network at a safe level is at its minimum. These costs and lifecycles will also be incorporated into Whole of Government Accounts (WGA) submission which will show that Nottingham will be carrying out maintenance in line with its annual depreciation.

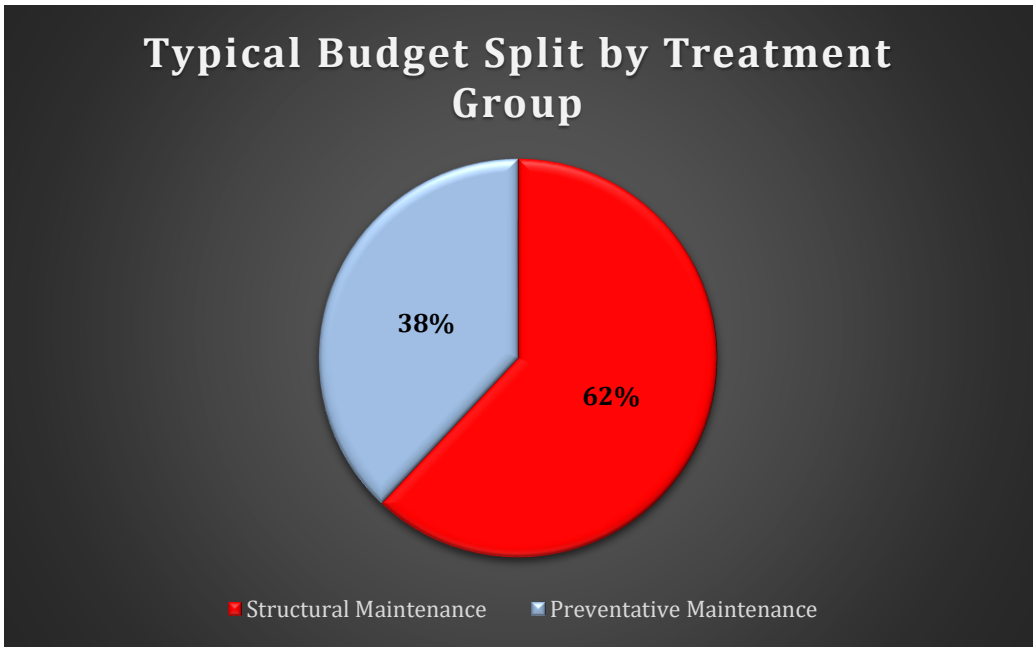
The following diagram illustrates the position in which the Nottingham network is being maintained at in lifecycle B. Lifecycle A shows how the network would be maintained at ensuring value for money. Lifecycle B costs approximately 1.78 times the cost of lifecycle A, which doesn't include user delay costs or decrease in revenue costs for reactive safety repairs.



Lifecycle planning is considered to be the foundation for asset management. It effects all elements in the maintenance process and a robust regime for accurate asset data ais essential for Life Cycle planning and mitigating future risks to the authority. The Department for Transport expect all local authorities to score well in this area through the self-assessment process. Not demonstrating this could mean a financial loss in the funding allocation from DfT.



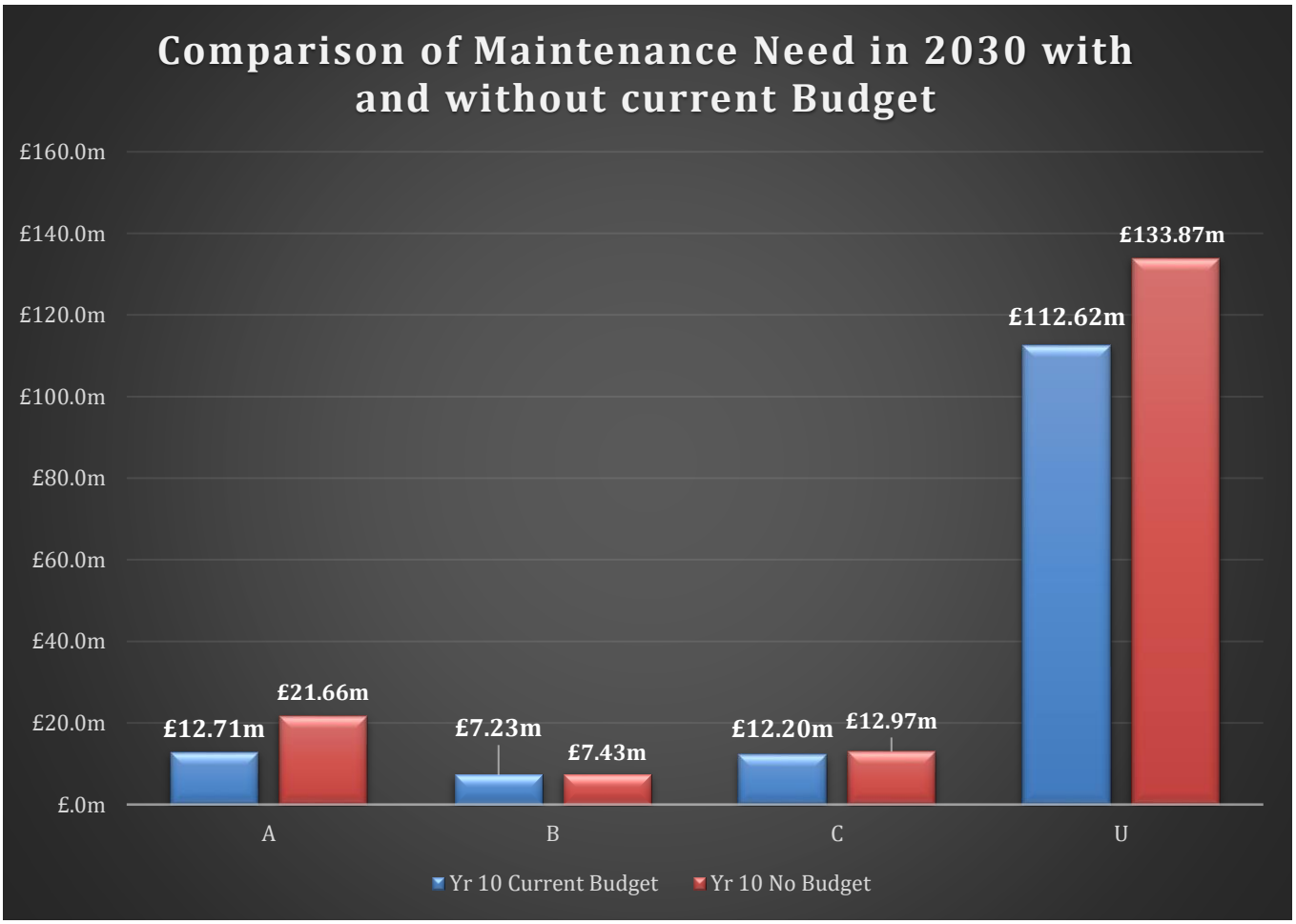
Budget Split by Road Class:



Budget Split by Treatment Group

5. Analysis

In order to understand the effect of any condition projection model the data is required to be processed against a budget to understand the out-turn position. The following demonstrates the effect of any budget constraints on the network. The initial Model run is to understand the need without investment. The following graph illustrates how the road classes are deteriorating over the next 10 years with regards to maintenance need, if no work was carried out on the network. The maintenance need increases by **£31million to £175million**. This is an increase in maintenance need of **£17.3m** above the normal budget spend.



Graph Illustrating affect on Maintenance Need without investment

5.1. Budgeting

The following budgets were analysed to understand the out-turn condition

Scenario 1 – Existing Budget split – £1.385 million (exclusive of patching monies)

Road Class	Network Length (km)	Percentage of Network	Width (m)	Structural (£)	Preventative (£)
A Roads	75,564	10%	8.5	£400,000	£0.00
B & C Roads	64,801	8%	8		
U Roads	634,032	82%	6.5	£542,000	£443,000
			TOTAL Budget	**£1.385m**	

Scenario 2 – Existing Budget split by LCP

Road Class	Network Length (km)	Percentage of Network	Structural (£)	Preventative (£)
A Roads	75,564	10%	£139,552	£89,221
B & C Roads	64,801	8%	£79,955	£51,119
U Roads	634,032	82%	£645,846	£379,306
		TOTAL Budget	**£1.385m**	

Scenario 3 – Existing Budget split – £1.385 million (additional funding modelled for Levelling up Fund)

Road Class	Network Length (km)	Percentage of Network	Structural (£)	Preventative (£)
A Roads	75,564	10%	£139,552	£89,221
B & C Roads	64,801	8%	£79,955	£51,119
U Roads	634,032	82%	£645,846	£379,306
		TOTAL Budget	**£1.385m**	

Additional funding. Above existing budget, applied as per the table below:

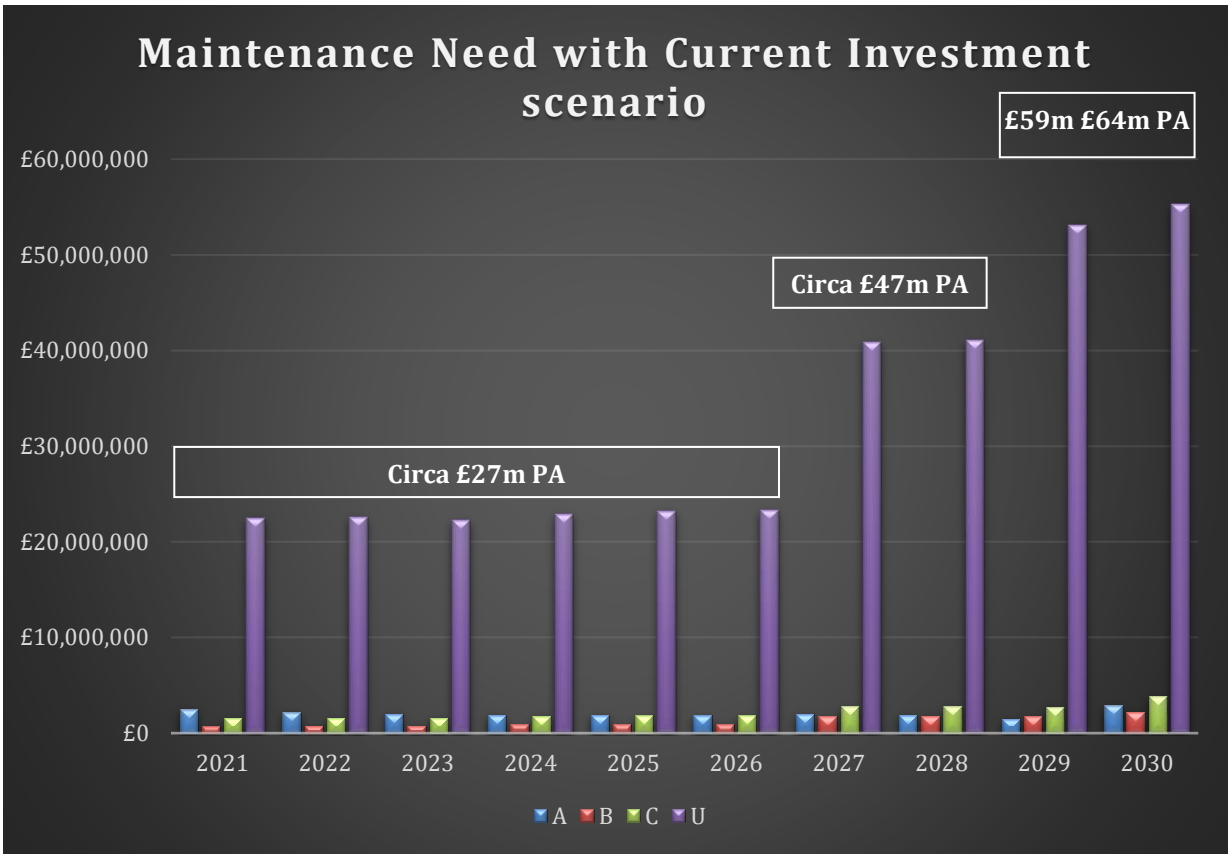
Year	Road Class	Structural (£)	Preventative (£)
2021/22	C Roads	£525,000	£225,000
2021/22	U Roads	£1,575,000	£675,000
2022/23	C Roads	£1,050,000	£450,000
2022/23	U Roads	£3,150,000	£1,350,000
2023/24	C Roads	£525,000	£225,000
2023/24	U Roads	£1,575,000	£675,000

6. Results

In order to understand the effect of the processing carried out, the following demonstrates the effect of the budget constraints on the network

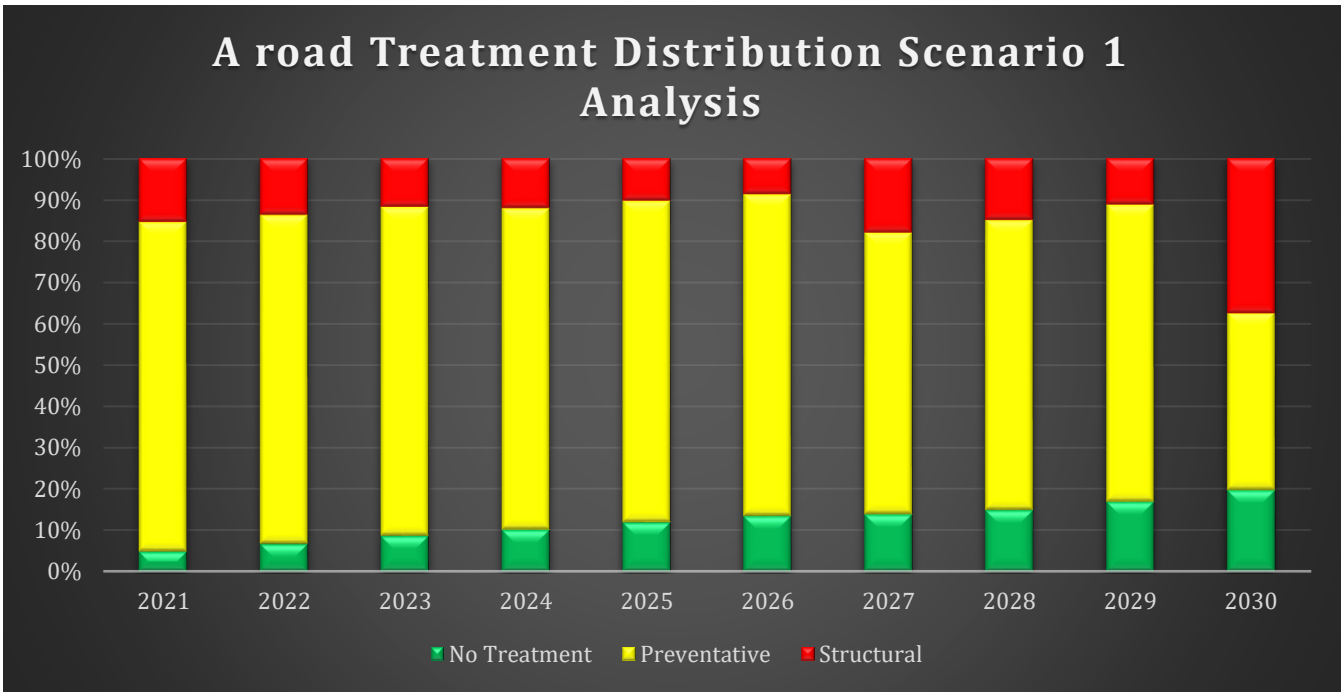
6.1. Scenario 1 – 10 Year Analysis

The graph below shows the maintenance need across the infrastructure network over the next 10 years, using current budget splits.



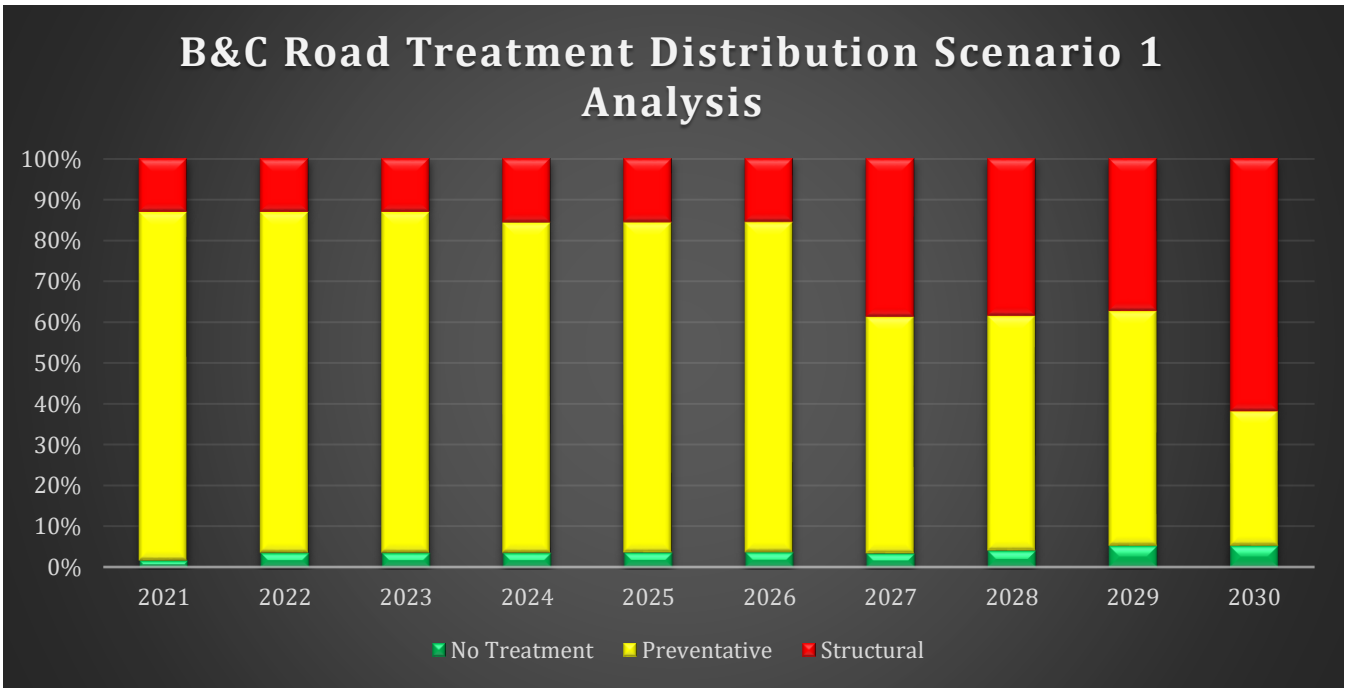
Main Road Maintenance 10 Year Projection results

A Class Roads Results



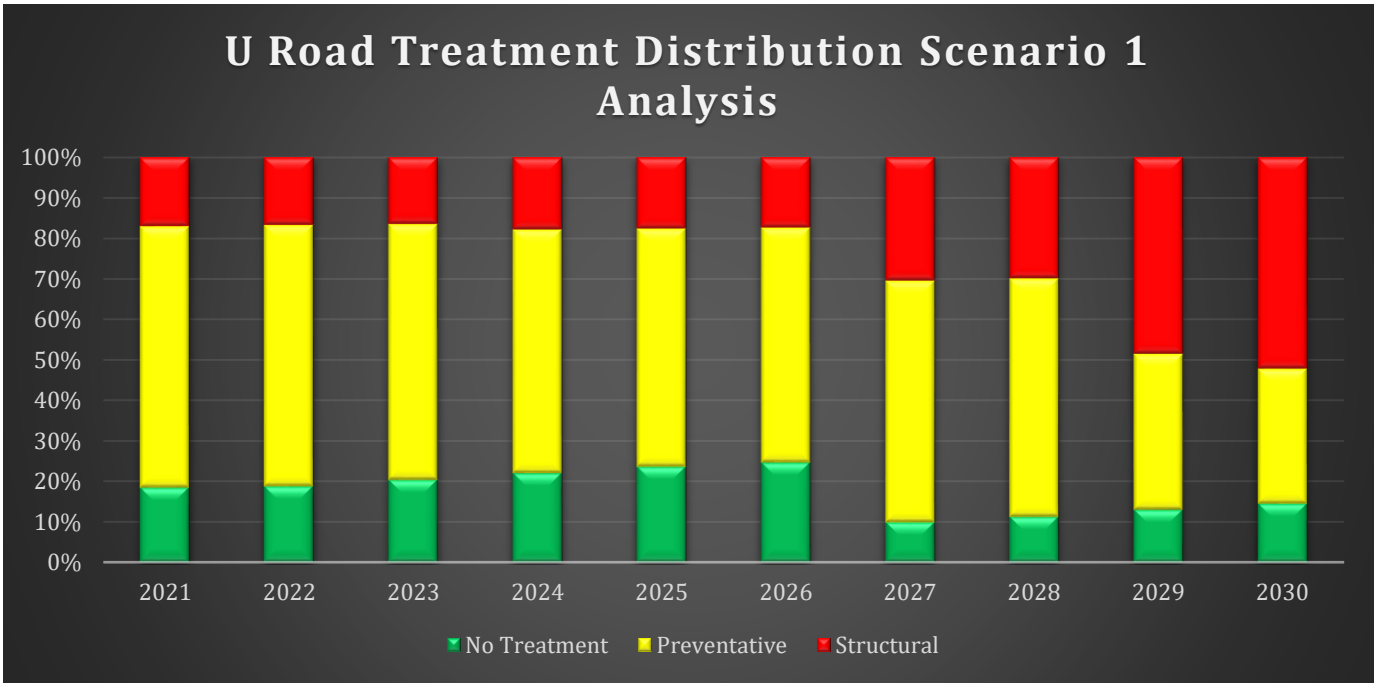
In 2030 the maintenance need for this hierarchy is **£12.7 Million**.

B&C Class Roads Results



In 2030 the maintenance need for this hierarchy is **£19.4 Million**.

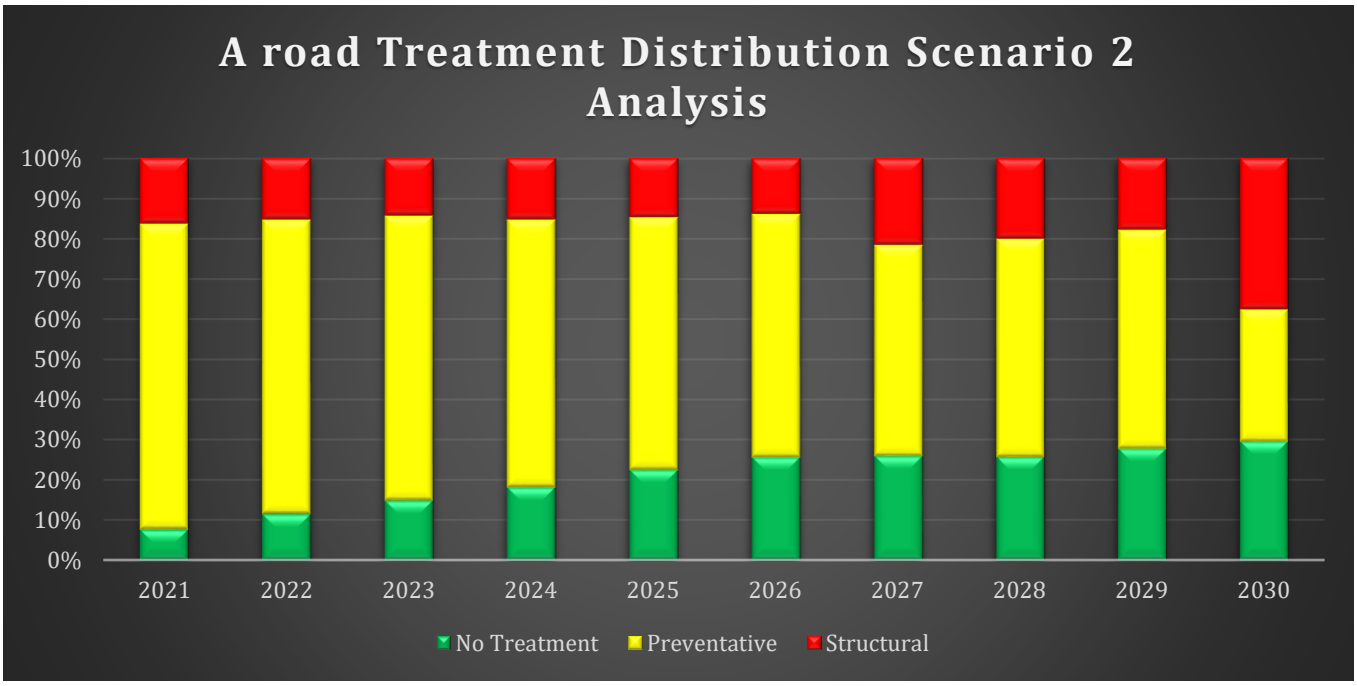
U Class Roads Results



In 2030 the maintenance need for this hierarchy is **£112.6 Million**.

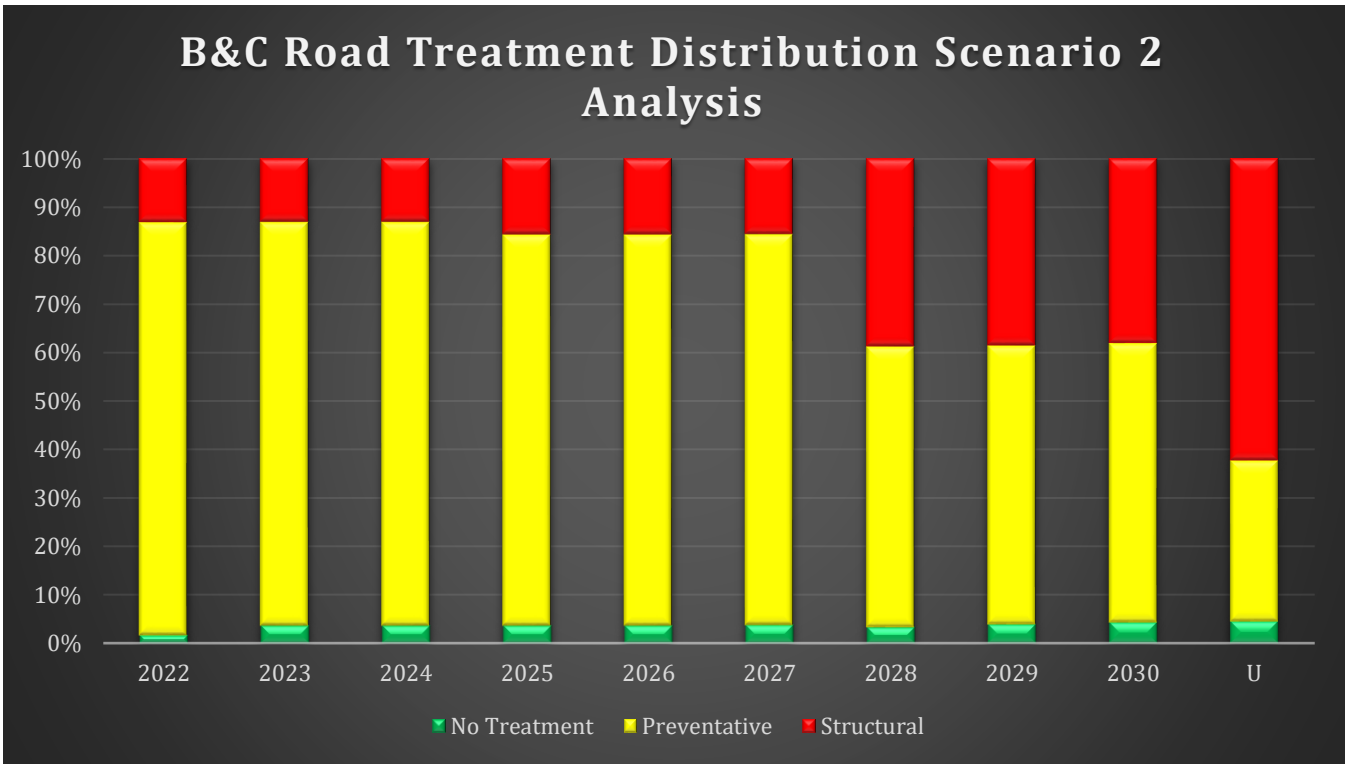
6.2. Scenario 2 – 10 Year Analysis

A ClassRoads Results



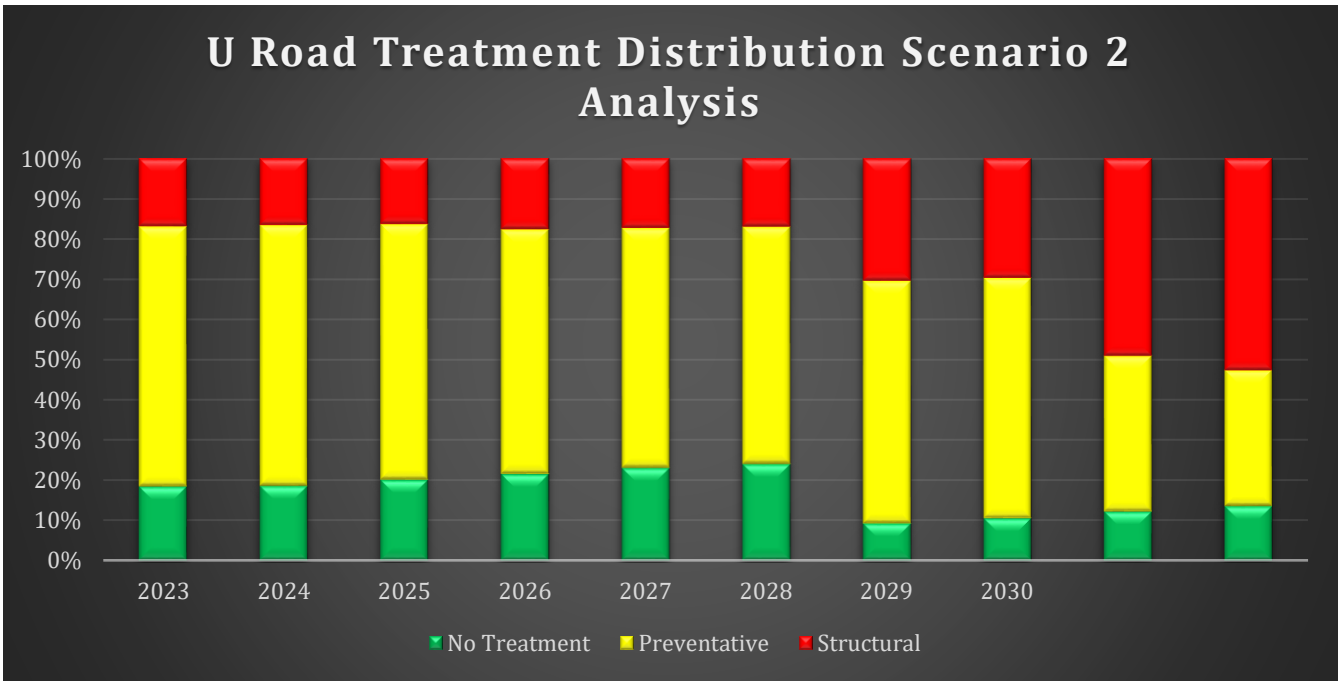
In 2030 the maintenance need for this hierarchy is **£12.3 Million**.

B&C Class Roads Results



In 2030 the maintenance need for this hierarchy is **£19.5 Million**.

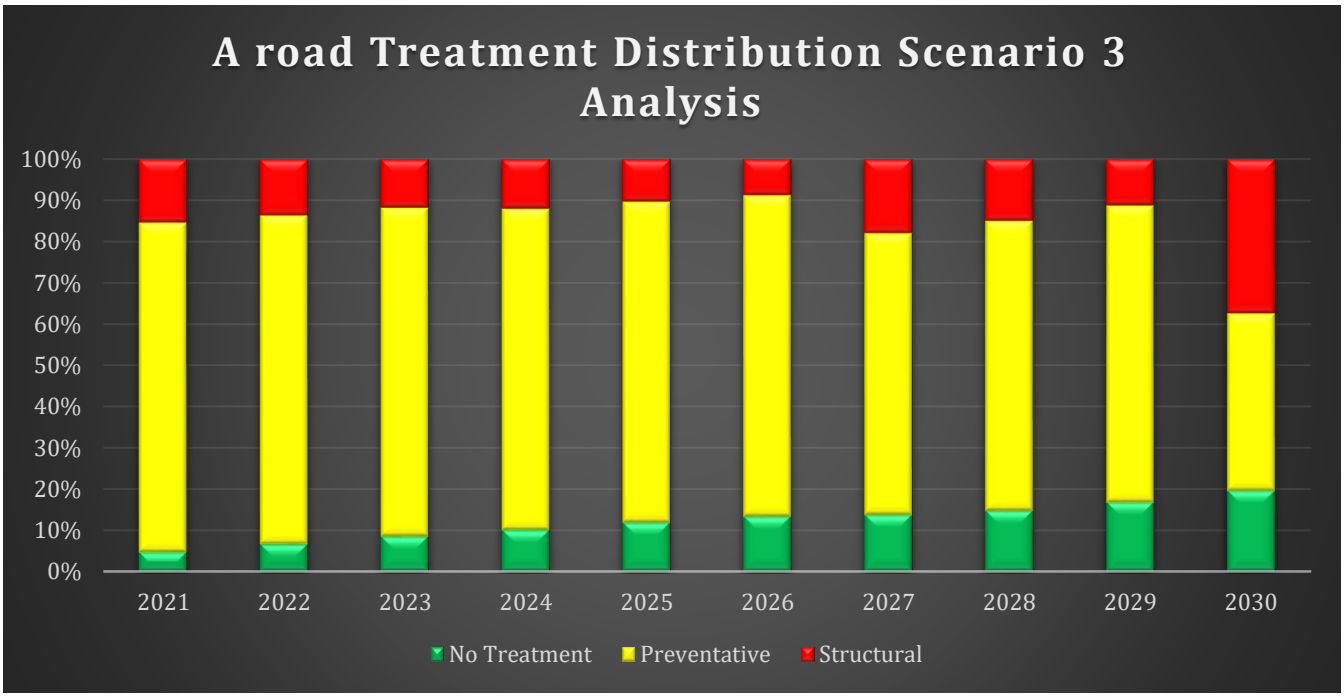
U Class Roads Results



In 2030 the maintenance need for this hierarchy is **£113.5 Million**.

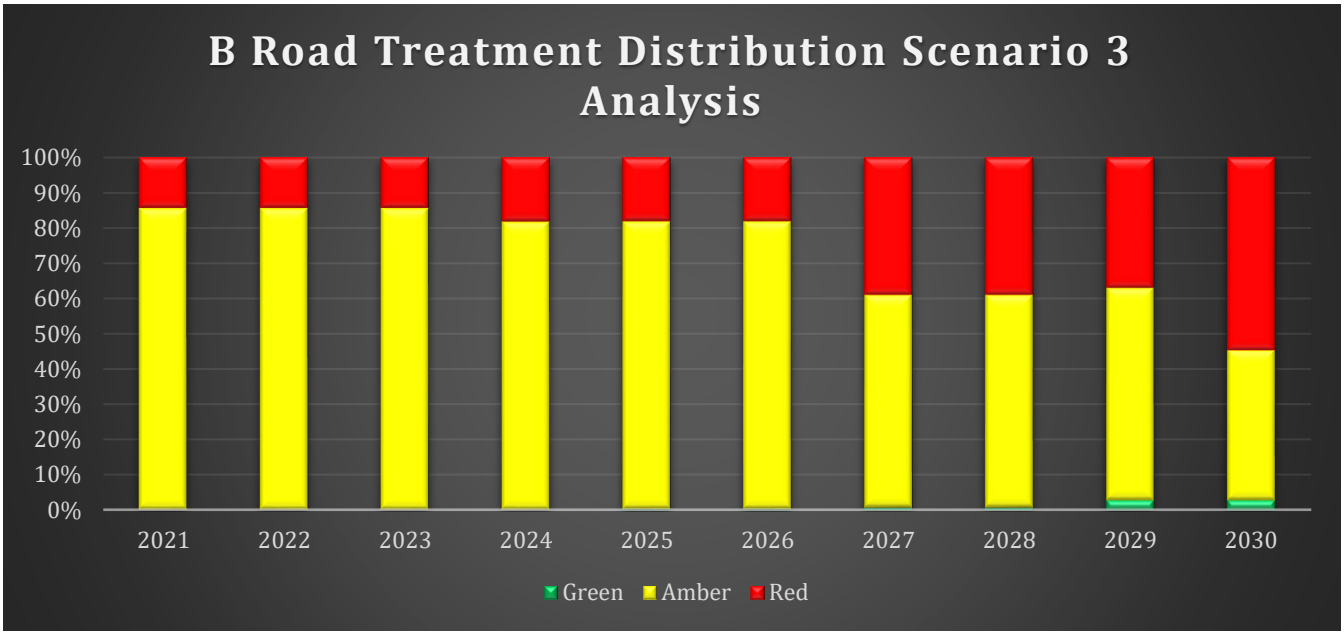
6.3. Scenario 3 – Additional Funding as required for the Levelling Up Fund bid

A Class Roads Results



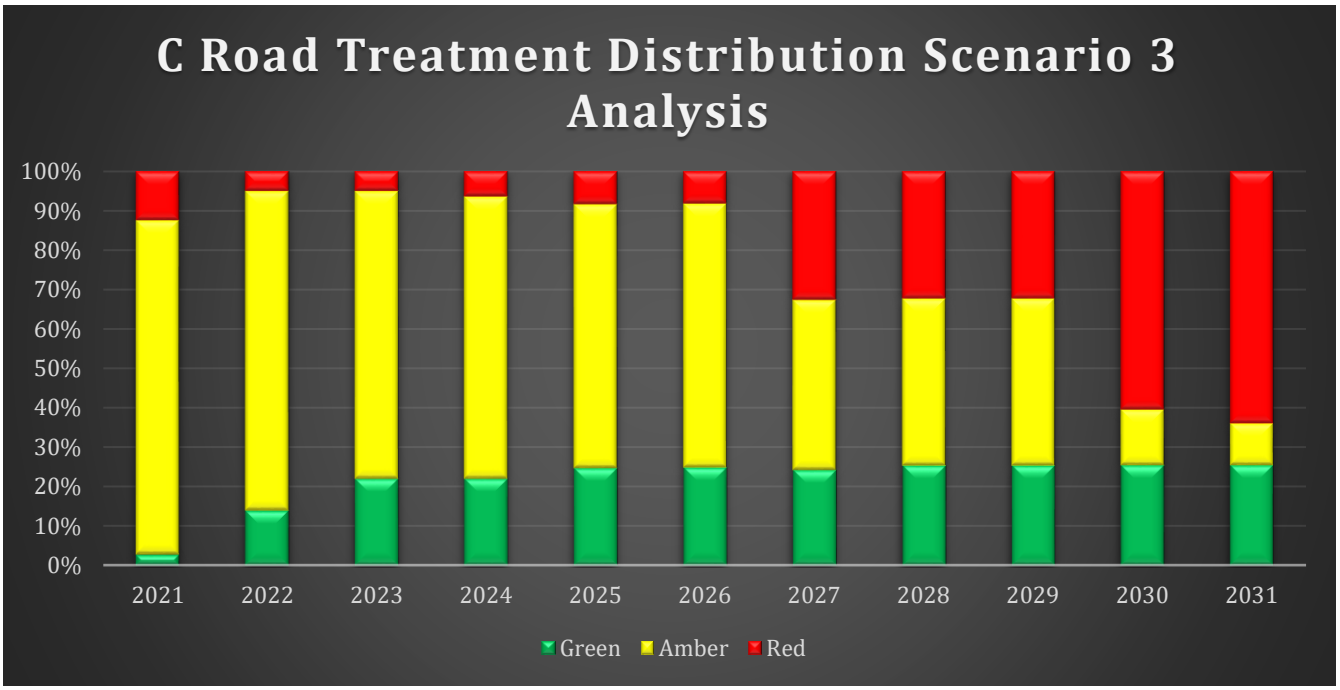
In 2030 the maintenance need for this hierarchy is **£12.7 Million**.

B Class Roads Results



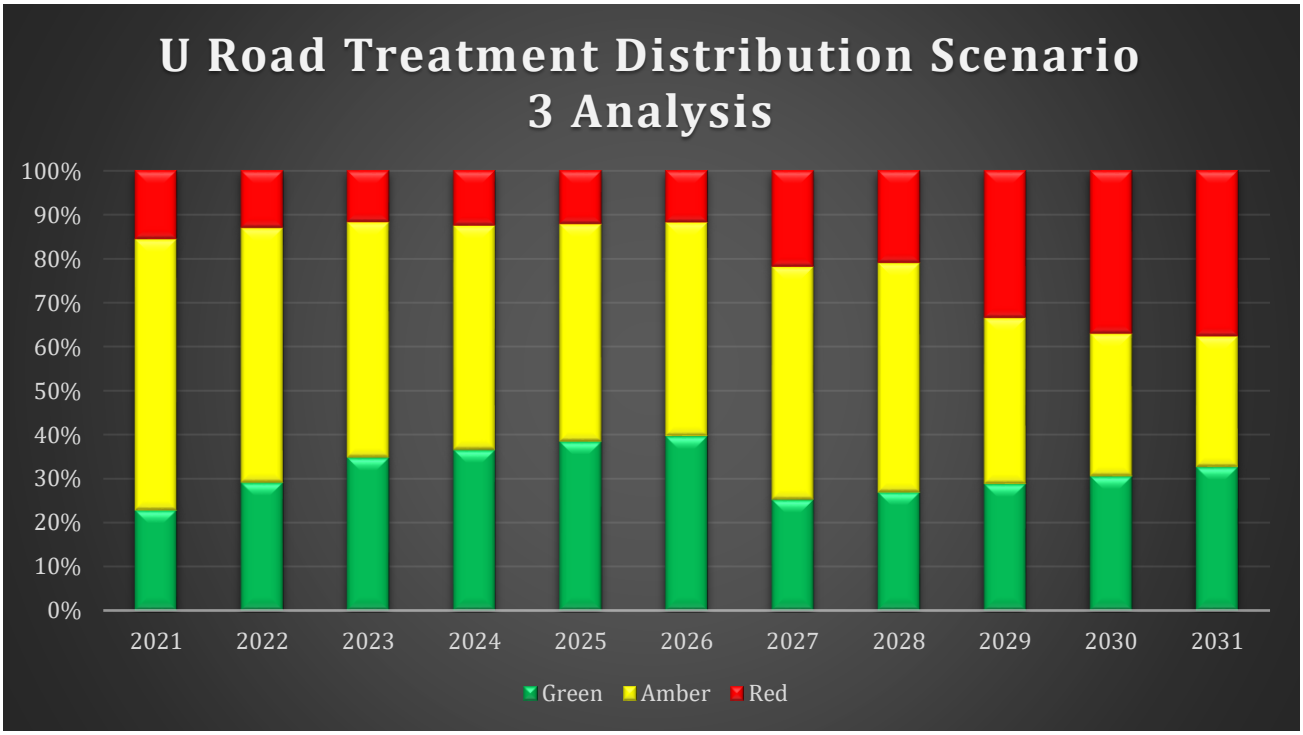
In 2030 the maintenance need for this hierarchy is **£7.2 Million**.

C Class Roads Results



In 2030 the maintenance need for this hierarchy is **£7.6 Million**.

U Class Roads Results



In 2030 the maintenance need for this hierarchy is **£97.3 Million**.

6.4. Scenario 4 – LCP Budget

Road Class	Network Length (km)	Percentage of Network	Structural (£)	Preventative (£)
A Roads	75,564	10%	£643,31	£418,095
B & C Roads	64,801	8%	£368,421	£239,545
U Roads	634,032	82%	£2,999,667	£1,755,332
		TOTAL Budget	**£6.424m**	

The table above shows the annual budget required to maintain steady state.

7. Summary

The report outlines the need for increased and sustained investment in the highway network and recommends the most cost effective and methodical approach to repairs, in line with asset management best practice and lifecycle planning.

A reduction in capital maintenance which leads to a deteriorating asset condition increases the need for reactive maintenance to make safe defects. This is an ineffective use of already stretched budgets.

The following table illustrates the maintenance need under the modelled investment strategy at 2030:

Maintenance Hierarchy	Current Budget (£1.4m) allocated	Current Budget (£1.4m allocated as per LCP analysis	Budget as required by LCP (£6.4m)	No Budget
M101	£12.7m	£12.3m	£8.3m	£21.7m
M102 & M103	£19.4m	£19.5m	£6.0m	£20.4m
M104 – M108	£112.6m	£113.5m	£42.7m	£133.9m
TOTAL	**£144.70m**	**£145.30m**	**£57.0m**	**£176m**

Table 7.1 – showing maintenance need at the end of the budget strategy.

The existing maintenance need is **£57m,** therefore if the council wishes to maintain this level of service, they will need to adopt a budget strategy which is close to maintaining that maintenance need, the LCP Budget.

The LCP budget, of **£6.4m** per annum, is the closest modelled scenarios, it is noted that this strategy may increase the maintenance need as we are maintaining a failing network.

However, is should be noted that if the council increases its investment, then there will be an overall saving in maintenance need. If the LCP budget is applied to the network in the correct areas the maintenance need is £57m in 2030 compared to £144m with current budget, a difference of **£87m**. Therefore, the LCP investment will save **£23m** (£2.3m per annum) in maintenance need and also help reduce ancillary items such as claims, and revenue spend whilst creating inward investment.

If under investment continues and the condition of key assets deteriorate further, there will inevitably be an increase in third party claims against the authority. Poor condition assets can put all highway users at risk and lead to the increased likelihood of accidents

Reactive maintenance, including the repairing of potholes is costing Nottingham **£0.9m** per year. This equates to **39%** of the budget allocated for highway maintenance. It has been shown by the Asphalt Industry Alliance (AIA) through their ALARM survey that the spend on a network that is at "Steady State" should be at or below 16% of the maintenance allocation from DfT. If the LCP Budget required is set as the correct value for the investment in the infrastructure to deliver steady state, there would be an expected saving of **£0.5m** per year, after the initial maintenance need has been

rectified. This will also reduce staff costs in paperwork and time repudiating claims against the authority.

Appropriate lifecycles will ensure less interventions, a reduction in raw materials, less standing traffic in roadworks and less primary aggregates therefore a lower carbon footprint.

The current highway maintenance funding levels are below those recommended by lifecycle planning and below those required to maintain a steady state for our highway assets. In practice this means we are only slowing their deterioration and their condition will continue to get worse.

Highways in poor condition impact on the reputation of the Council, cause delays due to increased reactive maintenance activities and increase the risk of accidents and third-party claims. A severe winter and flooding will have a serious knock-on effect to an already deteriorating asset and will reduce the appeal to invest in Nottingham City.

Good management of our highway assets will contribute towards the priority outcomes of:

- Enabling individuals and communities
- Supporting Regeneration
- Making the most of our assets

It is recommended that Nottingham's current unit rates and section widths are investigated to confirm the costs within the model, as these have a significant effect on the outputs.