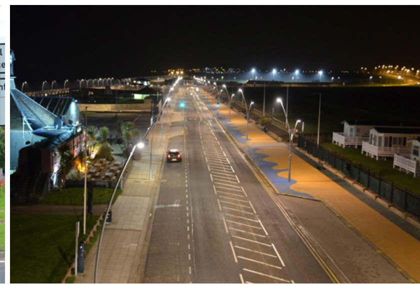
South Tyneside Council

Carriageway Life Cycle Plan



South Tyneside Council

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Introduction

Asset management has been widely accepted by central and local government as a means to deliver a more efficient and effective approach to management of highway infrastructure assets through longer term planning, ensuring that standards are defined and achievable for available budgets. It supports making the case for funding and better communication with stakeholders, facilitating a greater understanding of the contribution highway infrastructure assets make to economic growth and the needs of local communities.

The demand for a more efficient approach to the management of highway infrastructure assets has come to prominence in the light of the financial challenges faced by both by central and local government.

To encourage an aligned approach to the delivery of asset management, in 2014 the Department for Transport announced an unprecedented £6 billion to be spent on tackling potholes and improving local roads between 2015 and 2021. A proportion of this funding is set aside to reward councils who demonstrate they are delivering value for money in carrying out cost effective improvements.

This document outlines what Yotta can offer to support local authorities with the DfT Incentive Fund and ensuring they can achieve maximum funding award to deliver an excellent value highway service to businesses and residents of the county.

Principle

Principle of Lifecycle Planning for Highway Network assets is a strategic, as opposed to tactical, approach to managing highway assets. The process, in order, is:

- Performance expectations, consistent with goals, available budgets, and organisational policies, are established and used to guide the analytical process, as well as the decision-making framework.
- Inventory and performance information are collected and analysed. This information provides input on future network requirements.
- The use of analytical tools and reproducible procedures, develops viable cost-effective strategies for budgets to satisfy authority needs and requirements, using performance expectations as critical inputs.
- Alternative choices are then evaluated, consistent with long-range plans, policies, and goals. The entire process is re-evaluated annually through performance monitoring and systematic processes.

Objective

The objectives of lifecycle plan for major assets are set out below:

- Identify long-term investment for highway infrastructure assets and develop an appropriate maintenance strategy.
- Predict future performance of highway infrastructure assets for different levels of investment and different maintenance strategies.
- Determine the level of investment required to achieve the required performance.
- Determine the performance that will be achieved for available funding and/or future investment.
- Support decision-making, the case for investing in maintenance activities, and demonstrate the impact of different funding scenarios.
- Minimise costs over the lifecycle, whilst maintaining the required performance.

Figure 1 shows the overview of the Asset management process and Lifecycle Plan.

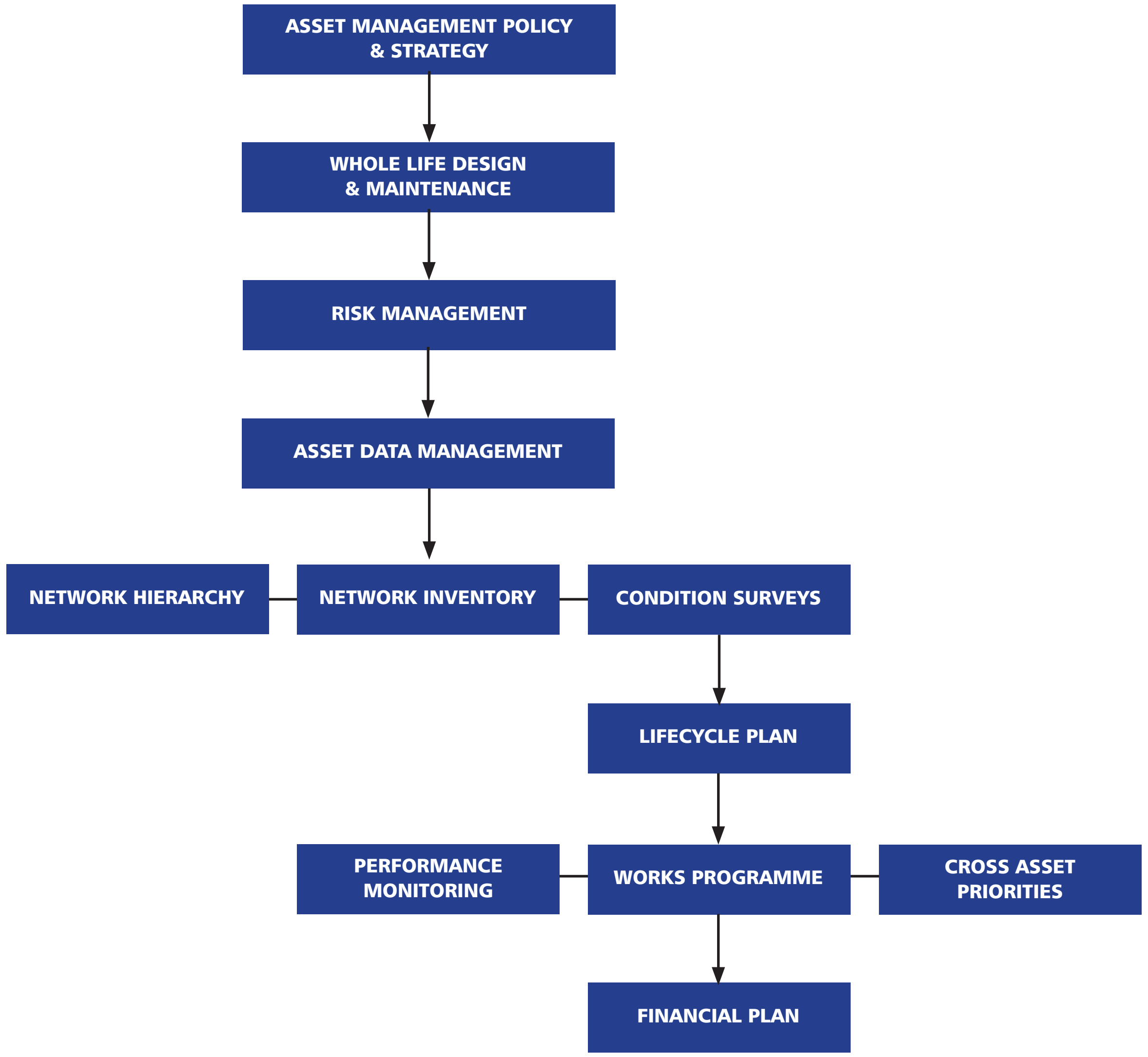

Figure 1: Process Flow Chart

Engineering Judgement

The use of sound judgement based on engineering principles and experience is important to ensure that the parameters used in the development of the investment program are well founded and are likely to provide realistic results. This has been done by making use of experienced people with a wide range of skills in highway construction and maintenance.

Lifecycle Plan Process

The carriageway asset lifecycle plan essentially consists of five main elements; a) Asset data management, b) Performance indicator, c) Lifecycle analysis model, d) Work program and e) Investment program.

A. Asset data management is the process of capturing the asset data in terms of the condition and length

B. Performance Indicator is the required measurement of the asset condition performance that has to be met at the end of the Lifecycle analysis.

C. Lifecycle analysis model takes the asset condition data and analysed generates schemes/schedule of works to meet the set performance criteria.

D. Work program is the list of schemes/schedule of works that is generated for a period of time as the outcome of the Lifecycle analysis.

E. Investment program is the required budget for undertaking the schemes/schedule of works generated as Lifecycle analysis to meet the performance target.

However, essence of the lifecycle plan is that it is a continuous process. The most important part of a successful "Lifecycle plan" is to have connectivity between planned/generated work schedules, actual work undertaken, and that data being taken in account in subsequent analysis for generating future work plan. Figure 2 below shows the connectivity between all the elements that forms the Lifecycle Plan.

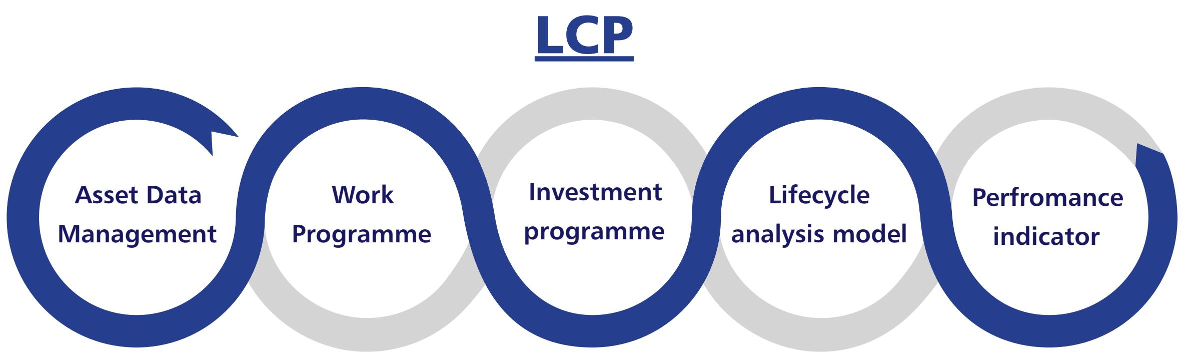

Figure 2 - Lifecycle Plan Process

Asset Data Management

Asset data management is the process of capturing the asset data in terms of the condition, inventory, and length/area and storing the data in a form of meaningful, repeatable, reliable, and accessible source of information.

Network Hierarchy

Primarily, the road asset network is categorised in terms of type or general purpose of the road as Hierarchies. The definition of the road classifications remains generally unchanged, although in practice the usage and importance of roads does change over time. In accordance with 'Well Managed Highways: A Code of Practice' (2016), South Tyneside City Council have reviewed road hierarchies and Table 1 describes the definition of each Hierarchy and the corresponding total length of carriageway network in each hierarchy.

Maintenance Hierarchy	Category	Characteristics	Frequency
C1	Strategic Local Highway Route	Routes to provide strategic links to the wider region with little frontage access or pedestrian traffic.	62.7
C2	Main Distributor	Key arterial routes serving major employment and residential areas within the borough.	32.2
C3	Secondary Distributor and Link Roads	Urban routes carrying bus, HGV and local traffic with front access and frequent junctions. All remaining through routes which have not been classified as strategic or main distributor.	33.8
C4	Estate and minor roads linking to secondary distributor	Roads which do not fall into the above categories will be captured in this maintenance hierarchy. These are primarily residential roads Where a footway is adjacent to a C4 category, the carriageway inspection regime will default to the footway network category frequency.	436.2

Table 1: Network Hierarchy characteristics and frequency

However, these Network Hierarchy have not yet been applied for the purpose for analysis modelling. For modelling purposes DfT road classification has been used and the total length for each of road classification is shown in Table 2. The new Network Hierarchy according to the Code of Practice will be implemented in the future for the modelling.

Road Class (DfT)	Description	Total Length
		m
A	Principal/Strategic Roads (dual carriageway)	62,780
B	Secondary Roads (single lane)	31,409
C	Link Roads (single lane)	33,883
U	Unclassified Roads (single lane)	503,722
Total Length of Network		631,795

Table 2: Network Hierarchy and frequency

Condition Surveys

The carriageway condition data is made up from three data sets as described in Table 3 below, which provides the basis for the identification of treatments and the associated performance measures that are derived from them. These are a combination of machine and visual based survey methodologies and have different survey cycles which vary depending on the survey type and road classification. The condition data is modelled in "Horizon" for Lifecycle analysis. However, skid resistance survey data is not considered within this modelling and managed as part of a separate strategy.

Type of Survey	Carriageway surveyed	Percentage coverage
Course Visual Inspection (CVI)	Unclassified Roads (U road) flexible	33% per year
DVI	Unclassified Concrete	33% per year
SCANNER (machine measurement surveys)	A (both directions), B and C	100% A per year. 50% B and C per year
SCRIM (Skid resistance deficiency survey)	A, B and C	100% per road

Table 3: Condition Survey Frequency

Inventory Data

Accurate and up to date inventory of the asset is an important element to good asset management and this will be a continued focus to enhance modelling in future years, as inventory records continue to build and used to support the decision-making process.

South Tyneside Council maintain inventory data collected through various UKPMS surveys, which has been utilised in the lifecycle modelling process and has a considerably higher proportion of concrete carriageways than other highway authorities. The national average is estimated at around 3% of the highway network whereas 27% of the network is concrete construction. This has an impact upon the type, extent, and cost of remedial works that can be undertaken.

Concrete carriageways life span is far more than asphalt carriageway. Table 4 below shows the length distribution of different types of carriageway throughout the network.

Road Class (DfT)	Description	Construction Type			
		Concrete	Covered Concrete	Flexible	Total Length
		m	M	m	m
A	Principal/Strategic Roads (dual carriageway)	242	7030	55508	62780
B	Secondary Roads (single lane)	4602	2810	23997	31409
C	Link Roads (single lane)	3204	67	30612	33883
U	Unclassified Roads (single lane)	153565		350157	503722
Total Network Length					631795

Table 4: Carriageway Construction Types

Data Management

Carriageway Asset data is held in the Horizons and MARCHpms systems. Horizon is the analysis software aimed at preparing programs of work based on current condition and at forecasting the future condition of a road network by making use of condition projections that are modified by planned interventions. Taken together with assessed costs of interventions, the amount of work required is estimated firstly, to improve the network condition to the prescribed levels and secondly, to maintain the network at or below the prescribed condition threshold for next 10 years.

The condition of the network is monitored through a program of routine surveys, safety inspections, and ad-hoc inspections in response to defect reports.

In this lifecycle plan only the performance indicators calculated through routine condition surveys are considered, although the number of reactive defects and claims will be directly influenced as a result of effective planned maintenance and through the application of lifecycle planning.

Performance Management

Table 5 below lists the Performance Measures that we will use to monitor progression towards the targets that we have set for service delivery. The targets will be reviewed annually to take account of changes to legislation, corporate aims and objectives and changes to the level of funding available.

Performance Measure	Definition	National or Local set criteria
SDL 130-01 For "A" category roads	Principal road % where maintenance should be considered	National
SDL 130-02 For "B" and "C" category road	Non-principal classified roads % where maintenance should be considered	National
STC 224b For "U" category roads allowable	Unclassified road % in need of maintenance	Local

Table 5 – performance measures

Reactive Maintenance and Defect Repairs

Over the past three years, the number of potholes has been generally decreasing and one of the aims of the carriageway Lifecycle plan will be to support the continued reduction of potholes and carriageway defects repairs. The reduction in the number of defects has also been reflected by the reduction in the 130-01 and 130-02 indicators.

Lifecycle Analysis Model

The Lifecycle analysis modelling process involves a number of steps as described below. This defines the parameters that describe the behaviour of the model. These include the following, some of which are described in more detail later:

1. Condition data & Deterioration profile
2. Treatments
3. Maintenance Plan
4. Analysis Criteria
5. Prioritisation
6. Budget constraints

Condition Data and Deterioration Profile

The accuracy of the modelling process is essentially based on the accuracy and coverage of the condition data. Condition data is the information on the type, severity, and extent of defects on the carriageway; e.g, rutting, cracking, longitudinal profile variance, texture, and SCRIM.

These defect data forms the decision principle of triggering the type and time of any "Treatments" needed to improve the condition the road and also the overall carriageway network. Hence, this eventually determines the amount of investment needed to maintain the carriageway network.

The model also determines the treatment for future years, based on the projected defect profile. The projection of defect data is defined in Deterioration Profile within the Analysis Model, which also takes in account of the effect of the applied treatment and its design life. Deterioration profiles are the modeller's best estimate of the change in the value of each defect condition value with time. These profiles, taken together with the treatments and treatment effects, define the future condition of the network. The Figure below shows the Defect Data Cycle in the analysis process.

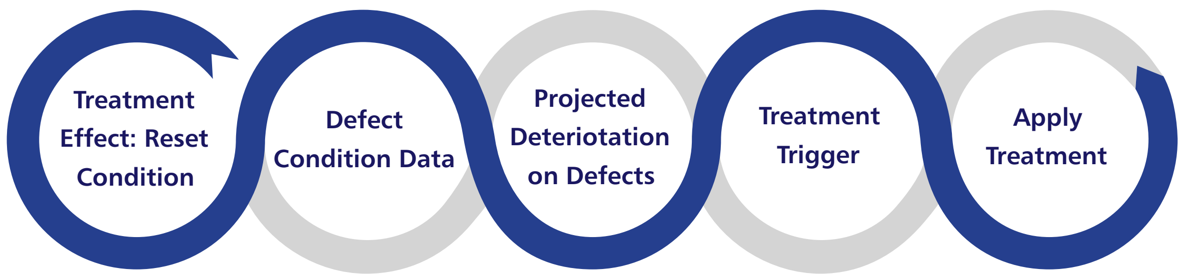

Figure 3: Defect Data Cycle

List of Treatments

We have developed a range of different treatments that are in use in various combinations on different parts of the network to provide the required levels of performance.

Treatment types are considered and applied based on carriageway construction type and condition. There is an amount of concrete construction carriageway on the unclassified roads and these have been defined as a separate asset group to assign appropriate treatment and provide a more accurate backlog calculation, as the type and cost of treatment is vastly different for bituminous and concrete remedial repair.

The use of specific treatments in the carriageway analysis is problematic, because the large number of different treatments leads to a complicated treatment selection decision structure which is difficult to deal with and does not add to the accuracy of the solution.

Accordingly, for the analysis, we have elected to use "Generic Treatments" where various specific treatments are grouped together into the following generic Treatment categories:

The list of treatments for the carriageway network is detailed in table 6:

Treatment Name	Surface/ Pavement Type	Description
ST	Bituminous	Surface Treatment (Surface Dressing)
R&R		Resurface and Repair (40mm Resurfacing with some structural/shape patching)
PDR		Partial Depth Reconstruct (100mm Inlay of the asphalt layers)
FDR		Full Depth Reconstruct (200mm inlay of the asphalt layers)
BRC	Concrete Surface	Bay Replacement for Concrete Surface
STC	Concrete Overlayed with Asphalt	40mm Resurface for Overlayed Concrete Surface with 25% Joint Sealing

Table 6: List of Treatments

Treatment trigger threshold

Each treatment needs to be triggered at a specific level of defect condition value, which is defined as treatment thresholds in the model. These threshold levels are used together with the Treatment Selection Rules to decide type and time of the treatment to be triggered in the analysis model.

Treatment reset for defects

When treatment is applied, it has effect on the defect condition(s). The Analysis model resets the condition(s) of the treated section of the road and the defect condition is again projected for future from that reset defect value.

Treatment life & Unit Cost

Our approach to modelling is to base the key inputs on experience and good engineering judgement. Treatment life has been chosen to match industry-expected norms. Each treatment has a unit cost which is used to calculate the cost of the works. For example, resurfacing will have longer life than surface dressing

(ST), also surface dressing will have longer life on unclassified road than principal road. Each treatment has been designed to include elements of repair works or pre-treatments to ensure that:

i. the unit rates are appropriate

ii. Provision is made for dealing with underlying structure problems before overlay or inlay, thus ensuring good performance life.

Table 7 shows the detail of the different treatment lives considered in the model.

Road Class	Flexible Treatment Life			Concrete Treatment Life		
	ST	R&R	PDR	FDR	BRC	STC
A road	5	10	30	40	40	12
B road	7	12	25	40	40	20
C road	10	15	30	50	40	25
U Road	15	20	30	60	40	30

Table 7: Treatment Lives

Maintenance Plan

Associated with each treatment is a maintenance lifecycle plan that describes the expected planned work to be done on the network. This plan is important in that it ensures that future maintenance work is properly scheduled and this in turn has the effect of preserving the network.

A treatment plan consists of a number of successive treatments at set intervals. The treatment plans and lives of treatments are chosen to represent good maintenance practice and to achieve the objectives of the analysis.

The analysis period used in Horizon is 10 years. We have defined treatment plans as shown below in figure 4 as part of the for long-term whole life cost analysis.

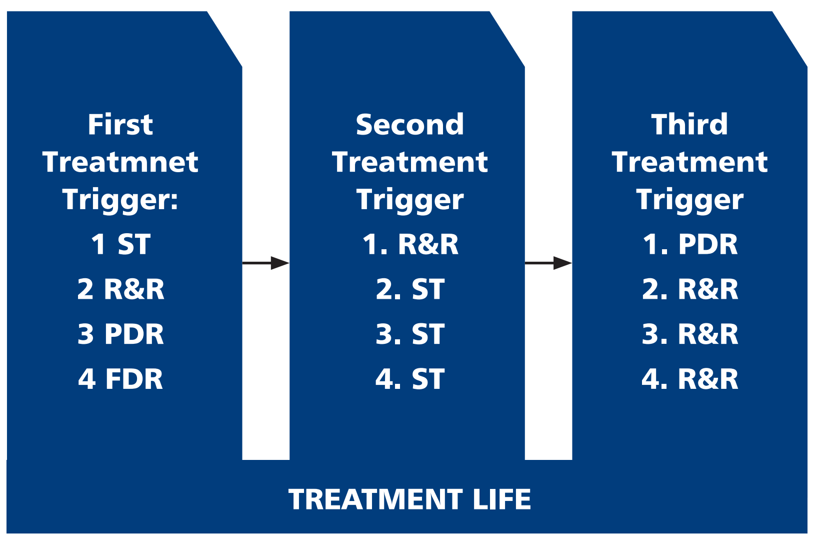

Figure 4: Maintenance Plan

Analysis Criteria/parameters

Lifecycle analysis to generate set of treatment schedules are carried out using the condition data collected in SCANNER (for A and B roads) and CVI data (for U roads).

The condition parameters for SCANNER surveys are grouped into surface condition parameters and indicative structural parameters. Surface parameters have been used as triggers within the modelling for surface treatments, such as micro asphalt, or 40 mm Inlay for the principal and classified roads. Structural treatments, such as deep resurfacing (100 mm) treatments are triggered using a combination of structural condition parameters, such as rutting, longitudinal profile variance and wheel track cracking. For the concrete pavement, a bespoke DVI defect condition; “Critical Defects” have been considered for triggering the Bay Replacement Treatment. Defects are measured per Bay and then scored as “Critical Defect Score”, the higher the presence of defects per bay, the higher the score. For the overlaid concrete carriageway, the presence of transverse and longitudinal cracking is considered to trigger the treatment for resurfacing the carriageway.

Prioritisation

The analysis model prioritise schemes based on a set prioritisation criteria to invest the set budget allowance per year and generates scenarios to show the effect of maintenance program on the network for the analysis period. Following the risk-based approach according to the Code of Practice, we have prioritised the schemes based on “Resilient Network”.

Budget Constraints

The schemes are generated based on all the defined criteria as mentioned above. The Work Program is based on the Budget allowed per year. Budget is the financial constraint that defines how much work can be undertaken per year. The analysis model generates two scenarios for each budget profile for the whole analysis period;

1. Worst first and

2. Asset Sweating.

“Worst first” is where budget is committed first to treat the worst condition part of the network. “Asset Sweating” is the process where budget is spread throughout the network to bring up the overall condition instead of targeting the Budget to treat the worst condition only.

Work Programme

The program of works is developed for a 10-year period using Horizon Asset management Software. Carriageway “schemes” generated by the automatic processes are taken as a basis for the preparation of work programs. Each “scheme” that qualifies for treatment according to the treatment selection rules is assigned a treatment type and associated maintenance lifecycle plan, and is then assigned, in priority order, to the works program. The works program is the output of the treatment parameters and rules described above, and describes in detail the work to be done, the year of implementation and the cost of each scheme.

The Council prepares the works program to executed following initial scheme generation by the analysis model. This has enabled us to have closer control over the individual schemes to be executed in any one year, enabled the introduction of schemes targeted at specific issues and enabled the adoption of variable treatment lives to simulate the differing performance of individual road sections that is observed in practice. The work program process flow is demonstrated in figure 5.

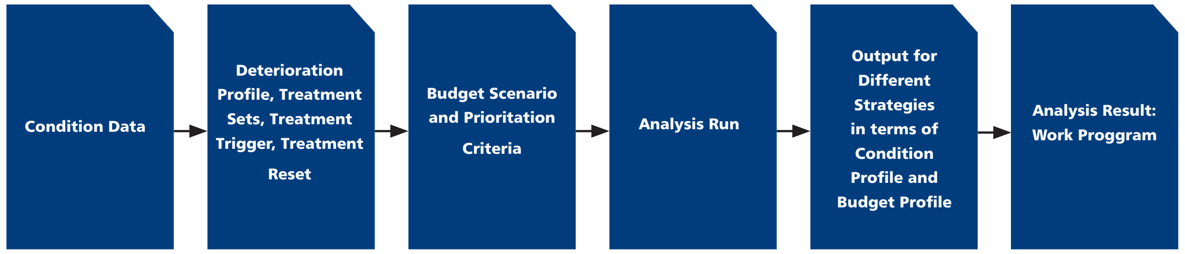

Figure 5: Work Program Process Flow

Previous Year Works Done Records
The Council hold "works done" records going back several years. This historic maintenance records provide a valuable insight into the performance and condition deterioration of the carriageway asset. This information has been utilised within the carriageway modelling and analysis scenarios, within this lifecycle plan.

Investment Scenarios

Within this lifecycle plan, four investment scenarios have been analysed using South Tyneside's Asset Management System, Horizons. The below analysis projects the condition impact on the network based on the National Indicators over a ten-year analysis period. The four investment scenarios have been presented using the accredited national indicators separately for the A roads (130-01), Band C roads (130-02) and the Unclassified roads (Bv224b).

Scenario 1: Full LTP allocation on the resilient network only:

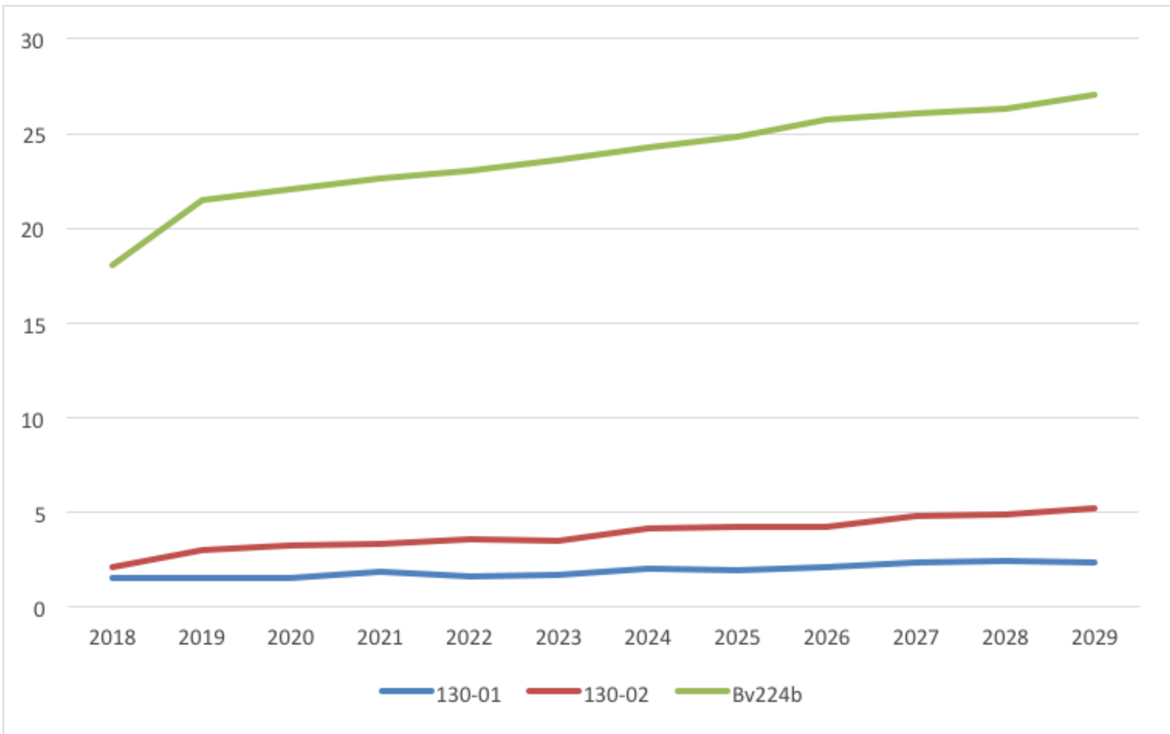

Figure 6 - Full LTP allocation on the resilient network all indicators

Scenario 1 focusses the budget purely on the resilient network. The resilient network comprises of mainly A-roads with some main routes from the B and C roads. This scenario does not select any roads for maintenance on the unclassified network and allows this to deteriorate with only reactive maintenance being applied.

Scenario 2: Full LTP allocation on the whole network:

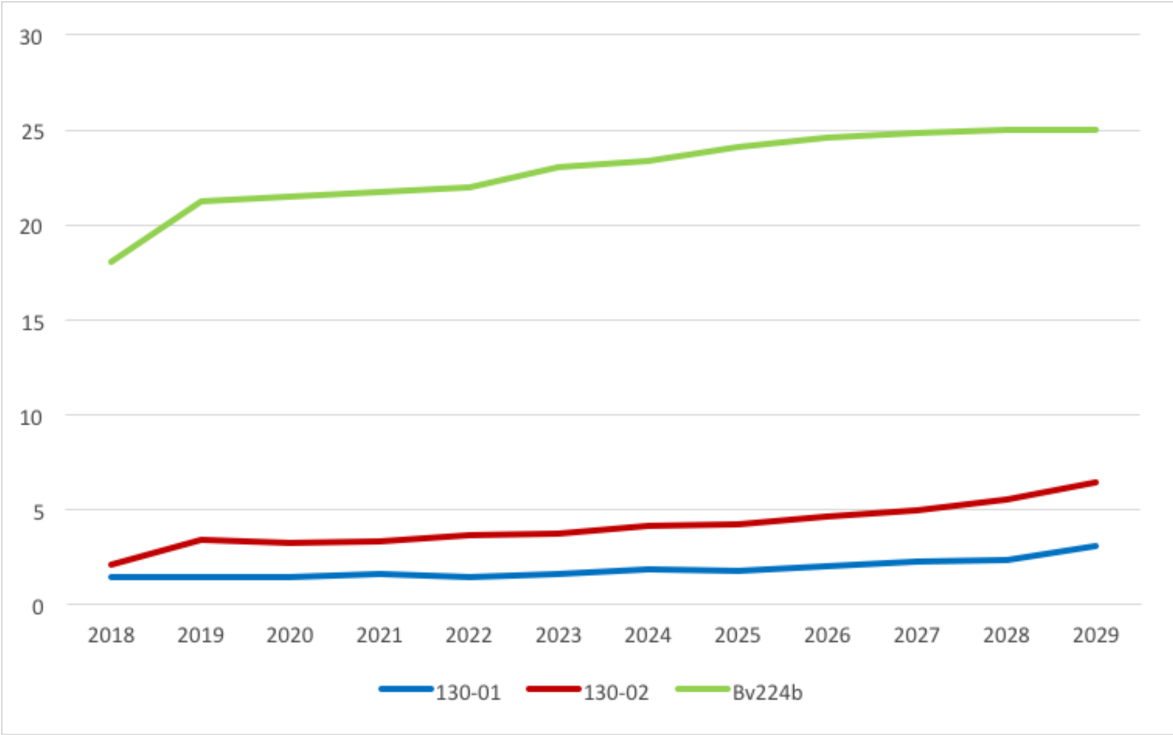

Figure 7 - Full LTP allocation on the whole network all indicators

Scenario 2 allows treatments to be selected across the entire network. This scenario shows an increase in all indicators by the end of the ten-year analysis period. This demonstrates the impact on the classified road condition if maintenance is also conducted in the unclassified network.

Scenario 3: £3m on the resilient network, £2 m Unclassified:

Scenario 3 targets £3m budgets spend on the resilient network and £2m on the unclassified roads. This scenario improves the classified network condition to below 1% and reduces the unclassified indicator to 12. It should be noted that the condition improvement can never reach zero, as the resilient network does not include the entire classified network. In addition, there will always be a proportion of the network in poor condition, as isolated sub sections will not reach the minimum treatment length to formulate a 'scheme' length. These isolated subsections may be remedied through reactive maintenance, such as patching. There is an initial increase in the indicator as the model has considered deterioration applied from the last condition survey used in the modelling up to the present day.

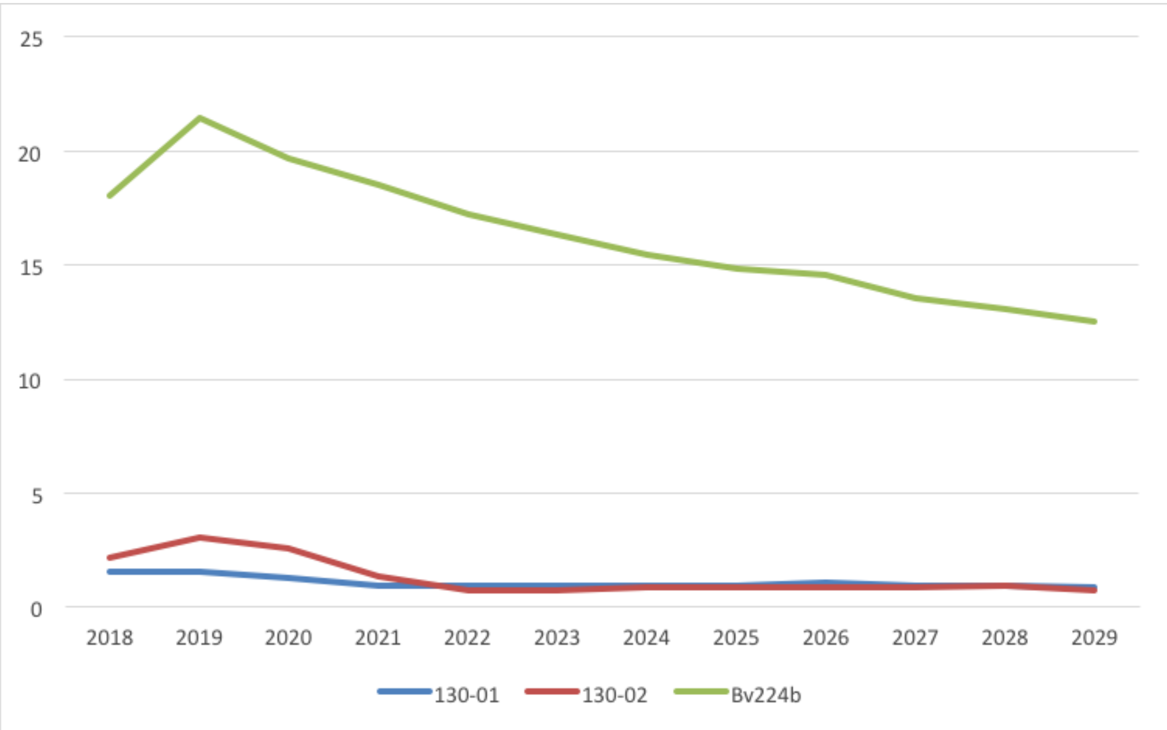

Figure 8 - £3m on the resilient network, £2m Unclassified all Indicators

Scenario 4: LTP on the resilient network, £2m Unclassified:

Scenario 4 targets LTP budget on the resilient network and £2m on the unclassified roads. This scenario predicts classified network condition to 2.5% for A roads and 5.5% for B and C roads. It reduces the unclassified indicator to 12.5%.There is an initial increase in the indicator as the model has considered deterioration applied from the last condition survey used in the modelling up to the present day

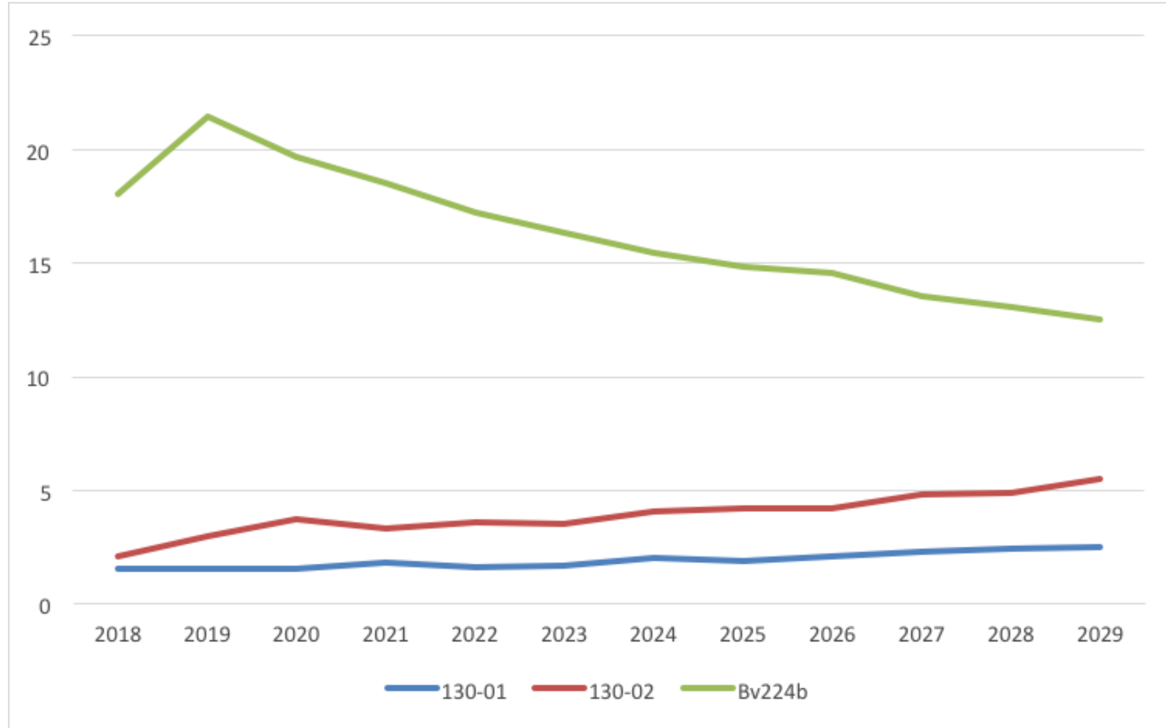

Figure 9 - LTP on the resilient network, £2 million Unclassified all Indicators

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