

ITS Lifecycle Modelling & Planning: Hertfordshire

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1. Introduction

Hertfordshire is located in the east of England, just north of London. It has a population of over one million people (the second most densely populated county in the country) and a very busy highway network. Growth over the next 10 to 15 years will see around 175,000 more people and 100,000 more houses. Hertfordshire County Council is the local highway, transport and street lighting authority with a budget for 20-21 of circa £860 million.

We are responsible for managing and maintaining around 5,300km of footways & cycleways, 5,100km of roads, 110,000 street lights and 681 traffic signals (208 no. Junctions, 473 no. Crossings).

We are one of only a few local highway authorities to have an Integrated Transport Control Centre to help us keep Hertfordshire moving and manage our intelligent transport systems, including traffic signals.

This paper sets out how the IMTRAC Asset Lifecycle Planning Module has been used in great effect in Hertfordshire.

Hertfordshire Map



2. IMTRAC LIFE CYCLE PLANNING SCENARIOS

IMTRAC is a comprehensive asset and fault management system that is used in over 80 Local Authorities in the UK and Ireland. Initially deployed in 2008 IMTRAC has evolved in response to user needs/feedback. During 2019 and 2020 the system was further enhanced to allow the asset data within to be used to generate life cycle planning scenarios and support Local Authorities in life cycle planning.

Core Parameters

In order to undertake life cycle planning functions, four core attributes per component are required:

- Condition. In IMTRAC this is represented as an integer value between 1 (lowest) and 100 (best). Typically, these are allocated as:
 - 100 – Excellent;
 - 75 – Good;
 - 50 – Average;
 - 25 – Poor; and
 - 1 – Failing
- Age;
- Replacement cost. The supply and install cost to replace this component, this value is ‘rounded’ by the user to allow for case by case variances; and
- Target lifespan. How long the component is expected to ‘survive’ for, for example a steel pole may be 15 years whereas an aluminium pole may be 50 years.

The core parameters used in the life cycle planning process as follows (Figure 3.1 shows how assets are defined in IMTRAC):

- Condition and Target Lifespan. The process for degrading asset involves calculating the rate at which a component will degrade, this is known as the component degradation factor. This is calculated by dividing the maximum asset condition (100) by the target life span. Thus, a component with a 15 year life expectancy will degrade by 6.67 points of condition per year;
- Age. For each year iteration, the component ages by 1 year unless the site is refurbished at which point the age is reinitialised to 0; and
- Replacement cost. Used to calculate the cost to replace a site (civils and TM costs can also be included).

Figure 3.1 – Equipment at Site

Ref	Type	Colour	Details	Comments	Installed	Condition	Attached Equipment	Admin
FP1		Galvanised	Generic - Large		01-10-2003	Average	Nothing attached!	Update Delete
CAB1		Grey	Generic - Full Size		01-10-2003	Average	Nothing attached!	Update Delete
CONT1		N/A	Peek - TRX	Free main...	01-10-2003	Average	<ul style="list-style-type: none"> • OMU/OTU - Peek Chameleon OTU (OTU1) • OMU/OTU - Siemens Gemini OMU (OMU1) • Detector Pack - Generic 4 Channel (Pack 7) • Detector Pack - Generic 4 Channel (Pack 6) • Detector Pack - Generic 4 Channel (Pack 5) • Detector Pack - Generic 4 Channel (Pack 4) • Detector Pack - Generic 4 Channel (Pack 3) • Detector Pack - Generic 4 Channel (Pack 2) • Detector Pack - Generic 4 Channel (Pack 1) ◦ Condition: Excellent ◦ Installed: 01-10-2003 ◦ Comments: 	Update Delete
1	4.0m Swan Signal Pole	Grey	Material: Steel Width: 115mm Base Width: 115mm Pole Cap Type: Standard Pole Cap Condition: Average Access Door: No Pole Socket: No		01-10-2003	Average	<ul style="list-style-type: none"> • Signal Head - Generic TH RAG Head • Signal Head - Generic TH RAG Head • Signal Head - Generic TH RAG Head 	Update Delete
2	4.0m Swan Signal Pole	Grey	Material: Steel Width: 115mm Base Width: 115mm Pole Cap Type: Standard Pole Cap Condition: Average Access Door: No Pole Socket: No		01-10-2003	Average	<ul style="list-style-type: none"> • Signal Head - Generic TH Farside Pedestrian Head • Pushbutton - Generic Farside - Pedestrian • Pedestrian Facility - Generic Tactile 	Update Delete
3	4.0m Swan Signal Pole	Grey	Material: Steel Width: 115mm Base Width: 115mm Pole Cap Type: Standard Pole Cap Condition: Average Access Door: No Pole Socket: No		01-10-2003	Average	<ul style="list-style-type: none"> • Signal Head - Generic TH RAG Head • Signal Head - Generic TH RAG Head • Signal Head - Generic TH Farside Pedestrian Head • Pushbutton - Generic Farside - Pedestrian • Pedestrian Facility - Generic Tactile 	Update Delete
4	4.0m Swan Signal Pole	Grey	Material: Steel Width: 115mm Base Width: 115mm Pole Cap Type: Standard Pole Cap Condition: Average Access Door: No Pole Socket: No		01-10-2003	Average	<ul style="list-style-type: none"> • Signal Head - Generic TH Farside Pedestrian Head • Pushbutton - Generic Farside - Pedestrian • Pedestrian Facility - Generic Tactile 	Update Delete
6	4.0m Swan Signal Pole	Grey	Material: Steel Width: 115mm Base Width: 115mm		01-10-2003	Average	<ul style="list-style-type: none"> • Signal Head - Generic TH RAG Head • Signal Head - Generic TH Farside Pedestrian Head • Pushbutton - Generic Farside - Pedestrian 	Update Delete

Records 1 - 200 of 13296 displayed. Page 1 of 67 page(s)

Configuration Options

In order to produce life cycle planning data, the user must first configure the 'rules' which the tool will use to generate the output. These are broken down into:

- a) Core – high level settings as shown in Figure 3.2. Elements in this section include:
- Upper year: Range calculations will be performed over
 - Objective (this links to policy objectives):
 - Maintenance spending on condition – spend the defined available money refurbishing the sites in the worst condition first;
 - Maintenance spending on age – spend the defined available money refurbishing the oldest sites first;
 - Maintenance spending to maintain a specified condition – sites are kept at no worse than a specified value regardless of cost. This process can be used to provide a baseline of what 'acceptable' estate may cost; and
 - Generation Type:
 - Simple – a single set of values for 'Maintenance Budget', 'Inflation' and 'Cost Multiplier' are utilised; and
 - Complex – yearly values for 'Maintenance Budget', 'Inflation' and 'Cost Multiplier' are utilised. This can be used to model the impact of 'capital drops' e.g. significant extra funding in year 8;
 - Maintenance Budget: The amount available for refurbishment in a given year;
 - Inflation: Cost increase per year applied to each component;
 - Maintenance budget inflation: whether inflation is applied to maintenance budget (or not);
 - Cost multiplier: Any costs attributed to a site are multiplied by this value when a refurbishment occurs;
 - Rollover budget: Whether any residual money is carried to the next year; and
 - Minimum condition at which equipment refurbished: Prevents sites being refurbished if there is available money but the site condition is greater than this value.

The screenshot shows a configuration window titled 'Core'. It contains several settings, each with a label and a control element (dropdown, spinner, or slider):

- Upper Year:** 15 (dropdown)
- Objective:** Maintenance Spending on Condition (dropdown)
- Generation Type:** Simple (dropdown)
- Maintenance Budget:** 500000 (spinner)
- Inflation:** 2 (spinner, with a '%' symbol below it)
- Apply inflation to Maintenance Budget:** No (dropdown)
- Cost Multiplier:** 1.5 (spinner)
- Rollover Budget:** Yes (dropdown)
- Minimum Condition at which Equipment Refurbished:** 50 (slider, with a blue arrow pointing to the value 50)

Figure 3.2 – Core configuration settings

- b) Asset 'decisions' – specific parameters relating to degradation and cost calculations as shown in Figure 3.3:
- Random degradation factor. This factor allows the component degradation factor to be varied by a random factor between the specified Lower and Upper values (the factor is generated every time the degradation calculator occurs). Thus, in a given year a component can then degrade more 'randomly'. Using the upper and lower values in Figure 3.2, a component with a 15 year life expectancy may degrade by between 5 and 8.3 points of condition; and

- Set NAL socket quantity = pole quantity. If a pole is not in a NAL socket then one will be added during any refurbishment event;

Asset 'Decisions'

Random Degredation Factor: Yes

Lower: 0.75

Upper: 1.25

Set NAL socket quantity = pole quantity: Yes

Figure 3.3 – Asset Decisions

- c) Site costs – high level costs such as design, traffic management and civil engineering works;
- d) Growth – specific parameters relating to how sites will be added to the calculations over the requested period as shown in Figure 3.4:

- Users can define their own growth values (split by type);
- On a year by year basis for each equipment type a random value between 0 and the specified ceiling is selected; and
- The system then clones the returned number of sites at random from the existing sites and reinitialises condition and age values for the cloned site(s);

Growth

Junction growth: 1

Midblock growth: 1

Figure 3.3 – Growth Settings

- e) Output formatting allows users to apply a degree of formatting to the charts and tables that are generated as shown in Figure 3.5:

- Threshold fields allow users to allocate the 'condition cut points' at which a site is allocated to a colour coded condition bin;
- Label fields provide the ability for the descriptions within the charts to be as specified by the user;
- Colour code cells as graph ensures that the colour code utilised in the condition by year graph are also applied to the site by site condition by year table; and
- Add condition thresholds to average change chart allows two additional fields (per site per year) to be added to the associated output table;

Output

Graph

Green threshold: 50

Green label: Average or better

Yellow threshold: 25

Yellow label: Average to Poor

Amber threshold: 10

Amber label: Poor to Failing

Red threshold: 1

Red label: Failing

Table

Colour code cells as graph: Yes

Add condition thresholds to average change chart: Yes

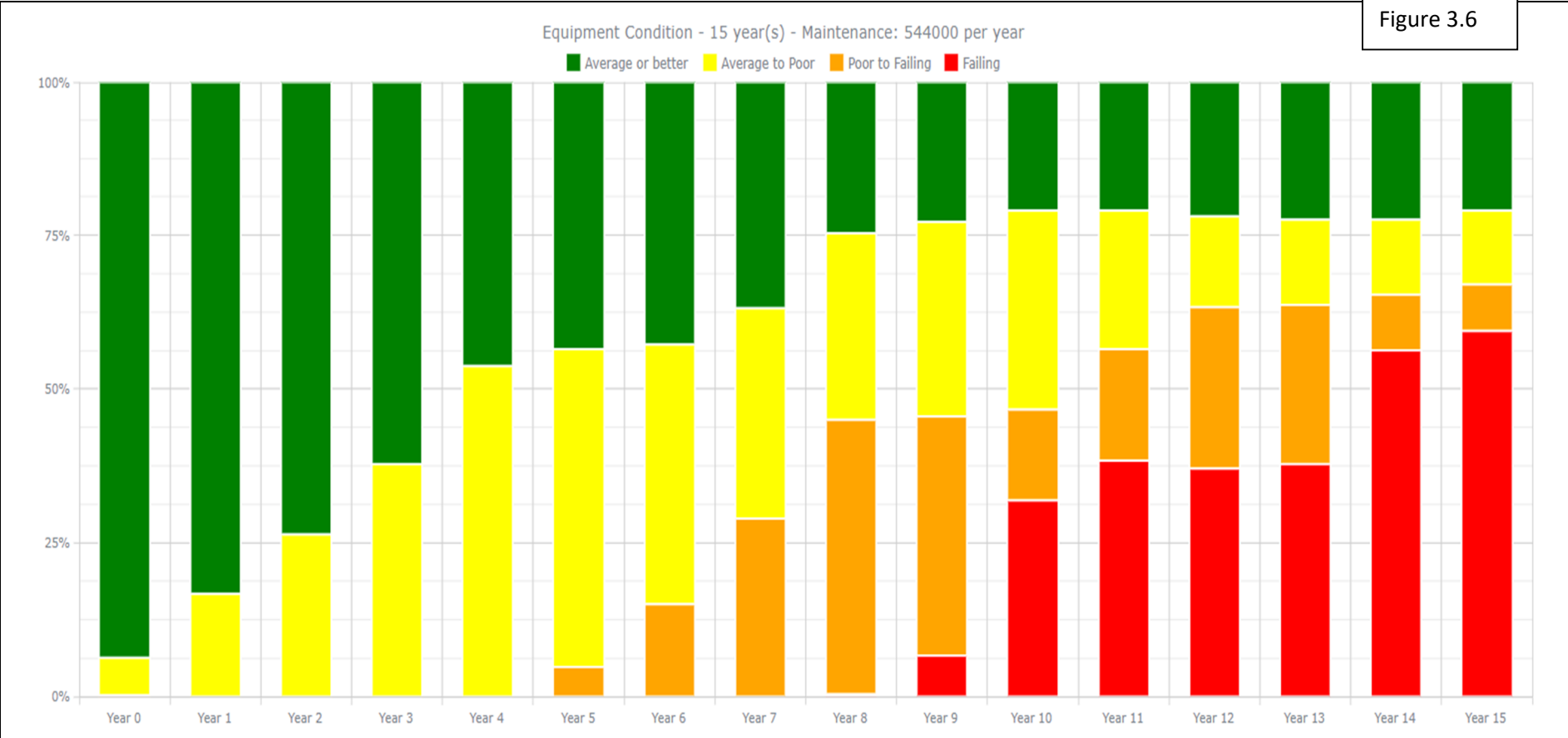
Figure 3.5 – Output Settings

Output

In order to generate the output, the process uses the defined parameters and range specified to create various graphs and tables:

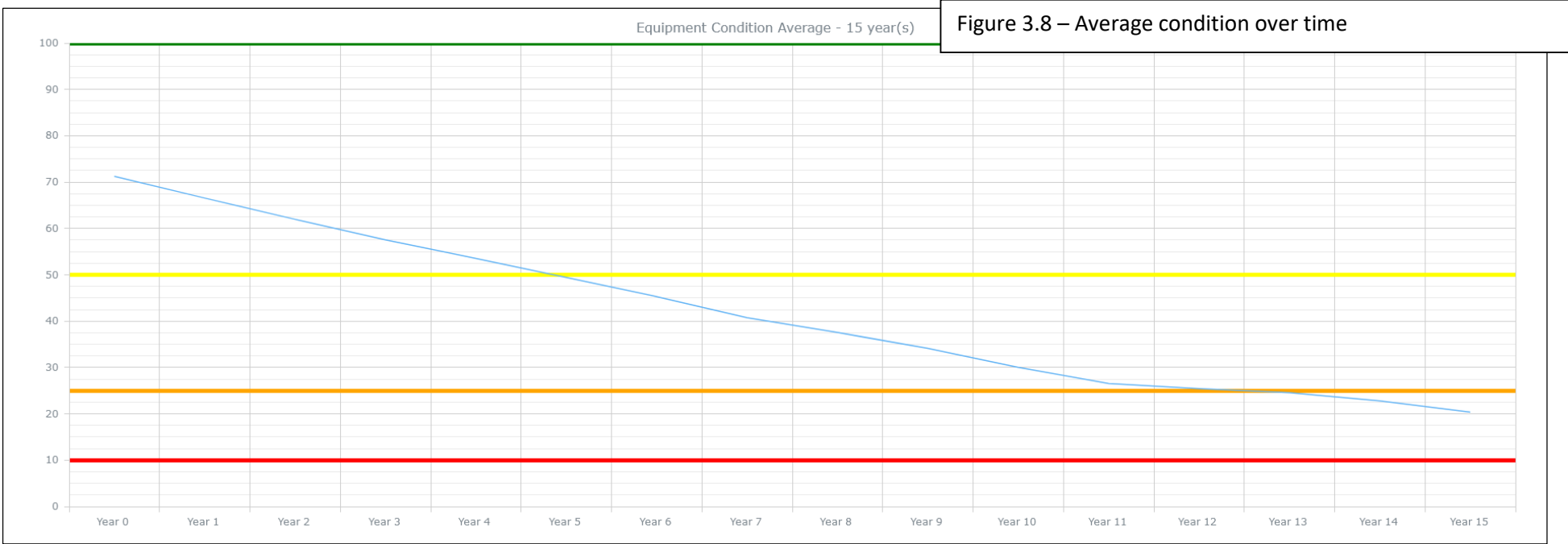
- a) Site average condition per year grouped into colour coded condition bins as shown in Figures 3.6 and 3.10. The figures show:
 - Figure 3.6 clearly shows that the proposed refurbishment spend is insufficient to maintain the current estate condition. It is based on:
 - £544k per year refurbishment budget on average asset condition over 15 years;
 - Condition colour coding as follows:
 - Average condition $\geq 50\%$ = Green;
 - Average condition $\geq 25\%$ but $< 50\%$ = Yellow;
 - Average condition $\geq 10\%$ but $< 25\%$ = Amber; and
 - Average condition $\geq 0\%$ but $< 10\%$ = Red;
 - In year 15 sites are allocated to 'bins' as follows:
 - Green: 156;
 - Yellow: 88;
 - Amber: 56;
 - Red: 441;
 - Figure 3.10 demonstrates that increasing the proposed refurbishment spend is almost sufficient to maintain the current estate condition. It is based on:
 - £1.5m per year refurbishment budget on average asset condition over 15 years;
 - Condition colour coding as follows:
 - Average condition $\geq 50\%$ = Green;
 - Average condition $\geq 25\%$ but $< 50\%$ = Yellow;
 - Average condition $\geq 10\%$ but $< 25\%$ = Amber; and
 - Average condition $\geq 0\%$ but $< 10\%$ = Red;
 - In year 15 sites are allocated to 'bins' as follows:
 - Green: 377;
 - Yellow: 224;
 - Amber: 105; and
 - Red: 38;
- b) Number of sites and average condition over time as shown in figures 3.7 and 3.11 show the average site degrades over the specified time period. This data is then in turn used to populate the graphs shown in figures 3.8 and 3.12;
- c) Individual site attributes are shown in figures 3.9 and 3.13 which show:
 - The condition of each site (starting in year 0 and modelled thereafter);
 - The expected condition based on the average age of the components at the site relative to the average target expectancy;
 - The average component age relative to the average target life expectancy for the components at the site (negative numbers indicate that the site has exceeded the target); and
 - The estimated cost to replace the site in the given year;
- d) Once a number of scenarios have been run it is possible to compare them as shown in figure 3.14

Figure 3.6



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	48669	45525	42447	39412	36725	34008	31211	28075	25912	23624	20838	18487	17731	17148	15938	14240
Site No.	683	684	685	685	686	688	689	689	690	692	694	696	697	698	699	699
Average	71.26	66.56	61.97	57.54	53.53	49.43	45.3	40.75	37.55	34.14	30.03	26.56	25.44	24.57	22.8	20.37

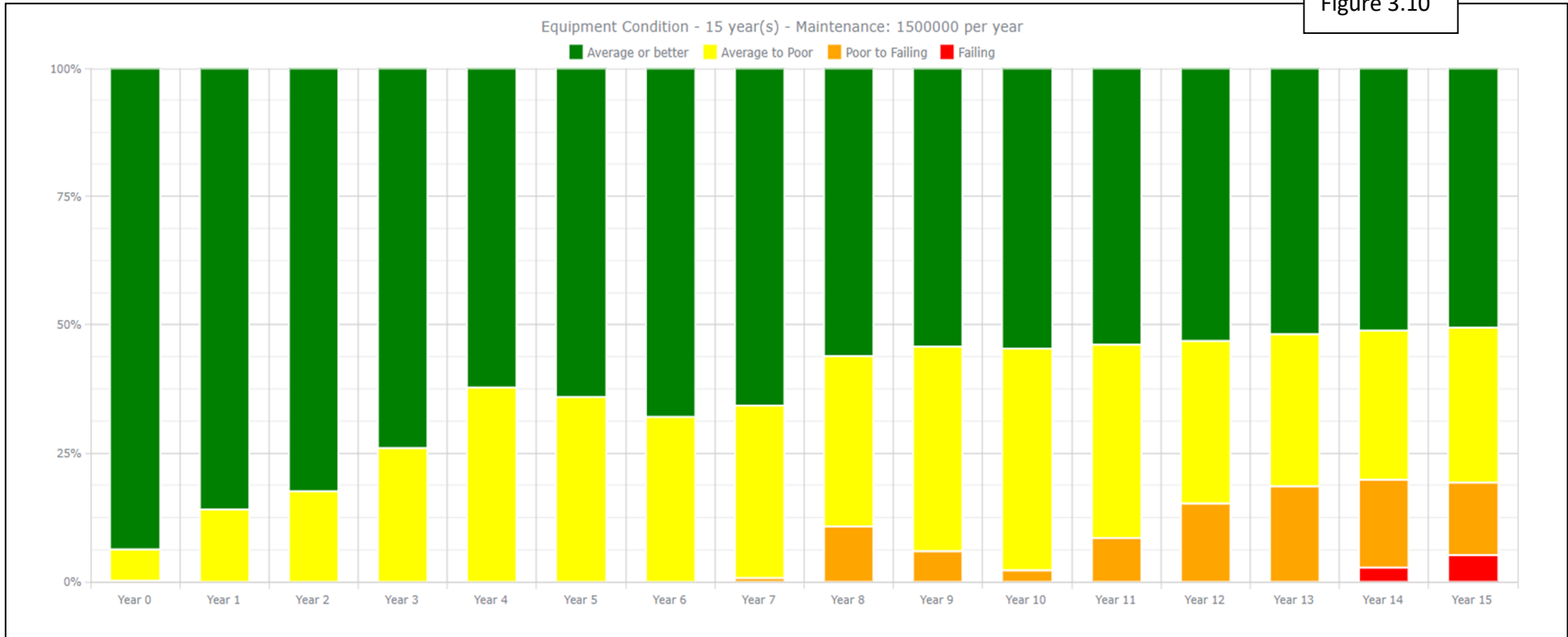
Figure 3.7 – Number of sites and average condition over time



Site ID	0			1			2			3			4			5			C					
	Condition	Expected Condition	Age Relative to Target	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target		Cost to Replace				
S005	56.94	1	-1.9	50.17	1	-2.9	£38504.01	43.51	1	-3.9	£39142.63	36.84	1	-4.9	£42444.74	30.17	1	-5.9	£43109.16	23.51	1	-6.9	£41136.14	1
S006	99.22	97.49	14.62	92.55	90.83	13.62	£50280.41	85.88	84.16	12.62	£51286.01	79.22	77.49	11.62	£52311.73	72.55	70.81	10.62	£53357.97	65.88	64.14	9.62	£54425.13	5
S008	60.32	1	-2.4	53.65	1	-3.4	£25506.09	46.98	1	-4.4	£22340.16	40.32	1	-5.4	£26343.41	33.68	1	-6.4	£26774.67	27.08	1	-7.4	£29142.35	2
S010	76.4	40	6	69.73	33.34	5	£15321	63.06	26.67	4	£15579.62	56.4	20	3	£14053.18	49.73	13.32	2	£16112.47	43.06	6.65	1	£17350.81	3
S011	63.82	32.55	4.88	57.15	25.88	3.88	£54408.84	50.48	19.22	2.88	£55497.02	43.82	12.55	1.88	£56606.96	37.21	5.87	0.88	£57739.1	30.69	1	-0.12	£58893.88	2
S012	70.42	36.95	5.54	63.75	30.29	4.54	£24302.21	57.09	23.62	3.54	£24788.25	50.42	16.95	2.54	£25284.01	43.85	10.27	1.54	£25789.69	37.41	3.6	0.54	£26305.49	3
S014	60.04	13.59	2.04	53.38	6.93	1.04	£48475.79	46.71	0.26	0.04	£49445.3	40.04	1	-0.96	£50434.21	33.38	1	-1.96	£51442.89	26.71	1	-2.96	£52471.75	2
S015	62.08	36.39	5.46	55.41	29.72	4.46	£23245.17	48.75	23.05	3.46	£23710.07	42.08	16.39	2.46	£24184.27	35.62	9.7	1.46	£24667.96	29.47	3.04	0.46	£25161.32	2
S016	54.85	11.22	1.68	48.19	4.55	0.68	£21389.82	41.52	1	-0.32	£21817.62	34.85	1	-1.32	£22253.97	28.69	1	-2.32	£22699.05	23.3	1	-3.32	£23153.03	1
S017	93.58	94.48	14.17	86.91	87.82	13.17	£15445.82	80.24	81.15	12.17	£15754.73	73.58	74.48	11.17	£16069.83	66.91	67.8	10.17	£16391.22	60.24	61.13	9.17	£16719.05	5

Figure 3.9 – Site by site condition / replacement cost by year

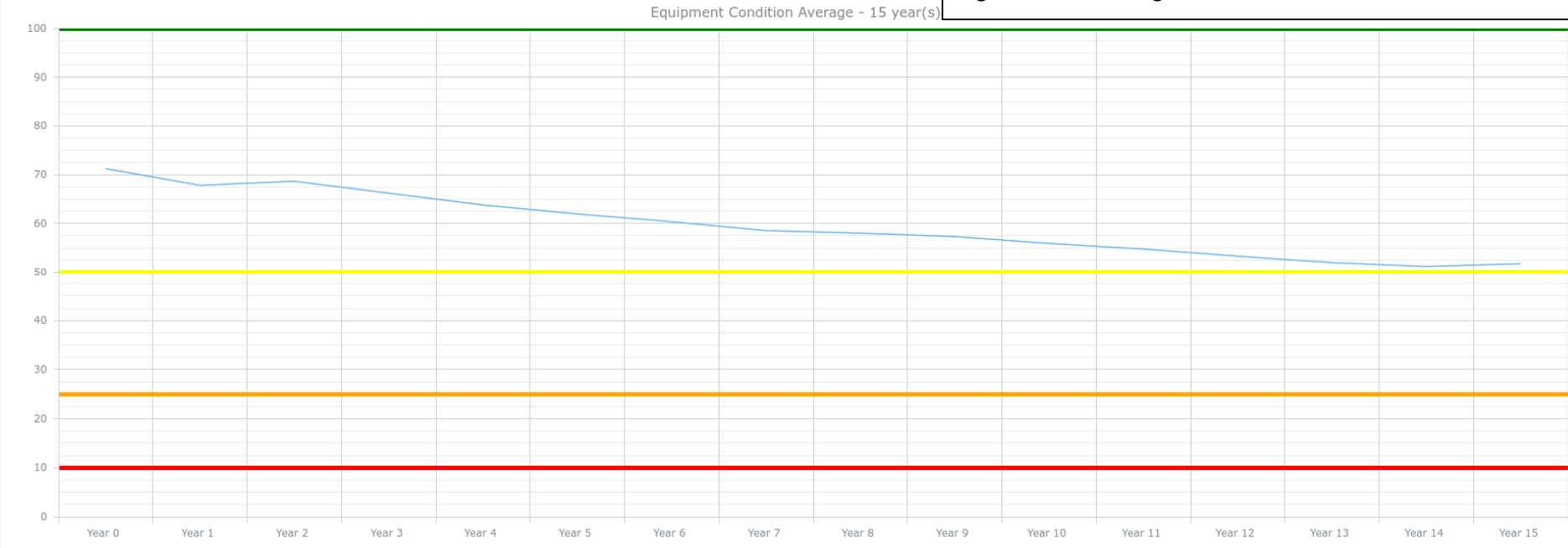
Figure 3.10



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	48671	46390	47000	45450	44161	42814	41901	40650	40118	39860	38965	37987	36856	35987	35713	36247
Site No.	683	684	686	688	690	692	694	695	695	697	698	699	699	700	701	702
Average	71.26	67.82	68.51	66.06	64	61.87	60.38	58.49	57.72	57.19	55.82	54.34	52.73	51.41	50.95	51.63

Figure 3.11 – Number of sites and average condition over time

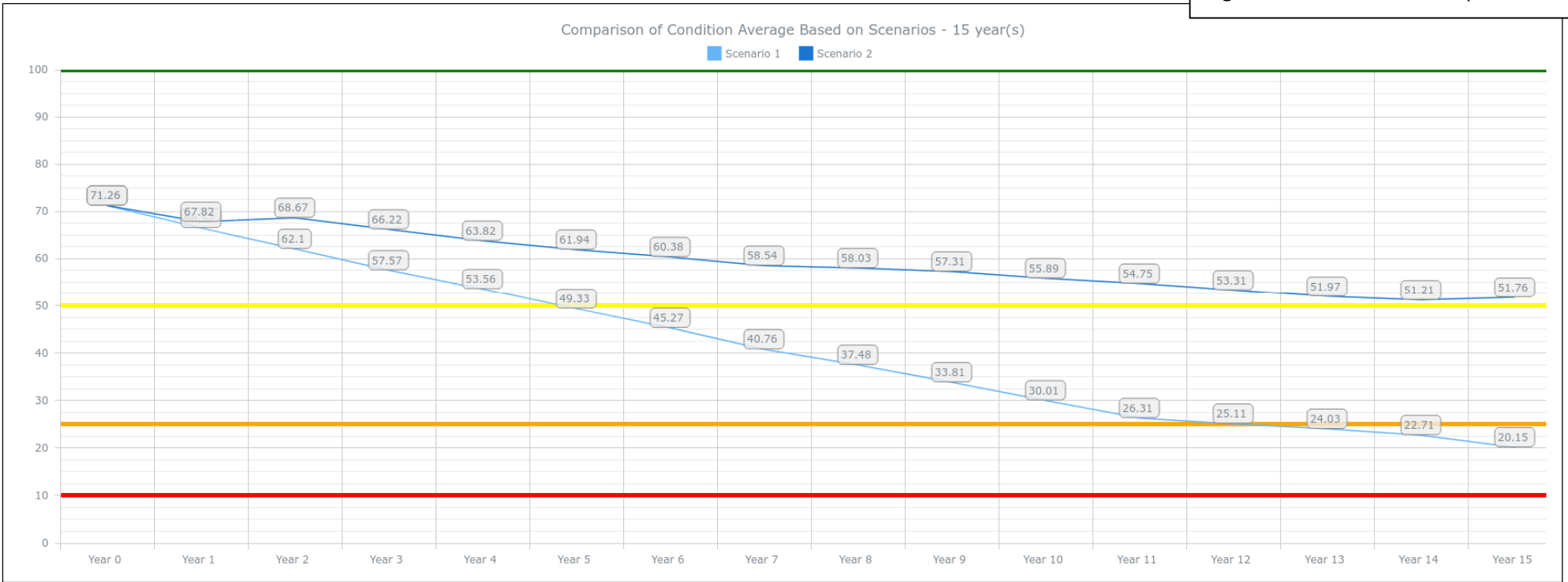
Figure 3.12 – Average condition over time



Site ID	0				1				2				3				4				5				6			
	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace	Condition	Expected Condition	Age Relative to Target	Cost to Replace
S005	56.84	1	-1.9	£41154.74	50.17	1	-2.9	£41154.74	43.51	1	-3.9	£39142.63	93.33	100	15	£34870.91	86.67	93.32	14	£34044.51	80	86.65	13	£34725.4	73.33	79.98	12	£35419.91
S006	99.22	97.49	14.62	£50280.41	92.55	90.83	13.62	£50280.41	85.88	84.16	12.62	£51286.01	79.22	77.49	11.62	£52311.73	72.55	70.81	10.62	£53357.97	65.88	64.14	9.62	£54425.13	59.22	57.47	8.62	£55513.63
S008	60.32	1	-2.4	£21925.65	53.65	1	-3.4	£21925.65	46.98	1	-4.4	£22340.16	40.32	1	-5.4	£28271.21	93.33	100	15	£26774.67	86.67	93.33	14	£23080.92	80	86.67	13	£23542.54
S010	76.4	40	6	£15321	69.73	33.34	5	£15321	63.06	26.67	4	£15579.62	56.4	20	3	£16807.3	49.73	13.32	2	£14322.25	43.06	6.65	1	£14596.69	36.4	-0.02	-0	£16666.85
S011	63.82	32.55	4.88	£54408.84	57.15	25.88	3.88	£54408.84	50.48	19.22	2.88	£55497.02	43.82	12.55	1.88	£56606.96	37.21	5.87	0.88	£57739.1	93.33	100	15	£58893.88	86.67	93.33	14	£60237.37
S012	70.42	36.95	5.54	£24302.21	63.75	30.29	4.54	£24302.21	57.09	23.62	3.54	£24788.25	50.42	16.95	2.54	£25284.01	43.85	10.27	1.54	£25789.69	37.41	3.6	0.54	£26305.49	30.98	1	-0.46	£26831.6
S014	60.04	13.59	2.04	£48475.79	53.38	6.93	1.04	£48475.79	46.71	0.26	0.04	£49445.3	40.04	1	-0.96	£50434.21	93.33	100	15	£51442.89	86.67	93.33	14	£53118.56	80	86.67	13	£54180.93
S015	62.08	36.39	5.46	£23245.17	55.41	29.72	4.46	£23245.17	48.75	23.05	3.46	£23710.07	42.08	16.39	2.46	£24184.27	35.62	9.7	1.46	£24667.96	93.33	100	15	£25161.32	86.67	93.33	14	£25830.16
S016	54.85	11.22	1.68	£21389.82	48.19	4.55	0.68	£21389.82	41.52	1	-0.32	£21817.62	93.33	100	15	£22253.97	86.67	93.32	14	£22858.23	80	86.65	13	£23315.39	73.33	79.98	12	£23781.7
S017	93.58	94.48	14.17	£15445.82	86.91	87.82	13.17	£15445.82	80.24	81.15	12.17	£15754.73	73.58	74.48	11.17	£16069.83	66.91	67.8	10.17	£16391.22	60.24	61.13	9.17	£16719.05	53.58	54.46	8.17	£17053.43

Figure 3.13 – Site by site condition / replacement cost by year

Figure 3.14 – Scenario Comparison



Summary

In summary, the approach is to:

- a) Define data required: parameters, treatments, costs, maintenance regimes;
 - Consider strategies: minimising whole life costs, meeting statutory requirements, meeting performance targets, managing risk. Always linked to Asset Management Strategy;
 - Select deterioration profiles: service life, historical performance, local knowledge, best practice;
 - Select scenarios to run: Do Nothing, Do Minimum, Lower than current condition / expenditure, sustaining current condition / expenditure, prioritised improvements / investment, meeting performance targets etc;
- b) Use the outputs to gain operational benefits: increased understanding of the network and its performance, data driven inspections and effective use of asset condition, highlighting maintenance regime and delivery;
- c) Use the outputs to gain strategic: member / senior officer buy in to support long term investment decisions, support budget decisions and allocations, in this case in 20-21 financial year funding secured for circa 60 sites compared to 23 sites in the financial year 19-20; and
- d) Build on the successes achieved to create positive evolution and potential additional applications, e.g. street lighting, safety barriers etc so the benefits achieved for traffic signals can be applied in other areas to support Hertfordshire moving forward ensuring safe, reliable, sustainable and smart travel.

3. What Next

It is acknowledged that thus far the life cycle planning tool within IMTRAC has only begun to scratch the surface of what is possible and the tool will continue to be updated and expanded from user feedback.

Going forward the following developments are planned:

- a) Model street lighting data within Hertfordshire;
- b) Additional objective to model IMTRAC's component serviceability index i.e. the measure of obsolescence; and
- c) Further granular parameter flexibility.