Moloney Asset Management Systems

Report Following the Survey of Bridge Assets for Sample Council

Inspected Jan-18

Report produced by Moloney Asset Management Systems
exclusively for Sample Council

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Section 1: Report Summary

This report provides a summary of the major findings following the bridge and major culvert asset condition survey, undertaken in Jan-18 for Sample Council by Moloney Asset Management Systems (MAMS).

1.1 Overall Report Findings

The following are the major findings coming out of the condition survey and analysis of results within this report.

1. *The bridge assets were found to be in very poor overall condition with a quite measurable condition decline since the last survey in 2013.*

2. *There were three structures found to be at or above the intervention level of condition 8.0. This represents 10.60% of the total network value and is a very high figure by industry standards. As a general guide, any level of over intervention assets that exceeds three years value in the annual depreciation rate is considered to be very poor. Sample Council currently has a value of over intervention assets of $3,475,084 representing 17.0 years of annual depreciation.*

3. *There were a further 29 structures found to be within the 6.0 - 7.0 condition range with an estimated replacement value of $3,090,000. These structures while not as urgent for attention as the condition 8 - 9 structures are none the less in quite poor overall condition and some may require major works over the next 10-years.*

4. *The extent of the asset base at and above condition 6 has risen from 16.4% in 2013 up to 21.4% in 2018. This represents a very heavy overall condition decline.*

5. *The present renewal demand coming from our model is at $1,243,000 pa in year one, to maintain all assets below the adopted intervention level of condition 8.0. (See figure 5.6). However, it needs to be understood that the total level of over intervention assets is at $3,475,084 and that the model was designed to eliminate all over intervention assets over a five year period and not just one year.*

6. *It is recommended that council commence funding the bridge asset renewal program at their planned level of $250,000 pa and that this be subject to an 8.6% compounding annual increase over the next 10-years. It would be desirable to raise the renewal expenditure at a faster rate but we have aimed at commencing from your current position.*

7. *All three of the condition 8 and above structures fall outside of what could be considered the normal bridge replacement parameters. Two may not justify renewal and the third is a quite historic structure that may attract special external funding. Council needs to do a little investigation on all three structures in order to determine how to move forward financially.*

8. *The planned average renewal expenditure level over the next 5-years at $250,000 pa, if maintained will result in a downward trend in the total level of over intervention assets. But it will only be down to 5.8% after 10-years which remains at a very high level. Clearly it would be desirable to raise the renewal expenditure level on this asset class.*

9. *There were 4 bridges identified with existing load limits and a further 10 identified as possibly benefiting from the imposition of new load limits. Most of the recommended load limits relate to asset preservation rather than the danger of a bridge collapse or failure.*

10. *There were 209 works projects identified during the bridge condition survey with a total estimated treatment cost of $402,600. Of the total recommended works projects identified 50 were rated as urgent (with their urgency rating at and above level 7). The total estimated cost of the urgent works requirements being $175,000 .*

11. *The extent of urgent works requirements remains high and has resin by around 80% since 2013.*

12. *There were 24 bridges with reinforced concrete (RC) U-Slabs identified and only 3 of these with cast in place RC decks overlays. This leaves 21 bridges that may need RC overlays in the future for asset preservation. But 11 have been identifies as prime targets for an RC overlay for asset preservation.*

13. *There were 8 works projects identified that involved the recommendation of a higher level investigation. These should be programmed as funding and time permits.*

14. *The renewal requirements and works projects identified during the survey present council with a heavy future financial demand. The three structures currently at and above condition 8 will not require full replacement but there may not be much of a saving as the repair costs on the Creswick Lawrence Rd bridge will come close to the current full book value of the asset*

15. *Certain financial demand matters may be doubled up within this report and within the bridge database. By way of example a poor condition bridge may be called up for renewal in say 5-years time. It may also have certain works requirements called up against it that will be redundant if it is replaced. We have not made any decisions or firm recommendations as to wether you replace such structures or undertake remedial work to extend their service life. Thus the total combined value of renewal demand and works requirements will tend to be overstated.*

1.2 Summary of Asset Condition Findings

Key Cond. Indic. No.	Bridge Condition Indicator	Figures from Previous Survey in Oct-13	Figures from Current Survey in Jan-18	Actual Change Negative is a Condition Decline	% Change Between Surveys	Better or Worse Since last Survey
1	Weighted Average Asset Condition	3.71	3.96	-0.25	-6.6%	Worse
2	Total $/sqm of Bridge Deck area For Urgent Works (above urgency Rating 7)	$10.03	$18.16	-8.13	-81.1%	Worse
3	Total $/sqm of Bridge Deck area For all other identified works	$26.54	$23.62	2.92	11.0%	Better
4	% of Asset Base above Condition 6	16.4%	21.4%	-0.05	-31.1%	Worse
5	% of Asset Base above Condition 7	9.5%	11.4%	-0.02	-21%	Worse
6	% of Asset Base above Condition 8	6.1%	10.6%	-0.05	-73.9%	Worse

Renewal Demand Being Met For:	% of Long Term Demand Being Met
Bridge Asset Group	122%

Fig 1.1 Summary of key condition indicators

The above table details how certain key condition indicators have changed since the previous survey. The Weighted Average asset condition is a single condition factor representing the condition of the whole asset set, with assets in each condition rating weighted for value. The urgent works are those identified with an urgency rating of 7 and greater (on a 1 – 10 scale) and should be addressed immediately. The other works represent all other works requirements that are not considered to be urgent. The extent of poor condition assets is represented by the extent of the asset base at and above conditions 6 to 8. The Moloney Condition rating system is consistent across all asset types and commences at zero with a new asset and ends in the 8 to 10 range when there is no remaining life in the asset.

The key performance indicators within Figure 1.1 demonstrate that overall asset condition has declined a little since 2013, and the extent of works requirements as well as the extent of poor condition assets has risen quite substantially. This is despite the renewal expenditure being at 122% of the consumption rate over that same period.

Section 2: Introduction

The aim of this report is to draw together the findings of the most recent bridge condition inspection undertaken by Moloney Asset Management Systems. The report will cover the following areas.

- Examination of asset condition and condition change since the previous survey
- Production of asset degradation curves based upon the statistical analysis of condition change between surveys
- Establishment of the capital renewal demand pattern using the Moloney financial model
- The identification of matters requiring further investigation beyond the scope of this project
- The identification and prioritising of other major works and maintenance requirements
- The identification of bridge renewal and upgrade targets for the next 10 to 15 years

2.1 Source of financial modelling input information

Modelling outcome is very much dependent upon the accuracy of the input data and how assets are grouped. The basic five input criteria required for the modelling process are detailed below with their source identified. Council has supplied the rehabilitation unit rates and present expenditure levels. The survey of the assets has delivered the other three variables. The degradation curves used were specifically developed for Sample Council via a statistical analysis of the condition change between the two condition surveys in 2002 and 2008.

Rehabilitation Cost	—	Supplied by Council
Present Expenditure Levels	—	Supplied by Council
Asset Quantity	—	Directly from this survey
Asset Condition	—	Directly from this survey
Degradation Curves	—	Specifically developed for Sample Council via statistical Analysis of condition change between 3 condition surveys

Modelling outcome is dependent upon all 5 of the above variables. If any one is of poor or questionable quality then the whole process can be flawed.

2.3 Capital Rehabilitation - Renewal and Capital Expansion Works

The term **Capital Expenditure** has a broad meaning that can denote different things under certain circumstances. For the purpose of this report all **Capital Expenditure** relates to Renewal or **Capital Rehabilitation Expenditure**. That is, expenditure put towards the replacement or rehabilitation of existing assets.

This report is limited in its financial analysis to the costs associated with the ongoing cyclical rehabilitation of the existing bridge asset base. Costs associated with new or upgraded assets would need to be added to the total expenditure levels delivered within the report. The financial analyses undertaken within the report can best be seen as an estimate of the ongoing financial demand to maintain the present asset base in perpetuity.

Section 3: Valuations and Current Expenditure Levels

This section will examine the overall asset valuations and the current level of capital-renewal and maintenance expenditure.

3.1 Estimated Asset Valuations

Following the completion of the survey the data was placed into the Moloney asset management system and the table below represents a summary of the overall asset quantities and valuations. The Annual Depreciation figure of $204,743 is really an accounting figure and may vary from the actual annual renewal demand or what we term the Annual Renewal Liability. Annual Depreciation represents the first attempt to define the annual loss in capital value within the asset set. At its most basic level it represents the rate of annual capital consumption of the asset base.

Latest Survey Valuations **Jan-18**

Figures taken from the Bridges 4 file and include the Major Culvert Assets

ASSET DESCRIPTION	Total Quantity	Units	Weighted Av. Asset Cond.	Asset Life in Years	Replace. Value $	Written Down Value $	Accumul. Deprec. $	Annual Deprec. $	Average Date of Cond. Assessment
All Bridges and Major Culverts	9,635	sqm	3.956	118.2	28,497,632	14,551,872	13,945,760	204,743	Jan-18

Fig 3.1 Table of asset valuations

Important Note:

There are many variables that can be applied in the derivation of asset valuations. The above table is a draft only, based upon the best available details at the time of preparing the report and may not accord with the figures within the accounting system.

The above figures and the inputs that delivered them should be reviewed by council before they are adopted as the accounting valuation figures.

3.2 Current Levels of Renewal Expenditure vs. Av Long-term Demand

Sub Asset Description	5 Year Average Planned Annual Capital Renewal Expenditure	Annual Depreciation or Average Long term Annual Demand	% of Annual Depreciation Being Met
All Bridges	**$250,000**	**$204,743**	122%

Fig 3.2 Details of Current Expenditure Levels and demand

Figure 3.2 provides some very important overall figures. It indicates that the average long-term annual renewal demand (depreciation) is $204,743 pa and that the planned average capital renewal expenditure for the next 5-years is $250,000 pa.

Council is presently funding 122% of the average long-term demand (Depreciation). Modelling within later sections of this report will indicate if this level of expenditure is appropriate or not.

Section 4: Asset Degradation – Performance Curves

Asset degradation or performance curves, unique to the district, can be developed once two or more consistent condition surveys have been undertaken. This is done in the Moloney system by examining all assets within a given condition rating following the first survey and determining which have degraded by the time of the second survey.

The condition change between surveys is used to predict the annual statistical probability of an asset degrading from one asset condition to the next. In turn this equates to an expected average life within each condition rating. The degradation curves serve two very important functions. Firstly they are used within the financial modelling section of the Moloney system to predict future asset condition movement and financial demand. Secondly they should form the basis of the justification for the selection of depreciation life cycles within the accounting system.

Within the asset degradation tables below the results are expressed as an expected life in years within each of the condition ratings 0 to 9. Little or no asset life is allocated above condition 8 as this is generally considered the upper condition limit for an asset to remain in service. The other important information within the table is the **% of total asset base within the start condition**. That is, the % of the total asset base that was within the commencing condition range at the time of the first survey, the higher the figure here, the more reliable the prediction.

Figures sometimes need to be manually adjusted to remove inconsistencies resulting from small sample size at the extreme ends of the condition range. In all cases the total expected life will be reduced because of the small sample size. In no situations will the total life be increased other than the rare case where there is no asset within a given condition or no asset within a condition range has degraded between the two surveys.

4.1 Bridge Asset Degradation Curves

Asset Condition Range	All Bridges 2013 - 2018	Long Life Bridges 2013 - 2018	All Culverts 2013 - 2018	All Footbridges and Jettys
9 - 10	1.0	1.0	1.0	1.0
8 - 9	5.0	5.0	5.0	5.0
7 - 8	8.6	20.0	10.0	10.0
6 - 7	20.0	20.0	13.5	10.0
5 - 6	27.4	50.9	10.0	10.0
4 - 5	14.6	14.6	7.1	6.0
3 - 4	11.1	11.1	8.9	6.0
2 - 3	8.0	8.0	8.0	6.0
1 - 2	8.5	8.5	7.0	5.0
0 - 1	7.0	7.0	7.0	4.2
	111.2	**146.2**	**77.5**	**63.2**

Fig 4.1 Bridge Degradation Curves - Expected life within each condition rating

The above degradation tables have been specifically developed for Sample Council by analysing the condition change between two condition surveys in 2013 and 2018. The sample size is small but there has been reasonable consistency with results from other council districts.

Long life bridges were found to have a total life to condition 10 of around 145 years and a life to intervention of around 130-years. For major culverts these figures were 75 and 65 respectively.

The lives found for the culverts are at the lower end of expectations and may be an anomaly, but there were an abnormally high number of assets that did degrade over the time frame. If they stabilise in condition over the next 3 - 5 years these lives may increase.

Section 5: Whole of asset group performance

This section will deal with the performance of the bridge assets as a total group. It will commence by examining the overall condition and how this has changed since the last survey. It will then go on to analyse the future bridge renewal demand using the Moloney Asset Management Systems modelling tools.

5.1 Key Condition Indicators – Weighted Average Asset Condition

The weighted average asset condition is a single condition indicator that represents the whole condition distribution in one figure. It is derived by weighting the raw asset condition scale 0 - 10 for the extent of asset within each condition and so provides a basic single figure summary of the overall condition of the asset set and is very useful as a condition movement indicator.

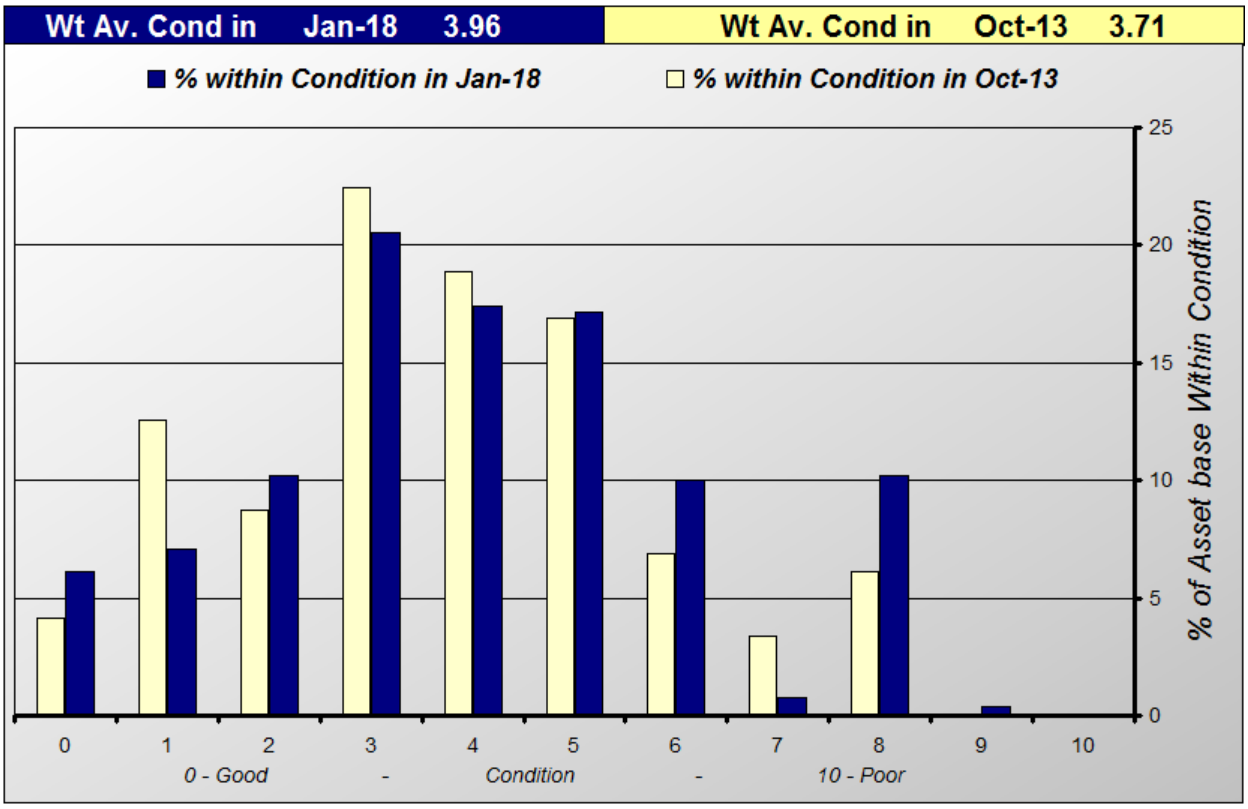

Fig. 5.1 Condition Distribution Comparison Graph – Between Surveys

Key Cond. Indic. No.	Bridge Condition Indicator	Figures from Previous Survey in Oct-13	Figures from Current Survey in Jan-18	Actual Change Negative is a Condition Decline	% Change Between Surveys	Better or Worse Since last Survey
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6	% of Asset Base above Condition 8	6.1%	10.6%	-0.05	-73.9%	Worse

Renewal Demand Being Met For:	% of Long Term Demand Being Met
Bridge Asset Group	122%

Fig. 5.2 Table of Key Condition Indicator Change since the last Survey

The above 2 figures provide details of how the Bridge asset condition has changed since the last survey. Figure 5.1 details the condition distribution for both surveys along with the first of the key indicators the "weighted average asset condition".

Figure 5.2 contains the six key condition indicators and also shows how they have changed since the previous survey. At the bottom of the table are two very important figures. These indicate the percentage of the present renewal demand (from modelling) and annual depreciation being met.

The key performance indicators within Figure 5.2 demonstrate that overall asset condition has declined a little, and the extent of works requirements as well as the extent of poor condition assets has risen quite substantially since 2013. This is despite the renewal expenditure being at 122% of the consumption rate over that same period.

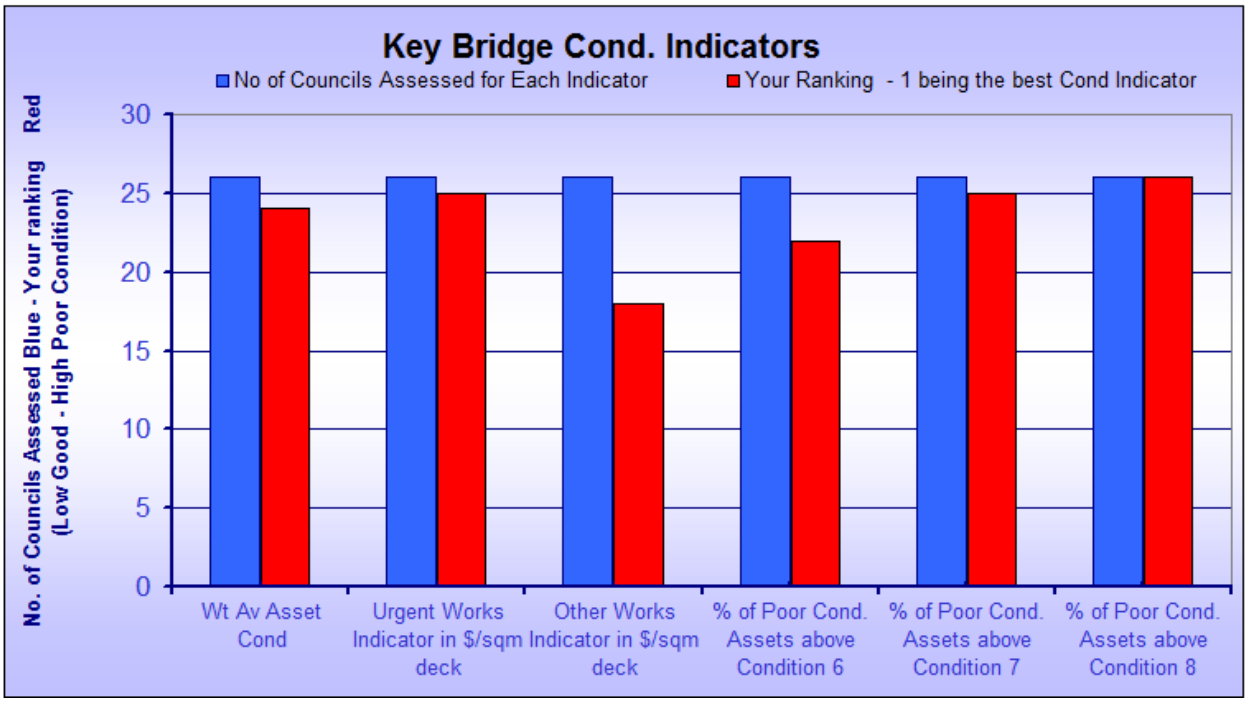


Fig. 5.3 Key Condition Indicators - Compared with other Councils surveyed

The same key condition indicators can be used to benchmark Council against all other council districts assessed by MAMS. Figure 5.3 ranks the key condition indicators against those of all other councils assessed by MAMS. The lower the red bar the better the condition indicator. The blue bars represent the total number of councils assessed. The red bar at 1 equates to the best condition indicator encountered. The red bar level with the blue, represents the worst condition indicator.

The comparison with the 26 councils assessed by MAMS in figure 5.3 indicates that Cample Council Shire's bridges are in relatively poor overall condition with the second worst weighted average asset condition and the highest extent of assets at and above condition 8.

The very high extent of condition 8 and above assets are linked to 3 road bridges on the Anderson Mill Rd, The Creswick Lawrence Rd and the Deep Spring Rd. Most of the liability is tied up with the Sir John Monash bridge on the Creswick Lawrence Rd. The other two structures may not be council assets and could both be rehabilitated with a new deck and main beams over the existing foundations.

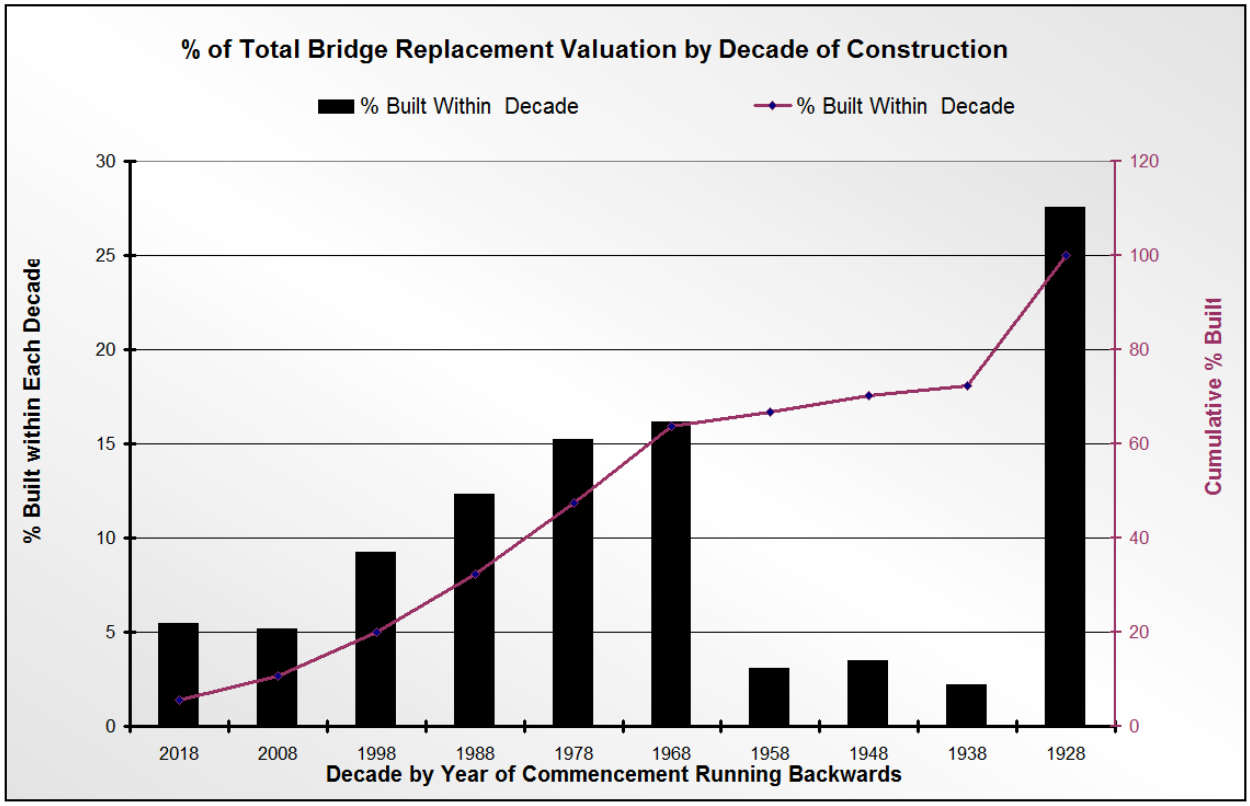


Fig. 5.4 Bridge age by decade of construction

During the survey a date of construction was established as well as a recommended date for renewal. Of the 165 structures only 27 had known dates of construction. The others were all allocated an estimated construction date. It is felt that 90% of these dates will have a 5-10 year accuracy based on the 43 plus years of experience of the assessor. Figure 5.4 presents the age of the structures in terms of the percentage of the total replacement value, by decade of construction commencing with the current year and running backwards.

There has been a reasonable replacement of the structures over the last 20 - 60 years but the very high percentage constructed prior to 1928 is the highest we have encountered. Several of these structures have had new decks placed but the old stone abutments go back prior to 1928.

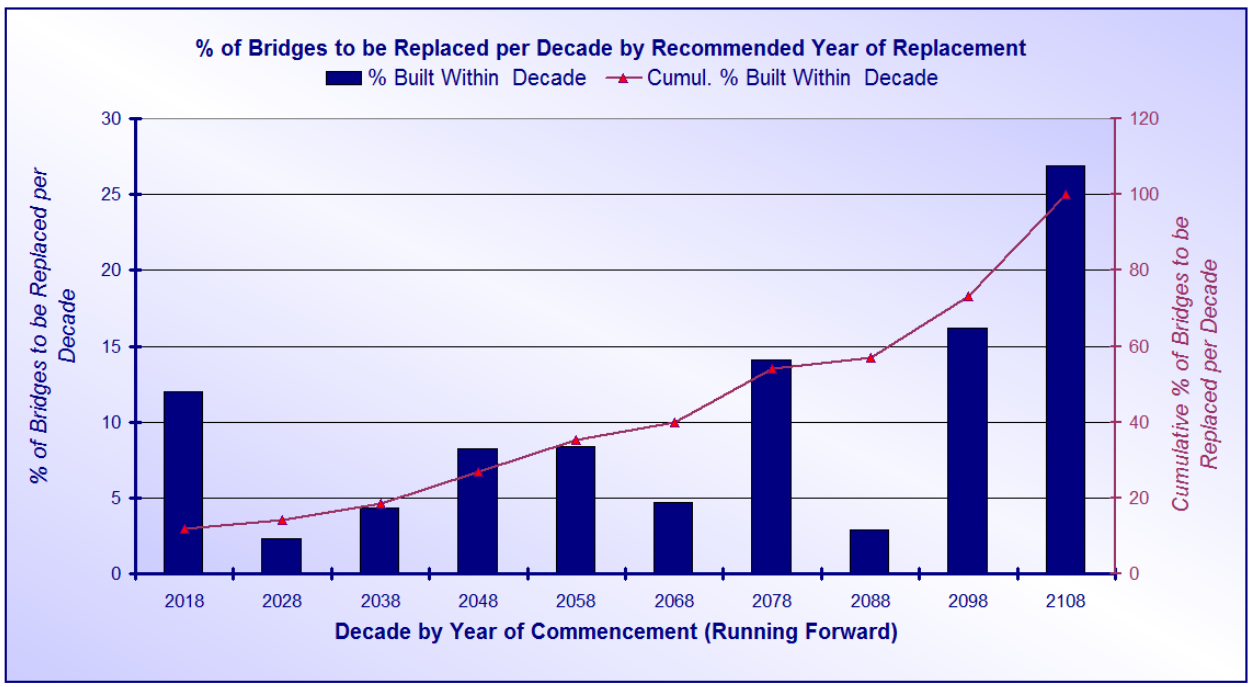


Fig. 5.5 Recommended decade of Bridge replacement

Figure 5.5 graphs the percentage of the assets that need to be replaced in future decades based upon the recommended year of renewal as assessed during the survey. The upcoming decade has around 12% of the network recommended for renewal followed by two decades of relatively low renewal demand. Our recommended date of renewal does tend to be a maximum date that the bridge could remain in service for and may require both major maintenance work and an imposed load limit to achieve this. It tends to be an optimistic forecast that may not accord with your desired level of service.

It is interesting that the single largest decade of demand falls within the decade commencing in 2108. However, there is still a higher than average renewal demand within the upcoming decade.

5.1.1 Whole of Bridge Asset Group Condition Summary

Cample Council Shire's bridge assets were found to be in very poor overall condition and had experienced a quite measurable condition decline in most of the key performance indicators since the last survey in 2013 (see Figure 5.2.

5.2 Bridge Assets Financial Modelling Analysis

The Bridge assets will be modelled in four groups with the results aggregated into a single presentation. The table below contains a list of the basic modelling parameters used for each of the groups to be modelled.

The expected service life (for asset grouping) was established by taking the date of construction from the recommended renewal date as described in the text under Figure 5.4.

Modelling Parameter	All Road Bridges	All Maj Culverts	Long Life Footbridges > 40 Years	Short Life Footbridges < 40 Years
Asset Quantity - sqm	5,970	3,208	220	236
Unit Renewal Rate	**$3,998**	**$2,458**	**$2,222**	**$1,732**
Total Asset Group Renewal Cost	$23,866,428	$7,886,162	$488,868	$408,716
Present Annual Renewal Exp.	**$220,000**	**$20,000**	**$5,000**	**$5,000**
Annual Maintenance Exp.	$20,000	$50,000	$20,000	$0
Retreat. Intervention Condition	8.0	8.0	8.0	8.0
Life to Condition 10 in Years	140	80	75	35
Life in years to Intervention	**134**	**74**	**68**	**32**

Fig. 5.6 Basic Financial Modelling input figures

The intervention level has been set to reflect the current level of service and is at condition 8 for all assets which is generally accepted as the industry standard for most local roads. Asset life cycles have been set based upon the work coming out of the degradation analysis within section 4 above.

It should be remembered that the life to the intervention level in the bottom row of the table represents the expected service life of the structures, as they do not remain in service up to condition 10 and would normally be replaced when they reach the retreatment intervention level as detailed above at around condition 7.5 - 8.0.

Note also that for the modelling work we adopted a total replacement value that was 15% higher than the asset valuation figure used for accounting purposes. This is because in many cases the replacement structure will be a little longer and or wider than the existing structure and there may well be approach works required. It also covers other contingencies that invariably arise with the replacement of bridge assets.

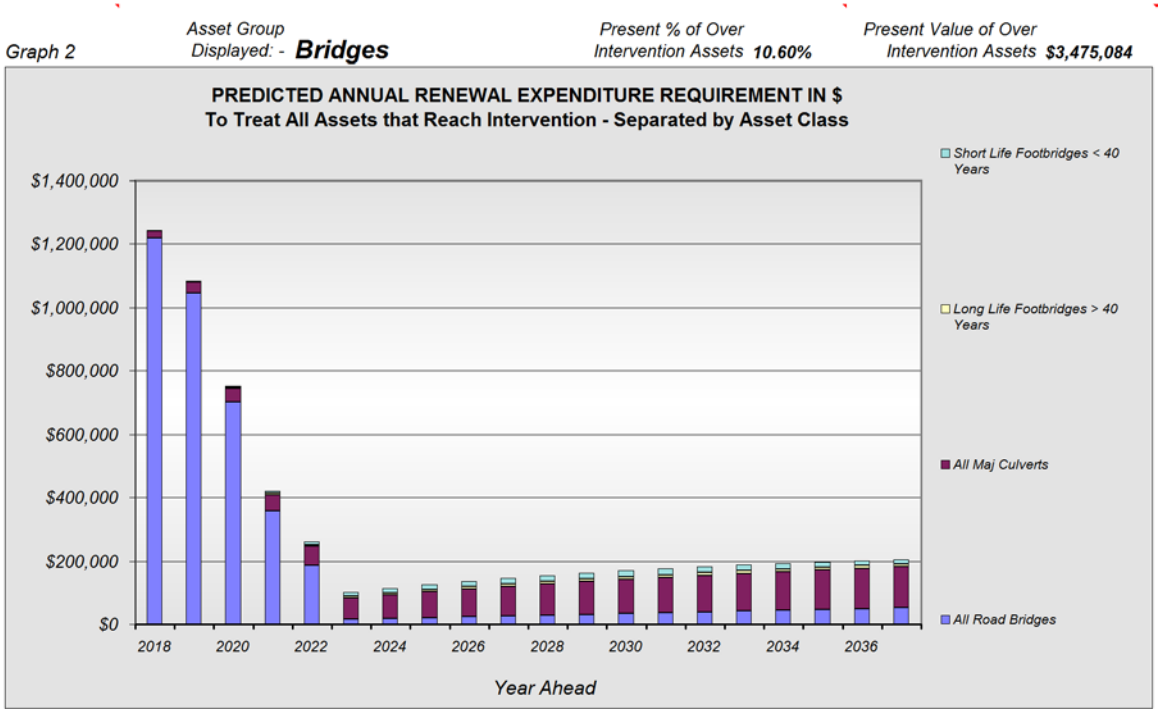


Fig. 5.7 Predicted Capital Renewal demand to treat all assets that reach the selected retreatment intervention level through the normal degradation process

Figures 5.7 provides a profile of the predicted renewal demand to treat all assets that reach the intervention level through the degradation process. It also details the individual annual demand for each asset class that was modelled.

Figure 5.7 clearly shows that the high upfront renewal demand is associated with the 3 road bridges at and above condition 8. The model has eased in this expenditure requirement over a 5-year period in order to avoid the year one expenditure being several million dollars followed by a huge drop in year 2. It will take 5 years of funding even at these elevated levels to deal with the 3 over intervention assets. With these three bridges dealt with after year 5 the emphasis switches to some of the condition 6 - 6.5 major culverts over the remaining modelling period, but total renewal demand is predicted to drop drastically.

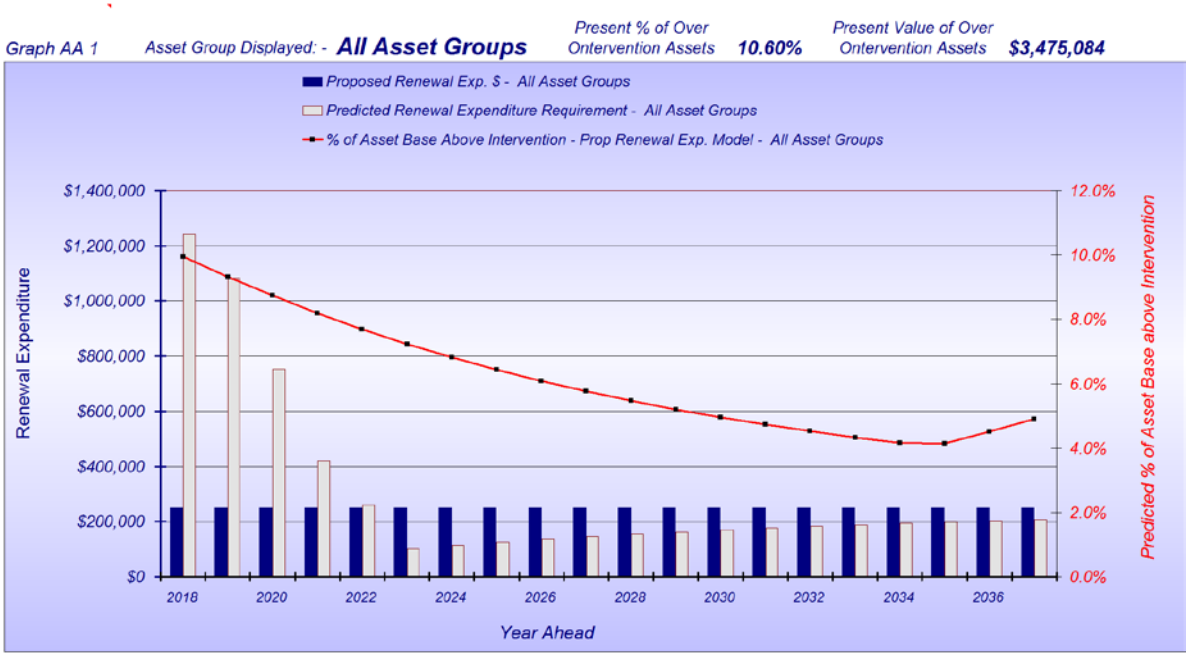


Fig. 5.8 Predicted Future Condition based on the planned Renewal Expenditure profile

Figure 5.8 plots the extent of the asset base that is predicted to rise above the intervention level (the red line) based upon the planned renewal expenditure levels over the next 10 - 20 years (Blue bars). It also plots the predicted demand to maintain all assets below the intervention level (Grey Bars) which is the same as the total figures within Figure 5.7.

Renewal demand is presently sitting at $1,243,000 pa which also represents the peak demand over the next 20-years. Note that the year one predicted renewal demand is less than the total extent of over intervention assets at $3,475,084 as reporter at the top of figure 5.8. This is because when the raw difference in the renewal demand to treat all over intervention assets between year 1 and year 2 is greater than 30% the model eases in the demand on a falling scale over a 5-year period. This avoids a very high figure in year-1 followed by a massive drop off in year -2.

Figure 5.8 indicates that if the planned average renewal expenditure of $250,000 pa is maintained over the next 20-years there will be a slow but continuous decline in the extent of over intervention assets up to the year 2035. But the rate of decline is perhaps a little slow.

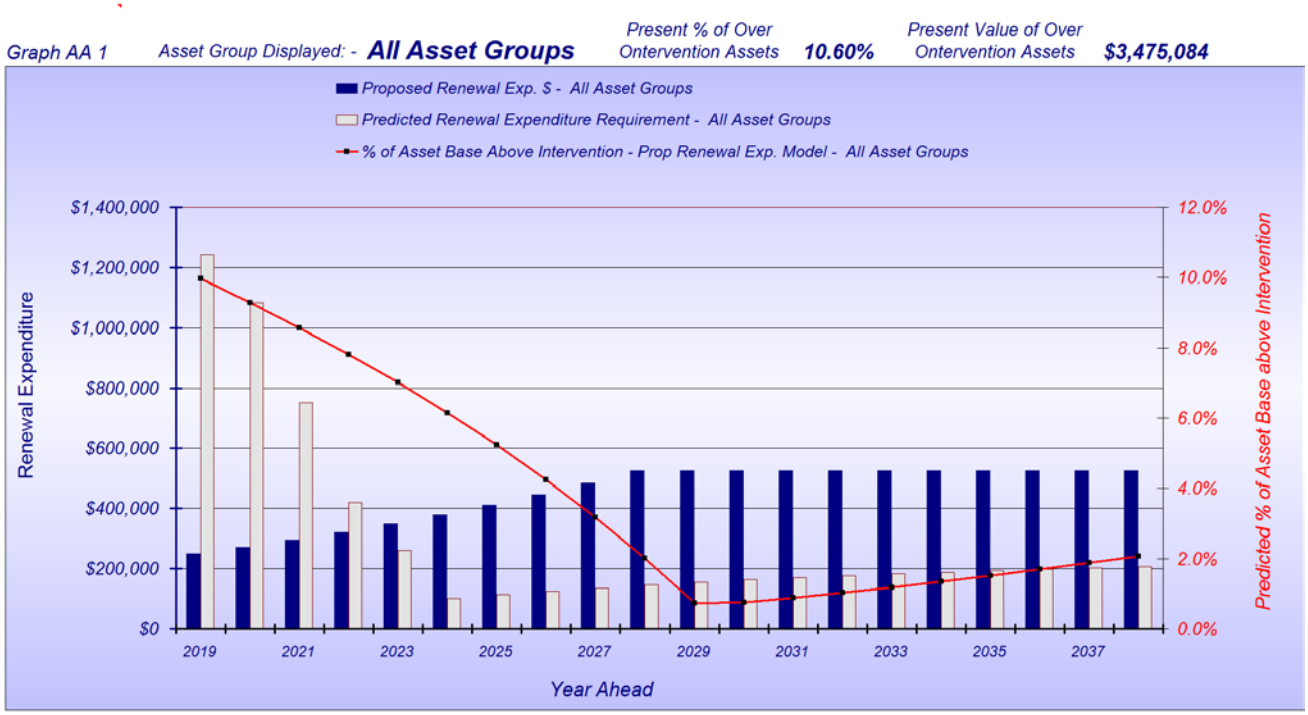


Fig 5.9 Recommended 10-years funding profile

Fig 5.9 comes from the same modelling process as Fig 5.8. Accept that here a recommended total renewal expenditure profile has been developed that will achieve a desired condition outcome within a designated period of time.

The Moloney financial model has been used to deliver a recommended 10 - 20 year renewal funding profile that will achieve a desired condition outcome within a selected time frame. The model has 3 variables that are set and then through an iterative process the model delivers the required funding profile that will achieve the desired outcome. In broad terms the variables that are set are as detailed below.

- The extent of the asset base that will be over the selected intervention level
- The time by which you want this to occur
- The annual % increase in funding that you require. (used if you want the start spend to be lower)

In this case the following 3 parameters were set:

- *Total extent of over intervention assets to be : 2% (Present level 10.60%)*
- *To achieve this within 10-years*
- *With a compounding annual increase of 8.6%*

The model predicts that this outcome can be achieved with a commencing annual expenditure of $250,000 pa (same as the planned level) and a compounding annual increase in expenditure of 8.6% for the next 10-years. This scenario is recommended as it's commencing expenditure is the same as that planned for next year.

Other scenarios can be run within the model and council is encouraged to trial different scenarios to establish the one that best fits its needs.

Section 6: Specific matters coming from the bridge survey

Section 5 above dealt with the overall findings from the bridge inspection project at a whole of asset group level and was focused on an examination of the condition and financial demand of the entire asset group.

This section will deal with a number of specific matters relating to individual structures. While the asset renewal demand has been analysed in section 5, this section will deal with further financial and other demands associated with the bridge assets. Areas to be covered within this section are as detailed below.

- Recommended Further higher level inspections – investigations
- Recommended and Existing bridge load limits
- Recommended urgent maintenance and other works
- Non Urgent maintenance matters and upgrade works
- Recommended renewal Program

6.1 Higher level Investigation Requirements

This bridge condition inspection program has been a basic level inspection program that was aimed at condition rating the assets as well as identifying problems and potential problems. Certain matters fall outside of the scope of this basic inspection and will require a higher-level inspection and or analysis.

Within this section of the report are listed all items that were identified as requiring a higher or further level of investigation. There were eight further investigation items identified as detailed in figure 6.1 below.

Each work item identified within the survey has been allocated an urgency number from 0 to 10. Zero having no urgency and 10 being the most urgent. Matters with urgency ratings greater than 7 are generally considered to be of a high priority.

A rough estimate of cost has also been provided for the works item, but this is intended only as a rough guide. There is also a code of proposed treatment provided. In this case the code is “I” referring to a need for further investigation. The works treatment codes are as detailed below in their entirety.

CODE	Works Treatment Code Description (Required Works Listed in Sub Asset Section)	Updated By On
M	A Maintenance Item	PM Oct 2001
I	An Item Requireing Further Investigation	PM Oct 2001
CI	A Capital Improvement or Upgrade Item	PM Oct 2001
CR	A Capital Replacement Item	PM Oct 2001

Fig. 6.1A Explanation of Works Treatment codes

8 Works Projects								$45,000				

Br. No. Mol Prog REQ	BRIDGE GENERAL DETAILS							Proposed Works Details				
	ROAD NAME	LOCAT. in m	REFERENCE CHAINAGE 00 AT	Insp Cond 0-10	Year Const	Est Year Date	Replace. Value $	DETAILS OF PROPOSED ASSET WORKS				
								Deg Urg 0-10	Est. Cost $	DESCRIPTION OF PROPOSED WORKS	Code Prop Treat	Year of Treat
34	Road	7,830	Start	**6.0**	1900	2100	843,000	**10**	2,500	Investigate condition of floor and foundations - The stone floor has been washed away some	I	2018
75	Road	8,327	Start	**8.0**	1900	2020	2,540,300	**10**	30,000	Investigate repair - Replacement options for Mass Concrete retaining walls	I	2018
24	Road	420	Start	**6.0**	1920	2045	26,472	**9**	3,000	Investigate repair options for this quite historic structure - Almost one of a kind.	I	2018
160	Road	35	Start	**7.0**	1960	2050	13,608	**9**	1,500	Investigate Redeck or closure options	I	2018
121	Road	700	Start	**6.0**	1970	2030	23,736	**7**	2,500	Investigate corrosion protection options for the base of the steel culvert.	I	2018
106	Road	1,000	Start	**9.0**	1900	2015	10,000	**7**	1,000	Investigate the ownership of this asset	I	2018
5	Road	979	Start	**6.0**	1975	2045	207,360	**6**	2,500	Investigate corrosion protection options for the base of the steel culvert.	I	2018
141	Road	1,360	Start	**6.0**	1900	2045	38,200	**5**	2,000	Investigate repair work on weathered brickwork	I	2018

Fig. 6.1 Table of matters requiring further investigation

There were eight matters identified with a recommendation for further investigation. The estimated total cost being $45,000.

RECOMMENDATION: That all matters requiring further investigation be undertaken as funding permits.

6.2 Load Limits

There were 3 bridges found with an existing load limit and a further 10 were identified as possibly benefiting from the imposition of load limits

Detailed below are all bridges with the reason for the proposed limit indicated. No engineering calculations have been undertaken as part of this simple low-level inspection. However, the recommendations are drawn from around 45 years of experience in working with local government bridge assets.

Load limits are recommended for two purposes. Firstly for the safety of the travelling public and secondly to preserve and extend the asset life. Bridges seldom fail catastrophically, so in most instances the proposed load limits are more an attempt to maximise the service life of the structures.

Br. No. Mol Prog REQ	BRIDGE LOCATION DETAIL					General Details		
	ROAD NAME	LOCAT. in m	REFERENCE CHAINAGE 00 AT	Insp Cond 0-10	GENERAL DESCRIPTION	Load Limits		
						Existing Limits Tonnes	Prop Limits Tonne	Reason for Load Limits
75	Road	8,327	Start	**8.0**	Old historic Twin span RC arch bridge on stone abutments	15		Condition of retaining wall
53	Road	5,830	Start	**5.0**	Four Span Full RC U-Slab Bridge	25		RC U-Slab Condition - Cracking and configuration
147	Road	120	Start	**3.0**	Single span full RC U-Slab Bridge	25		RC U-Slab condition and Cracking

Fig. 6.2 Table of Structures with existing Load Limits

Br. No. Mol Prog REQ	BRIDGE LOCATION DETAIL					General Details		
	ROAD NAME	LOCAT. in m	REFERENCE CHAINAGE 00 AT	Insp Cond 0-10	GENERAL DESCRIPTION	Load Limits		
						Existing Limits Tonnes	Prop Limits Tonne	Reason for Load Limits
11	Road	1,681	Start	**6.0**	Single Span full RC U-Slab Bridge		25	RC U-Slab cracking and configuration
12	Road	9,058	Start	**3.0**	Large Three Span Full RC U-Slab Bridge		25	RC U-Slab configuration and Cracking underneath
28	Road	5,839	Start	**4.0**	Twin Span Full RC U-Slab Bridge		25	RC U-Slab condition and Configuration
30	Road	3,893	Start	**4.0**	Twin Span Full RC U-Slab Bridge		25	RC U-Slab cracking and configuration
50	Road	2,440	Start	**4.0**	Large single Span Full RC U-Slab Bridge		25	RC U-Slab condition and Configuration
58	Road	5,461	Start	**5.0**	Twin Span Full RC U-Slab Bridge		25	RC U-Slab Condition and configuration
59	Road	400	Start	**4.0**	Twin Span Full RC U-Slab Bridge		25	RC U-Slab cracking and configuration
60	Road	578	Start	**4.0**	Twin Span Full RC U-Slab Bridge		25	RC U-Slab Condition and configuration
62	Road	850	Start	**6.0**	Twin Span Full RC U-Slab Bridge		15	RC U-Slab Cracking and configuration
89	Road	6,700	Start	**5.5**	Large single span bridge with Stone abutments and steel deck		25	General configuration, cross head condition and cross beam overhang

Fig. 6.3 Table of Structures recommended for consideration of Load Limits

Most of the recommendations for load limits relate to bridges with precast RC U-Slabs that were constructed between 1962 and 1980. These bridges were not provided with an RC slab overlay (this tended to be added after 1980) and modern higher truck loading is causing cracking of the underside of the U-Slabs. The load limit is seen as an interim measure to remain in place until an RC overlay slab is placed.

RECOMMENDATION: That further investigations be undertaken into the benefits of imposing load limits in relation to the bridges listed within Figure 6.3

6.3 Works Requirements and Urgent Works Requirements

During the bridge condition survey, work requirements were identified that needed attending to. Each work requirement was assigned an approximate treatment cost as well as a degree of urgency from 1 - 10, with 1 being not urgent at all up to 10 that's extremely urgent. An urgency ranking of 7 or greater is considered to be an urgent works requirement that needs to be attended to ASAP.

There were a total of 209 works projects identified with a total treatment cost of $402,600. Of the total projects 50 were ranked as urgent with an estimated total treatment cost of $175,000, leaving non urgent works requirements with an estimated treatment cost of $227,600.

The urgent works requirements are quite high, and their extent has increased by around 80% since the last survey in 2013 (see figure 5.2 above).

Listed below within Figures 6.4 are the details of the urgent works requirements.

50	Total & Average Figures	50 Works Projects						$175,000				
Br.	BRIDGE GENERAL DETAILS							Proposed Works Details				
No. Mol Prog REQ	ROAD NAME	LOCAT. in m	REFERENCE CHAINAGE 00 AT	Insp Cond 0-10	Year of Const	Est Year of Rep	Replace. Value $	DETAILS OF PROPOSED ASSET WORKS Deg Urg 0-10	Est. Cost $	DESCRIPTION OF PROPOSED WORKS	Code Prop Treat	Year of Treat
34	Road	7,830	Start	6.0	1900	2100	843,000	10	$ 2,500	Investigate condition of floor and foundations - The stone floor has been washed away some 15 m - Appears to be on reef after that but whole length needs to be assessed - will need artificial lighting	I	2018
88	Road	4,120	Start	7.0	1960	2040	204,680	10	$ 15,000	Repair spalled areas throughout the culvert CO 1	M	2018
75	Road	8,327	Start	8.0	1900	2020	2,540,300	10	$ 30,000	Investigate repair - Replacement options for Mass Concrete retaining walls	I	2018
134	Road	5,100	Start	5.0	1900	2080	42,880	9	$ 4,000	Provide erosion protection to one abutment at one end and replace missing stone floor CO 1	M	2018
24	Road	420	Start	6.0	1920	2045	26,472	9	$ 3,000	Investigate repair options for this quite historic structure - Almost one of a kind.	I	2018
160	Road	35	Start	7.0	1960	2050	13,608	9	$ 1,500	Investigate Redeck or closure options	I	2018
71	Road	1,729	Start	1.0	1995	2100	57,320	9	$ 1,800	Replace one damaged end section to guard rail and clear excessive growth	M	2018
17	Road	2,486	Start	3.0	1900	2100	204,352	9	$ 400	Replace one missing chevron sign CO 1	M	2018
155	Road	50	Start	2.0	1970	2080	45,254	8	$ 300	Fill hole behind abutment at deck level	M	2018
12	Road	9,058	Start	3.0	1970	2100	854,080	8	$ 7,000	Provide erosion protection to abutments	M	2018
62	Road	850	Start	6.0	1962	2050	164,000	8	$ 1,500	Clear excess growth from guardrail and structure generally CO 1	M	2018
118	Road	360	Start	6.0	1975	2030	135,962	8	$ 2,500	Reduce gap in handrails to prevent a fall from the bridge and replace rotten timber CO 1	CI	2018
138	Road	2,200	Start	5.0	1940	2060	120,584	8	$ 1,200	Clear excess growth from structure and guardrail generally	M	2018
66	Road	70	Start	2.0	1970	2100	39,000	8	$ 1,800	Clear excess growth from structure CO 1	M	2018
15	Road	1,960	Start	6.0	1900	2060	117,000	8	$ 1,500	Clear black berries both sides and then inspect culvert once access is enabled	M	2018
126	Road	1,940	Start	4.0	1960	2050	174,000	8	$ 3,000	Clear excess growth upstream and downstream unblock outlet and then reinspect when accessible	R	2018
63	Road	976	Start	3.0	1900	2150	432,000	8	$ 2,000	Clear excess growth from structure generally and Reinspect	R	2018
113	Road	20	Start	4.0	1950	2040	9,945	8	$ 800	Clear Blackberry's and growth from structure generally	M	2018
129	Road	3,000	Start	2.0	1980	2100	134,280	8	$ 1,500	Clear excess growth and debris from structure Generally	M	2018
140	Road	2,340	Start	4.0	1960	2050	43,200	8	$ 2,000	Clear excess growth upstream and downstream unblock outlet and then reinspect when accessible	R	2018
121	Road	700	Start	6.0	1970	2030	23,736	8	$ 1,500	Place 4 No Chevron and 2 No Narrow Bridge signs	CI	2018
11	Road	1,681	Start	6.0	1962	2050	146,776	8	$ 5,000	Repair Outer RC U-slabs where water intrusion has caused spalling	M	2018
87	Road	1,899	Start	5.0	1953	2050	148,848	8	$ 1,500	Seal full deck width to prevent water penetration and corrosion of RC U-Slabs	CI	2018
62	Road	850	Start	6.0	1962	2050	164,000	8	$ 1,500	Seal full deck width to prevent water penetration and corrosion of RC U-Slabs CO 1	CI	2018
150	Road	300	Start	4.0	1900	2070	129,824	7	$ 12,000	Place floor under bridge or otherwise provide erosion protection to foundations	M	2018
68	Road	2,637	Start	5.0	1947	2100	176,000	7	$ 3,000	Provide erosion protection to one abutment foundation	M	2018
140	Road	2,340	Start	4.0	1960	2050	43,200	7	$ 500	Clear excess growth and reinspect	M	2018
122	Road	10	Start	6.0	1970	2035	181,170	7	$ 14,000	Provide Corrosion protection to invert with RC floor or other treatment	CI	2018
39	Road	3,605	Start	5.5	1900	2055	104,376	7	$ 6,000	Provide erosion protection to abutments - May need an RC floor	CI	2018
80	Road	10,715	Start	5.0	1961	2080	321,344	7	$ 6,000	Provide erosion protection to one abutment	M	2018
121	Road	700	Start	6.0	1970	2030	23,736	7	$ 2,500	Investigate corrosion protection options for the base of the steel culvert.	I	2018
84	Road	2,100	Start	1.0	1995	2120	1,167,936	7	$ 300	Clear excess growth from around guardrail	M	2018
11	Road	1,681	Start	6.0	1962	2050	146,776	7	$ 1,000	Clear excess growth from guardrail and structure generally	M	2018
113	Road	20	Start	4.0	1950	2040	9,945	7	$ 1,800	Reduce gap in handrails to prevent a fall from the bridge and repaint	CI	2018
173	Road	20	Start	3.0	1900	2120	208,000	7	$ 1,200	Reduce gap in handrails to prevent a fall from the bridge	CI	2018
115	Road	475	Start	1.0	2000	2100	28,160	7	$ 1,200	Reduce gap in handrails to prevent a fall from the bridge	CI	2018
68	Road	2,637	Start	5.0	1947	2100	176,000	7	$ 1,000	Clear excess growth from structure and guardrail generally	M	2018
106	Road	1,000	Start	9.0	1900	2015	10,000	7	$ 1,000	Investigate the ownership of this asset	I	2018
16	Road	742	Start	5.0	1970	2050	129,600	7	$ 1,000	Clear growth from guardrail and structure generally	M	2018
81	Road	1,527	Start	2.0	1986	2120	1,079,840	7	$ 2,000	Clear excess growth from Guardrail and structure generally	M	2018
178	Road	2,350	Start	5.0	1960	2060	101,200	7	$ 1,200	Replace signs	CR	2018
96	Road	684	Start	4.0	1970	2060	40,048	7	$ 2,000	Place 4 depth indicators and 2 advanced floodway signs	CI	2018
70	Road	685	Start	4.0	1905	2100	68,568	7	$ 1,500	Place 4 No Chevron and 2 No Narrow Bridge signs	CI	2018
87	Road	1,899	Start	5.0	1953	2050	148,848	7	$ 3,500	Repair spalled areas of RC U-Slabs	M	2018
53	Road	5,830	Start	5.0	1960	2060	311,040	7	$ 2,000	Repair several spalled areas on outside slab caused by water intrusion from above	M	2018
62	Road	850	Start	6.0	1962	2050	164,000	7	$ 3,000	Repair spalled areas on RC U-Slabs	M	2018
130	Road	3,500	Start	5.0	1900	2060	134,720	7	$ 3,000	Clean off and Paint steelwork	M	2018
118	Road	360	Start	6.0	1975	2030	135,962	7	$ 2,500	Provide a waterproofing coating to the laminated beams	CI	2018
47	Road	14,243	Start	4.0	1964	2100	630,208	7	$ 1,000	Seal full deck width to prevent water penetration and corrosion of RC U-Slabs - Causing spalling	CI	2018
89	Road	6,700	Start	5.5	1940	2040	143,348	7	$ 8,000	Replace one crosshead	CR	2018

Fig. 6.4 List Part 1 of Urgent Works Requirements

RECOMMENDATION: That the urgent works requirements be inspected and programmed for treatment as funds permit.

6.4 Other Works Requirements Recommended

There were 159 further works requirements identified within the urgency range 1 to 6. These projects while not as urgent as the ones above are recommended for attention as time and funds permit. The projects have not been listed here but can be found within the "Prop Works" sheet of the Moloney Bridges software file and their estimated treatment cost comes to $227,600

RECOMMENDATION: That the additional desirable works identified during the survey be programmed as time and funds permit.

6.5 Bridges at and above condition 6.5 – Renewal program

This section lists all structures that were classified as being at and above condition 6.5. They are the structures that are most likely to require major rehabilitation or renewal over the next 10-years. Some will clearly require attention while others may remain in service for some time to come.

It is very difficult to provide a definitive list for replacement without taking the function of the road into account and this has not been done within this report. Rather, all structures that are at and beyond what is considered to be a condition approaching the need for rehabilitation have been listed in the table below and then presented individually with a set of photographs and a brief comment.

Council will need to draw its own renewal and major rehabilitation program from the list of these structured over the next 10-years. However, with a further 25 structures within the condition 6.0, some of these may deteriorate to a point where they become a propriety over the next decade. So while every effort has been made to pin down the target structures the line between a condition 6, 6.5 and condition 7 structure is sometimes difficult to discern with only a visual condition inspection.

Br. No. Mol Prog	BRIDGE LOCATION DETAIL			OVERALL BRIDGE DETAILS									Replace. Value $	Cumul. Replace. Value $ Calc.
	ROAD NAME	LOCAT in m	REFERENCE CHAINAGE 00 AT	Wid B/W Kerbs m	Tot Wid m	Tot Leng m	Deck Area sqm	Insp Cond 0-10	Const. Date	Const. E If Est.	Est Rep Date	GENERAL DESCRIPTION		
106	Road	1,000	Start	4.0	4.2	7.9	33	**9.0**	1900	E	2015	Old Stone abutment single span bridge with Timber deck	$116,176	$116,176
74	Road	300	Start	4.2	4.6	23.8	109	**8.0**	1916	A	2015	Three span Timber bridge with stone abutments	$365,336	$481,512
75	Road	8,327	Start	7.2	8.2	53.0	435	**8.0**	1900	A	2020	Old historic Twin span RC arch bridge on stone abutments	$2,540,300	$3,021,812
171	Road	0	Start	0.9	1.0	14.3	14	**7.0**	1900	E	2015	Low construction standard foot bridge incorporating parts of the old railway bridge	$8,580	$3,030,392
160	Road	35	Start	1.2	1.4	8.1	11	**7.0**	1960	E	2050	Single span footbridge with timber deck	$13,608	$3,044,000
88	Road	4,120	Start	5.9	15.7	6.2	97	**7.0**	1960	E	2040	Twin Cell 3050 x 1800 Precast RC Crown Units	$204,680	$3,248,680
156	Road	50	Start	1.0	1.2	3.0	4	**6.5**	1960	E	2015	Small Footbridge on medium to low construction standard	$2,160	$3,250,840

Fig. 7.0 List of Possible Bridge replacements – Major Rehabilitation Targets

6.5.1 ID 106- Condition 9.0

A small single span timber bridge with stone abutments. The stone abutments are in good condition, the main timber beams probably require replacement and the timber deck has completely failed. It may be able to be redecked and used as a pedestrian bridge but if vehicles are to be taken over it the main beams would also need replacing. It serves only a single shed on the far side and it may not be a council asset.

6.5.2 ID 74 – Condition 8.0

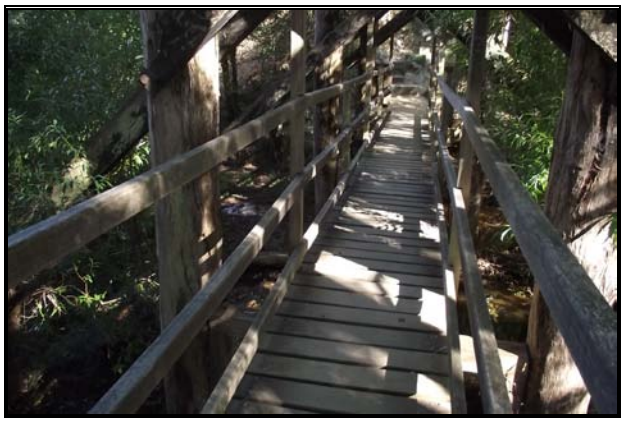
A large triple span timber bridge with very sound stone abutments and piers. The timber main beams and deck have failed. Traffic has been barred from the structure and it is now open to pedestrian traffic only. It would need a complete redeck including the main beams if it is to be reopened to traffic. Foundations abutments and piers are all in excellent condition.

6.5.3 ID 75 – Condition 8.0

This is a very large twin span stone and concrete arch bridge. The stone foundations, abutments and piers are all in very good condition. There is a little movement in one abutment but not severe. The reinforced concrete arches do have substantial spalling but it is felt that this could be repaired and they may be able to remain in place. The real problem is the un-reinforced mass concrete retaining walls above the RC arches. These have cracked badly and pushed out severely in many places. They probably had steel tie beams between the two sides, but based on the excessive movement it is suspected that these have rusted through.

The bridge is of considerable historic importance as Sir John Monash was one of the engineers involved with its design and construction in around 1900. It would also be one of the oldest RC arch bridges in the country. It is felt that the RC arches could be preserved, but all of the mass concrete retaining walls above them would need to be replaced. The concrete retaining walls have deteriorated quite considerably since our last survey in 2013 and are in real danger of collapse at any time. There is a 15 tonne load limit on the structure but it is felt that this should be reduced to 2 - 5 tonne as the deterioration of the concrete retaining walls has been quite measurable and accelerated since 2013.

6.5.4 ID 171 – Condition 7.0



This is a very low construction standard timber footbridge. The timber foundations from the former railway bridge are in poor overall condition and the main timber beams appear to be too small for the span. It is a bridge in generally poor overall condition, but it has not deteriorated much since our last inspection and could remain in service for some time. It is strongly recommended that the gap in the hand rails be reduced if the bridge is to remain in service as the structure is just upstream of a quite high water fall and if a child fell off while water was moving it could be a real problem.

6.5.5 ID 160 – Condition 7.0

A small single span footbridge that has a very poor condition timber deck and abutments. It does not appear to have a lot of use and if it is to remain in service the timber deck should be replaced ASAP. With a new timber deck it could remain in service for many years.

6.5.6 ID 88 – Condition 7.0

This is a twin cell 3050 x 1800 Precast RC Box Culvert with very bad spalling throughout. It appears that the steel reinforcing was not provided with enough concrete cover and or the concrete was not compacted enough to keep out the water. The spalled areas need to be cleaned off and appropriately covered to prevent further deterioration. With this work undertaken the culvert could remain in service for many more years.

6.5.7 ID 156 – Condition 6.5

A small single span timber footbridge with quite a poor condition timber deck and timber bed log foundations. The 60 x 240 hardwood timber deck planks are spanning 2700 which does appear to be a bit long for the timber size. The structure is not in good condition but it has recently had it's handrails replaced and it could probably remain in service for some years yet.

6.5.13 Summary of the structures at and above condition 7.0

Sample Council has seven structures at and above condition 6.5 with an estimated replacement value of 3,250,840. There are a further 25 structures within condition 6.0 with an estimated replacement value of $2,560,000. Several of the condition 6.5 and above structures do not require full replacement but do need major works if they are to remain in service.

With the new condition information council is in a position to determine its preliminary renewal – rehabilitation program for the next 10-years by further considering the strategic importance of the various routs.

Some of the condition 7.0 structures may well be able to remain in service for greater than 10-years and some of the condition 6.0 structures may deteriorate at a faster rate and need attention within the next 10-years. Regular surveillance is recommended on all structures but particularly the ones at and above condition 6 to ensure that the risk associated with these structures is minimized.

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For a detailed Explanation of the Moloney Model its assumptions and operations please refer to the document “Model All Explanation”. This is available from our web site at www.moloneys.com.au