Investment Evaluation Summary (IES)

Project Details:

Project Name:	Low Conductor Span Rectification - Building Clearance LV CAPEX
Project ID:	00582
Thread:	Overhead
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	D
Work Category Code:	RELCL
Work Category Description:	Replace/relocate LV OH (Building Clearances)
Preferred Option Description:	Do nothing
Preferred Option Estimate (Nominal Dollars):	$0

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Unit ($)	$15,100	$15,100	$15,100	$15,100	$15,100	$15,100	$15,100	$15,100	$15,100	$15,100
Volume	12	12	12	5	5	5	5	5	5	5
Estimate ($)	$181,200	$181,200	$181,200	$75,500	$75,500	$75,500	$75,500	$75,500	$75,500	$75,500
Total ($)	$181,200	$181,200	$181,200	$75,500	$75,500	$75,500	$75,500	$75,500	$75,500	$75,500

Governance:

Project Initiator:	Jack Terry	**Date:**	24/03/2015
Thread Approved:	David Ellis	**Date:**	02/11/2015
Project Approver:	David Eccles	**Date:**	30/10/2015

Document Details:

Version Number:	1

Related Documents:

Description	URL

IES Document	http://projectzone.tnad.tasnetworks.com.au/business-projects/nis-program/DD17SAM/Deliverables/Overhead%20Systems%20and%20Structures/AROLC%20REHCR%20RELCL%20RELCR%20Under%20Clearance%20Conductors/Investment%20Evaluation%20Summary%20-%20Low%20Clearances%20R1.docx
NPV Document	http://projectzone.tnad.tasnetworks.com.au/business-projects/nis-program/DD17SAM/Deliverables/Overhead%20Systems%20and%20Structures/AROLC%20REHCR%20RELCL%20RELCR%20Under%20Clearance%20Conductors/Low%20Conductor%20Spans%20NPV%20R3.XLSM

Section 1 (Gated Investment Step 1)

1. Background

The provision of adequate clearances of conductor spans is essential for the safe and reliable operation of the distribution network. For the installation of new conductor spans, TasNetworks apply design practices that are consistent with Australian Standard AS/NZ 7000 (see Table 1). The number and lengths of different conductor classes present in TasNetworks' distribution network are provided in Table 2. There are currently no records stored on the height of poles, length of particular conductor spans or the tension of conductors in TasNetworks' GTech model of the distribution network.

Table 1: Minimum clearances of conductors at system voltages (AS7000 Table 3.6)

TABLE 3.6

MINIMUM CLEARANCE FROM GROUND, LINES OTHER THAN INSULATED SERVICE LINES

Nominal system voltage U	Distance to ground in any direction m		
	Over the carriageway of roads	Over land other than the carriageway of roads	Over land which due to its steepness or swampiness is not traversable by vehicles more than 3 m in height
Bare or insulated conductor or any other cable $U \leq 1000$ V OR Insulated conductor with earthed screen $U > 1000$ V	5.5	5.5	4.5
Insulated conductor without earthed screen $U > 1000$ V	6.0	5.5	4.5
Bare or covered conductor			
1000 V $< U \leq$ 33 kV	6.7	5.5	4.5
33 V $< U \leq$ 132 kV	6.7	6.7	5.5
132 kV $< U \leq$ 275 kV	7.5	7.5	6.0
275 kV $< U \leq$ 330 kV	8.0	8.0	6.7
330 kV $< U \leq$ 400 kV	9.0	9.0	7.5
400 kV $< U \leq$ 500 kV	9.0	9.0	7.5

Table 2: Distribution network approximate[1] span numbers and lengths

Span Type	Number of Spans	Total Length (km)
HV Span	159,818	15,424
LV Span	95,568	4,935
LV Service Span	66,697[2]	2,096

Notes:

1. These numbers are indicative only.
2. This only includes service spans between two Aurora owned poles.

1.1 Investment Need

Incidents overview

TasNetworks has seen a number of incidents where members of the public have had machinery or plant contact conductors, resulting in a network fault which presents a health and safety risk. Although none of these incidents have resulted in injury to members of the public or TasNetworks personnel, it is possible that under a different set of circumstances, serious injury or death would have been incurred. These incidents have all occurred in rural areas, as a result of agricultural machinery or plant contact with overhead lines.

In some of these incidents, it has been identified that the conductor clearance is well below the defined Australian Standard, to which the conductor span should be constructed. It has not been possible to attribute this non-compliance to a single particular cause at this stage; however the factors that may result in this can be generally grouped as follows:

- Deficiencies in TasNetworks' design standards.
- Deficiencies in TasNetworks' design practices.
- Deficiencies in TasNetworks' work practices.

A detailed investigation is needed to determine what the root cause(s) of the clearance defects are, so that these may be appropriately addressed through changes in the current practices.

Whatever the cause(s) of the defects are, the presence of under clearance conductors presents an unacceptable health and safety risk to the public and as such TasNetworks, in its duty of care obligations, needs to take the appropriate risk mitigation measures to manage these risks.

Historical inspection, maintenance and renewal practice

Through the routine overhead inspection program (AIOHS), TasNetworks' inspectors check the clearances of spans to verify compliance with the standards. Where the conductor spans do not meet the required standards, these defective spans are recorded in TasNetworks' distribution asset inspection system (DAIS) against the pole ID. These spans are then rectified through work categories that TasNetworks has developed for these asset defects. There are four work categories for the rectification of under clearance spans:

1. REHCR – Replace/relocate LV OH (low clearances) (CAPEX)
2. RELCL – Replace/relocate LV OH (building clearances) (CAPEX)
3. RELCR – Replace/relocate LV OH (low clearances) (CAPEX)
4. AROLC – Overhead system low conductor clearance rectification (OPEX)

Historical completion of rectification jobs are detailed in Table 3.

Table 3: Historical completion of low conductor span defect jobs.

	Work Category Historical Spending				Work Category Volumes			
Financial Year	AROLC	REHCR	RELCL	RELCR	AROLC	REHCR	RELCL	RELCR
2010/2011	$261,097	$1,045,500	$172,330	$2,923,324	210	-	-	-
2011/2012	$158,914	$407,661	$294,308	$1,702,257	301	60	18	134
2012/2013	$263,055	$477,289	$124,062	$1,314,099[JT2]	158	35	14	134
2013/2014	$288,512	$333,499	$66,001	$1,218,030	277	19	4	114
2014/2015	$151,046	$142,448	$93,034	$719,854	500	14	6	77

Where an asset defect is identified, rectification is performed through one of the following corrective actions, as appropriate:

1. Where the conductor under clearance is a result of insufficient conductor tension the issue may be resolved by re-tensioning the conductor appropriately.
2. Where the under clearance is a result of sufficient pole height, it may be appropriate to address the under clearance by removing that pole, and installing a taller pole.
3. Where the under clearance is caused by a conductor span being too long, it may be appropriate to address the issue by installing an additional pole between the two poles.
4. Where the under clearance is a result of any of the above, it may be appropriate and cost effective to remove soil to ensure adequate ground to conductor clearance is re-established.

It should be noted that the suitability of these rectification actions cannot be guaranteed based on this information alone; design should be performed for each under clearance defect to determine the most appropriate action taking into account other contributing factors such a ambient temperature effects on conductor sag. Although it cannot be guaranteed without manually sorting through the lists of completed works for each of these work categories, these activities can roughly be attributed to CAPEX and OPEX categories, as shown in Table 4. This allows the average historical costs of these jobs to be estimated for forecasting purposes.

Table 4: Completed CAPEX/OPEX and average costs for low clearances, for 11/12-13/14 FY

CAPEX/OPEX	**AROLC**	**REHCR**	**RELCL**	**RELCR**
OPEX (Re-tension conductor)	$288,512	-		
CAPEX (Re-pole or mid pole)	-	$333,499	$66,001	$1,218,031
Number Completed	277	19	4	114
Percentage of jobs	66.91%	4.59%	0.97%	27.54%
Average Cost	$1,080	$12,557	$11,134	$10,139

Immediate risk mitigation measures

TasNetworks is implementing a number of actions to mitigate the risk presented by the presence of under clearance span defects in the distribution network. These include:

- Revision of the design clearances in the overhead manual to 0.5 m above the clearance values that are specified in Table 3.6 of AS7000.
- Development of simple tools and methodologies for improving the accuracy of existing practices used by asset inspectors to identify low spans.
- Preparation and distribution of a public alert letter or sheet, targeted at rural land owners.
- Removal of allowance for “ground not negotiable by vehicles” unless an obvious terrain barrier exists.
- Establish targeted education package including stickers and brochures to be distributed to farmers and/or suppliers/servicers of agricultural machinery.

Current job list and expected work

There are approximately 2200 under clearance defects that have been identified and stored in WASP to be rectified.

Concerns have been raised that the current inspection practice does not adequately capture low clearance defects, as the inspector only performs a physical measurement of the span if it is visually identified as low. It is therefore feasible under the current inspection processes that the inspectors may fail to identify an under clearance defect during a routine inspection. A review of the current asset inspection practice is required to determine its adequacy for identifying these defects. TasNetworks will implement appropriate changes to operational practices to ensure that under clearance spans are adequately identified as a part of the routine overhead asset inspection program.

TasNetworks is currently performing a targeted aerial inspection program for the identification of overhead asset defects (including, but not limited to under clearance spans). This will serve as a preliminary indicator for the scope of work that may be required in the future. Analysis will be performed on the spans inspected to determine if there is a systemic cause of this defect class, which will form the basis for future audit and rectification work.

Until the results of this inspection program are received, there is no knowledge of the extent or severity of the presence of conductor under clearance defects. It is necessary to make assumptions in defining the quantity and necessity of work required to be completed in the 17/18 regulatory period.

As the sag of the lines is proportional to the square of the conductor length, it becomes more important for the conductors to be tensioned correctly, as the length of the span increases. Given this critical relationship, it is reasonable to assume, that spans that are longer are more likely to have inadequate clearances. A query was performed on TasNetworks' distribution network, to determine the number of conductor sections that have lengths greater than 180m and 220m respectively.

The risk presented by a particular under clearance span is directly related to the frequency at which large machinery or plant passes under the conductors. In consideration of the incidences that have already occurred, the highest risk conductors are those that are located in agricultural areas. The conductor spans identified through the above query was linked to the land parcels on which they reside, to determine the number of long spans that reside on agricultural land parcels. A summary of the results of this analysis are presented in Table 5.

Table 5: Summary of long spans with agricultural land use filter.

	Land Parcel Classification	
Span Length	**All Land Uses**	**Land Use is Agricultural**
180 m<span length<220 m	6556	3226
span length>220 m	6943	3422

Spans that were located on agricultural land parcels were imported into GeoMedia and joined to existing data connections to display their location spatially (see Figure 1). From the displayed view, it is clear that areas with high densities of long spans align with those areas that have significant agricultural industry. This provides some level of validation that the query and filtering performed is meaningful and appropriate.

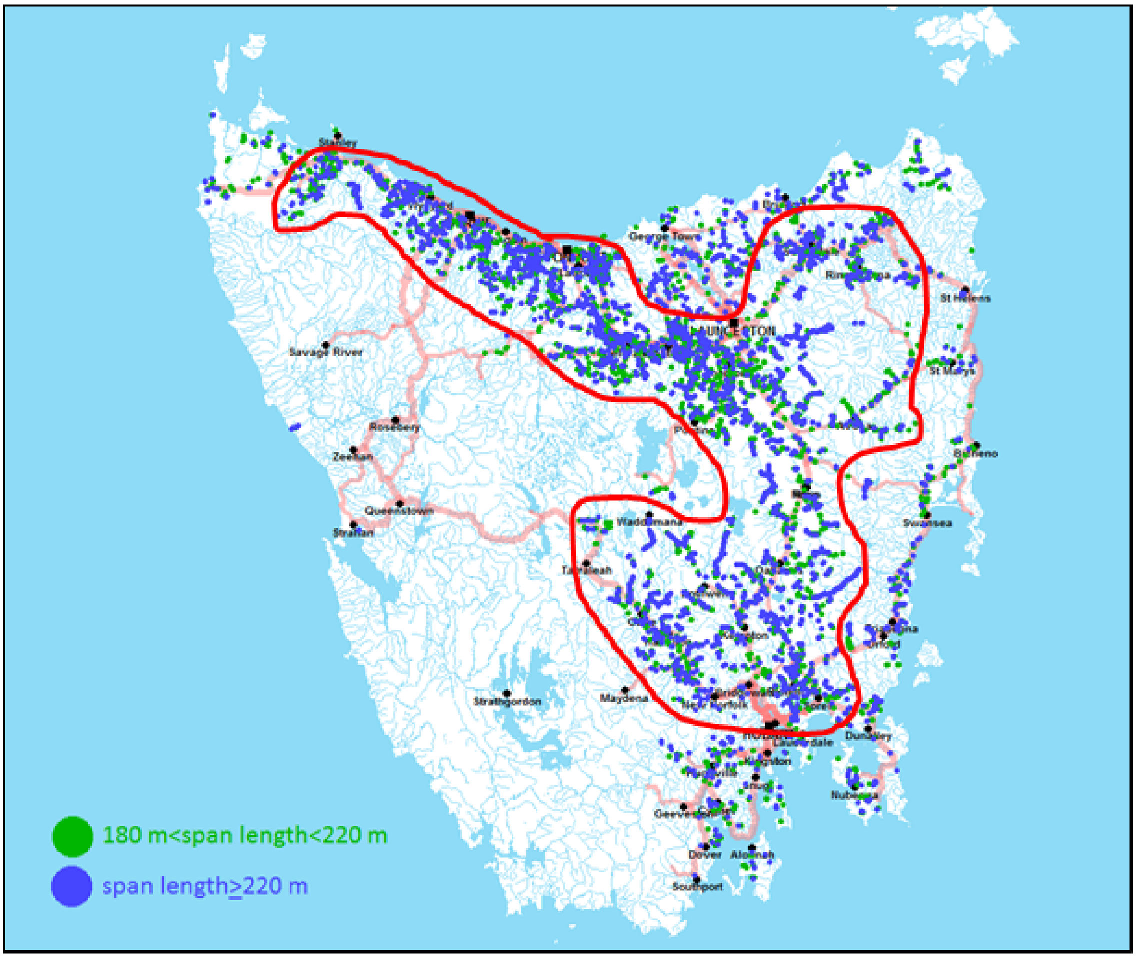

Figure 1: Long spans located on agricultural land parcels.

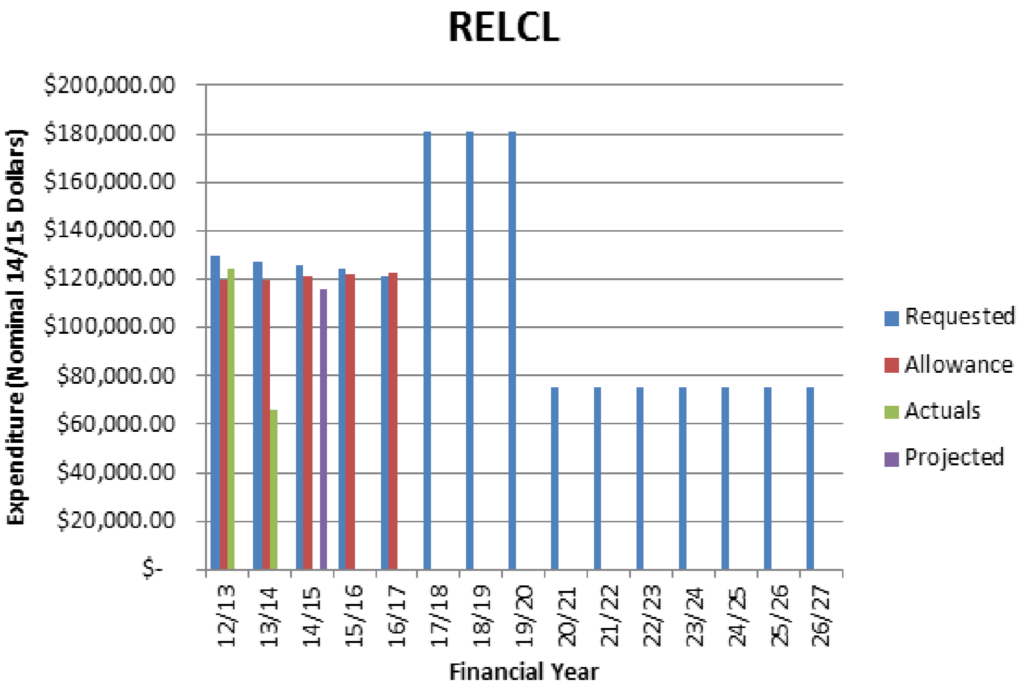

Figure 2: Replace/relocate LV OH (Building Clearances) Expenditure

1.2 Customer Needs or Impact

The only impact of this project on the customer is the cost impact through implementation of the project. The selected option minimises cost to the customer, while adequately mitigating and/or addressing the risk presented by the issue.

1.3 Regulatory Considerations

This project was included in the 2012/2013-2016/2017 revenue submission for distribution, with funding was allocated to the category codes AROLC, REHCR, RELCL, RELCR.

The expenditure for this project will be ongoing to address the quantity of asset defects; however there is a greater expenditure budgeted for the first financial years to address the quantity of high risk defects present in the distribution network.

2. Project Objectives

The proposed project is the implementation of a program to adequately address the health and safety risk to members of the public through the presence of low conductor spans.

Key objectives of this project are

1. Rectification, (or otherwise removal where appropriate) of low conductor span defects currently in the defect pool.
2. Rectification of defects identified in the future.

3. Strategic Alignment

3.1 Business Objectives

Achieving Zero Harm is a key part of enabling TasNetworks to achieve its strategic goal of taking care of its assets, delivering safe and reliable network services while transforming our business. This investment helps achieve this business objective, by mitigating the health and safety risk presented by under clearance conductor spans.

3.2 Business Initiatives

The realisation of condition and risk based asset management capability is central to TasNetworks' strategic initiative of 'One TasNetworks' program. The collection of asset information on span clearances through the proposed audit aligns with this strategic initiative, and will allow TasNetworks to develop an informed strategy for the management of these asset defects.

4. Current Risk Evaluation

The main risk of not undertaking this investment is the serious injury or loss of life of a member of public, as a result of machinery or plant contacting an overhead conductor.

4.1 5x5 Risk Matrix

TasNetworks business risks are analysed utilising the 5x5 corporate risk matrix, as outlined in TasNetworks Risk Management Framework.

Relevant strategic business risk factors that apply are follows:

Risk Category	Risk	Likelihood	Consequence	Risk Rating
Customer	Non-material supply interruption to up to 1000 customers.	Possible	Negligible	Low
Network Performance	Increased SAIDI/SAIFI through outage due to conductor contact event.	Possible	Negligible	Low
Safety and People	Contact of person or machinery/plant with conductors, resulting in fatality or permanent impairment.	Almost Certain		

Section 1 Approvals (Gated Investment Step 1)

Project Initiator:	Jack Terry	**Date:**	24/03/2015
Line Manager:		**Date:**	
Manager (Network Projects) **or** **Group/Business Manager (Non-network projects):**		**Date:**	
[Send this signed and endorsed summary to the Capital Works Program Coordinator.]			

Actions			
CWP Project Manager commenced initiation:		**Assigned CW Project Manager:**	
PI notified project initiation commenced:		**Actioned by:**	

Section 2 (Gated Investment Step 2)

5. Preferred Option:

To mitigate the risk presented by low conductor spans in the distribution network, it is necessary to

1. Identify and classify the magnitude of the risk presented by these defects currently in the defect pool.
2. Manage the risk presented by the population of defective spans through the rectification of these spans appropriately.

Where sites have been identified as high risk, it is proposed that rectification action be performed immediately (i.e. in the current financial year). Where sites have been identified as moderate risk, it is proposed that rectification action be performed within three years. Where sites have been identified as low risk, it is recommended that action be taken, when resources become available.

If this action is not taken, it is possible that at some point in the future, the contact of machinery or plant with overhead conductors will result in the death or serious injury of the member of the public.

5.1 Scope

The scope of this work is to rectify the known under clearance asset defects in the distribution network, to appropriately address the risk presented by these defects.

At this point in time there are approximately 2200 under clearance conductor defects residing in the defect pool, with limited details on the necessity for rectification and the type of work that may be required for rectification. It is proposed that these defects are handled over the next three years, managed with additional defects identified according to their priority/necessity for replacement.

As discussed above, the action required to address these under defects is dependent on the specific nature of the defect. In many instances, it generally not possible for the appropriate action to be determined, without a designer performing detailed analysis on defective span. Without this knowledge, it is challenging to estimate the proportion of works that must be performed through the CAPEX and OPEX categories respectively. It is necessary to make the assumption that the ratio of asset defects that can be addressed through each of the work categories are equivalent to what they have been historically. That is

- 67% of asset defects will be rectified through AROLC.
- 27.4% of asset defects will be rectified through RELCR.
- 4.6% of asset defects will be rectified through REHCR.
- 1.0% of asset defects will be rectified through RELCL.

The priority with which these defects are addressed should be determined through a risk assessment process, taking into consideration how far under the minimum clearance the conductor is, and the frequency of access under the span.

5.2 Expected outcomes and benefits

The main expected outcome of this work is a reduction in the risk presented by the presence of under clearance conductor spans in the distribution network. This will translate directly into a reduction in the number of health and safety incidents as a result of low conductor clearance defects.

This will be recorded and reviewed on an annual basis and documented in the asset management plan. However, a review may be performed in a shorter time frame, if a significant incident rate is still occurring, and it has been identified that additional action is required.

5.3 Regulatory Test

6. Options Analysis

Option description	
Option 0 - Do Nothing	No pro-active action to address the unknown quantities of defects in the distribution network. Ongoing rectification of low conductor spans through current rectification practices.
Option 1	Perform a detailed audit on 51077 spans. Perform rectification on 10% of these assets (5108 spans). Rectification action consists of 1. 3524 cases of rectification through OPEX activities. 2. 1583 cases of rectification through CAPEX activities. Rectification of existing under clearance defects at the same rate that the rectifications had previously been performed at.
Option 2	Perform a detailed audit on 25539 spans. Perform rectification on 10% of these assets (2554 spans). Rectification action consists of 1. 1762 cases of rectification through OPEX activities. 2. 792 cases of rectification through CAPEX activities. Rectification of existing under clearance defects at the same rate that the rectifications had previously been performed at.
Option 3	Perform a detailed audit on 13499 spans. Perform rectification on 10% of these assets (1350 spans). Rectification action consists of 1. 932 cases of rectification through OPEX activities. 2. 418 cases of rectification through CAPEX activities. Rectification of existing under clearance defects at the same rate that the rectifications had previously been performed at.
Option 4	Perform a detailed audit on 6648 spans. Perform rectification on 10% of these assets (665 spans). Rectification action consists of 1. 459 cases of rectification through OPEX activities. 2. 206 cases of rectification through CAPEX activities. Rectification of existing under clearance defects at the same rate that the rectifications had previously been performed at.
Option 5	Rectification of back log of defects over first three years, consists of 1. 491 cases of rectification through OPEX activities per year. 2. 243 cases of rectification through CAPEX activities per year. Rectification of new defects over ten years consists of 1. 339 cases of rectification through OPEX activities per year. 2. 167 cases of rectification through CAPEX activities per year.

6.1 Option Summary

Option description	
Option 0 (preferred)	Do nothing

Option 1	Perform detailed audit on targeted 20% of the distribution network. Perform rectification on all asset defects identified (assuming 10% defect rate).
Option 2	Perform detailed audit on targeted 10% of the distribution network. Perform rectification on all asset defects identified (assuming 10% defect rate).
Option 3	Perform detailed audit on all spans over 180m. Perform rectification on all asset defects identified (assuming 10% defect rate).
Option 4	Perform detailed audit on all spans over 180m in agricultural land parcels. Perform rectification on all asset defects identified (assuming 10% defect rate).
Option 5 (preferred)	Rectification of backlog of 2200 defects over 17/18 - 20/21. Ongoing rectification of 506 defects per year over 17/18 – 26/27.

6.2 Summary of Drivers

Option	
Option 0 (preferred)	
Option 1	Health and Safety - Partial mitigation Minimise cost to the customer - High cost
Option 2	Health and Safety - Partial mitigation Minimise cost to the customer - High cost
Option 3	Health and Safety - Partial mitigation Minimise cost to the customer - Moderate cost
Option 4	Health and Safety - Partial mitigation Minimise cost to the customer - Low cost
Option 5 (preferred)	See line item "Low Conductor Span Rectification - Low Clearance LV CAPEX"

6.3 Summary of Costs

Option	Total Cost ($)
Option 0 (preferred)	$0
Option 1	$44,889,747
Option 2	$33,630,876
Option 3	$28,333,821
Option 4	$25,246,824
Option 5 (preferred)	$34,290,120

6.4 Summary of Risk

The main risks associated with selecting option 0 are

1. Serious injury to or death of members of the public as a result of machinery or plant contact with under clearance conductor spans. Under TasNetworks' risk appetite statement, TasNetworks has **no appetite** for the death or serious injury of members of the public.
2. Inability to make informed decisions as a result of lack of asset defect information. Under TasNetworks' risk appetite statement, TasNetworks has a **low appetite** for the inadequate planning and management of asset investment/renewal/maintenance programs.

6.5 Economic analysis

Option	Description	NPV
Option 0 (preferred)	Do nothing	$0
Option 1	Perform detailed audit on targeted 20% of the distribution network. Perform rectification on all asset defects identified (assuming 10% defect rate).	-$14,936,428
Option 2	Perform detailed audit on targeted 10% of the distribution network. Perform rectification on all asset defects identified (assuming 10% defect rate).	-$7,503,885
Option 3	Perform detailed audit on all spans over 180m. Perform rectification on all asset defects identified (assuming 10% defect rate).	-$3,997,983
Option 4	Perform detailed audit on all spans over 180m in agricultural land parcels. Perform rectification on all asset defects identified (assuming 10% defect rate).	-$1,927,018
Option 5 (preferred)	Rectification of backlog of 2200 defects over 17/18 - 20/21. Ongoing rectification of 506 defects per year over 17/18 – 26/27.	-$6,569,315

6.5.1 Quantitative Risk Analysis

6.5.2 Benchmarking

6.5.3 Expert findings

6.5.4 Assumptions

1. The total number of defective spans required to be rectified over a three year period (high/medium priority) is 2200 (inclusive of new spans identified).
2. The defect identification rate remains the same as it has been previously.

Section 2 Approvals (Gated Investment Step 2)

Project Initiator:	Jack Terry	**Date:**	24/03/2015
Project Manager:		**Date:**	

Actions			
Submitted for CIRT review:		**Actioned by:**	
CIRT outcome:			