# High Level Internal Review into State of the PWC Networks, Manning Levels, Training and Maintenance Requirements



**Stephen Blanch – Dellwind Pty Ltd** **December 2006**

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# 1 Introduction

This Report has been prepared at the request of Power and Water Corporation (PWC) in order to summarise the findings of an internal review that was carried out over the period October to December 2006.

An experienced utility executive, Stephen Blanch, who was one of the 3 panel members of the Queensland Utility Industry Independent Review Panel set up in 2004 to review the state of Queensland Electricity Distribution and Service Delivery, has written the report[1].

# 2 Background

Following the last EBA it was agreed to set up an internal bipartite review between the CEPU and PWC to fully investigate and report on: -

- The current state of the PWC systems, taking particular note of the Generation, Transmission and Distribution areas of PWC's Assets.
- Maintenance levels at PWC
- Workloads in all business units of PWC.
- Manning levels in all business units of PWC, and
- The adequacy of the current training regime in PWC, taking particular note of safety training.

A bipartite advisory committee was formed to oversee the carrying out of this internal review.

The advisory committee consisted of: -

- 1 CEPU representative; Paul Kirby (who was substantially full time)
- 1 AMWU representative; Ron Kirk
- 1 CPSU representative; Marg Williams
- 1 APESMA representative; Russell Jennings
- 3 PWC representatives; Bertram Birk, Paul Heaton, Karen Ross
- 1 Independent Chairperson, who has been agreed between the CEPU and PWC; Stephen Blanch

This committee had, subject to any legal or contractual requirements, unfettered access to all relevant PWC files, workplaces, employees and contractors.



[1] Queensland Electricity Distribution and Service Delivery (EDSD) for the 21st Century Review Report, July 2004 by D Somerville, S Blanch & J Camp QNRME04165, ISBN 1 920920 72 2

The committee formed technical advisory groups, as required; to enable the collection of appropriate data, and ensure that there was an appropriate cross section of employees interviewed during the consultation phase of the review.

Members of the committee and technical advisory group members were given good support from all staff of PWC for gathering of information, identification of issues, and other appropriate material in order to assist the review.

The review commenced on Tuesday 17th October, Technical Advisory Groups were formed in the next few days. Site visits and interviews were then carried out over the next few weeks, as well as extensive data collection.
The diagram in Appendix 1 illustrates the general structure and roles of the Advisory Committee and Technical Advisory Groups.

## 2.1 Overview of Power and Water Corporation

Power and Water Corporation (PWC) is the largest owner and manager of network infrastructure in the Northern Territory. It owns and operates generation and electricity distribution networks in Darwin/Katherine (interconnected system), Alice Springs, Tennant Creek, Yulara and a number of small gazetted towns. It distributes energy to over 70,000 connected customers. The high voltage network totals some 4,000 km's, and covers city, urban and rural areas. In addition PWC is responsible for Indigenous Essential services with a network of some 800km of high voltage assets.

PWC also supplies water and wastewater services to around 40,000 customers in the Northern Territory with over 2000km of water mains and 1000km of sewer mains. Water and wastewater services are also provided to Indigenous communities throughout the Northern Territory via over 675km of water mains and 375 km of sewer mains.

PWC is one of the largest employers in the Northern Territory with staff levels in excess of 750.



## 2.2 Objectives and Approach

The approach in conducting this Review was, firstly, to establish the facts. This was done by interviewing a large number of PWC personnel and also studying the current state of the assets and the performance of the electricity, water and wastewater systems in PWC, together with a number of reports relating to the business. PWC staff members were co-operative and forthcoming with both verbal and written information.

## 2.3 Responsibility and Limitations

This report has been prepared for the exclusive use of PWC in managing their business, and in setting a strategic framework. It has also been prepared to assist in developing arguments in support of appropriate capital and operating expenditures for the next 5 years. No responsibility to any third party shall be accepted, as the report has not been prepared for any other purpose. The report has been prepared as a high level review only and is based largely on information provided directly by PWC and their personnel. As such the information has been taken in good faith as being accurate and complete. No independent inquiry has been made to verify the accuracy of the data.

## 2.4 Meeting the requirements of the review

| Requirements of the Review | Relevant Chapter/s of this Report |
|---|---|
| 1. The current state of the PWC systems, taking particular note of the Generation, Transmission and Distribution areas of PWC's Assets. | 2,5,6,7,8 |
| 2. Maintenance levels at PWC | 2,5,7 |
| 3. Workloads in all business units of PWC. | 2,5,6,7,8,9 |
| 4. Manning levels in all business units of PWC, and | 2,9 |
| 5. The adequacy of the current training regime in PWC, taking particular note of safety training | 2,9 |



## 2.5 Summary Findings

A high level analysis of PWC's processes and available data together with discussions with management and key staff at PWC leads me to believe that: -

### 2.5.1 The current state of the PWC systems

Overall, assets in all areas of the Power and Water Corporation are showing their age. A significant number of assets were built in the immediate aftermath of cyclone Tracey, and those that existed before cyclone Tracy are now approaching their use-by date. To some extent, the assets have not been maintained as well as possible due to a combination of factors, including in the past a practice of allowing assets to run-to-fail. Some very good work is being done in the networks area, with re-insulating of some critical feeders, and the current building of a new zone substation to shore up reliability of supply to the Darwin CBD.

Similarly, there has been some good work done in the sewerage area, where a program of re-lining has been under way for some years. In most instances, older style pipe materials have a shorter life than their modern equivalents, hence many of the pipes installed in the water and sewerage systems up to 1980 are reaching their use-by dates, and storage capacity is limited in some areas. This will be considered in more detail in the body of the report.

In the generation area, it is pleasing to see that PWC is to install the first of two new gas turbines to provide much-needed support to the Darwin-Katherine interconnected system. Given the age of the generation assets, and the low spare capacity, it is essential that the first of these units be installed as soon as possible, preferably before the next build-up in late 2007.

A summary of the key findings is provided below.

**Key Findings Water and Sewerage**

- Capacity is becoming constrained
- Upgrading of water mains will be needed to meet increasing demand
- Storage is limited in some areas (e.g. Palmerston)
- There is industry acknowledgement of high failure rates of AC pipe and most AC pipes within PWC systems are close to their use by date
- Inundation in-flows are too high in wet season for the sewerage system
- Sewage treatment strategies need to be acted on
- Assets are adequate at this time, with some significant capital items due for replacement within five years
- Staffing levels are tight
- The organisation's long-term strategic plan is well thought through and will need to be implemented
- The asset management plans, which are mandatory, are quite good.

**Key Findings Generation (Channel Island)**

- More capacity is needed to meet contingencies
- Fuel shortages are acute (Gas pressure limitations on the Amadeus Basin to Darwin pipeline led to fuel shortages in late2006)
- Spinning reserve limited and expensive as a result of historically poor plant mix
- Forced outage rate is higher than best practice
- Instrumentation is ageing and is difficult to maintain
- Single points of failure in the Darwin generation, e.g. GIS Switchyard

**Key Findings Generation (Alice Springs)**

- There is community pressure to move the power station due to noise levels, therefore there is a reluctance to spend on the existing plant
- Installation of an improved exhaust silencer on the new unit has reduced noise level
- There is a limited skill base in maintenance
- Fire impact has significant consequences because all supply to Alice Springs runs through Power Station switch-yard
- Almost all plant exists in one station and the 11kV and 22kV switchboards at the power station are single points of failure

**Key Findings Networks**

- There has been a reduction in network reliability, but some improvements have been recorded in 2006, following an insulator replacement program
- Some assets are reaching the end of their design lives
- In-fill development in Darwin is straining the existing infrastructure
- Asset utilisation is okay but not much spare capacity
- Fault levels in the Darwin CBD are above capacity for some key plant, this will be exacerbated by the new zone substation
- Essential spares are inadequate, partially driven by ageing key assets
- More certified staff are needed to carry out HV operations
- Short-term works planning is not well documented, however there is a good 20-year planning document in place

### 2.5.2 Maintenance levels at PWC

- Over a long period there has been a "run-to-fail" mentality in networks, which has been addressed by the organisation over the past two years. The backlog of work is significant.
- Servicing of key plant is inadequate, for example regulators out of service for up to two years
- At PWC, like most Australian utilities, an increased focus on maintenance is needed, to a large extent resources are focused on new connections

### 2.5.3 Workloads in all business units of PWC

- The general view is that workloads are high and driven by new customer connection in both networks and water
- Call-outs can be significant, with number of staff available to cover leave, training and other external factors below adequate levels leading to some staff carrying excessive workload in field areas
- In smaller work groups and the more remote locations the number of people available to share the burden of standby can lead to significant restrictions on the personal lives of the staff
- The ongoing difficulty in filling positions, and a relatively high turn-over of staff is adding significantly to the workloads of the field staff

### 2.5.4 Manning levels in all line business units of PWC

- As is noticeable across the whole industry, there is a significantly ageing workforce
- Apprentice numbers need to be boosted in most areas, but in one area the ratio of apprentices to qualified tradesmen is too high
- Staff turn-over is high
- There are shortages in some key skills
- Vacancies and time to fill these vacancies are too high and take too long and with the high staff turnover it would be wise to carry some supernumeries to fill vacancies
- New starters generally need at least 3 months training to become fully familiar with the type of equipment encountered in PWC which exacerbates the staff shortage due to high turn-over

- There is a general impression that field staff numbers are inadequate
- Despite that impression there is still opportunity for improvement in productivity
- At the more experienced service worker, supervisor, senior engineer and manager level, salaries and packages are not competitive with the Queensland, New South Wales, South Australian and West Australian Utilities, and are definitely well below the other industries such as mining that are competing for the same resources

### 2.5.5 The adequacy of the current training regime in PWC, taking particular note of safety training

- Issues with accreditation. Examples of fully trained staff being held up for months on being accredited for basic things such as recipient authorisation.
- Training for specialists is poor because there are inadequate skilled trainers available in the Northern Territory to carry out the training.
- Training has been focused on service workers rather than office staff
- Access to skilled providers is very limited
- Problems with availability of training, particularly in remote (non Darwin) areas
- Mentoring needs to be extended and formalised

### 2.5.6 Safety

- Safety approach has improved dramatically since December 2003. The certification process and a strong top management commitment have led to a vast improvement in this area.
- Safety training has generally been carried out extensively
- There is a need to reduce the paperwork and focus on the physical actions. As inevitable with the introduction of strong formal processes, there is a reluctance to fill in the forms. For example, SAO's need to be before the event not filled in afterwards to comply with a formal requirement
- "Buy in" by staff in operational areas is patchy
- RISQ data base is being used but "close out" is not being communicated
- Safety committees are in place but it is too early to measure effectiveness. There is also a peak safety committee and a process of escalation.

### 2.5.7 General Observations

- Retention strategies for staff need to be developed as a matter of urgency.
- Good staff continue to be poached by "higher paying and better conditions" offered by other Australian utilities who are in need of experienced resources to meet their high workloads
- PWC is data poor. There are some areas where significant work has been undertaken to re-gather basic plant history data, but a lot has been lost permanently.
- A large number of system critical drawings need to be updated
- Run to fail mentality is prevalent
- The asset management approach is in its infancy in Networks, but has shown some good progress in the Water and Sewerage business unit.

- Induction programs need to be implemented both corporately and within the business units. New employees should be given all the basic information they need to be able to perform their work within the first week. This would include appropriate authorisations to work, as mentioned previously.
- Age profile of workforce is very high leading to significant risk of loss of knowledge and experience
- Contingency planning is patchy at best. There is however an excellent set of emergency response plans which is being presented to all staff. The concern I have is related to fall-back strategies when major equipment fails.

The above points are provided to enable the Power and Water Corporation to move to a best practice multi-utility environment. It should be noted that there are many unique challenges facing PWC, due to the tyranny of distance, the harsh environmental conditions faced by the field staff and the general difficulty in recruiting key staff. The following report provides a detailed discussion of each of the key areas of the review.



## 2.6 Recommendations

- Increase staffing levels to ensure that as a minimum the establishment numbers are in place. This should be done by carrying some strategic supernumeries in areas where staff turnover is high.

- A mentoring program needs to be put in place to capture as much knowledge as possible from the soon to be retiring key staff members.

- An increased focus on maintenance and refurbishment in all areas of the business should take place

- Training needs to be budgeted by the line units and then consolidated and managed by the HR Training unit. Note that specialist training which is associated with new equipment should be included in standard procurement procedures and should be included in the line unit budgets and managed by the line units

- Capital and maintenance expenditure needs to increase to ensure that the average asset age does not further deteriorate.

- "Good Industry Practice" Asset Management practices need to be developed and employed for PWC's entire asset base.

- Reliability needs to be improved in the major business centre of Darwin, and the Tourist driven Alice Springs. There are too many single points of failure in the system.

- PWC should be allowed to ring fence, and manage its EBA negotiations to enable competitive packages to be offered to staff that are at least comparable to the other states.

- There needs to be a strategy developed for maximising staff retention. (Note money is not the only incentive to capture staff retention)

- Training needs to be more aligned to the needs of the business, and not just seen as a method of pay progression.

- There is an urgent need to obtain better service from the training provider in technical and vocational training, and if unsuccessful then PWC needs to explore the option of returning specialist training to in-house.

- The previous HV training area should be replicated urgently as a means of providing hands–on practical training on PWC's equipment for new HV Operators

- Certification and authorisation processes need to be far more time efficient.

- Pay structures need to be reviewed for coordinators to minimise the reluctance of service workers to step up. They currently lose of the order of $10,000 to take up the additional responsibilities. In addition this reluctance is hindering succession planning

- As a minimum there is a need to bring salary packages up to a comparable level with the other States of Australia in the Utility Industry. Particularly at the Band 3 and above level where PWC trends well below the first quartile on recent benchmarks[2]



[2] Discussion Paper on Employment Arrangements, Power and Water Corporation, Mercer Human Resource Consulting 15 March 2006, page 14

# 3 The Principals of Asset Management

Electric and Water utilities, like many other basic infrastructure businesses, have a large physical asset base with significant diversity of age profiles for the installed assets. In order to maximise the long term economic value of these assets and to ensure that they deliver an appropriate level of service it is necessary to employ effective asset management.

An excellent manual on modern infrastructure management has been produced by a New Zealand Company "The NAMS Group", known as the International Infrastructure Management Manual"[3]. The document provides a comprehensive framework for the effective management of Infrastructure assets.

Section 1.1.3 of that report states "The goal of modern infrastructure asset management is to deliver the required level of service in the most cost effective way through the creation, acquisition, maintenance, operation, rehabilitation and disposal of assets to provide for present and future customers.

The key elements of Infrastructure asset management are:

- Taking a life cycle approach
- Developing cost-effective management strategies for the long term
- Providing a defined level of service and monitoring performance
- Managing risks associated with asset failures
- Sustainable use of physical resources
- Continuous improvement in asset management practices"

Most modern Utilities employ asset management techniques to ensure that their assets are delivering long-term benefit to all stakeholders. The degree to which the principles are applied can be assessed from a review of the asset management plans in place in the business, and the degree to which the plans are implemented in the field.

Good asset management plans will ensure that the five pillars of effective asset management are in place.
These are: -

- Comprehensive knowledge of all of the assets
- Sound capital investment decision making processes and criteria
- Effective maintenance policies and processes
- Maximising asset life (refurbishments strategies)
- Operating conditions and practices



[3] "International Infrastructure Management Manual" by NAMS Group Version 2, 2002

The overall purpose of asset management is to "maximise the value of assets by: -

- Appropriate asset utilisation (maximising, within acceptable risk levels)
- Minimising redundancy
- Just in time maintenance
- Use of condition based maintenance and refurbishment where appropriate
- Optimising life cycle value of the asset by trading off capital versus operating costs
- Finding least cost approaches to delivering required outcomes
- Effective replacement strategies
- Comprehensive risk identification and management and business continuity planning
- Looking for continuous improvement in processes and practices

Asset management is a part of the overall strategic planning process at a modern Utility. The initial phase of the process is to determine the required service levels to be delivered by the assets, in both the short term and the long term. A series of tactical plans is then developed, including customer service plans, financial plans, asset management plans, human resource plans and these are then further developed into operational plans and processes to ensure delivery.

In most Utilities this is an annual process, and in many States of Australia all the infrastructure utilities are required to produce annual asset management plans, to be published by midyear. This discipline has been in place for at least 3 years, and the plans are improving each year.

# 4 Asset Management at PWC

In order to fully explore the present state of the assets at PWC as per Requirement 1 of the review an assessment of the degree to which PWC adhered to good asset management practices was undertaken. The first area to look at was the asset management plans and strategic plans in place for PWC.

The main purpose of the asset management plans for PWC for 2005 is to “outline PWC’s asset management programs, processes and practices currently in place as well as initiatives that are going to be established by PWC to ensure service levels meet water and electricity network users’ and consumers’ expectations as well as PWC’s business and statutory obligations”. The Water and Sewerage Asset Management Plans[4] are prepared to fulfil the requirements of Section 48 of the Water Supply and Sewerage Services Act, (2002).

In the case of the Electricity Asset Management plans there are no current statutory requirements but this may change in the near future as it has in the other states of Australia.

The information provided in the water and sewerage plans are on the whole quite well developed. There are some areas where historic information is limited, which is not unexpected, given the history of the business and the many changes of structure from pure government department through to a Government Owned Corporation combined with the Electricity business. The plan appears to accurately reflect the challenges and proposed solutions facing PWC water and sewerage assets, and with its proper execution PWC should continue to deliver the required level of service.

There are no areas of consequence that have been omitted from the plan, although I would expect to see a more detailed analysis of proposed projects to address poorer performing parts of the networks in the next plan.

On the whole the plan has all the essential ingredients of a good utility’s Asset Management Planning Process. The key is in the delivery of the plan, and the recognition of the significant short-term future capital costs which will need to be expended in order to meet the existing performance targets.

The PWC Asset Management plans[5]and the strategic plans[6] were examined to determine to what degree PWC’s projected capital and operating expenditures do align with good industry practice when evaluated against asset age, demand forecast, reliability and risks.



[4] Water Supply and Sewerage Services Asset Management Plans Feb 2006 (22 plans covering all water and sewerage assets

[5] Power Networks Asset Management Plan Sep 2003 (updated 2006)

[6] Power Networks Network Development Plan 2006-2026, Networks planning report No NPR0629 Sep 2006

## 4.1 Good Asset Management Practices

In order to come to a view of the current state of the networks an analysis of the quality of the asset management plans gives a good indication of their state, together with an overview of the policies and processes that are employed to ensure the reliability of the networks. This review was supplemented by both physical inspections of many of the key assets and interviews with many field staff. The following notes comment on the asset management plans for both water and sewerage, and networks.

### 4.1.1 Appropriate asset utilisation

In general terms the asset utilisation at PWC is conservative at the network and feeder level, with significant spare capacity in the cables and lines.

The asset utilisation for major assets is fairly high, and without the network switching capability, would be bordering on the unacceptable. There is no real problem with unexpected load growth, and the system generally experiences modest growth. There are some augmentation requirements around the Darwin CBD to enhance reliability of supply, and it is noted that these works are in progress. The move to the use of cyclic ratings and dynamic ratings for key equipment in the system, will give some breathing space for any overstretched assets should an N-1 event occur.
In the Water and Sewerage area there is a comprehensive analysis of asset utilisation. For example in the Darwin water supply asset management report[7] asset utilisation ranges from 40% for groundwater source up to 99% for surface water source (which is limited by licence). Water storage is at 83% utilisation. On the whole asset utilisation is high, and there will be augmentation requirements within the next 5-10 years, which is well recognised in the plans.



### 4.1.2 Minimising redundancy

Both the water and sewerage networks and the electricity networks are built with little redundancy. There are multiple pumps in both the water and sewerage pumping stations, and the level of redundancy leads to a better than industry average level of supply reliability for the water services. There is no excess of redundancy in the water network. In the electricity network, there is a design philosophy of meeting N-1 reliability criteria for all major network assets, and the ring main round the CBD provides an appropriate level of redundancy. As the loads are increasing the redundancy is reducing and there is now little spare capacity as will be discussed in section 5.

### 4.1.3 Just in time maintenance

The concept of “just in time “ maintenance is to ensure that predictive methods are used to determine the optimum time to maintain, repair and refurbish assets. PWC have for many years used a run to fail approach to maintenance, which is quite appropriate for minor non-critical items, but it has been seriously overdone in PWC. The result has been to carry out “reactive’, or breakdown maintenance as a standard procedure. A study done in New Zealand showed that replacing or repairing assets on

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[7] Page 29, Darwin Potable Water Supply System Asset Management Draft Plan-2006

a breakdown basis can cost up to 1.8 times more than to do planned replacement or maintenance.

### 4.1.4 Use of condition based maintenance and refurbishment

There is evidence of PWC employing appropriate condition monitoring techniques including infrared thermography on key assets, and routine DGA (Dissolved Gas Analysis) on zone substation transformers. This is in line with good industry practice and is well described in the Asset Management Plan.

In the wastewater area good use is made CCTV cameras to study the internal surfaces of the major pipes in the sewer network. Also thermo-scanning, vibration analysis and Impedance testing of electromechanical plant are carried out.

In the generation business they have a good regime for monitoring the condition of the larger alternators. There is also some limited use of vibration monitoring and analysis to assist in predicting plant performance and outage planning. Both Generation and Networks have a good regime for routine testing of protection relays.

There is plenty of room for more use of predictive techniques to improve maintenance planning.



### 4.1.5 Optimising life cycle value of the asset

The asset replacement and disposal strategy for networks is outlined in section 4.5 of the Asset Management Plan[8]. There is recognition of the need to target critical high value assets and to either replace or refurbish depending on the cost benefit of the alternative strategies. Some examples of this approach have been the replacement of station batteries in critical zone substations, and the replacement of old low quality insulators on a poor performing feeder. There is mention of use of age profiles, assessment of technical lives and availability of spare parts in order to prioritise expenditure. This approach appears to be sound, but there is not sufficient information in the Asset Management Plan to enable a clear optimisation strategy to be developed. Also with the poor data history in PWC it is a difficult task to establish the economic life of some of the key assets, such as zone substation transformers, and circuit breakers.

In the sewerage area the extensive relining program is a good example of optimising asset lives. Also as outlined in the Darwin Potable water Asset Management Plan[9] there is a condition assessment program under way. This will be a precursor to an assessment of remaining life of the assets and will enable an optimisation of the life cycle value of the assets. The assets management plans in water and sewerage while not specifically addressing life cycle optimisation does have most of the ingredients within the asset management plans.

[8] Power Networks Asset Management Plan September 2003, section 4.5 page 28.
[9] Darwin Potable Water Supply System Asset Management Draft Plan 2006, section 10.2, page 48.

### 4.1.6 Finding least cost approaches to delivering required outcomes

Best practice asset management strategy looks at finding the least cost solutions to minimise capital and operational costs. Examples of this could include local generation to avoid the need for network augmentation, looping gas mains to reduce pressure drop and increase line pack, or in the water area it could mean automating dosing plants. While these activities may well be taking place there is not much evidence of this type of thinking shown in the Asset Management Plans. Where major works are to take place a discussion of the various options considered would be a useful addition to the asset management plans.

### 4.1.7 Effective replacement strategies

The capital and operational expenditure plans as outlined in section 5 of the Networks Asset Management Plan are comprehensive and indicate a well thought through replacement and augmentation strategy. However in discussions with many staff it is clear that the highest priority is given to new customer extensions, quite rightly, and the execution of the replacement program is not rigorously followed.



### 4.1.8 Comprehensive risk identification and management and business continuity planning

The Water and Sewerage Asset Management Plans contain a section on risk management, section 8[10], which gives a good summary of the key risks. An example is the Darwin Sewerage report that outlines the key risks faced by the sewerage system, the most prevalent risk is failure of the aged Cementious sewer pipes laid between 1949 and 1985. The mitigation strategies in place include a 10-year program of CCTV assessments and a reline and replacement program. In the case of failure of the pipes or other critical plant such as sewage pump stations; there is a contingency plan in place and a very good emergency response procedure, both of which are recorded on the Intranet for PWC. Each of the water and sewerage systems appears to have an adequate risk identification and business continuity plan in place.

The Networks Asset Management Plan does not address the key risks in the business or the risk mitigation strategies. These items should be added to the plan. The major risks to the Network are failure of key plant items such as transformers at zone substations, or the main transmission systems. At this time there is adequate reserve capacity to avoid a long term blackout, such as Auckland, however there are a number of single points of failure which need adequate contingency plans to avoid short term problems. There needs to be more work done in both Networks and Generation to address risk identification and mitigation.

There is a very good emergency response procedure document[11], which has been widely disseminated through the workforce. It outlines, “What is an emergency”, “what to do if one occurs” and it defines the roles and actions to be taken by individuals within the corporation, including an appropriate escalation procedure. This is a very recent document and it is a very good document, and procedure. What

[10] Darwin Sewerage Services System Asset Management Plan 2006, section 8, page 35.
[11] Emergency Response Procedure PowerWater 2006

was not so obvious was the development of a detailed risk register with appropriate contingencies thought through for all high level risks.

### 4.1.9 Looking for continuous improvement in processes and practices

Best practice asset management relies on carrying out a comprehensive set of policies and procedures on an ongoing basis. The annual writing of an Asset Management Plan is not the end product of asset management. It is the enactment of that strategy on an ongoing basis, together with the continuous challenge to improve the processes and practices.

There is clearly a gap between what is written and the implementation in the field. I also observed that there is no formal “buy in” to the performance targets by the service providers, and there seems to be little incentive for them to meet PWC’s required targets.

In the water and sewerage area a lot of good work has been done on the development of asset management processes and practices, however there is a very small group of staff who are involved in the asset management area, and there are risks that PWC will fall back from good industry practice if these key resources are unavailable.

Wastewater and water crews are now separate with limited mobility between crews. While this has some advantages, the limited crew sizes can lead to difficulty in obtaining shift and call-out coverage.

PWC Water and Sewerage business unit has a good appreciation of the principles of Asset Management. The recommended Asset Manager/ Service Provider separation is being reinforced. Service level agreements with KPI’s have been developed.

In order to progress, PWC needs to further develop strategies and concepts to achieve best practice in Asset Management.

PWC has good deployment of technology including extensive SCADA and telemetry, GIS and works management systems, however quite a lot of the equipment is aging and in need of replacement.

There is plenty of scope for PWC to continuously improve in this area.



## 4.2 Overall Assessment of PWC’s Asset Management Practices

The preceding section outlines what is required to be considered as a good asset management business. PWC has in place some of the elements of a good asset management business and is in the process of implementing additional practices to re-enforce that position. On the whole, in reviewing the Asset Management Plans for 2006, and in discussions with the management and staff at PWC, I am of the view that the practices and approaches applied by PWC need improvement in order to meet good industry practice.

In overall terms the projected Capital in Water & Sewerage, Networks and Generation looks to be in line with requirements to ensure performance continues at least at the current level, with one caveat and that is that the actual work required needs to be done, and it is possible that increased costs of capital works will require more capital than that currently allowed in the plans. There is also a shortage of skilled resources in some key areas that will limit the ability of PWC to deliver on its asset management plans.

| Measure | Name | Performance Indicator | Description of Measure |
|---|---|---|---|
| Minutes off Supply | **SAIDI** | **S**ystem **A**verage **I**nterruption **D**uration **I**ndex | It measures the total minutes on average across the whole system that a customer could expect to be without supply over a year |
| Interruption Frequency | **SAIFI** | **S**ystem **A**verage **I**nterruption **F**requency **I**ndex | It measures the number of occasions per year when each customer could on average expect to experience a supply interruption (SAIFI excludes momentary interruptions of less than 1 minute duration) |
| Interruption Duration | **CAIDI** | **C**ustomer **A**verage **I**nterruption **D**uration **I**ndex | It measures the average time taken for supply to be restored when an unplanned interruption has occurred |

**Figure 1: Definitions of common terms for measuring Reliability of Supply**

The table in Figure 1 provides a brief explanation of the commonly used terms for measuring reliability of supply of electricity networks. These terms will be used extensively in the following sections of the report.

# 5 Impact of Capital Expenditure on Reliability

There is a clearly observable link between Capital expenditure on Networks and Performance outcomes. As Network assets are of long life, underspending on assets in the short term will not necessarily lead to reduced performance. The EDSD review in Queensland in 2004 found that there had been serious underspend on both Capital and maintenance for at least the previous 5 years. The real impacts of this underspend only really became obvious in terms of outages and stressed assets in the 2005 year.

In Victoria four of the five distributors spent their allotted Capital over two regulatory periods (8 years) as outlined in the Essential Services Commission Report of 2005[12], while one distributor systematically underspent their allotted Capital. The outcomes in terms of SAIDI are illustrated in Figure 2.
There has been a dramatic improvement in SAIDI performance for the four distributors that spent appropriate levels of system renewal capital and appropriate system enhancement Capital.

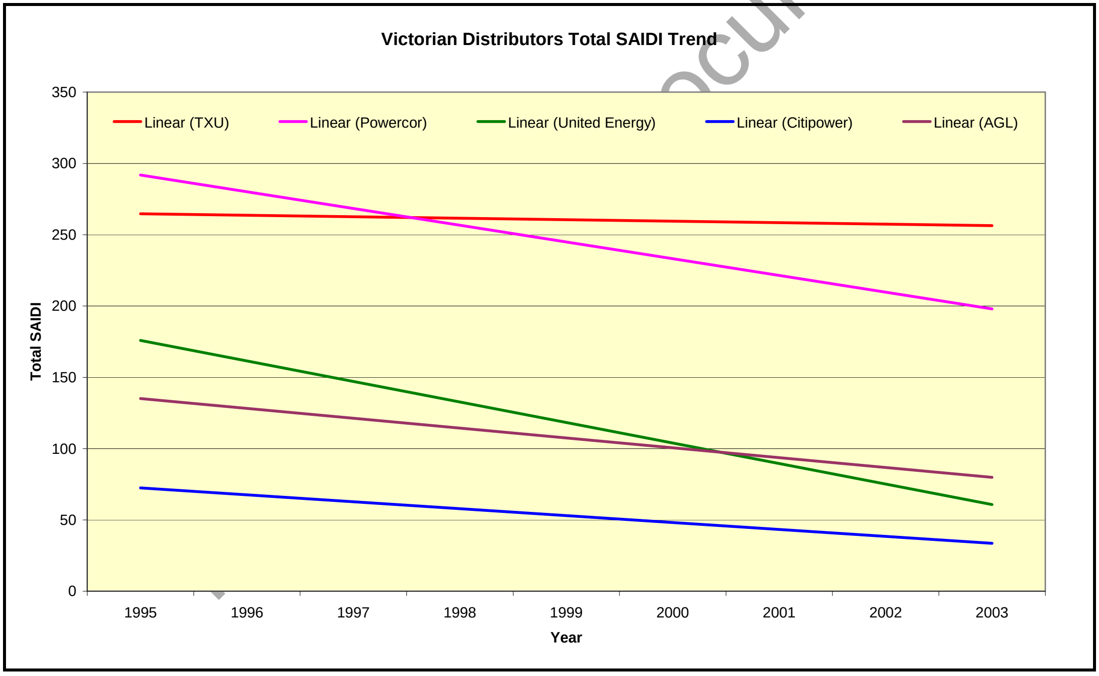



**Figure 2: Victorian Distributors Total SAIDI Trends**

The overall total SAIDI trend shown in Figure 2 to some extent hides the real impact of underspending on Capital, given that it includes both planned and unplanned outages. All Victorian distributors reduced the SAIDI impact of planned outages by more use of live line techniques.

When looking at the utility that underspent on Capital the performance on the unplanned SAIDI is shown in Figure 3. It can be seen that there has been a steadily deteriorating performance over the regulatory periods in which Capital underspend

[12] Victorian Essential Services Commission Report 2005

occurred. While this is a linear trend over the short term, failure rates on aging assets are not linear in the long run, and there would be an expectation of a further upward trend if Capital spending were not immediately applied to restoring a reasonable average asset age for the total network. The utility has recognised this need and intend to spend significantly higher Capital in the next 5 years in order to recover their performance.

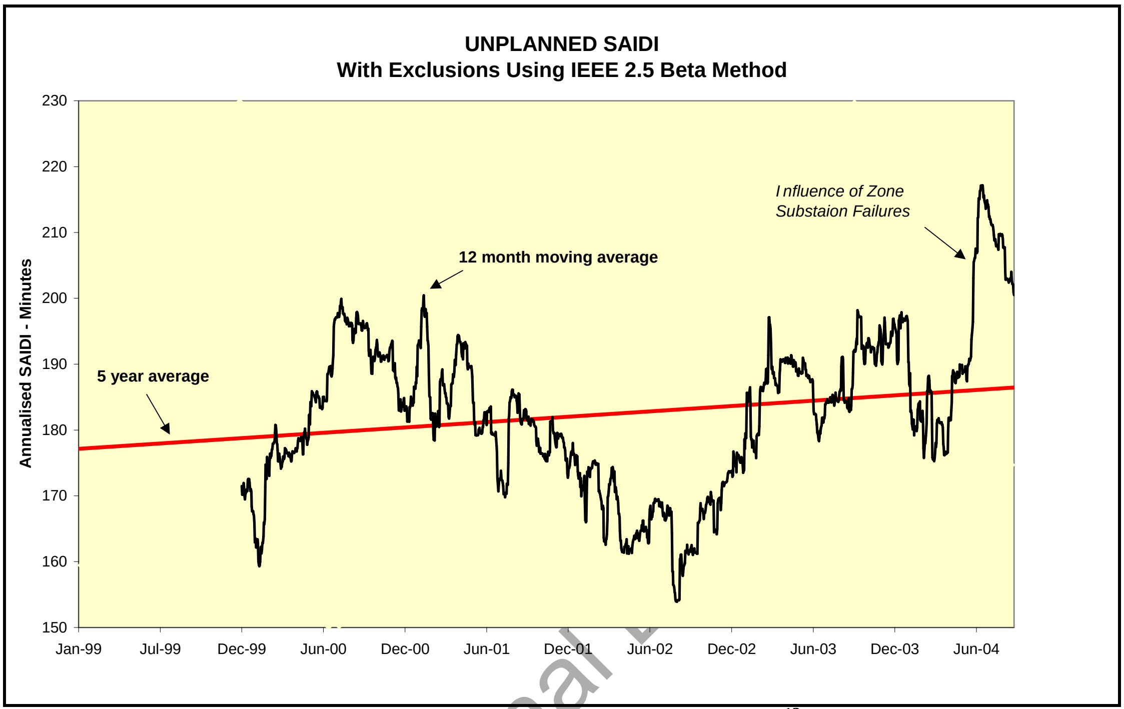



**Figure 3: 5 Year Unplanned SAIDI using 2.5 Beta Exclusion Method**[13]

## 5.1 PWC's Network Performance

In overall terms the linear trend in SAIDI at PWC as illustrated in Figure 4, has been rising steadily for the period 2002/3 to 2005/6. However in line with Utilities around the world there has been significant variation from year to year.



[13] "IEEE Guide for Electric Power Distribution Reliability Indices" IEEE Standard 1366 ISBN: 0-7381-3889-4 SH95193, 2003

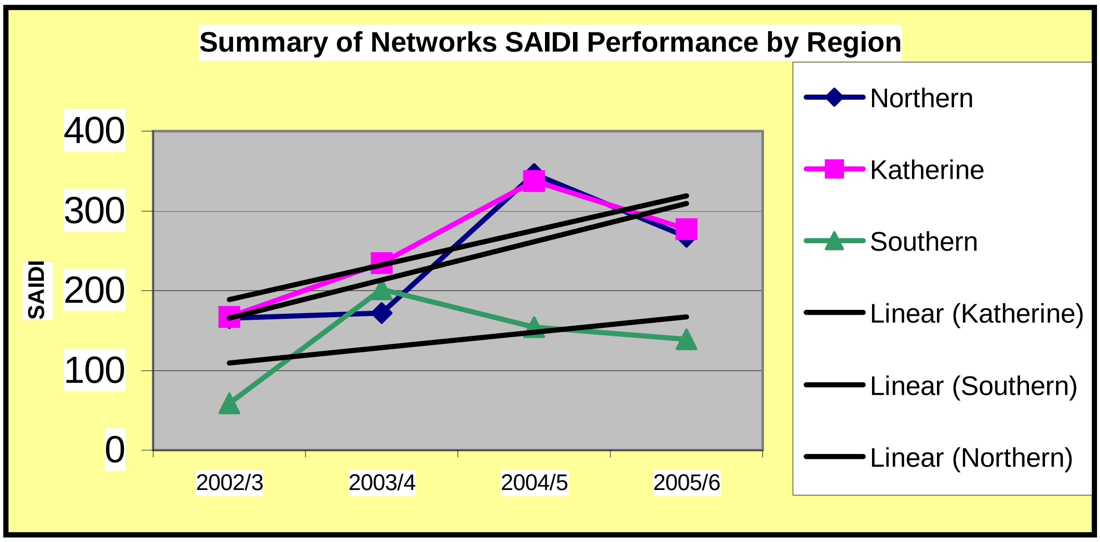



**Figure 4: Trend in SAIDI at PWC 2002/3-2005/6**

There is also a disturbing upward trend in SAIFI at PWC as shown in Figure 5. This trend signals that there is a risk of SAIDI increasing significantly in the future if appropriate action is not taken to address the root cause of this increasing trend. Note that the upward trend is almost identical across the 3 separate regions, indicating an underlying root cause, which is related to asset aging and under maintenance over the past many years. Network assets can take many years of underspend before they deteriorate to the point where failures increase markedly. Unfortunately they also take a long time to restore to previous performance after years of underspend.



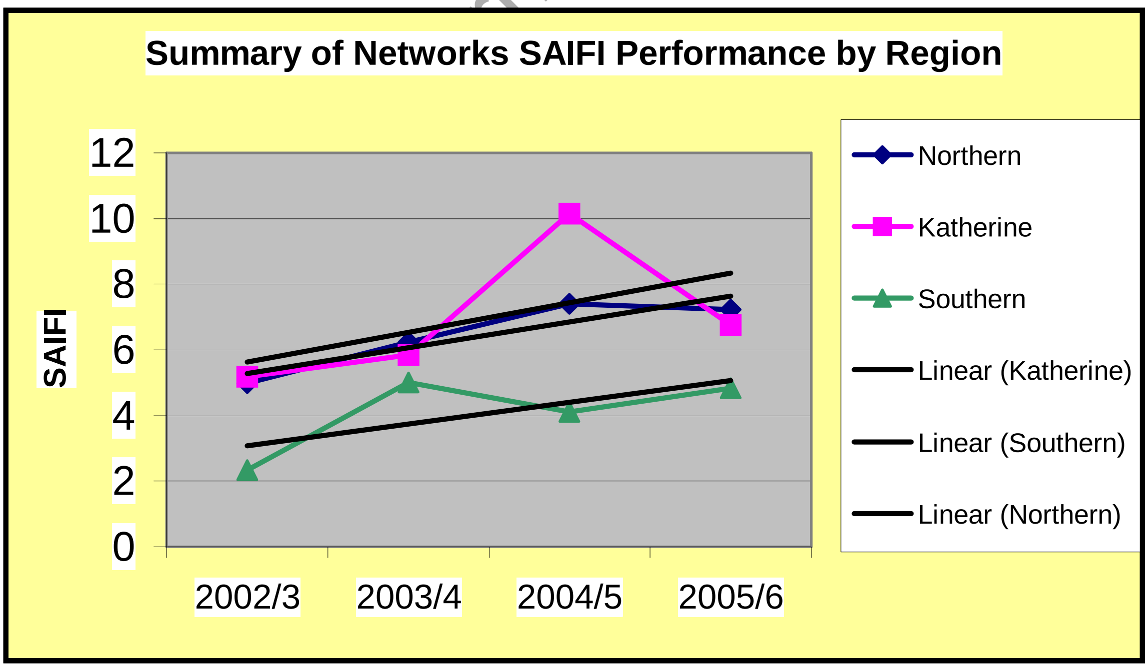



**Figure 5: Trend in SAIFI at PWC 1999-2005**

When the total network and generation impact on SAIDI are taken into account the 2003/4-year was the worst with a very significant impact by generation shortages. This is shown in Figure 6.

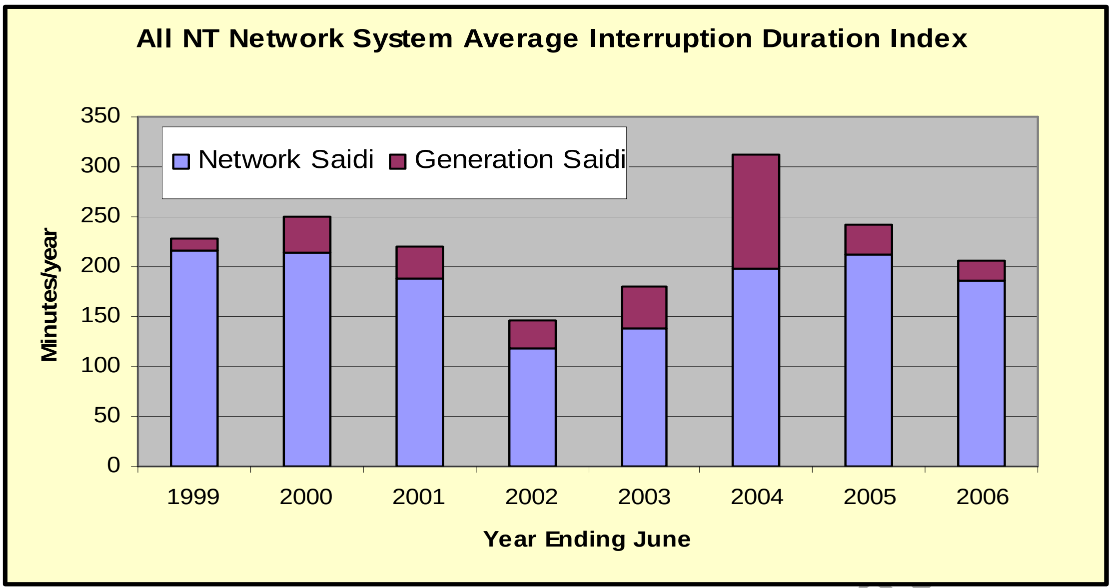



**Figure 6: Total SAIDI for Network and Generation 1999 to 2006**

Networks peaked in 1998/9 and again in 2004/5and have shown some improvement in the 2005/6-year. As mentioned above there is a lot of variability in the SAIDI index due to variability of external conditions such as climate, however given that an insulator replacement program is under way on the worst performing feeders, there is likely to be a positive impact on SAIDI. In fact Figure 7 shows the 12 months to November 2006 demonstrating a downward trend in SAIDI. While this is heading in the right direction it is still above the target agreed with the regulator of 165 minutes.

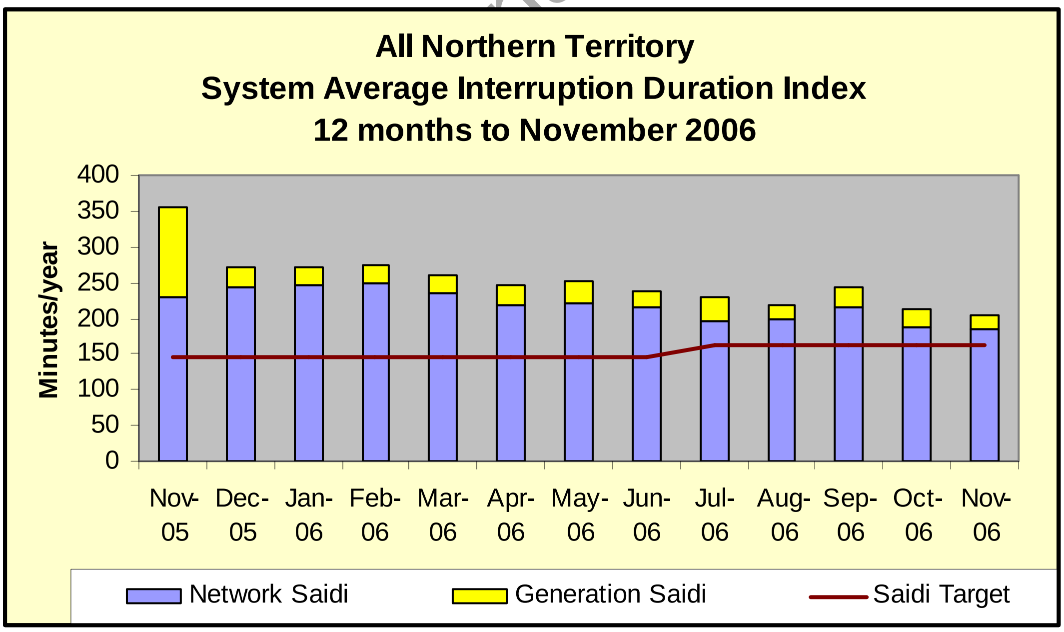



**Figure 7: NT SAIDI for 12 moths November 2005 to November 2006**

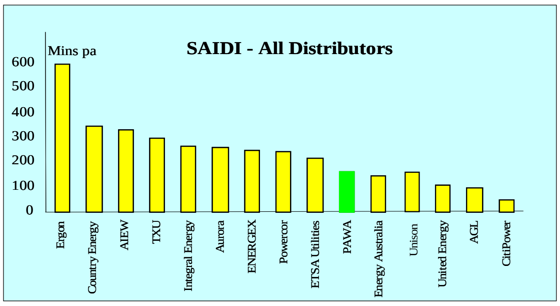
There is clearly still some work to be done as outlined in the Utilities Commission Report[14] of December 2006, which states on page 2 that the result for SAIDI in the Darwin Network exceeded targets being 231 minutes compared to a target of 220

[14] Electricity Standards of Service: 2005-06, December 2006 Utilities Commission, page 2 and page 21

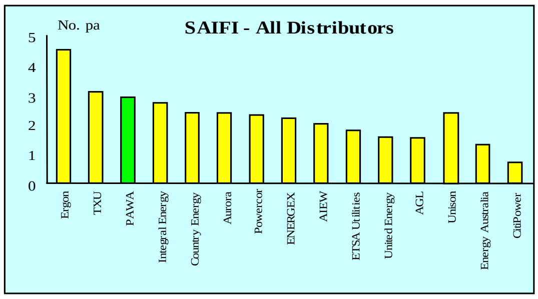
minutes. The Katherine and Alice Springs networks met or were better than their target as shown on page 21 of their report.

### 5.1.1 Comparison of PWC's Network Performance with other Australian Network Utilities

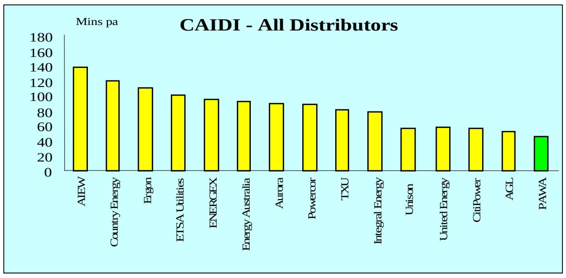
PWC is performing at about the average for Australian network companies, as can be seen in Figure 8, in terms of SAIDI, which is a commonly used method of comparing reliability performance. It is basically a short-term indicator, and tends to be a lag indicator, however given its general acceptance by regulators the comparison shows that PWC was holding its own back in 2003.




Australian Distributors SAIDI performance 2002/3 compared with PWC (PAWA)




Australian Distributors 2002/3 SAIFI Perfomance compared with PWC (PAWA)




Australian Distributors CAIDI performance 2002/3 compared with PWC (PAWA)

Source: Jurisdictional Regulatory Reports, PWC Data 2003

**Figure 8: Comparison of Network Performance from Australian Networks with PWC**

It is worthwhile comparing PWC's performance with similar utilities in Australia, Figure 8. In terms of SAIDI, PWC fits in the better performing end of the spectrum. However given the fairly small geographic area and the relatively short feeders PWC should be performing more in line with Utilities such as United Energy (Now Alinta) and AGL. These companies have similar mix of urban and short rural feeders, and although they have higher customer densities they also have their share of longer feeders. On this comparison PWC has significant room for improvement in terms of SAIDI.

PWC does not compare well with Australian Network utilities in terms of SAIFI.

In terms of CAIDI, the average duration of a customer outage is very good. This shows that PWC has a good set of processes in place to be able to respond to the excessively large number of faults in the network. It is also helped by the fact that most of the feeders are quite short.

## 5.2 Feeder Performance

In overall terms PWC has seen its network reliability performance decreasing over the past 4 years, as discussed in section 5.1. In terms of individual feeders, PWC is similar to most Australian and New Zealand Utilities, where a number of feeders experience very poor performance compared to the average. Averages provide a general trend, however customers on poor performing feeders suffer significantly poorer performance than the average.

In Figure 9 the contribution of individual feeders to the overall SAIDI for the Darwin network is shown. It can be seen that up to 20-25 of the feeders contribute the most significant amount of SAIDI, which does however portray the real impact on customers that is often overlooked when quoting averages.

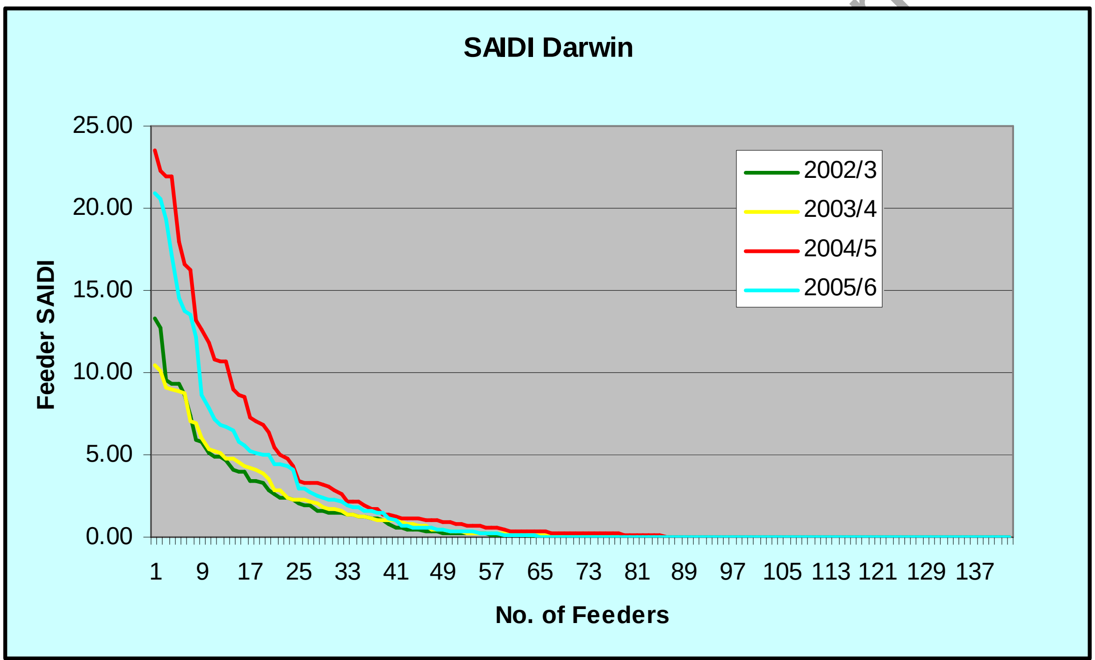



**Figure 9: Darwin Individual Feeder Performance as measured by SAIDI 2002/3 to 2005/6**

The same profile is evident in Alice Springs, as shown in Figure 10. In this case 3-4 of the feeders are the major contributor to SAIDI. In most cases these are the same feeders and are known to the networks business unit.

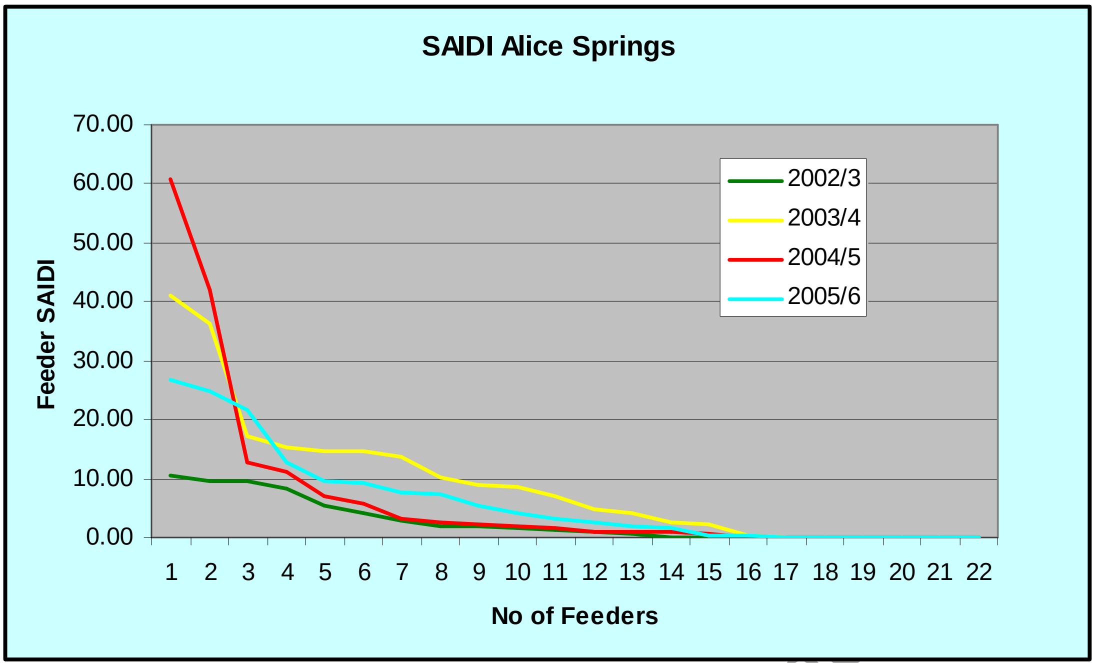



**Figure 10: Alice Springs Individual Feeder Performance as measured by SAIDI 2002/3 to 2005/6**

In Katherine, which only has 14 feeders, 4 or 5 contribute the most to the total SAIDI for the Katherine network as shown in Figure 11. There are clearly opportunities to improve the overall performance of the Katherine Network by addressing issues with these poorer performing feeders.

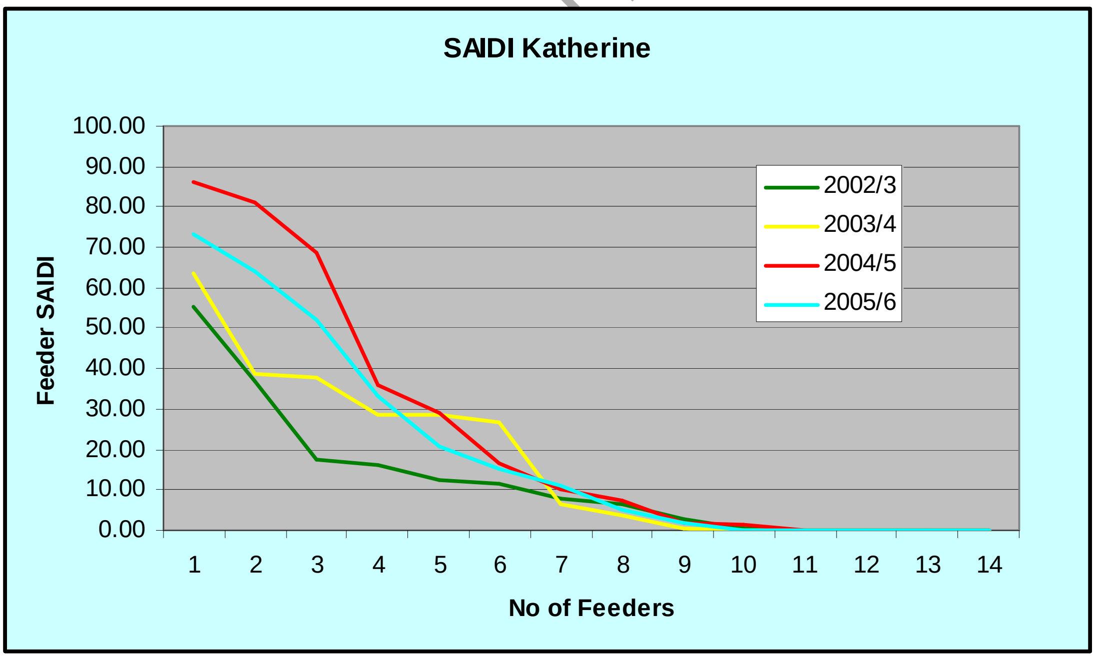



**Figure 11: Katherine Individual Feeder Performance as measured by SAIDI 2002/3 to 2005/6**

Another way of looking at this is to analyse the 5, 10, 15 and 20% worst performing feeders as shown in Figure 12. The difference between the worst 10% performing feeders and the average is in the range of 7 to 1 and the difference between the 20% of worst performing feeders and the average is in the range of 5 to 1 for the past 4 years As a comparison a Victorian Distributor was in the range of 4 to 1 and 2.9 to 1, and was put under a lot of pressure by both customers and the regulator to improve the performance of the outlying poor performance feeders. I have no doubt similar pressure will come on in PWC's territory, which will lead to a need for more capital investment in the network to improve restoration and reduce number of outages.

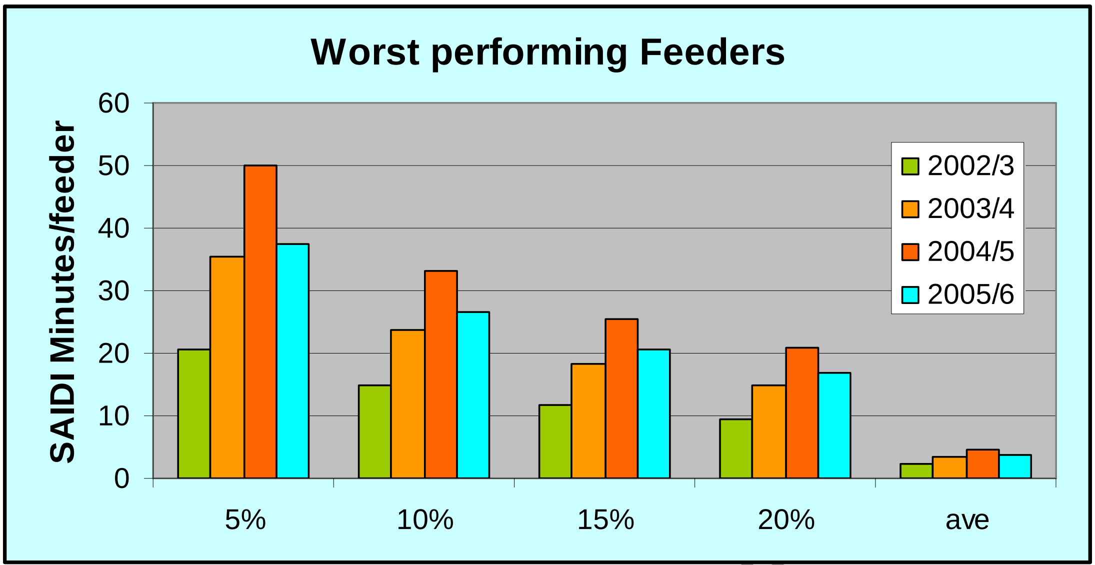



**Figure 12: PWC Worst Performing Feeders by Year**

Analysis of the frequency of feeder interruptions at PWC over the past 4 years shows a similar pattern to the feeder SAIDI, as it should. The Feeder "Weighted Frequency of Interruptions" shown in Figure 13 indicates that most of the feeders had few or no interruptions, while about 17 feeders contributed over 2% of the total system SAIDI each, and the worst 2 or 3 feeders contributed between 5 and 10% each to the total number of outages. Different consumers have different tolerance levels to frequency of interruptions, however on the worst performing feeders there is little doubt that improvement is required.

In the Australian regulatory regime Network Utilities are now being presented with targets for number of interruptions at the individual feeder (and in some cases individual customer) level with penalty payments to customers if these targets are not achieved. PWC will need to focus on reducing the number of preventable outages in the Network to reduce the number of feeders that are exceeding good industry practice. Note that good industry practice is not easy to define, as it depends very much on the geographic and climatic conditions prevalent in an area. However any thing more than about 10 sustained interruptions per year will focus attention on need for improvement.

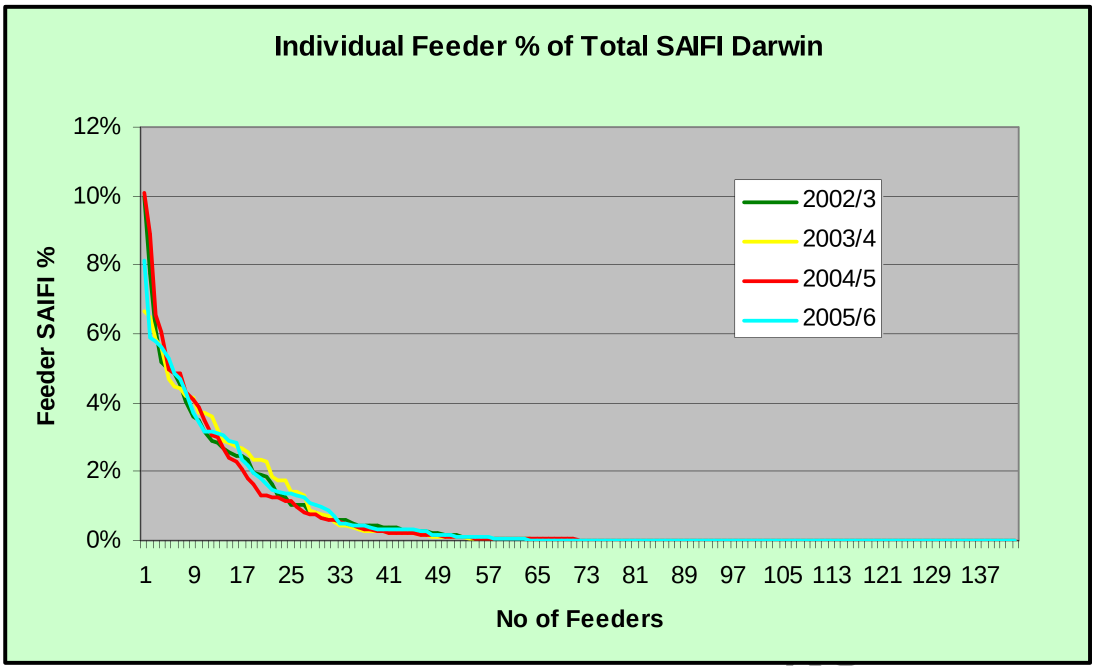



**Figure 13: Darwin Feeder level Frequency of Interruptions at PWC**

In similar fashion the Alice Springs Feeders, which have an average SAIFI for the whole network of almost 5 outages per feeder per year have 2 or 3 individual feeders who contribute most of that result. About half the feeders have no interruptions at all. This can be seen in Figure 14.

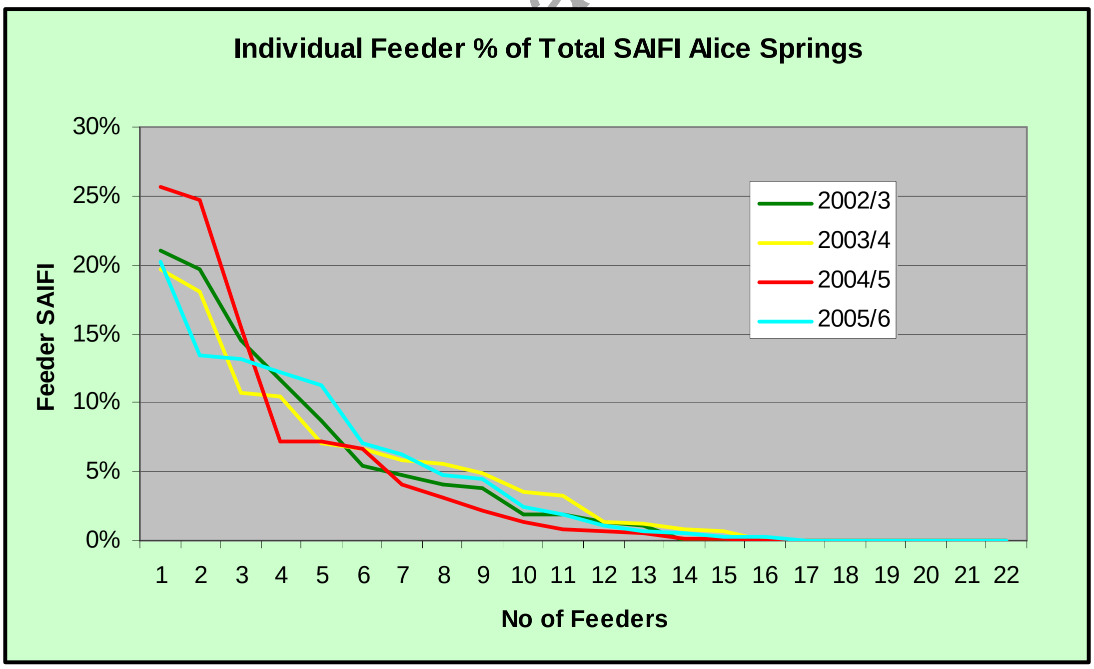



**Figure 14: Alice Springs Feeder level Frequency of Interruptions at PWC**

Of the 14 feeders in the Katherine network again 2 or 3 feeders contribute to most of the outages as shown in Figure 14. While this is not uncommon, it does point to the opportunity for improvement by better line maintenance, better vegetation management, and appropriate location of automatic line Reclosers to get reduction in number of outages and more rapid restoration.

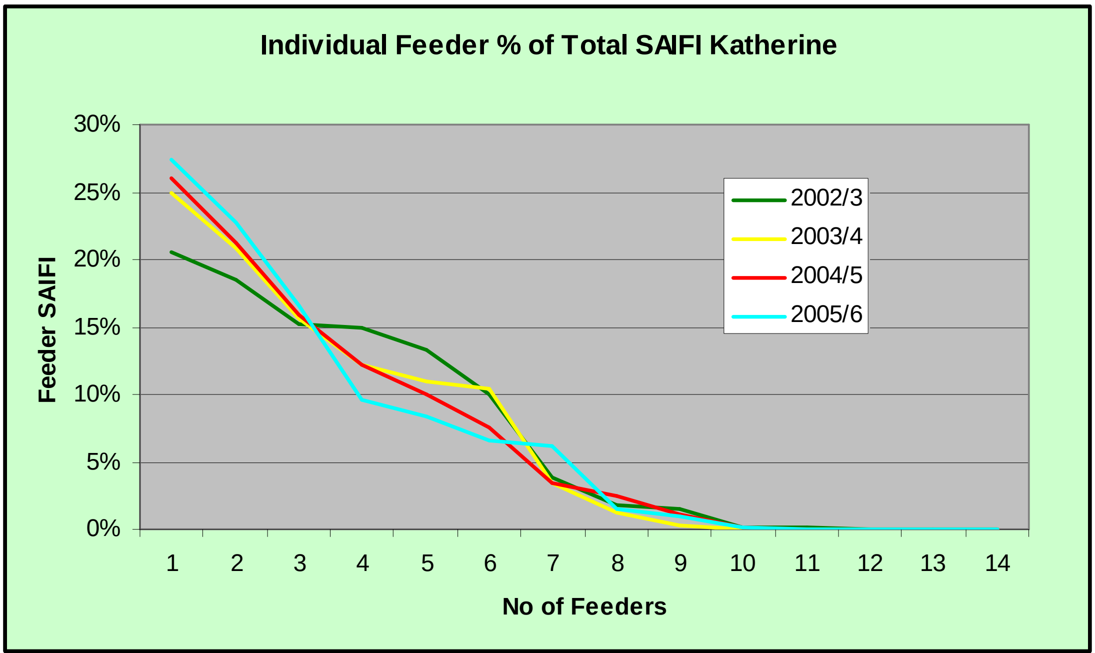



**Figure 15: Katherine Feeder level Frequency of Interruptions at PWC**



Over the past 4 years the average customer outage duration has been quite good by Australian standards at between 27 and 47 minutes. However as can be seen from Figure 16 a few feeders experienced very long outages. These long outages were invariably caused by equipment failure on long remote feeders. On the whole a pretty good result.

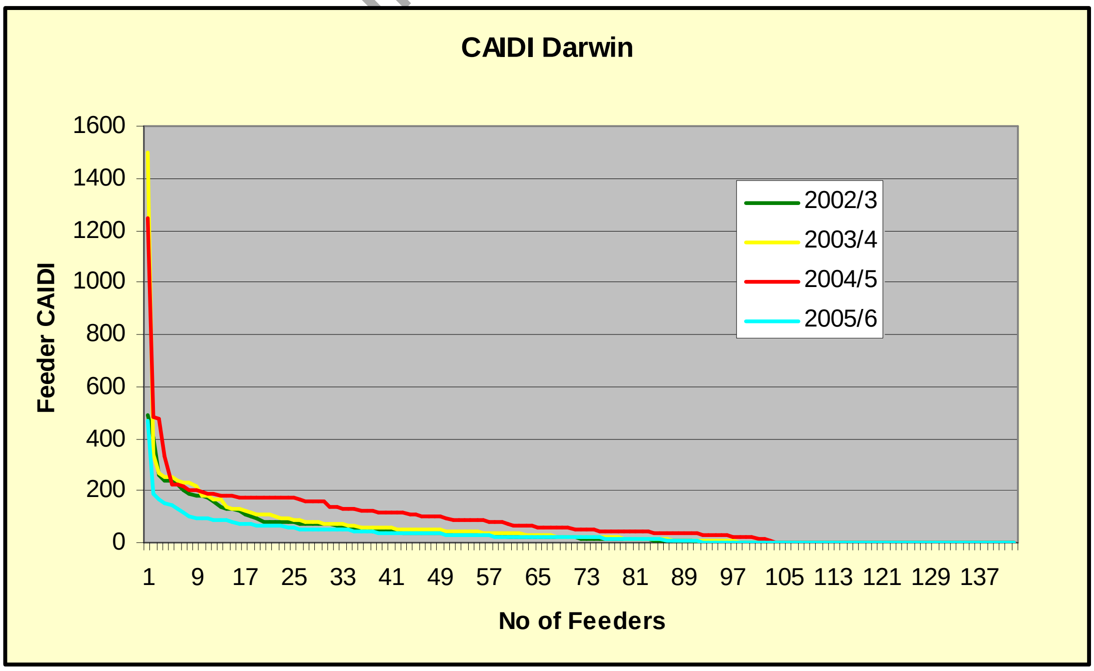



**Figure 16: Darwin Individual Feeder level Customer Average Interruption Duration Index (CAIDI) at PWC 2002/3 to 2005/6**

The average outage duration (CAIDI) for each customer in the Alice Springs network has been between 25 and 40 minutes over the past 4 years. This is a good result, however looking at Figure 17, shows that 2 feeders had well in excess of 100 minutes outage per fault.

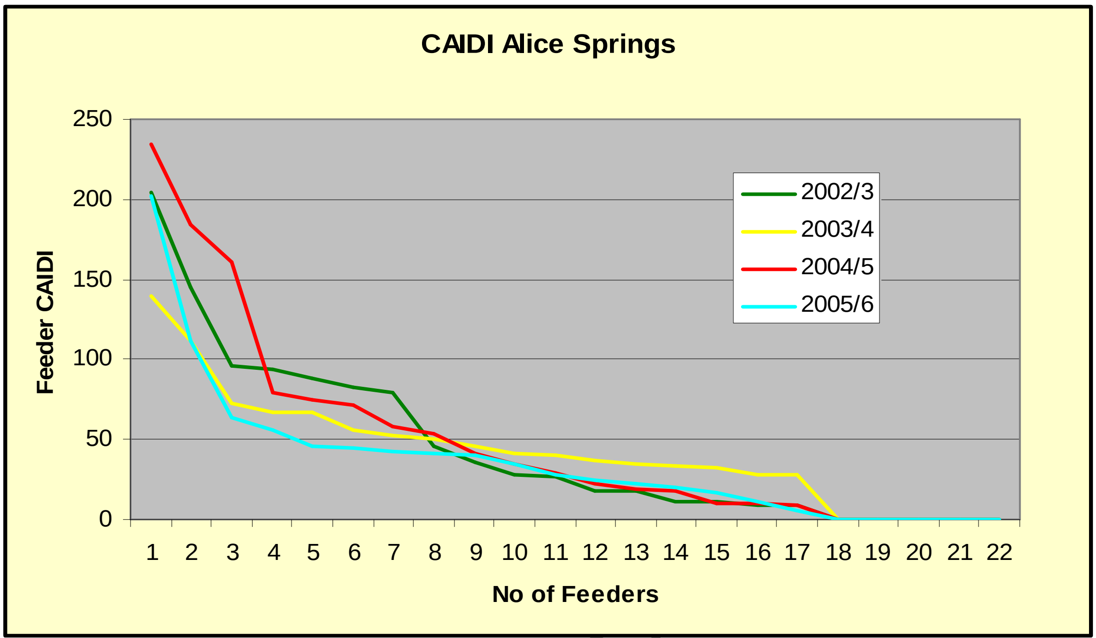



**Figure 17: Alice Springs Individual Feeder level Customer Average Interruption Duration Index (CAIDI) at PWC 2002/3 to 2005/6**



Katherine with only 14 feeders had an average of between 32 and 41 minutes per outage. The worst-case feeders typically were less than 100 minutes outage, with one exception in 2005/6 for 1 feeder, as shown in Figure 18. The performance in this area is again very good.

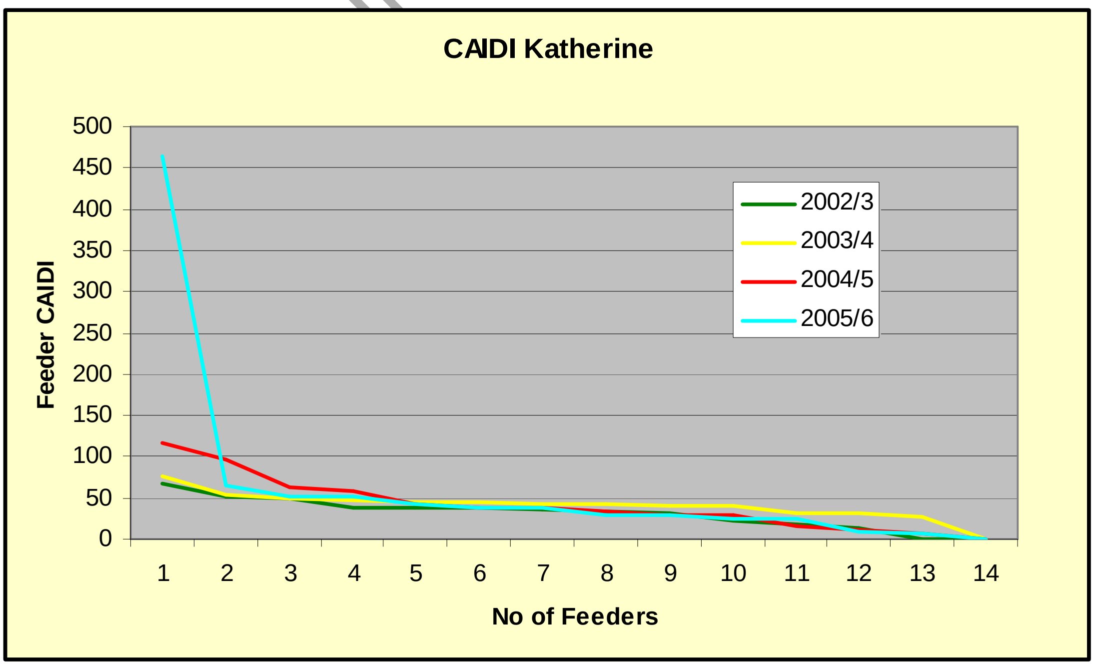



**Figure 18: Katherine Individual Feeder level Customer Average Interruption Duration Index (CAIDI) at PWC 2002/3 to 2005/6**

## 5.3 PWC's Generation Performance

### 5.3.1 Plant Availability

| Channel Island Total | | | | Annual Availability | | |
|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating MW | 2003/04 | 2004/05 | 2005/06 |
| GT 1 | GE Frame 6 | Gas or Diesel | 31.600 | 77.49% | 98.15% | 86.34% |
| GT 2 | GE Frame 6 | Gas or Diesel | 31.600 | 96.82% | 99.62% | 82.93% |
| GT 3 | GE Frame 6 | Gas or Diesel | 31.600 | 91.90% | 35.66% | 99.08% |
| GT 4 | GE Frame 6 | Gas or Diesel | 31.600 | 87.39% | 97.40% | 84.47% |
| GT 5 | GE Frame 6 | Gas or Diesel | 31.600 | 96.31% | 90.23% | 93.27% |
| ST 6 | Mitsubishi | Steam | 32.000 | 88.07% | 99.42% | 86.01% |
| GT 7 | GE LM6000 | Gas or Diesel | 36.000 | 70.17% | 80.35% | 70.34% |
| STATION | | | | 86.19% | 85.74% | 85.76% |

**Figure 19: Channel Island Power Station Availability of units**



Plant availability at Channel Island has not been particularly good, as can be seen in Figure 19. GE Frame 6 machines should achieve a long-term availability of over 95%, and between major hot gas path refurbishments (usually 6 yearly) availabilities of 97% to 98% are normal. Over the 3 years 2003/4 to 2005/6 only 3 unit years achieved over 97%. Both the steam turbine and the aero-derivative (LM6000) had lower availabilities than expected. Part of the reason is the difficulty in getting timely parts supply for unexpected replacement parts, but the rest of the poor performance is due to excessive outage time for major and minor overhauls and breakdown maintenance. It should be noted that the poor availability for GT3 in the 2004/5 year at 35.66% was due to a prolonged outage brought about by the failure of the alternator rotor, for which spares are not normally carried in a utility, and there is a long lead time to get an alternator rotor repaired.

| Katherine Total | | | | Annual Availability | | | |
|---|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating MW | 2002/03 | 2003/04 | 2004/05 | 2005/06 |
| GT 1 | Solar Mars | Gas or Diesel | 7.400 | 99.39% | 83.86% | 95.42% | 98.24% |
| GT 2 | Solar Mars | Gas or Diesel | 6.500 | 95.84% | 99.15% | 97.54% | 99.03% |
| GT 3 | Solar Mars | Gas or Diesel | 7.400 | 98.87% | 99.37% | 93.94% | 96.48% |
| STATION | | | | 98.04% | 94.13% | 95.64% | 97.87% |

**Figure 20: Katherine Power Station Availability of units**

The availability of units at Katherine Power station, as shown in Figure 20 is excellent and reflects the great care that is taken with this plant by the 3 local operators, along with an appropriate major and minor overhaul program. Given the issues at Channel

Island Power station and the significant load in the Darwin network these small units play a vital role in maintaining supply capacity on the interconnected Transmission network. Even for gas turbines, availability levels in the high 90’s are excellent.

| RGPS Total | | | | Annual Availability | | | |
|---|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating MW | 2001/02 | 2003/04 | 2004/05 | 2005/06 |
| Set 1 | Mirrlees KVSS12 | Diesel | 1.900 | 95.79% | 97.46% | 98.42% | 98.90% |
| Set 2 | Mirrlees KVSS12 | Diesel | 1.900 | 96.06% | 99.90% | 98.88% | 99.83% |
| Set 3 | Mirrlees KV16P Major | Dual Fuel | 4.200 | 95.82% | 93.90% | 68.46% | 77.64% |
| Set 4 | Mirrlees KV16P Major | Dual Fuel | 4.200 | 93.17% | 95.31% | 79.41% | 87.67% |
| Set 5 | Mirrlees KV16P Major | Dual Fuel | 4.200 | 83.03% | 96.53% | 94.52% | 94.51% |
| Set 6 | Pielstick PC2-3 V16 DF | Dual Fuel | 5.500 | 82.39% | 68.54% | 73.99% | 97.01% |
| Set 7 | Pielstick PC2-3 V16 DF | Dual Fuel | 5.500 | 88.46% | 91.86% | 90.88% | 7.33% |
| Set 8 | Pielstick PC2-3 V16 DF | Dual Fuel | 5.500 | 91.52% | 81.74% | 91.42% | 83.31% |
| Set 9 | ASEA GT35C | Gas or Diesel | 11.700 | 85.82% | 84.68% | 96.07% | 89.07% |
| Set 10 | Solar Titan 130 | Gas or Diesel | 10.100 | | | | 90.04% |
| F Set | Kongsberg KG5 | Gas or Diesel | 2.000 | 97.91% | 87.86% | 78.50% | 96.26% |
| G Set | Kongsberg KG5 | Gas or Diesel | 2.000 | 81.74% | 74.89% | 83.22% | 89.51% |
| H Set | Solar Taurus | Gas or Diesel | 3.900 | | | 95.32% | 96.36% |
| STATION | | | | 90.16% | 85.03% | 85.56% | 83.04% |

**Figure 21: Alice Springs Power Station Availability of units**



The majority of units at RGPS in Alice Springs are reciprocating engines that run predominantly on gas but can run on diesel, and should have a high availability. At least three of these units have run over 100,000 hours and will need to be replaced within the next 5-10 years. Availability of the units tends to reflect the age of the assets. Five of the units have had an excellent performance with availability in the high 90’s. The recently installed 10 MW Solar gas turbine is operating with an availability of 90%, which is acceptable for the first year of operation.
The Diesel units at Yulara are operating with a combined availability of 67.8%, and at Tennant Creek 85.8%. These levels of performance are low, and to some extent reflect the difficulty of getting resources to maintain and restore plant to service in the more remote locations.

### 5.3.2 Forced Outage Rates

Forced Outage rates are indicative of the appropriateness of the maintenance being carried out. Forced outages should be quite low for well-maintained plant running on gas or diesel fuel. The following figures show the forced outage rates for the 3 major power stations in the Northern Territory network.

| Channel Island Total | | | | Annual Forced Outage Factor | | | |
|---|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating | 2003/04 | 2004/05 | 2005/06 | Average |
| GT 1 | GE Frame 6 | Gas or Diesel | 31.600 | 4.41% | 0.30% | 2.96% | 2.55% |
| GT 2 | GE Frame 6 | Gas or Diesel | 31.600 | 0.65% | 0.03% | 0.10% | 0.26% |
| GT 3 | GE Frame 6 | Gas or Diesel | 31.600 | 0.19% | 60.21% | 0.67% | 20.36% |
| GT 4 | GE Frame 6 | Gas or Diesel | 31.600 | 0.00% | 0.23% | 0.80% | 0.34% |
| GT 5 | GE Frame 6 | Gas or Diesel | 31.600 | 1.01% | 1.94% | 0.37% | 1.11% |
| ST 6 | Mitsubishi | Steam | 32.000 | 0.18% | 0.58% | 0.94% | 0.57% |
| GT 7 | GE LM6000 | Gas or Diesel | 36.000 | 22.81% | 12.66% | 21.25% | 18.91% |
| Station | | | | 4.92% | 10.87% | 4.20% | 6.67% |

**Figure 22: Annual Forced outage rates at Channel Island Power Station**

For gas turbine plant both Frame and Aero-derivative the forced outage rates should be at or below 1% for best practice. As shown in Figure 22, 3 of the 6 gas turbines are at or about best practice, while the other 3 are far from adequate. The LM6000 has had a poor history and PWC seems to have done all the necessary things to improve its performance, but it still performs poorly. The steam set is where it should be. On the whole there is significant room for improvement in the plant forced outage rates and to some extent it is reflective of the age of the auxiliary systems. More maintenance on the auxiliary systems would lead to improvements in the forced outage rates of the units. As noted above the high forced outage rate for GT# in 2004/5 was due to the rotor failure.

Given the limited spinning reserve that is run in the Darwin network, forced outages almost inevitably lead to load shedding, which increases customer minutes off supply.

| Katherine Total | | | | Annual Forced Outage Factor | | | |
|---|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating | 2003/04 | 2004/05 | 2005/06 | Average |
| GT 1 | Solar Mars | Gas or Diesel | 7.400 | 12.85% | 1.60% | 0.72% | 5.06% |
| GT 2 | Solar Mars | Gas or Diesel | 6.500 | 0.31% | 0.21% | 0.37% | 0.30% |
| GT 3 | Solar Mars | Gas or Diesel | 7.400 | 0.12% | 4.94% | 0.88% | 1.98% |
| Station | | | | 4.43% | 2.25% | 0.67% | 2.45% |

**Figure 23: Annual Forced outage rates at Katherine Power Station**

The Katherine machines are generally well maintained, however there have been 2 out of 3 years when one unit has not performed at its best as can be seen from Figure 23. The performance in 2005/6 is more in line with industry best practice, and despite the age of the units because of a good set of maintenance procedures, and currency of spares for the auxiliary systems there is no reason to believe that the plant cannot continue to perform at this level.

| RGPS Total | | | | Annual Forced Outage Factor | | | |
|---|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating | 2003/04 | 2004/05 | 2005/06 | Average |
| Set 1 | Mirrlees KVSS12 | Diesel | 1.900 | | 1.51% | 1.01% | 1.26% |
| Set 2 | Mirrlees KVSS12 | Diesel | 1.900 | | 0.96% | 0.11% | 0.54% |
| Set 3 | Mirrlees KV16P Major | Dual Fuel | 4.200 | | 1.43% | 9.19% | 5.31% |
| Set 4 | Mirrlees KV16P Major | Dual Fuel | 4.200 | | 6.21% | 9.86% | 8.04% |
| Set 5 | Mirrlees KV16P Major | Dual Fuel | 4.200 | | 3.01% | 1.21% | 2.11% |
| Set 6 | Pielstick PC2-3 V16 DF | Dual Fuel | 5.500 | | 7.01% | 1.62% | 4.32% |
| Set 7 | Pielstick PC2-3 V16 DF | Dual Fuel | 5.500 | | 7.44% | 91.93% | 49.69% |
| Set 8 | Pielstick PC2-3 V16 DF | Dual Fuel | 5.500 | | 7.21% | 11.00% | 9.10% |
| Set 9 | ASEA GT35C | Gas or Diesel | 11.700 | | 2.25% | 1.10% | 1.68% |
| Set 10 | Solar Titan 130 | Gas or Diesel | 10.100 | | | 6.95% | 6.95% |
| F Set | Kongsberg KG5 | Gas or Diesel | 2.000 | | 21.49% | 3.36% | 12.43% |
| G Set | Kongsberg KG5 | Gas or Diesel | 2.000 | | 16.62% | 9.75% | 13.18% |
| H Set | Solar Taurus | Gas or Diesel | 3.900 | | 2.54% | 0.36% | 1.45% |
| Station | | | | 6.97% | 9.14% | 12.28% | 9.46% |

**Figure 24: Annual Forced outage rates at Alice Springs Power Station**

The oldest diesel fuel only sets 1 & 2 are performing at a very credible forced outage rate of less than 2% as shown in Figure 24. For old diesel plant this is a good performance. At the other end of the scale the latest Solar Titan and Taurus machines are exhibiting the usual teething troubles, but should settle down to a forced outage rate of less than 1%. There are some units that are clearly not performing well and it is likely that insufficient maintenance is taking place on these machines. Site visits indicated that there is a shortage of appropriately skilled diesel mechanics and Instrumentation and Control technicians to enable effective maintenance to be carried out.



### 5.3.3 Plant efficiency

The plant efficiency for the interconnected generation in the Darwin and Katherine network is shown in Figure 25. The efficiency is calculated on the basis of energy generated in MWhr versus the RGCV (Gross Calorific Value) of the Fuel used in generating the output. There has been a slight deterioration in efficiency in all units at Channel Island from around 25.7% to around 24.8% over a 3-year period as shown in Figure 26. Aging of plant and time since last major overhaul both impact on generator efficiency. Clearly from a merit order the LM6000 should be run first, after the combined cycle units, which are GT's 4 and 5 and ST6. Note that plant efficiency for combined cycle units is usually calculated for the total plant configuration. GT's 4 and 5 and ST6 as a combined cycle unit would have plant efficiency of the order of 38%. The Katherine units that need to be run very frequently to meet the build up peak demand are the least efficient units on the system. Taking into account the transmission losses the Katherine units should ideally only be run to meet the

Katherine load. Overall the plant efficiency is a little low, but it reflects the general age of the plant.

| Channel Island | | | | Plant efficiency on energy generated basis | | | |
|---|---|---|---|---|---|---|---|
| Location | Plant type | Fuel | Nominal Rating | 2002/03 | 2003/04 | 2004/05 | 2005/06 |
| GT 1 | GE Frame 6 | Gas or Diesel | 31.600 | 25.68% | 25.52% | 24.81% | 25.14% |
| GT 2 | GE Frame 6 | Gas or Diesel | 31.600 | 25.88% | 25.54% | 24.82% | 25.19% |
| GT 3 | GE Frame 6 | Gas or Diesel | 31.600 | 25.84% | 25.53% | 24.78% | 25.20% |
| GT 4 | GE Frame 6 | Gas or Diesel | 31.600 | 25.72% | 25.42% | 24.84% | 25.16% |
| GT 5 | GE Frame 6 | Gas or Diesel | 31.600 | 25.62% | 25.48% | 24.88% | 25.17% |
| ST 6 | Mitsubishi | Steam | 32.000 | | | | |
| GT 7 | GE LM6000 | Gas or Diesel | 36.000 | 31.25% | 30.56% | 30.17% | 31.38% |
| Station | | | | 33.74% | 33.33% | 33.18% | 32.53% |
| **Katherine** | | | | | | | |
| GT 1 | Solar Mars | Gas or Diesel | 7.400 | 22.23% | 21.85% | 24.89% | 24.99% |
| GT 2 | Solar Mars | Gas or Diesel | 6.500 | 17.00% | 24.61% | 23.85% | 24.35% |
| GT 3 | Solar Mars | Gas or Diesel | 7.400 | 21.50% | 24.02% | 24.73% | 22.36% |
| Station | | | | 23.45% | 23.70% | 24.32% | 24.21% |

**Figure 25: Annual Plant efficiency at Channel Island and Katherine Power Stations**



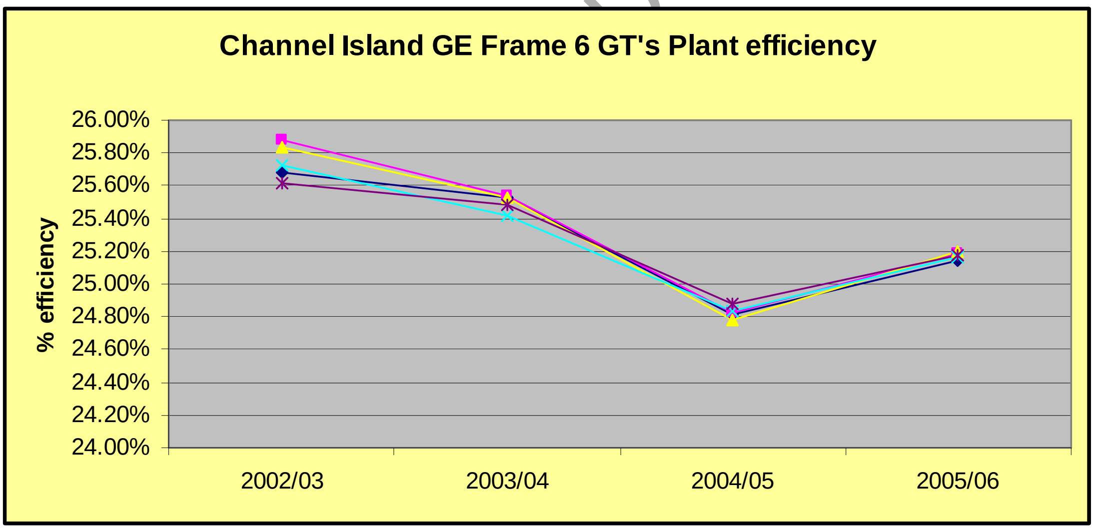



**Figure 26: Annual Plant efficiency at Channel Island for the Frame 6 GE gas turbines**

## 5.4 PWC's Water and Sewerage Network Performance

### 5.4.1 Darwin Water supply Reliability

PWC has participated in the national water benchmarking study in both 2002/3 and 2005/6. Benchmarking indicates that PWC can improve performance by reducing costs and increasing service levels of some civil maintenance activities. However it was found that supply reliability is quite good by Australian standards. The average customer outage time for planned outages is shown in Figure 27 and PWC is a significantly better performer than the Australian Average.

PWC water and sewerage business unit has a multi skilled and flexible labour force with good integration of direct labour and contract activities and it makes good use of these resources to deliver low outage times.

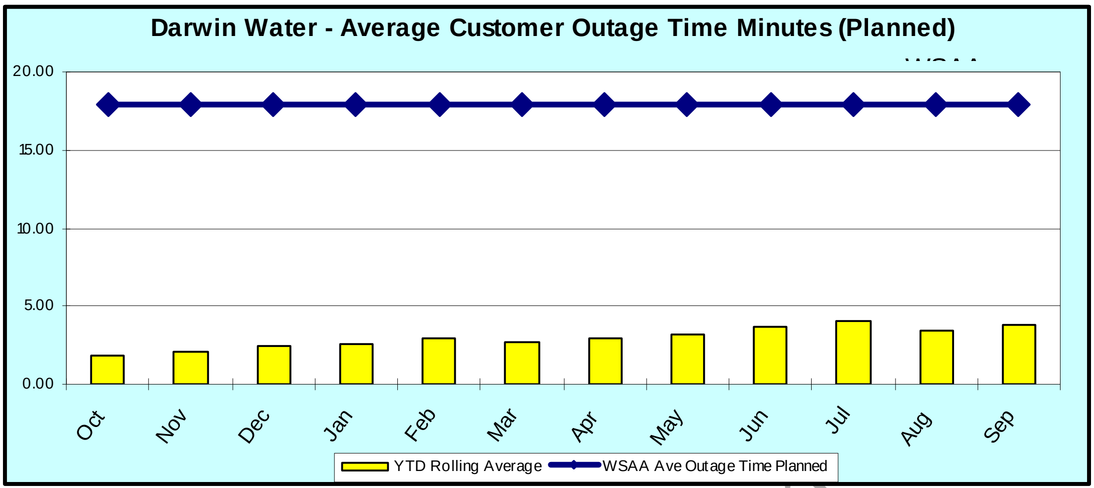



**Figure 27: Darwin Water Average planned outage time per customer**

The average customer minutes off supply due to unplanned outages are also well below the Australian Average as shown in Figure 28. This is a good result and it indicates a generally quick response to outages due to pipe breakages.

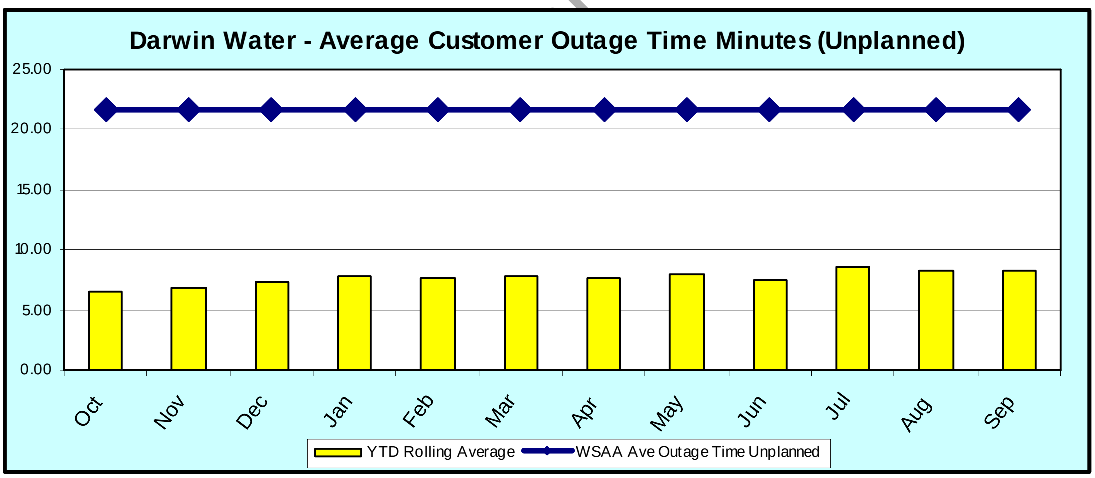



**Figure 28: Darwin Water Average unplanned outage time per customer**

The average planned duration of interruptions are shown in Figure 29 for the Darwin Water system. These figures compare well with the Statement of Corporate Intent (SCI) target, and are comparable with Australian averages.

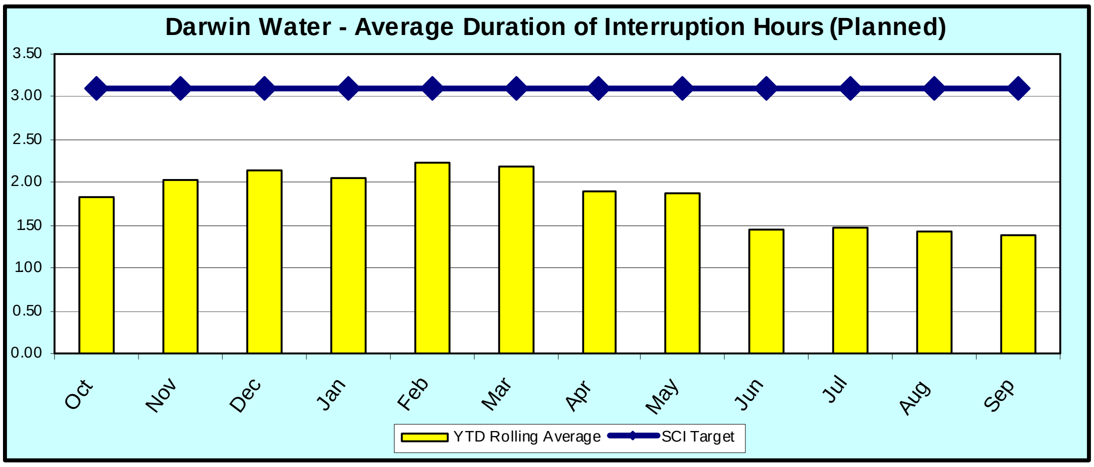



**Figure 29: Darwin Water Average planned duration of interruption**

On a similar basis the average duration of unplanned outages shows less than 1 hour which is well below the SCI target and below the Australian averages as can be seen in Figure 30.

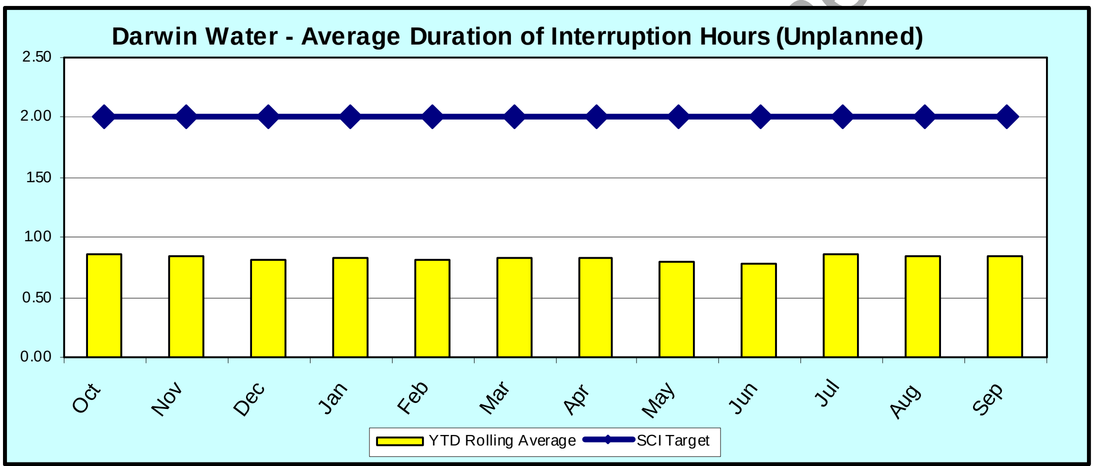



**Figure 30: Darwin Water Average unplanned duration of interruption**

The unplanned interruption frequency is shown in Figure 31. While this is still below the Australian water industry average it is only marginally below, which gives an indication that the assets may be starting to age.

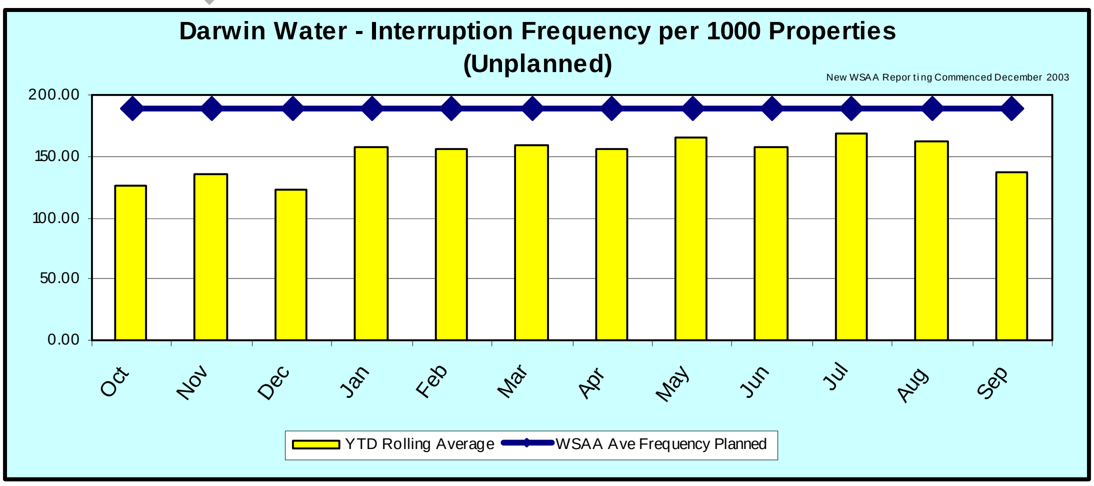



**Figure 31: Darwin Water Interruption Frequency per 1000 customers**

In summary the Darwin water system performance with respect to reliability is better than the Australian average, an d it is at least in part due to a smaller geographic service area, good response times from field staff and contractors, and good planning of outages. The frequency rate is becoming a challenge, which indicates that some assets are reaching higher failure rates.

### 5.4.2 Darwin Sewerage system Reliability

The previous National Water Services Association of Australia (WSAA) benchmarking study indicated that “Productivity is the key issue for PWC in high cost activities and the immediate focus should be on wastewater”. The performance of the sewerage staff and contractors on unplanned outages is shown in Figure 32 where the performance of PWC is at or slightly above the industry average. While there is no cause for alarm, there are indications that the assets are in need of some additional refurbishment or replacement. It is noted that a re-lining program is in progress for the main sewer pipes and this when completed should see a reduction in average customer outage times.

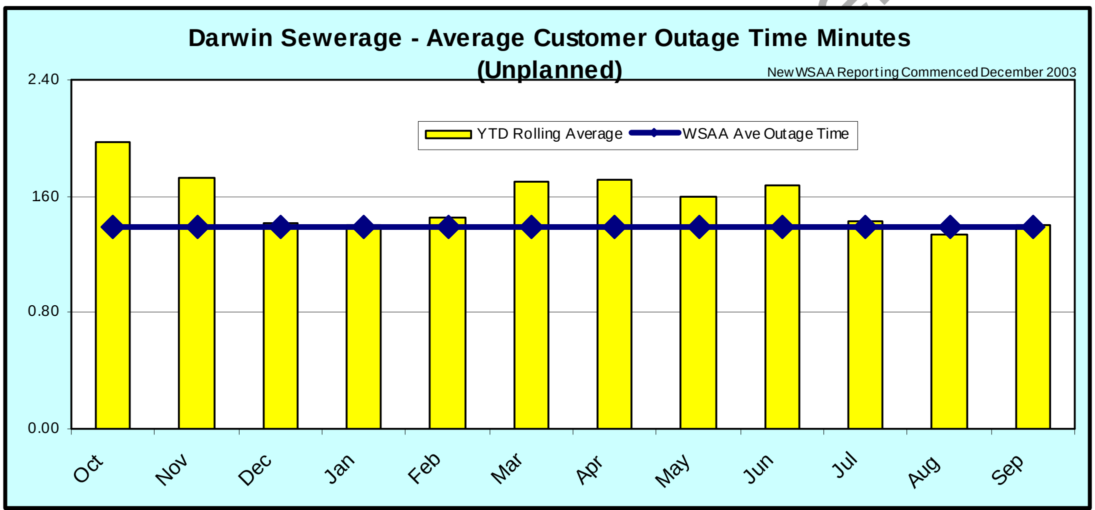



**Figure 32: Darwin Sewerage Average unplanned outage time per customer**

The average duration of interruption shown in Figure 33 is a creditable 1.5 hours against and SCI target of 3 hours, which is also the WSAA average.

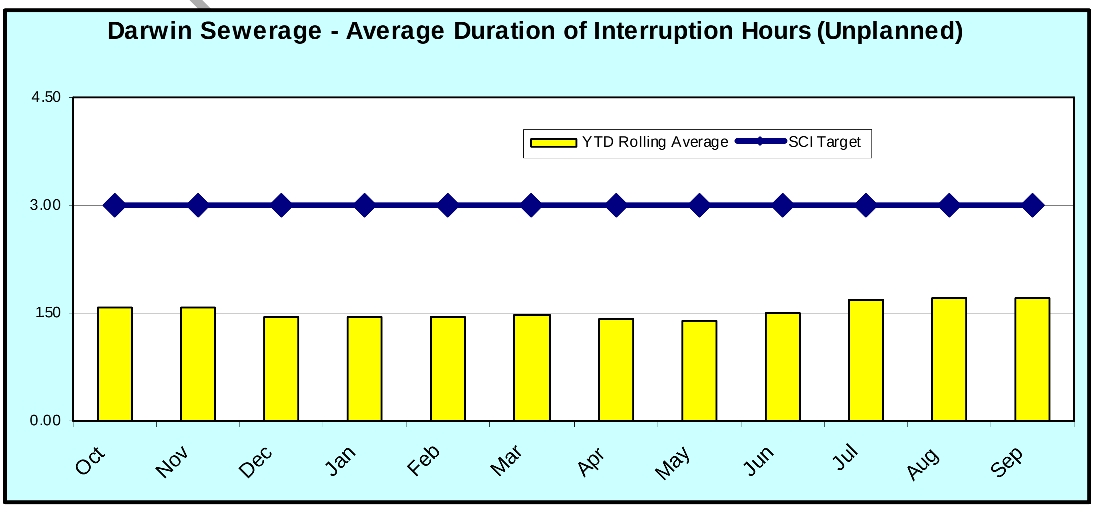



**Figure 33: Darwin Sewerage Average duration of Interruption**

Again the interruption frequency as shown in Figure 34 is well above the industry average, and is a further indication of deteriorated assets.

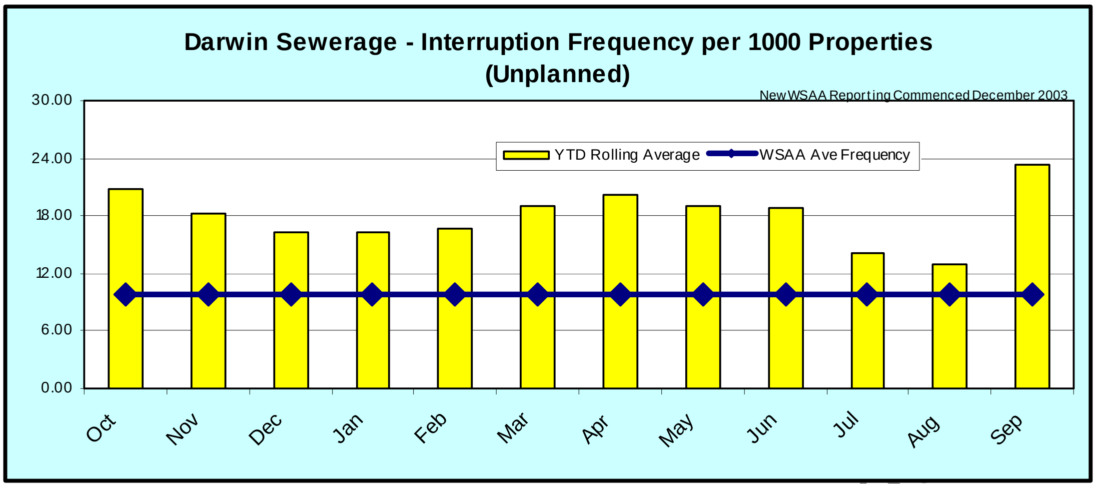



**Figure 34: Darwin Sewerage Interruption Frequency per 1000 customers**

### 5.4.3 Alice Springs Water supply reliability

Planned outages on the Alice Springs water supply system are carried out at well ahead of the industry average (17.9Minutes) as shown in Figure 35. The small size of the network does help in this area; however efficient staff and contractors are also a key factor in achieving this result.

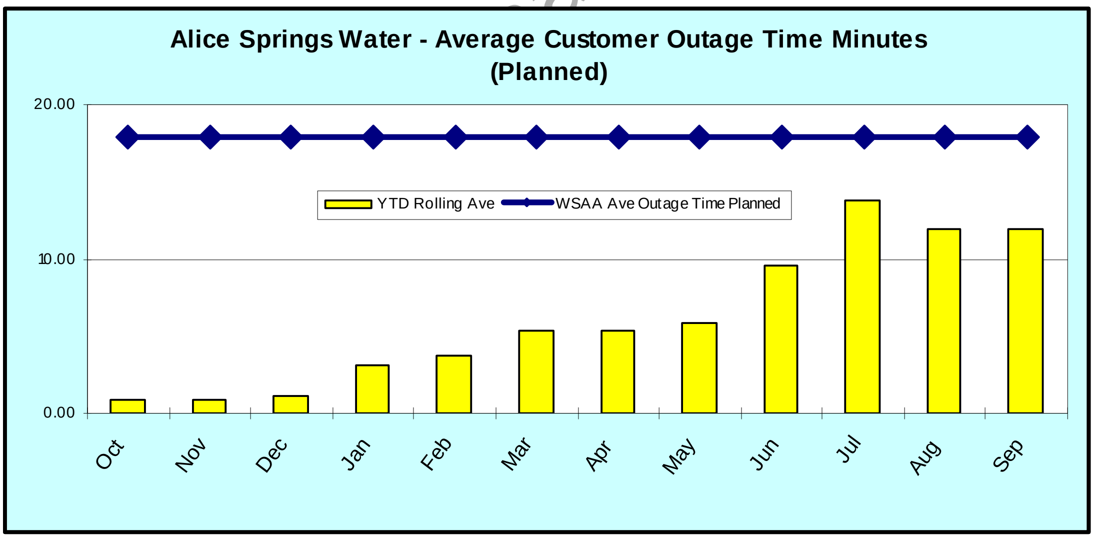



**Figure 35: Alice Springs Water Average planned outage time per customer**

The average unplanned outage times are at or about the Australian average (21.7 minutes) as shown in Figure 36. This implies that unlike the planned work, response time to get to and affect repairs is a little long. This is partly due to resource limitations again in a small community, where it is not always possible to get urgent response from contractors. However given that Alice Springs is at the WSAA average there are no immediate concerns in this area.

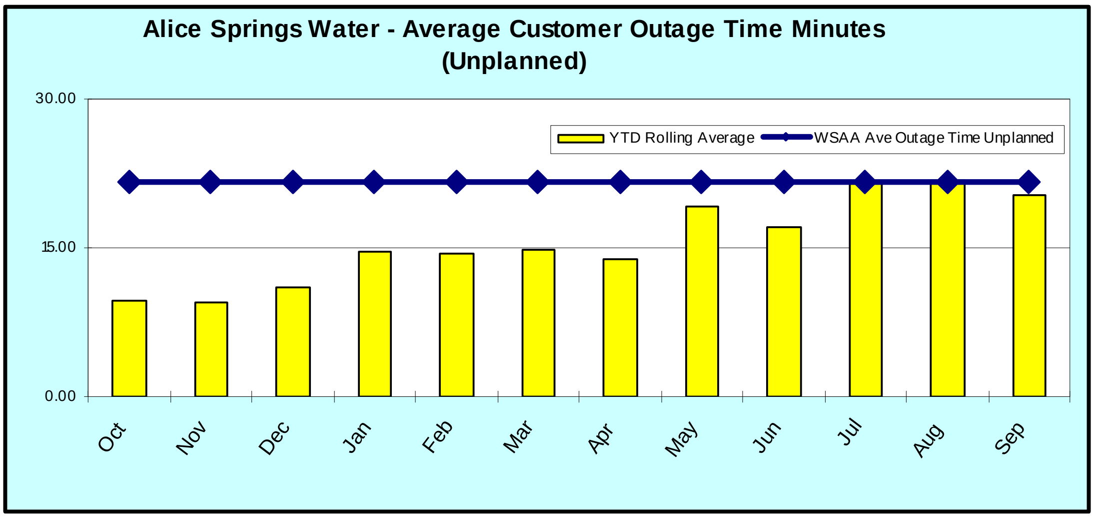



**Figure 36: Alice Springs Water Average unplanned outage time per customer**

The average unplanned customer outage duration in hours is a little below the Australian average (2 hours) as shown in Figure 37, as is the planned outage duration shown in Figure 38. The frequency of unplanned interruptions took an upward turn in September, pushing the rolling average marginally above the WSAA Australian Average. This should not be of concern provided that the trend returns to the previous good performance level as shown in Figure 39.

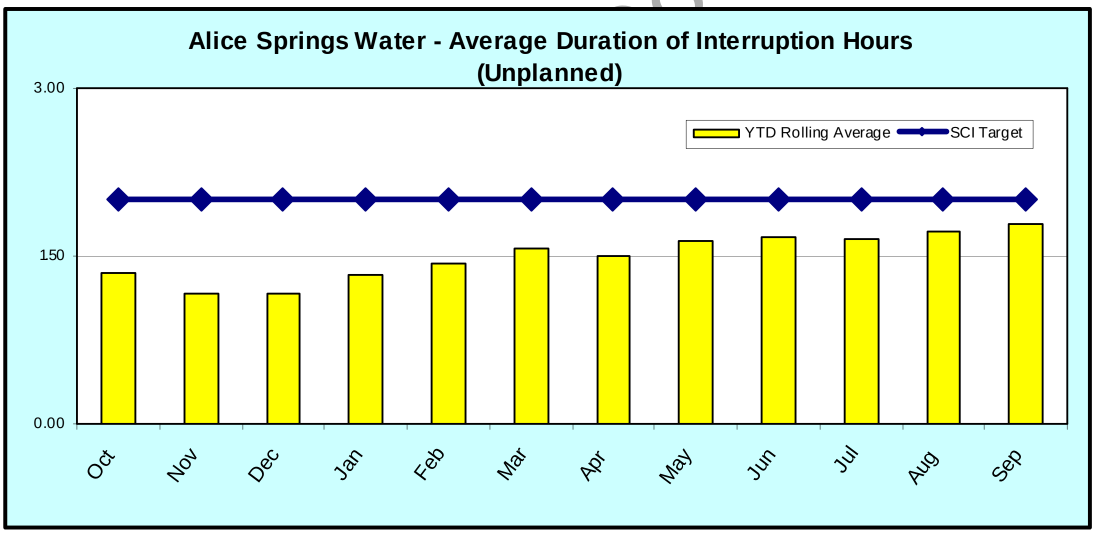



**Figure 37: Alice Springs Water Average unplanned duration of interruption**

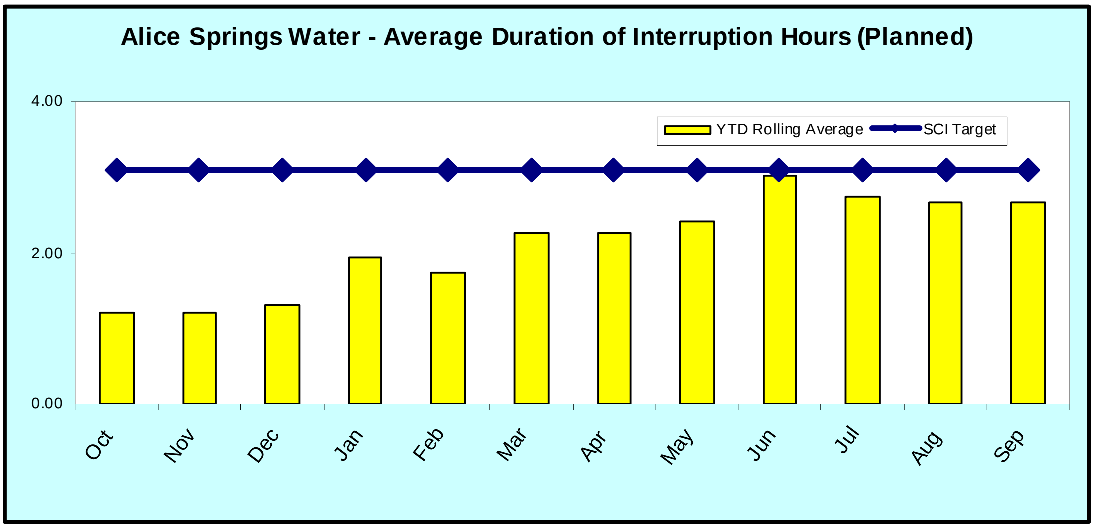



**Figure 38: Alice Springs Water Average planned duration of interruption**

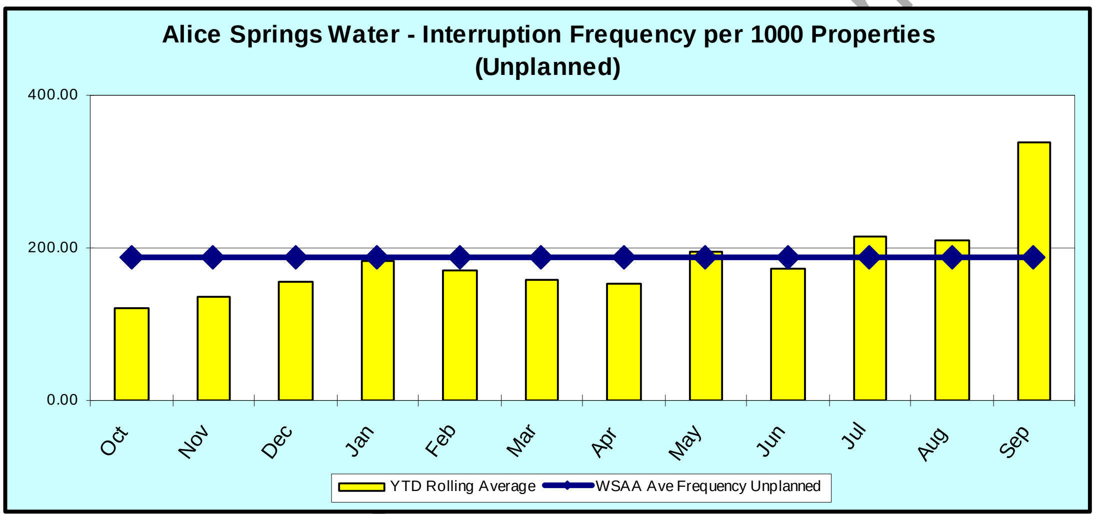



**Figure 39: Alice Springs Water unplanned interruption Frequency per 1000 properties**

### 5.4.4 Alice Springs Sewerage system Reliability

The Alice Springs sewerage system is performing well in terms response to unplanned outages and frequency of outages in the system as shown in Figure 40, Figure 41 and Figure 42. In all areas the performance is significantly better than the WASW average. However the size of the network should lead to this result.

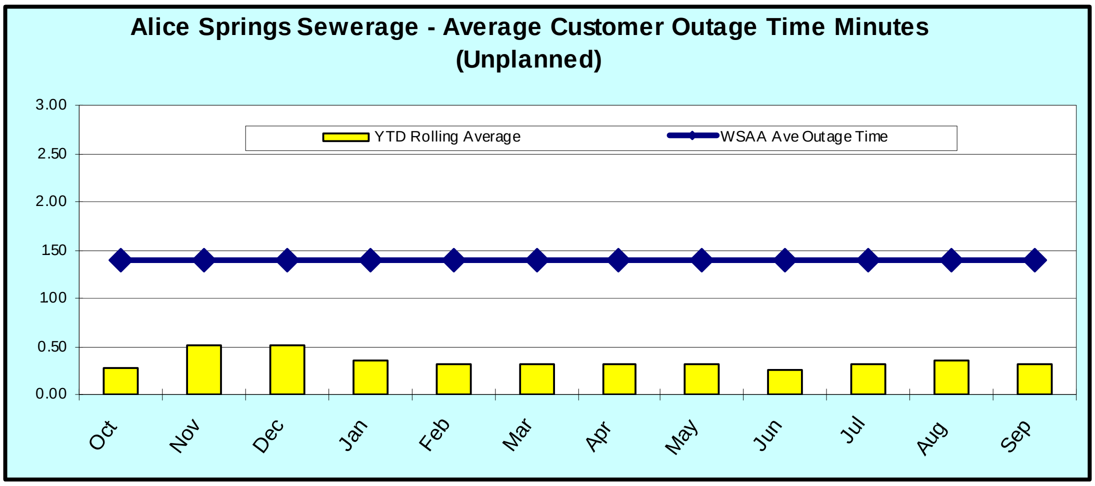



**Figure 40: Alice Springs Sewerage Average unplanned customer outage time**

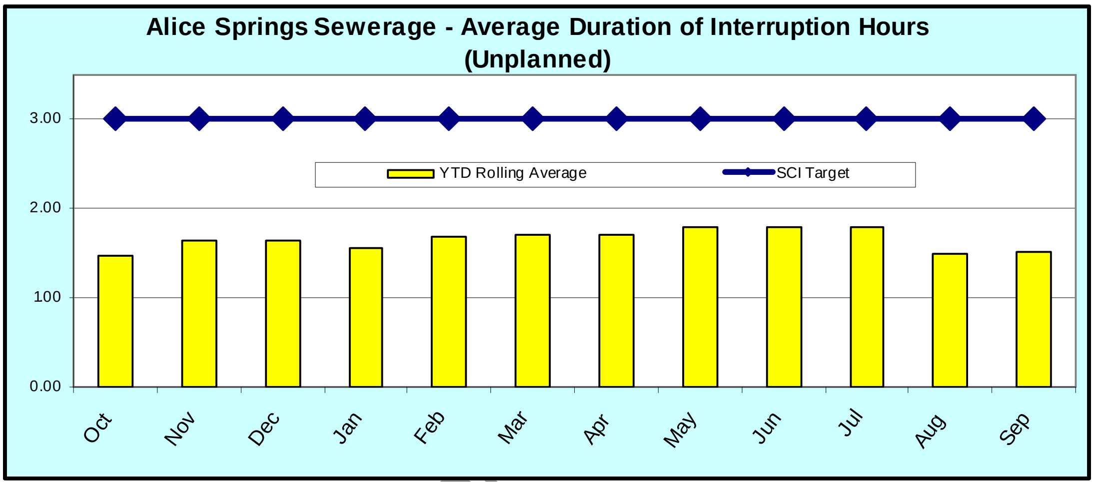



**Figure 41: Alice Springs Sewerage Average unplanned duration of interruption**

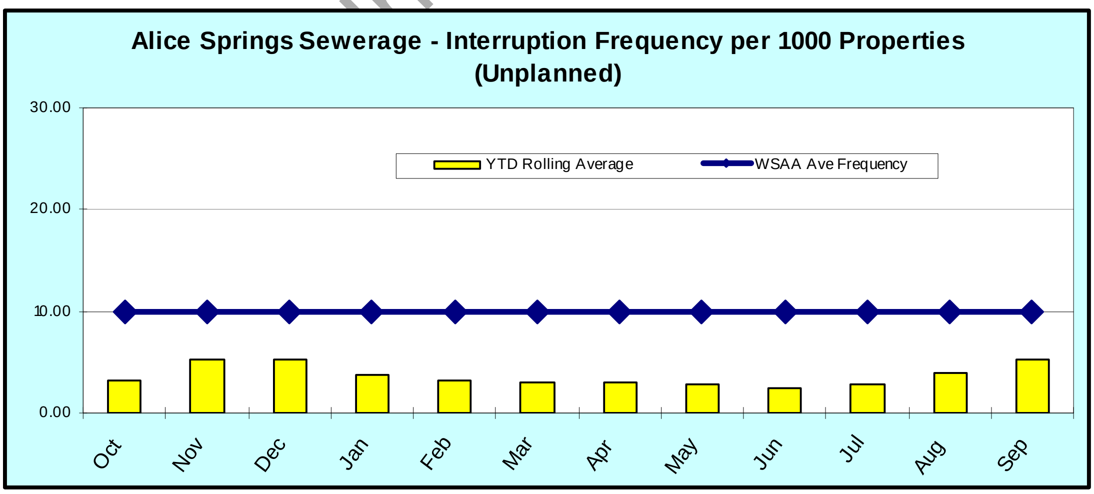



**Figure 42: Alice Springs Sewerage interruption Frequency per 1000 properties**

# 6 Capital Expenditure

Absolute amounts of expenditure are difficult to benchmark and will not always be indicative of adequacy or otherwise of the proposed levels of capital expenditure in a network. This follows from the fact that past capital expenditure patterns and the age of the individual assets, together with customer driven capital requirements will have a big impact on required capital expenditure. The best way of determining if capital expenditure is appropriate is to look at the state of and performance of the existing assets, together with the forecast load growth in various parts of the network.

To assess the state of the network the following factors were considered.

## 6.1 Contingent Capacity

### 6.1.1 Bulk Supply Point (Terminal station)

PWC takes supply for the Darwin Network from Channel Island Power Station and the Katherine Power Station and Pine Creek power station by 132kV lines terminating at Hudson Creek. There are 3 transformers at Hudson Creek that convert the 132kV to 66kV for Distribution to Darwin.

For the worst case loss of a single transformer, and at nominal rating terminal station meets the N-1 reliability criteria, see Figure 43. There is currently around 16% spare capacity at nominal rating to accommodate load growth while still retaining an N-1 capability. While this position is acceptable at the present time, if load growth continues at the present rate, some augmentation of main terminal station will need to be seriously considered in the 5-10 year time frame.

Note that there is normally a further 20-25% capacity available to meet short-term peaks by using the short time emergency cyclic rating capability of the transformers. This should enable Hudson Creek to meet load growth for some time. There is however a risk to Darwin supply by a catastrophic failure at Hudson Creek, because it is the only connection into Darwin from the Generation System. This is similar to the recent failure in Auckland, where a broken earth wire took out the whole of Otahu Terminal station thus blacking out Auckland. This just re-emphasise the need to keep all of the Hudson Creek assets well maintained, to reduce exposure to a catastrophic failure.



| Terminal Station Name | No of Trans-formers | Primary Voltage | Nominal Ratings | Secondary Voltage | N-1 Nominal Rating | Peak Summer Load 2005/6 | % Above nominal rating 2005/6 | Projected Peak Load Summer 2006/7 | % Above nominal rating 2006/7 |
|---|---|---|---|---|---|---|---|---|---|
| Hudson Creek | 3 | 132kV | 3x75/125 | 66kV | 250MVA | 205.1MVA | -18% | 211.2MVA | -16% |

**Figure 43: Point of Supply peak demand 2005/6 and 2006/7**

### 6.1.2 Transmission Lines

The major transmission lines feeding Hudson Creek terminal station are from Channel Island Power station. These 2 lines are critical to supply reliability to Darwin City.

There is sufficient spare capacity to meet N-1 reliability conditions as shown in Figure 44. Given that the ratings are on a nominal basis, and it is possible to run transmission lines at an emergency cyclic rating of up to 20% above nominal rating there is sufficient spare capacity to meet load growth needs for at least the next 5-10 years given the current long term load growth trend. It should be noted that transmission lines require a very long lead-time, particularly if new easements are required.

There is at least a slight risk of a double contingency event causing severe limitations to supply to Darwin if both circuits were to be taken out of service. Such an event could occur due to severe storm or bushfire because both circuits share the same easement. Future transmission development should consider an alternative easement to Hudson Creek.

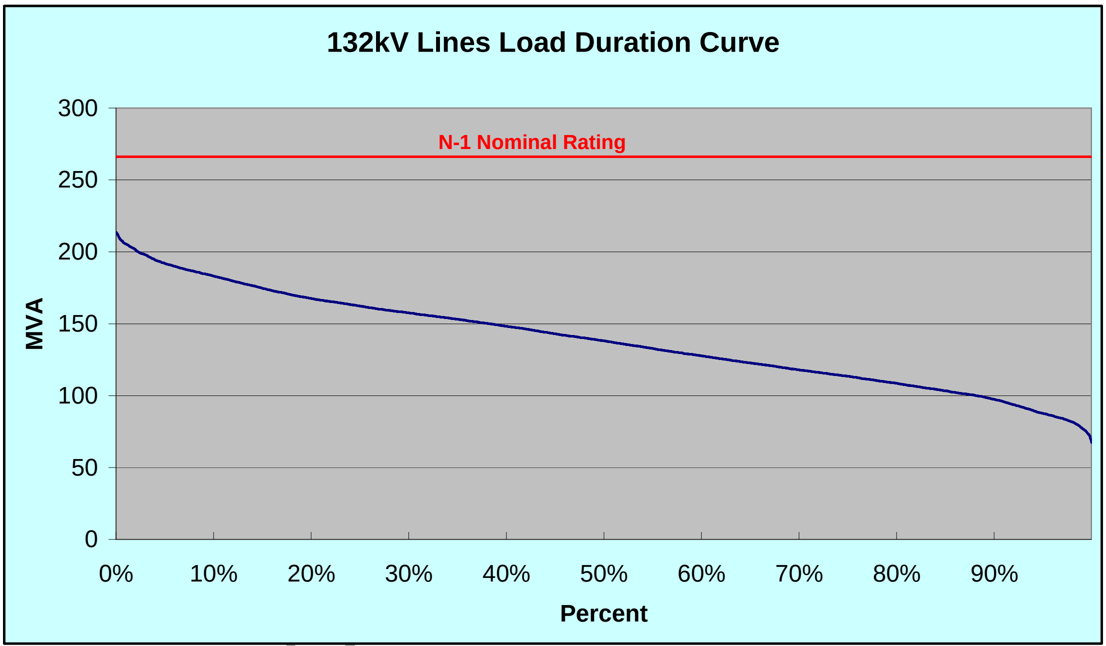



**Figure 44: Critical Transmission Lines Load Duration Curve**



### 6.1.3 Zone Substations

PWC has 13 substations with multi transformer installations. These provide a certain degree of reliability to the N-1 planning criteria. There are also 6 zone substations of the single transformer design, which are servicing more rural or customer specific reliability requirements. At actual peak demand in 2006 there were no substations that did not meet N-1 reliability criteria using nominal ratings, as can be seen from Figure 45. Note that the chart shown in Figure 46 indicates a 20% emergency cyclic capacity, which is well above the current conservative nominal capacity assumed by PWC. Provided that the peak load is of short duration the use of a higher short-term cyclic rating would be justified.

| Substation Name | Highest peak demand MVA | Lowest peak demand MVA | Average Load MVA | Load Factor | N-1 Nominal Rating MVA | Margin above Peak at N-1 |
|---|---|---|---|---|---|---|
| Berrimah | 33.0 | 17.0 | 18.20 | 0.55 | 38 | 15% |
| Casuarina | 39.0 | 21.7 | 25.41 | 0.65 | 76 | 95% |
| City Zone | 49.0 | 34.0 | 29.71 | 0.61 | 80 | 63% |
| Manton | 3.2 | 1.2 | 1.90 | 0.59 | Single unit | 0% |
| McMinns | 17.0 | 1.0 | 6.43 | 0.38 | 27 | 59% |
| Palmerston | 35.0 | 21.0 | 22.30 | 0.64 | 47.5 | 36% |
| Snell Street | 32.0 | 15.0 | 18.20 | 0.57 | 35 | 9% |
| Hudson Creek | 206.0 | 127.0 | 123.00 | 0.60 | 250 | 21% |

**Figure 45: Loading data for 2005 Northern Zone Substations**

At this time PWC do not have any plans to increase their Zone Transformer Capacity in existing multi transformer zone substations, which is appropriate for the next five years. PWC is however building a new Zone substation to meet reliability concerns in the Darwin CBD, It should be stressed that achieving high zone substation transformer utilisation by reliance on load transfer in the 11kV network should not be carried to far, or used in the case where high reliability is required such as major industrial sites or in cities. Over use of this approach could lead to negative impact on reliability statistics, and potential damage to PWC's reputation.



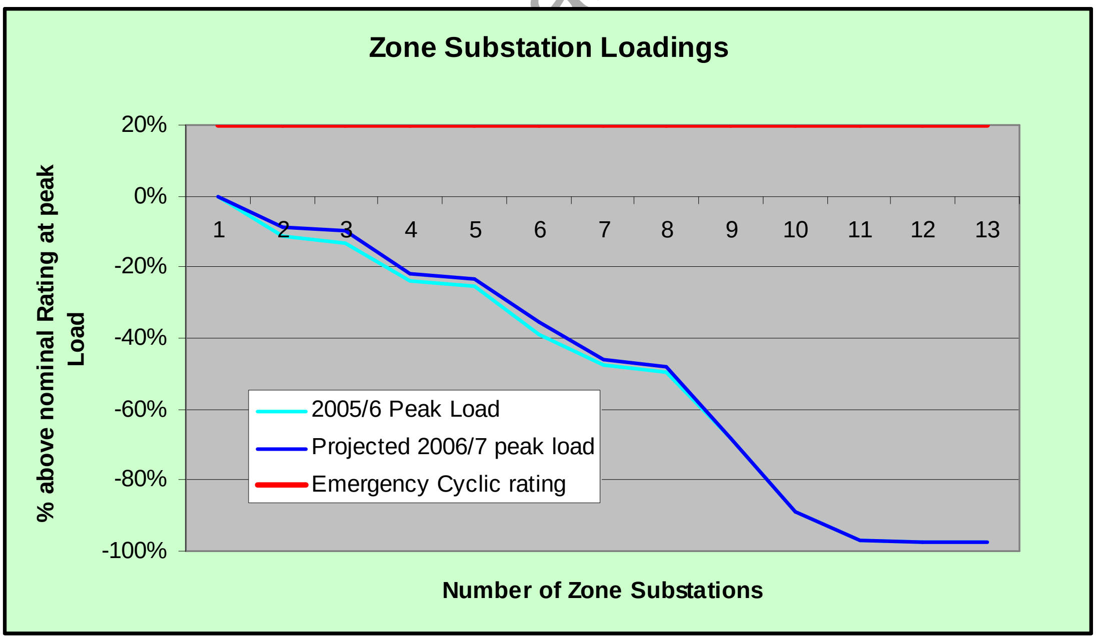



**Figure 46: Capacity of PWC Multi Transformer Zone Substations 2006 and 2007**

### 6.1.4 11kV and 22kV Feeders

The PWC 11kV and 22kV network has significant spare capacity at this time, which is important given the large degree of back up which the network provides for failure of a zone substation transformer. The average peak feeder utilisation is 55%. Figure

47 shows that only 5 feeders in the 11kV and 22kV networks exceed rating at maximum load and at the projected peak load for 2006/7 only 5 feeders are expected to exceed nominal capacity, the worst by 20%.

There is further scope to increase capacity in the 11kV and 22kV feeder networks by use of short-term ratings to meet peak demands. This approach, which is commonly used in Network businesses, is going to be implemented in PWC. This will enable the feeder network to supply peak capability for some years. A rebalancing of some of the highest loaded feeders will be necessary. Feeder upgrading should only be required to replace any aging feeder assets, or to meet spot load growths for the foreseeable future.

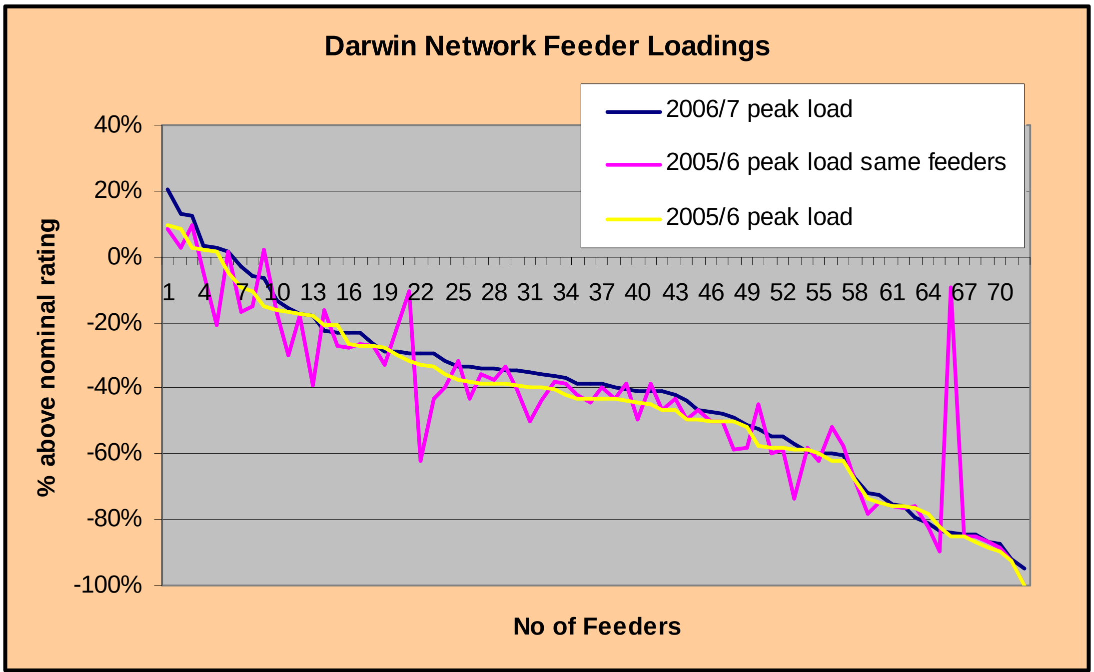



**Figure 47: Utilisation of Darwin 11kV Feeders at peak loading in 2005/6 and 2006/7**

There is little need to upgrade feeders to meet capacity requirements however the PWC Network, like most similar networks, is more driven by voltage drop issues than by pure current carrying capacity. There is a need to address voltage drops on long feeders, and the Asset Management Plan, and more recent management attention has identified the need to improve voltage performance on the network. Installing more voltage regulators at strategic points on long feeders will drive some of this improvement, and in some cases augmentation of feeder capacity will be required. I am confident that PWC Management is looking at "least cost" approaches to improve voltage performance, and will only upgrade feeders as a last resort.

### 6.1.5 Distribution Transformers

The overall peak distribution transformer utilisation for PWC is 18.6% for the 2004/5 year, based on installed capacity compared with peak demand, taking into account total system losses of 8.9%. The average utilisation of distribution transformers, which looks at total system demand against installed capacity, is a fairly low 8.2% compared with the Australian average utilisation of 21.5%. All utilities are keen to increase the distribution transformer and low voltage asset utilisation figures, however the load shape at the consumer level largely drives this.

Despite the fairly low utilisation factor at PWC, like most other utilities there will be some distribution transformers that are heavily loaded or even overloaded. Some replacement capital is needed to cater for these and to replace aged distribution transformers.

## 6.2 Past and Future Capital Expenditure at PWC

Past capital expenditure at PWC and its predecessor organisation is shown in Figure 48. It illustrates a general underspend of capital. It is most unusual for a utility with assets of the age profile as those in PWC to not be spending at least the equivalent of the asset depreciation on refurbishment or replacement. Given that there has been load growth of around 3% annually over the past many years it would be expected that new assets would also require significant capital expenditure. Even if government or customer contributions initially paid for a number of the assets there is always some component of head works augmentation to meet customer load growth, and that requires new capital over and above depreciation levels of expenditure.

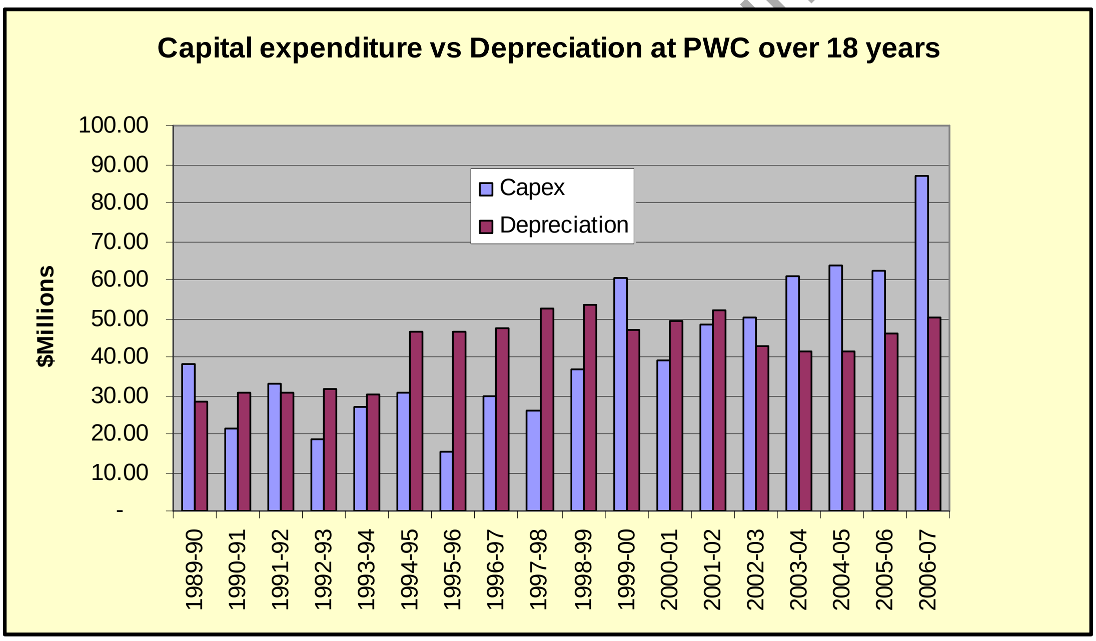



**Figure 48: Capital Expenditure and Depreciation & Amortisation at PWC past 18 years**

The cumulative capital expenditure over the past 18 years is shown in Figure 49 and it indicates that with the higher capital spend over the past 5 years, the total capital has approached the cumulative depreciation level. Given the load growth and the aging of assets there is no doubt that capital spending will need to increase further in the next 5 years to ensure that the performance of the electrical and water and sewerage networks maintain an adequate performance level.

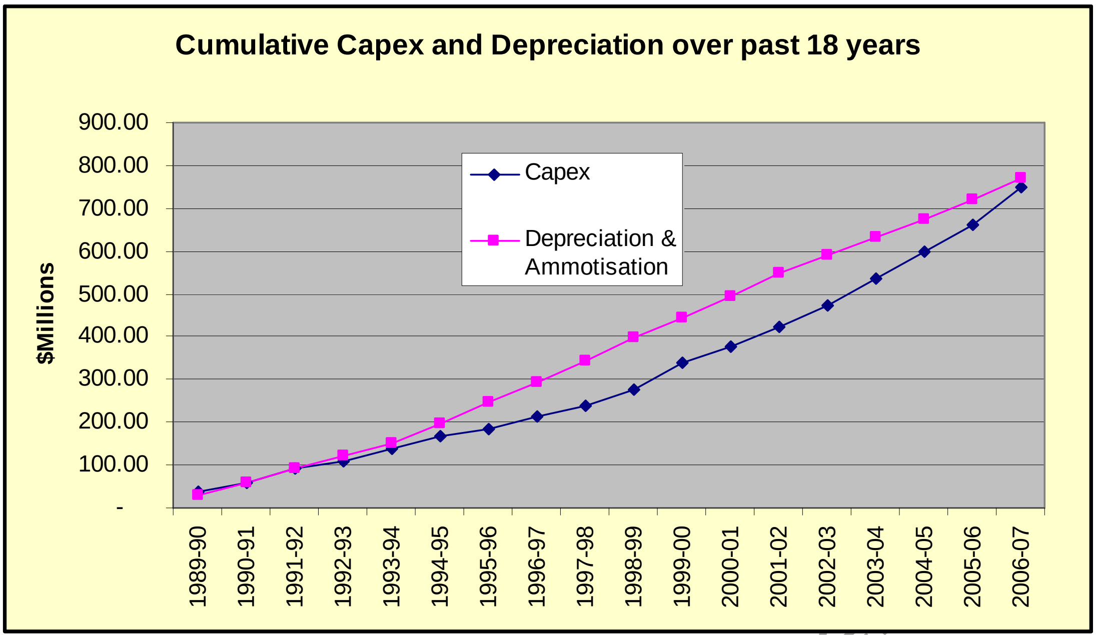



**Figure 49: Cumulative Capex and Depreciation & Amortisation at PWC past 18 years**

There will be some very significant one-offs in capital including the new generators, the new zone substation and the new head works for Darwin water supply, which will lead to some quite lumpy capital requirements going forward. An analysis of the current balance sheet of PWC allows me to believe that debt funding should be available to meet most of this need.

# 7 Operations and Maintenance at PWC

The processes and practices outlined in the Asset management Plans for operating and maintaining the PWC electric and water networks are consistent with good industry practice. PWC's maintenance work is reported to be based on: -

- Routine servicing
- Condition monitoring
- A combination of corrective and preventative maintenance
- An allowance for reactive unscheduled maintenance.

Interviews with staff and a review of the performance indicators show that maintenance is not being carried out in accordance with the processes outlined in the Asset Management Plan at this time. During the extensive interview process it was generally stated that the maintenance approach applied in almost all of PWC's business units is to use reactive maintenance i.e. "When it breaks fix it". While there are some assets in the system where this approach is appropriate, it is not good industry practice to rely on this approach across the broad band of assets to which it applies in PWC. Further the "fix it if it breaks" approach is not in line with the stated objectives in the Asset Management Plans of the various business units.

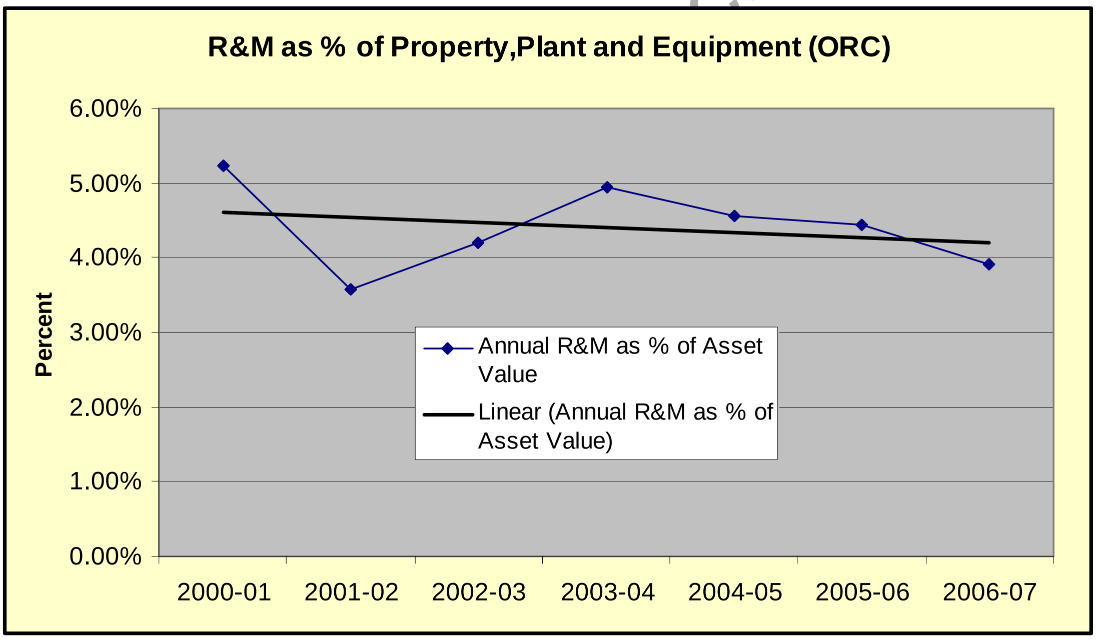



**Figure 50: Annual spend on R&M as a percent of ORC (Optimised Replacement Value)**

It is not practical to benchmark operating and maintenance expenditure directly, given the individual challenges faced by different networks in both electricity and water, and the different accounting treatments for capitalisation of replacement assets. However there has been a downward trend in expenditure on maintenance as can be seen from Figure 50. This would be good if it was brought about by productivity improvement, but given the previous discussion; it is more likely that the reduction has been brought about by a focus on new works to the detriment of maintenance.

## 7.1 Pole Testing and Replacement

Pole testing and replacement processes are an area where condition monitoring normally needs to be applied to ensure that these critical assets achieve maximum life, without risk of failing in operation. Industry standards dictate that pole inspection takes place on a routine basis and in such a way that remaining life as determined from routine inspections will at least last until the next routine testing period. Different routine inspection periods need to be used depending on the modes of failure and rate of deterioration of poles in service. For example in termite prone areas, inspection cycles are typically 3 years, whereas in normal environments 5 yearly cycles are appropriate. Condemnation rates following inspections should not exceed 3%.

Figure 51: Rust affected steel street light pole in Darwin Network

The pole shown in Figure 51 demonstrates that even with steel poles some formal routine inspection program is a necessity as there is an exposure to rust due to the acidity of the soils and the high moisture levels in the wet season. This type of inspection is often carried out as part of the vegetation inspection, which is done regularly in PWC, but it is not clear that any inspections are actually carried out on line assets as part of the vegetation management program.



## 7.2 Vegetation Management

Vegetation management is a vital process in managing the performance of overhead line assets. Almost 14% of all outages are caused by vegetation in PWC's network. A further 9% are of unknown cause, of which it is likely that a good percentage of those are also vegetation related. Good practice vegetation management will reduce system outages and improve SAIDI dramatically. This was clearly demonstrated in Queensland where major storms blacked out large areas of Brisbane. In areas where vegetation management had taken place, the incidence of outages was greatly reduced. Refer Table 7.3D, page 128 of the detailed report of the Independent Panel into Electricity Distribution and Service delivery (EDSD), (reference 1. The results were dramatic. In the area where vegetation management had taken place there were 9 outages compared with 65 in the non-cleared areas. Figure 52 illustrates that vegetation is growing into the HV and LV lines in the Darwin network. This photograph was taken in December 2006. While there is high vegetation growth in the tropics there still needs to be a good vegetation management program in place to minimise the encroachment of vegetation into the clearance space around lines.

**Figure 52: Vegetation growing into HV and LV lines**

Figure 53 shows the impact of vegetation related outages in the Darwin network. The Katherine and Alice Springs networks exhibit a lower impact from vegetation, which should be expected due to the terrain. Quite a lot of the outages caused by vegetation in the Darwin network are not readily preventable even with good vegetation management because of the strong winds and large numbers of palm trees. Despite this a lot of improvement can be obtained with a combination of tree trimming, removal of vegetation that impinges on clearance spaces, and some relocation or use of Aerial Bundled Conductor in areas of significance to reduce the impact of vegetation on outages.

It was noted that the latest vegetation management contract has recently been placed, and there is a strong expectation that this will lead to a significant improvement in vegetation management in the Darwin Network.



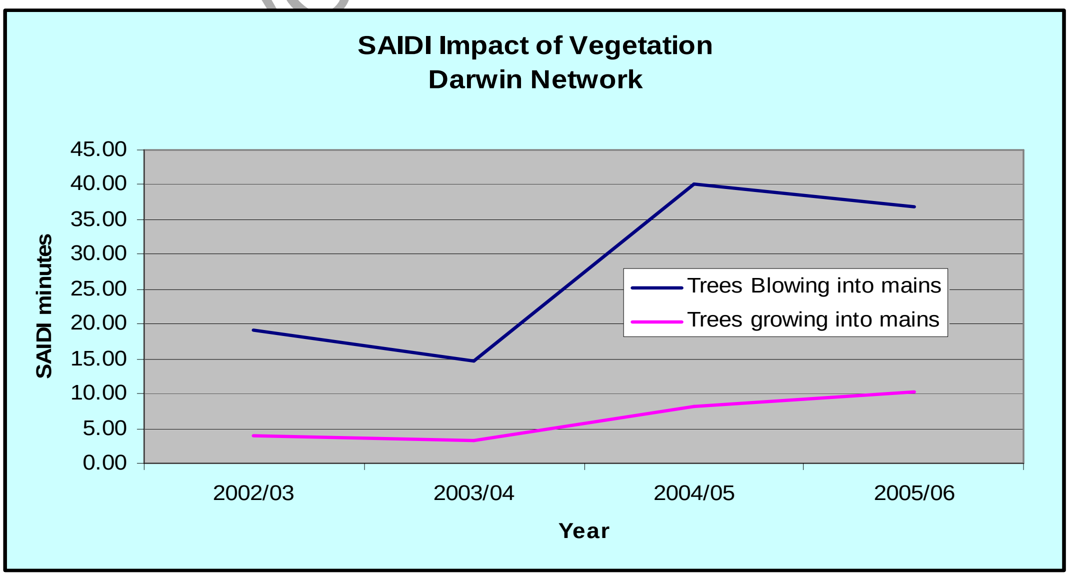



**Figure 53: SAIDI Impact of vegetation in Darwin network**

## 7.3 Cross-Arms

A good indicator of effective line inspection procedures, and competencies is the number of "in service" cross-arm failures per year. Ideally there should be no "in service" cross arm failures other than those caused by accidental actions. The potential impact of cross-arm failures is quite high.

Figure 54: Example of failed cross-arm in Darwin Network

It takes a lot of experience to identify poor cross-arms from ground inspections, and it will be important for PWC to retain skilled line inspectors to ensure that the failure rate trend does not increase. There is no direct data collected on in-service cross arm failures at PWC, as they are included in category A (Equipment failure or Defect), it would be a useful indicator and it is recommended that this data should be collected and analysed in the future.

It is understood that the majority of cross arms are steel, which should reduce the failures to extremely low levels. However there are examples of cross-arm failures as shown in Figure 54, which could be reduced by a more rigorous inspection program.



## 7.4 Air Break Switches

There is no data available to determine the adequacy of maintenance on Air Break Switches, however a review of the Operational Security Issue Register[15] showed that there are a large number of ABS's which have a defect notice, some of which have been defective since late 2004. This is a demonstration of the need for more rigorous maintenance management.

## 7.5 Causes of Network Outages

The largest cause of failure in the Darwin Network is load shedding shown in pale yellow. The second largest cause is equipment failure, which is seen clearly in Figure 55, Figure 56 and Figure 57.The purple coloured bar in the graph on Figure 55, shows an interesting fact. The number of equipment failures as a percentage is not as high as is the impact on SAIDI. This is similar to the animals and birds category "K" shown in bright pink. In general equipment damage and bird and animal strikes usually cause longer duration outages in order to repair and replace damaged assets. Another large impact was shown in blue "x" no cause found, and at over 25% of all incidents as a percentage of total incidents it is too high. More work needs to be carried out to determine the root cause of failures in the network. This will enable effective maintenance and replacement strategies to be developed.

[15] Operational Security Risk Register 11 Oct 2006

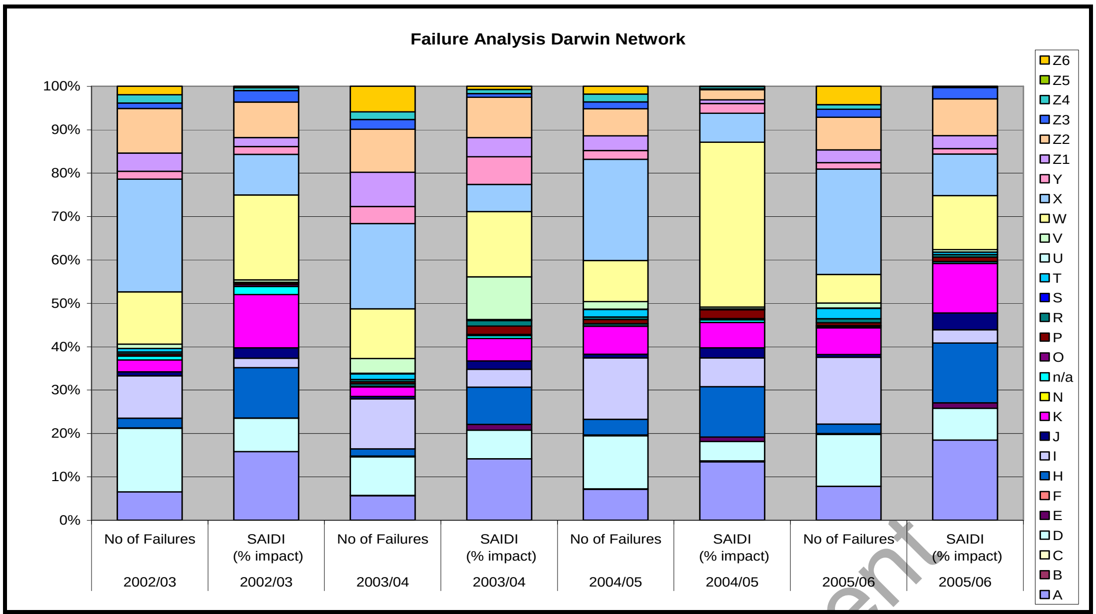



**Figure 55: Causes of Outages in PWC Darwin Network**

| Cause code | Category of Failure (Cause description.) | Cause code | Category of Failure (Cause description.) |
|---|---|---|---|
| A | Equipment - Failure or Defect | R | Operator or Tech Error |
| B | Inadequate Design or Construction | S | Industrial Relations |
| C | Equipment - Inadequate Maintenance | T | Safety |
| D | Lightning or Electrical Storm | U | Overload |
| E | Wind - including wind born materials | V | Generation or Transmission System |
| F | Cyclone | W | Load Shed |
| H | Trees Blown into Mains | X | No Cause Found - not weather |
| I | Weather - No Cause Found | Y | Other |
| J | Trees Growing into Mains | Z1 | Planned Construction |
| K | Animals or Birds | Z2 | Planned Maintenance |
| N | Fire | Z3 | Planned Repairs due to DAR |
| n/a | Not classified | Z4 | Planned Repairs - not DAR |
| O | Vandalism | Z5 | High Load Escort |
| P | Accident - Car etc | Z6 | Planned Other - Testing etc |

**Figure 56: Categories of Failure and Codes**

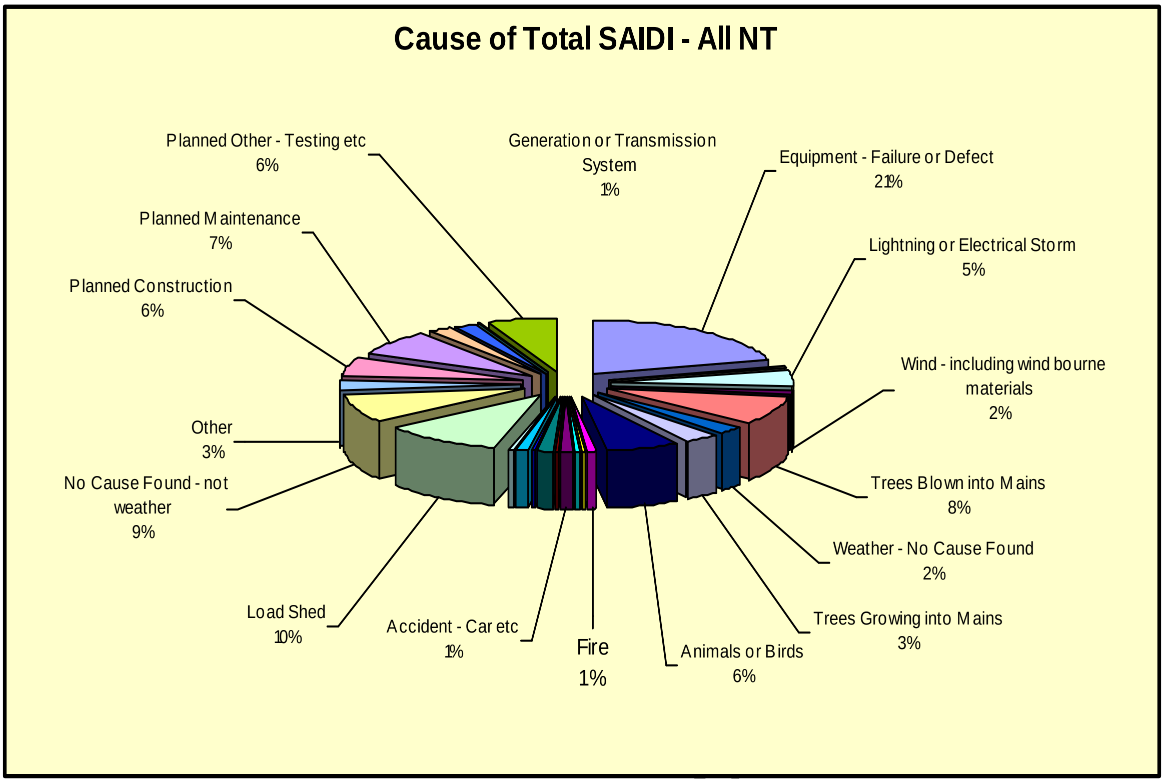



**Figure 57: Causes of Network Failure in 2005-6**

The major causes of outage in the Darwin Network for the 12 months to end of November 2006 are demonstrated in Figure 58below: -

| | % SAIDI | SAIDI |
|---|---|---|
| Equipment | 21 | 43.5 |
| Planned | 19 | 39.3 |
| Trees/Weather | 15 | 31.1 |
| Load Shed | 10 | 20.7 |
| No Cause | 9 | 18.6 |
| Animals and birds | 6 | 12.4 |
| Lightning | 5 | 10.4 |
| Other | 15 | 31.1 |
| Total | 100 | 207 |

**Figure 58: Major cause of outages in Darwin Network 12 months to November 2006**

It is clear that the major cause of outage is related to equipment failures, and is a good indicator of two factors, the first being inadequate maintenance and the second being increasing average age of assets. At 21%, and 43.5 minutes this is higher than expected. Planned maintenance is the second highest at 39.3 minutes and is brought about by a combination of a lot of new works and a low level of live-line activity.

Trees, vegetation and wind blown vegetation represent 15% of outages and as discussed above are capable of improvement. Load shedding at 10% or 20.7 minutes is very high by normal industry standards. The load shedding caused primarily by generation shortages, and insufficient spinning reserve is preventable, but it would add significant costs to the operations of the business by requiring expensive plant to operate at an inefficient level to provide rapid response to unplanned generator outages.

The “no cause found” category at 9% is a significant improvement on the past performance (25%) as discussed above. It is hoped that this improvement is sustained as it helps to determine the root cause of failures in the system, so that corrective action can be focussed on the real high priority issues.

## 7.6 Maintenance of the Water and Sewerage Network

There has been an increased focus on planned maintenance in the Water and Sewerage systems over the past 2 years. In the past there was a tendency to carry out maintenance on a breakdown basis, but recently there has been a concerted effort to get cyclic maintenance properly planned and carried out using the “WIMS” works planning package. The three types of maintenance budgeted in the Water and Sewerage systems are defined in 3 categories: -

- Unforeseen maintenance
  Which is unplanned reactive maintenance and it includes emergency breakdown and corrective maintenance that cannot be deferred to the following budget year.
- Cyclic maintenance
  This is planned preventative and predictive maintenance (PPM) and it includes PPM inspections, checks and servicing plus minor remedial work arising from the PPM program.
- Specific maintenance
  This work is previously identified by the PPM program and engineering studies that can be planned into following budget years.



There are now processes in place to ensure the cleaning of storage tanks annually. There is a 24-week cycle for flushing of distribution/reticulation/ transmission system[16] pipes. A comprehensive condition assessment of storage tanks in the Darwin system was carried out in 2004, which led to a series of preventative cyclic programs that have been incorporated into the cyclic maintenance program[17].

As previously mentioned in this report, there is an extensive remediation program in place to reline aged concrete and AC pipes in the sewerage system. This is funded as capital works.

Spills in the sewerage system outlined in the 2005 Wastewater treatment and reuse and discharge report[18] indicated that there were 5 spills in all: three from the sewerage system and two from the treatment system. While no spills is the ideal target 5 spills in total does not indicate any significant problems with maintenance, however the age of assets will lead to an increased spend on cyclic and specific maintenance in the next 5 years.

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[16] Power and Water Corporation Water Quality Report 2005 page 8
[17] Darwin Potable Water Supply System Asset Management Plan 2006, page 48,49
[18] Power and Water Corporation Wastewater Treatment, reuse and discharge Report 2005, pages 21,22

One of the specific challenges ahead for the Sewerage system is the reduction in wet weather inflow from sources other than sewer. At this time an objective has been set to ensure that sewage system is designed to contain all sewage for a 1 in 5 year storm event. For design purposes an assumed Peak Wet Weather Flow (PWWF) of 4 to 6 times the Average Dry Weather Flow (ADWF) is used to allow for system leakiness due to deterioration. Many of Darwin's Sewerage Mini-catchments have PWWF's much greater than 6 x ADWF. This has led to the need for a strong focus on the following maintenance and refurbishment activities.

Property Branches

- Repair broken connections between the main and the branch
- Repair other breaks along the property connection

Access chambers

- Raise covers above ground surface levels
- Repair broken covers, frames and concrete surrounds
- Fix cover sealing by cleaning, greasing or grinding sealing surfaces
- Repair holes in manhole walls due to breaks, internal corrosion

Overflow Relief Gullies

- Raise above ground surface level

Stormwater drains

- Disconnect illegal connections from stormwater drains into sewers

In addition there has been a strong focus in refurbishing the fire mains connections to the hydrants, and replacement of the old style above ground hydrants to reduce leakage in the water system.

The mechanical, plumbing, electrical and instrumentation assets have all been identified and a cyclic maintenance program is being put in place to ensure regular maintenance of all these assets. The actual maintenance of most of these assets is outsourced to contractors and there is an issue at this time with the availability of skilled electricians, who have familiarity with the equipment. There is a high turnover of contactor staff, which is leading to the need to continually supervise the contractors very closely.

Condition monitoring of mechanical and electrical assets for all major pump and motor units has commenced. This monitoring includes vibration analysis, thermography and impedance testing. The intention[19] is to collect results from the diagnostic testing to enable the maintenance to move from the traditional time-based maintenance to a condition based maintenance regime.

In summary, the maintenance approach in Water and Sewerage is moving towards a modern predictive preventative maintenance program, however there is still a lot of work to be done to reduce the reliance on unpredicted breakdown maintenance, most of which is identified, well understood and underway.



[19] Darwin Potable Water Supply System Asset Management Plan 2006, page 46

# 8 Asset Age Profiles

It is acknowledged that average age profile of many of PWC's assets is at least mid life. This does not mean that replacement Capex can be reduced, because there are many assets that have reached, or exceeded their expected lives and will need replacement in the next five years. Average ages can be quite misleading and there is a need to look at the actual asset age profiles in order to develop a realistic capital expenditure program. The analysis provided in the Asset Management Plans of both Networks and Water, and discussions with key staff in the Asset Management Groups at PWC leads me to believe that the required Capital expenditure in the next 5 years will need to be increased.

In the recent regulatory review in Victoria, all of the Network companies demonstrated a need to increase their capital expenditure to meet increased aging of assets, as well as improving network reliability, and meeting growth in customer demand.

In the Queensland regulatory review conducted in late 2004, both the network businesses, requested, and were granted massive increases in Capital for the next five years to ensure that the networks will be able to deliver an appropriate level of service. In the period 2001-2005 the total Capex was $2.6B[20] and the amount requested and approved by the regulator in Queensland for the period 2006-2010 was $6.4B, in excess of a 100% increase.

The average Capital expenditure as a percentage of Optimised Replacement Cost (ORC) for the 1999 Queensland, 2000 Victorian and 2003 New South Wales determinations was 4.9%, and against the ODRC regulated asset base was 8.7%. The current round of determinations will see those averages increase by at least 1.5%.

## 8.1 Age Profile of Zone Substation Transformers

The age profile of zone substation transformers shown in Figure 59 and Figure 60 indicates that the earliest assets installed have reached the end of their economic lives, and will need replacement in the next 5 years.



[20] Queensland Electricity Distribution and Service Delivery (EDSD) for the 21st Century Review Report, July 2004, by D Somerville, S Blanch & J Camp QNRME04165, ISBN 1 920920 72 2, Pages 105 and 108

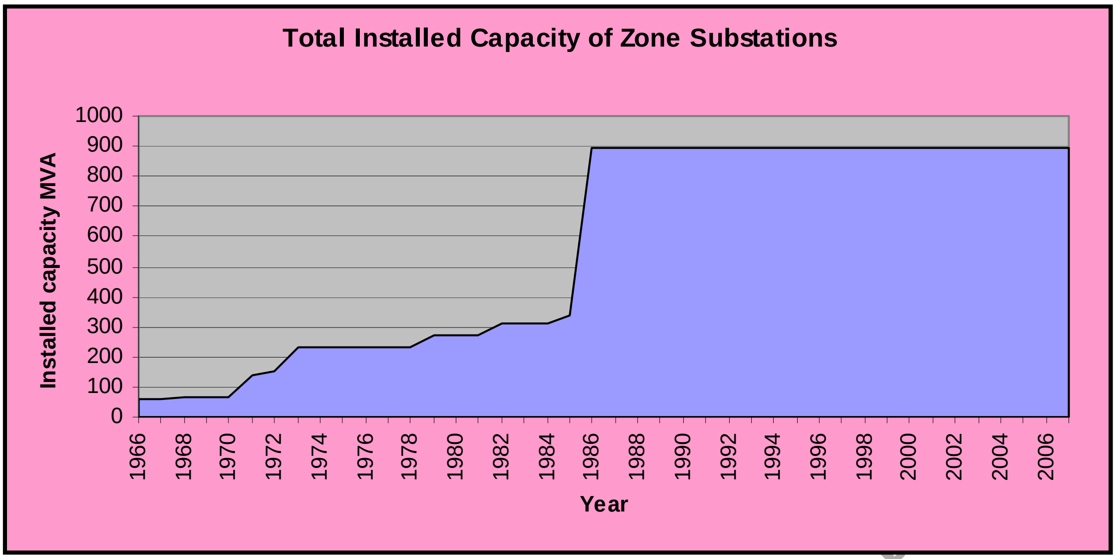


**Figure 59: Cumulative Installed Capacity of Zone Substation Transformers**

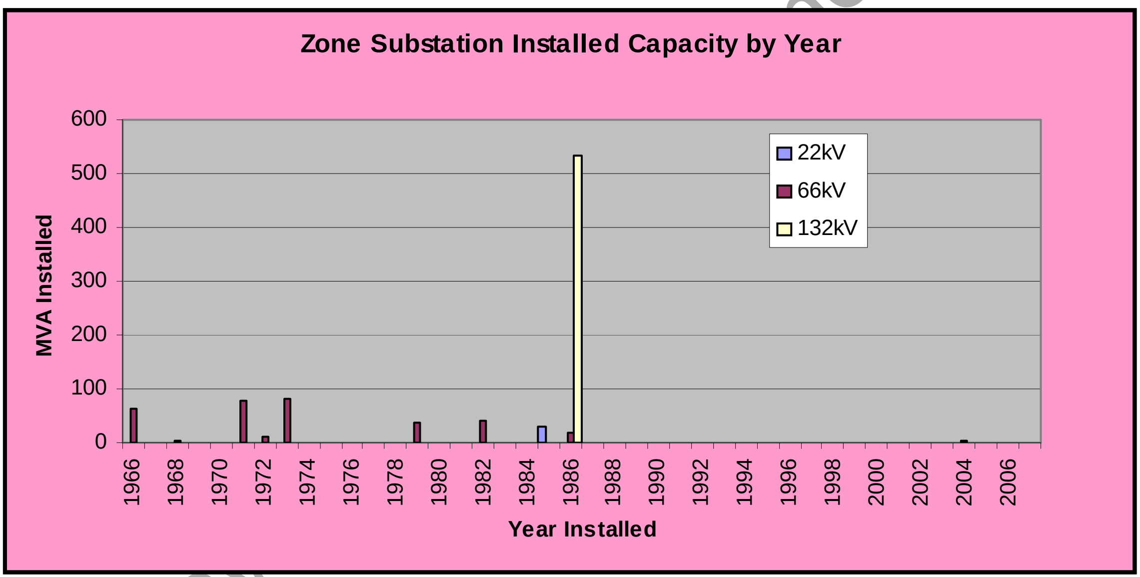


**Figure 60: Zone substation Installed capacity by year**

## 8.2 Age Profile of Distribution Transformers

The age profile of distribution transformers is not well known in the Northern Territory network. Of the 3516 distribution transformers installed, 3112 are of unknown age, in MVA terms 1790MVA out of a total of 2388MVA or 75% are of unknown age. It is reasonable to assume that the age profile of these assets will be similar to the Zone Substation total MVA installed where at least 10% will have reached 40 years or more. This is not a serious problem at this time provided that an inspection program identifies any seriously deteriorated transformers.

It is common practice for network businesses to replace these assets on failure. In order to minimise the impact on network reliability adequate spares need to be held to ensure that rapid replacement can take place. There is a high demand for distribution transformers in Australia and New Zealand at this time, and lead times are long for delivery of these assets. Adequate spares holdings need to be acquired to ensure that reliability does not deteriorate.

## 8.3 Age Profile of Lines

The age profile of lines installed in the network is not adequately defined and the available data indicates that no lines were installed prior to 1997, which is nonsense. A reasonable indication of line age can be obtained by looking at the age profile of steel poles installed in the network as shown in Figure 61. This figure indicates that most of the lines are younger than 31 years of age. While there are some older lines in the system, there is no issue with the average age of lines and poles at this time. Some of the early conductor installations, particularly near the coast will need to be monitored for corrosion as part of a regular inspection program. It is noted that a comprehensive inspection of the Transmission towers from Channel Island have been carried out recently.

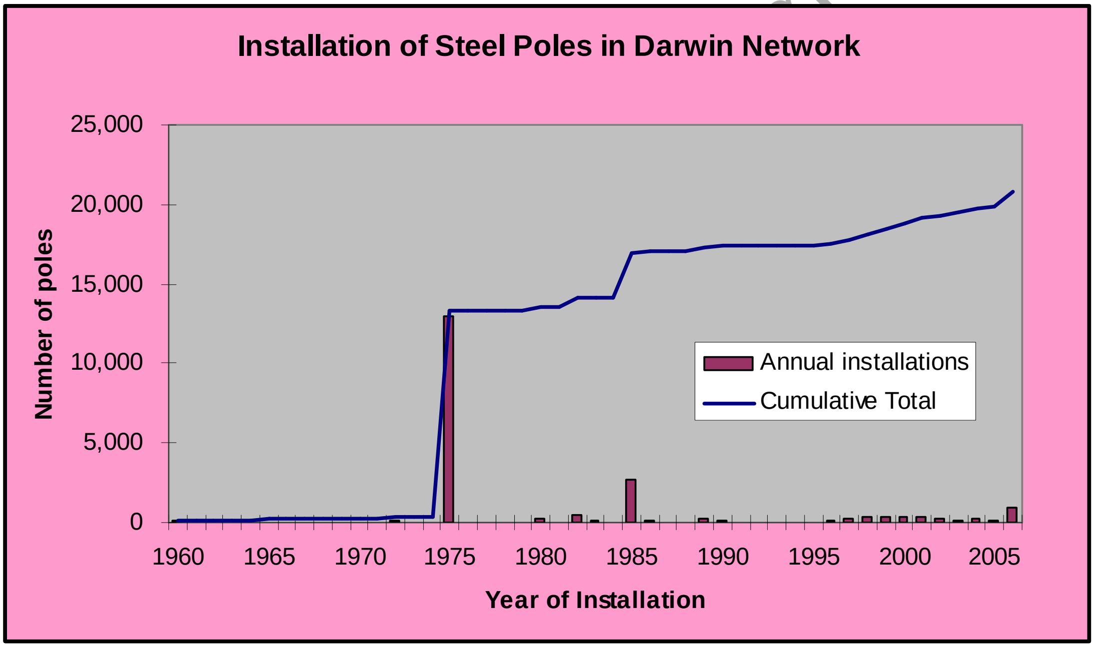


**Figure 61: Age Profile of Steel Poles in Darwin Network**

## 8.4 Age Profile of Sub-transmission and LV Cables

The cable age profile shown in Figure 62 appears to be fine. However there are a significant number of cables not included in the available data due to unknown age. It is estimated that at least 15% of all the cables installed in the network was installed pre cyclone Tracey, in the period 1960 to 1971. These cables are likely to have reached the end of their useful lives and will need to be replaced in the next 5 years.

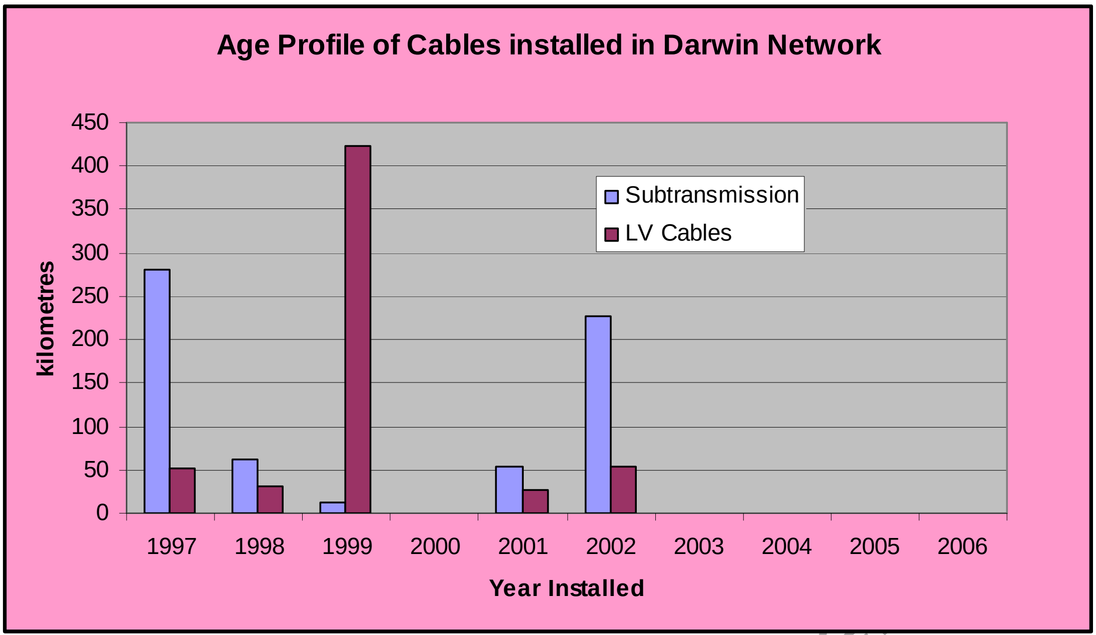


**Figure 62: Age Profile of sub-transmission and LV Cables**

The modern XLPE LV cables have been performing quite well, and there are no plans to replace these cables.

## 8.5 Age Profile of Circuit Breakers

The age profile of Circuit breakers is shown in Figure 63. There are 13 66kV Circuit Breakers that are over 40 years old. In itself this is not a problem, but the lack of adequate maintenance over the past 10 years would lead me to believe that these CB's will need to be replaced or refurbished in the near future. Availability of spares will be a real issue for refurbishment, and as such it is likely that at least 5 to 12 CB's will need to be replaced within the next 5-10 years.

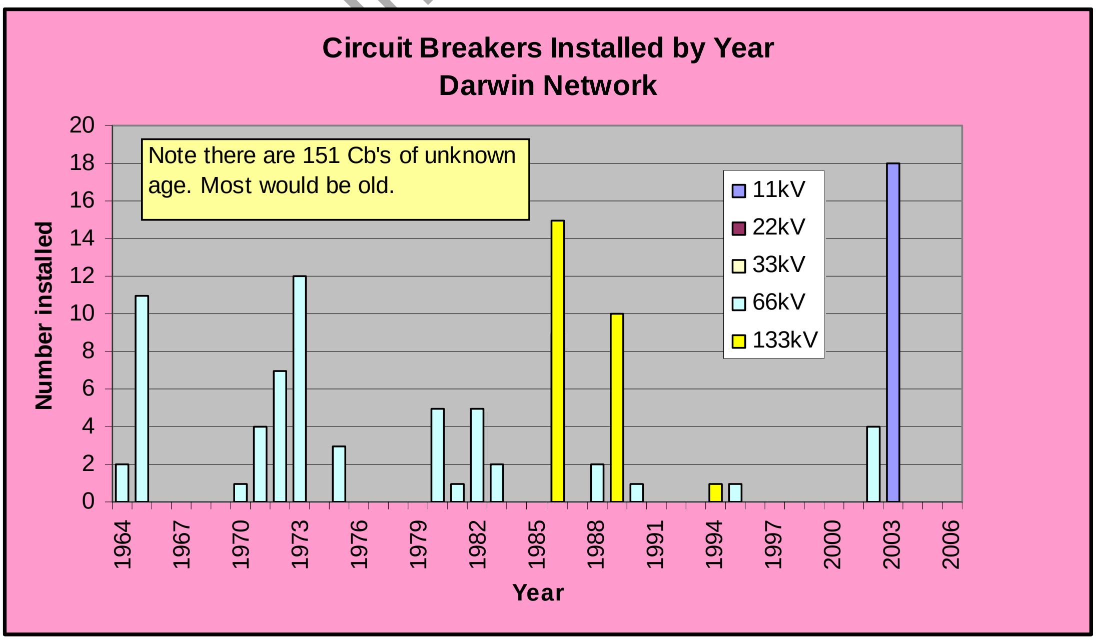


**Figure 63: Age Profile of Circuit Breakers Installed in Darwin Network**

## 8.6 Age Profile of Air Break Switches

Air Break switches are installed in the distribution network to provide the ability to isolate sections of feeders to enable work to be carried out and to switch loads from feeder to feeder. There are no Air Break switches that should have reached their use-by date. It is understood that little maintenance has been done on Air Break switches in the network, and as such some may need to be replaced early due to lack of maintenance, or where they are installed in onerous environmental conditions such as high salt exposure areas. There are no real issues with the age profile of these assets as can be seen in Figure 64 with none being over 30 years old.

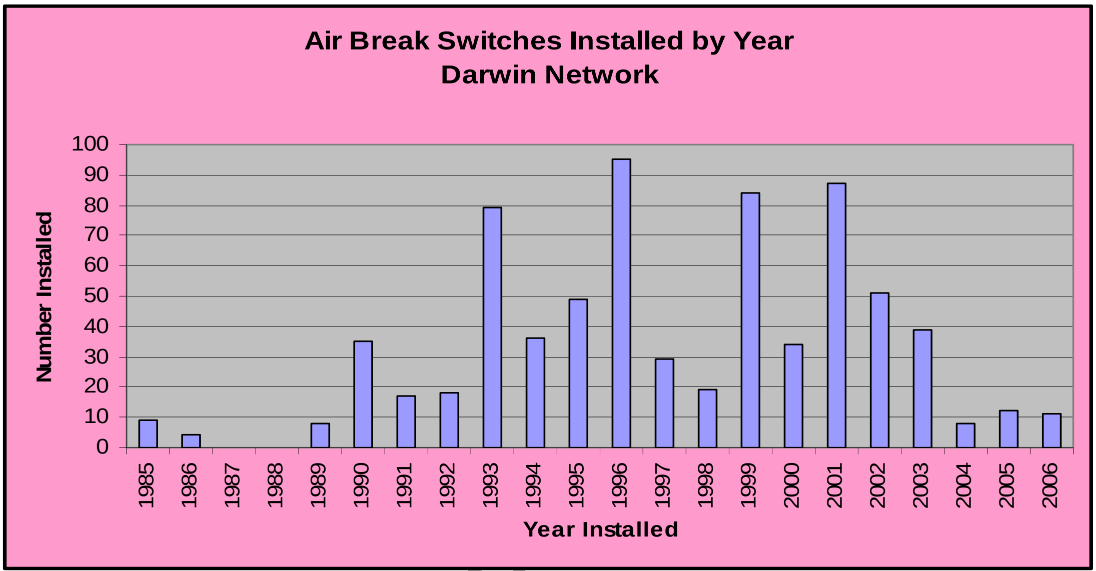


**Figure 64: Age Profile of Air Break switches installed in the Darwin Network**

## 8.7 Age Profile of Reclosers and Retail Meters

Reclosers are installed on the network to allow rapid restoration of supply following a transient interruption. These have only recently been installed in the Northern Territory Network. Figure 65 shows the number installed since 1998. There are no issues with the age of these assets.

Retail meters have a life of between 10 and 25 years, depending on both asset performance and regulatory issues. The profile of retail meter asset ages shown in Figure 66 indicates that there are no age related issues with retail meter installations. The figure also shows that there has been an extensive program of meter installations over the past 5 years, due to both customer growth and replacement of old meters.

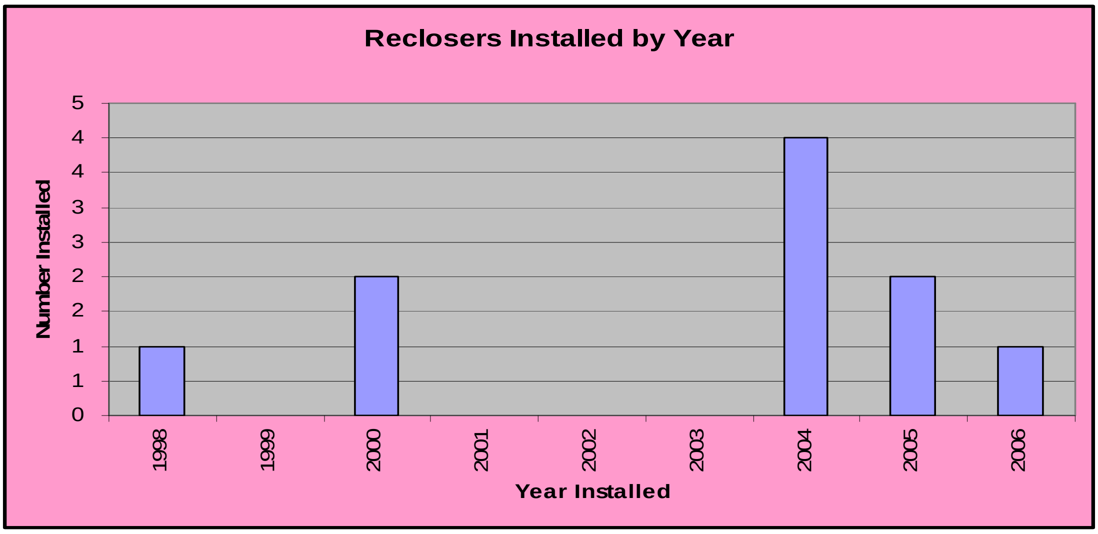


**Figure 65: Age profile of Reclosers in Network**

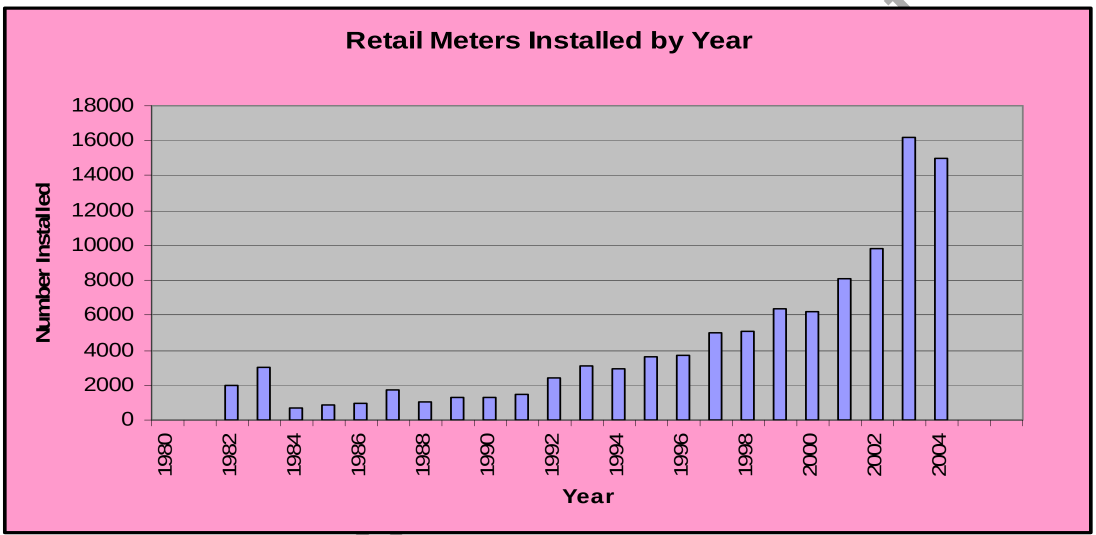


**Figure 66: Age profile of retail meters**

## 8.8 Age Profile of Water and Sewerage assets

### 8.8.1 Water network Pipes

The age profile of water pipes installed in the Darwin (Northern) network is quite lumpy with some bow wave issues that will need to be addressed. Figure 67 shows that the earliest pipes installed from 1936 to 1949 will have reached the end of their expected lives. It is a commonly held view that water pipes made of concrete will last forever, which is not the case, also some of the early pipes were AC and these definitely have a finite life of around 60 years. The lumpy nature of the profile is in line with the development of suburbs in and around Darwin, and will lead to a similar lumpy renewal program over the next 5-20 years. New suburb Development is shown in Figure 68.

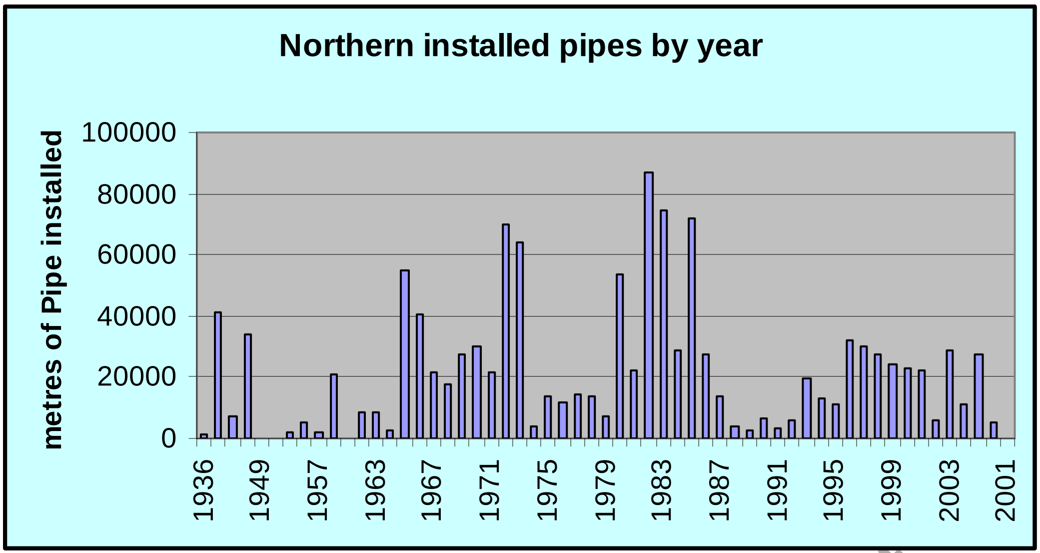


**Figure 67: Metres of installed water pipes in the Darwin Network by year**

| | |
|---|---|
| Late 40's | City |
| Early 50' | Fannie Bay |
| Late 50's | Stuart Park, Ludmilla, Nightcliff (north) Larrakeyah |
| Early 60's | Rapid Creek, Millner, Narrows |
| Late 60's | Alawa, Jingili, Moil, Woolner, Gardens |
| Early 70's | Nightcliff(south), Wagaman, Nakara, Wanguri, Malak, Anula, Tiwi, Wulagi, Coconut Grove |
| Late 70's | Winnellie, Berrimah |
| Early 80's | Karama, Leanyer, Brinkin |
| Late 80's | Berrimah (south) |
| Early 90's | Cullen Bay |
| Late 90's | Bayview, Parap Grove, Tipperary Waters |

**Figure 68: Suburb Development in Darwin – First Reticulation**



The installation of pipes in the Alice Springs Region also shows some lumpiness with some pipes reaching the end of their economic lives. Over 10,000metres of pipe are over 50 years old. There was also a reasonably large build of pipes in the mid 60's and early 70's as can be seen in Figure 69. There are no real problems at this time with the age profile at Alice Springs, but it will be necessary to watch the early installed pipes which are over 30 years old quite carefully. .

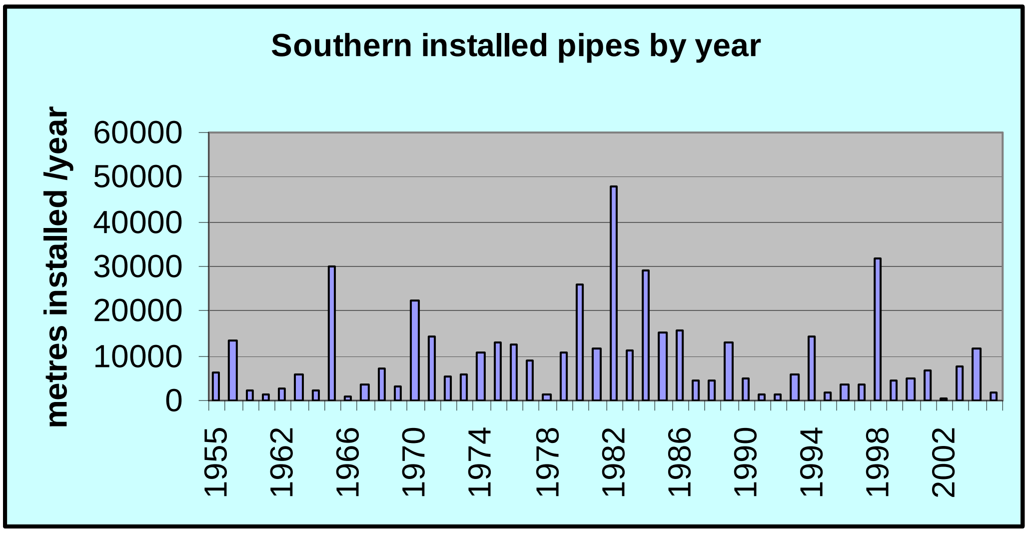


**Figure 69: Metres of installed water pipes in the Southern Network by year**



The water pipes installed in Katherine, Figure 70, and in Tenant Creek, Figure 71 show the original build in the late 60's for Tennant Creek and early 70's for Katherine followed by another growth spurt in the mid 80's for Katherine. The pipes installed in the late 60's and early 70's will be approaching the end of their economic lives but at this time there are no major issues with the water pipe system.

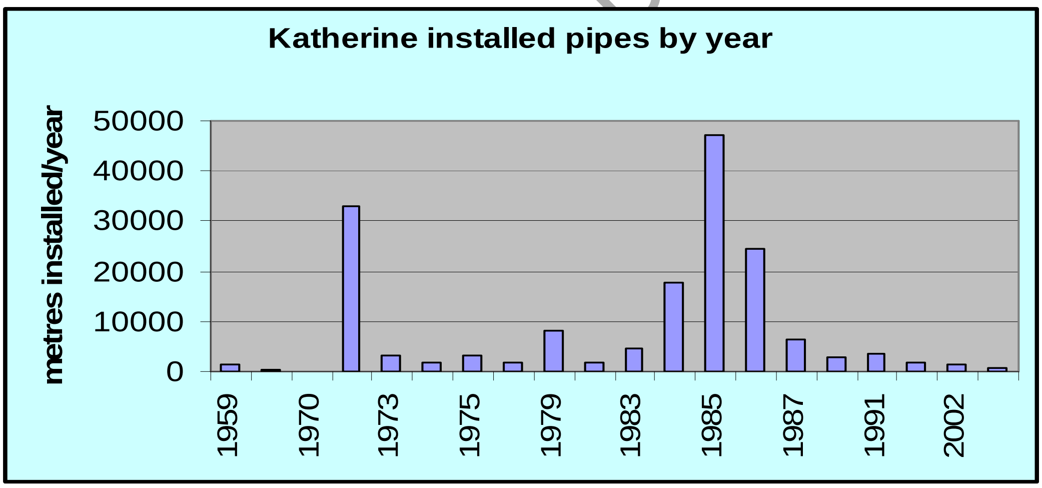


**Figure 70: Metres of installed water pipes in the Katherine Network by year**

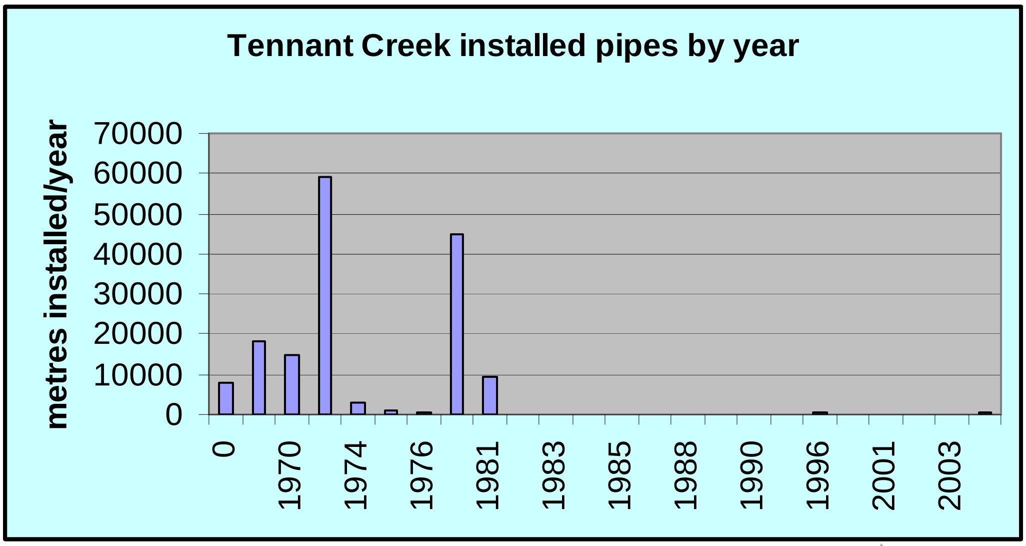


**Figure 71: Metres of installed water pipes in the Tennant Creek Network by year**

The cumulative installed pipe length in the 3 major water systems in the Northern Territory is shown in Figure 72. In total some 200,000 metres of pipe was installed by the mid 60's.

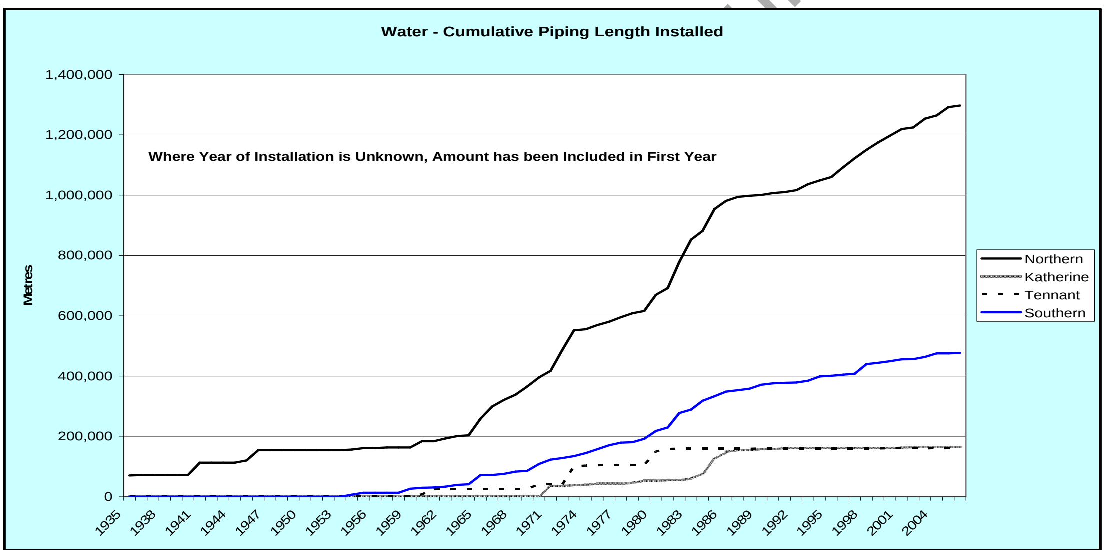


**Figure 72: Cumulative pipe length installed in Northern Territory Water systems**

### 8.8.2 Sewerage Network Pipes

The conditions for sewerage pipes are quite onerous in the Northern Territory. In warm climate zones hydrogen sulphide is quickly generated leading to corrosion of Portland cement in concrete, AC & cement lined metallic pipe. The worst locations for corrosion are further downstream and at the end of rising mains. Branch and trunk sewers are most at corrosion risk, as well as the general reticulation systems that can be exposed to significantly corrosive conditions.

As well as the effect of internal corrosion the high salinity soils particularly found in Alice Springs and Tennant Creek corrode cementitious materials externally. Acid and neutral sulphate soils found in coastal zones in Darwin also corrode the external surfaces of both sewer and water pipes.

There are methods of reducing corrosion in AC and concrete sewers such as corrosion retardant materials or coatings but these are not used in the Northern Territory, except for PVC lined concrete pipes.

As a result of the above conditions lives of less than 10 years are prevalent in some locations in Darwin. In general less than 30 years is an economic life for sewer pipes in this environment. The extensive use of AC pipes does extend the life of AC pipe over concrete pipe marginally due to asbestos fibres.

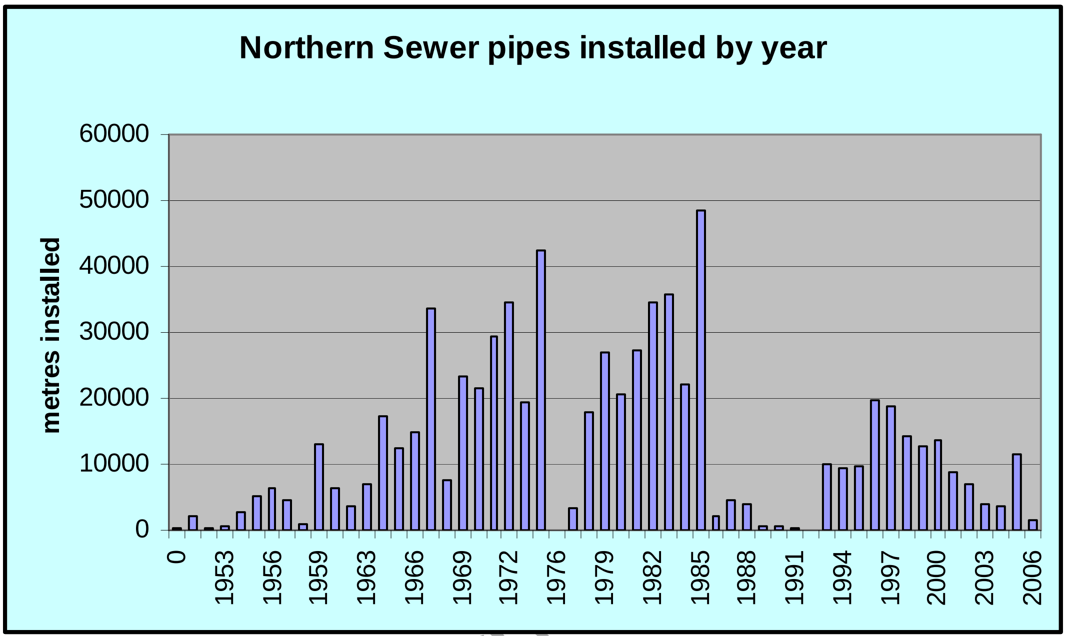


**Figure 73: Northern Sewer pipes installed by year**

There are a number of aged pipes in the Darwin sewer network as shown in Figure 73. Given that the expected lives of cement or AC pipes can be as low as about 30 years, there are many thousands of kilometres of sewer pipes installed before 1980 that have now reached the end of their economic lives and need either relining or replacement. The relining program that is underway will extend the lives substantially, and the maintenance and inspection programs currently in place should ensure that large-scale catastrophic failure does not occur.

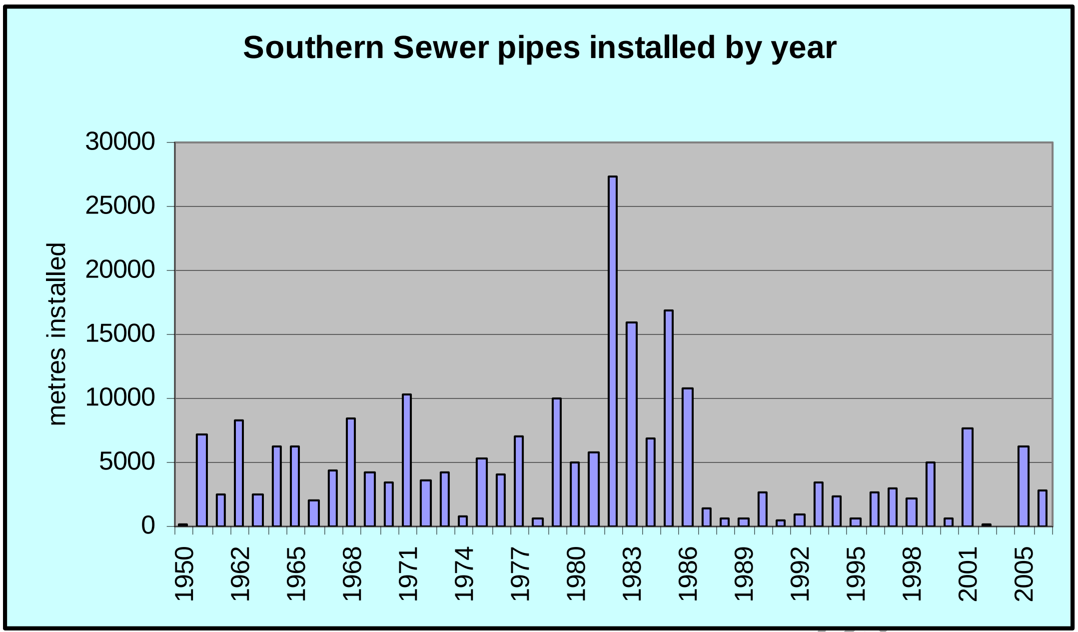


**Figure 74: Alice Springs region sewer pipes installed by year**

The Southern sewer network also has a large number of sewer pipes that have reached the end of their economic lives as seen in Figure 74. There was a significant surge in installation in the mid 80's and these pipes should still be in good condition.

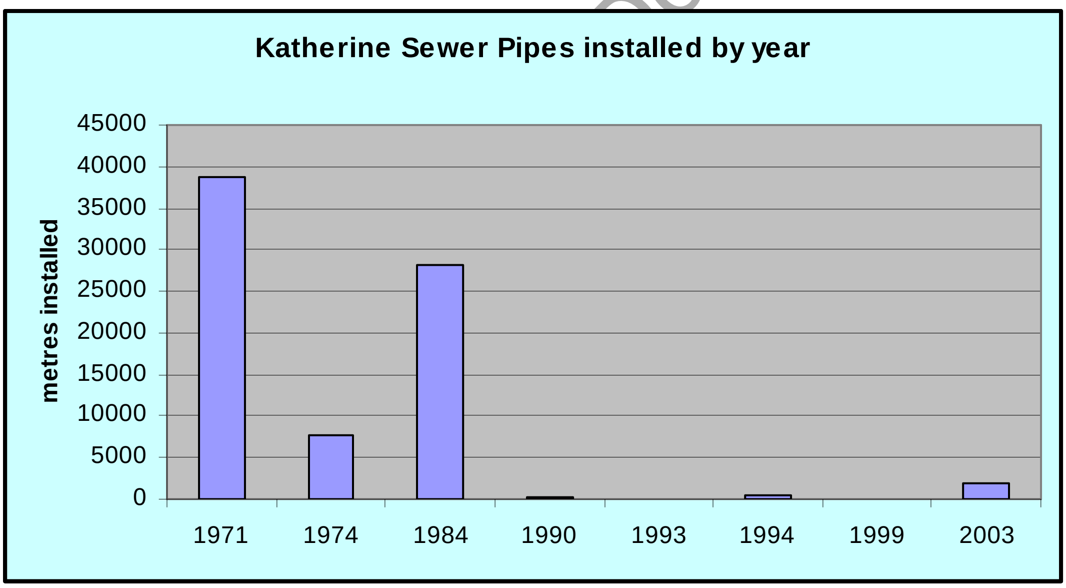


**Figure 75: Katherine region sewer pipes installed by year**

Most of the sewerage pipes installed in the Katherine region are of early 70's vintage and as such have also reached the end of their economic lives as shown in Figure 75. An additional surge in installation occurred in the mid 1980's and these pipes should be in good condition at this time. The inspection program and relining of corroded pipes will be an important focus for the Katherine Sewerage system over the next 5 years.

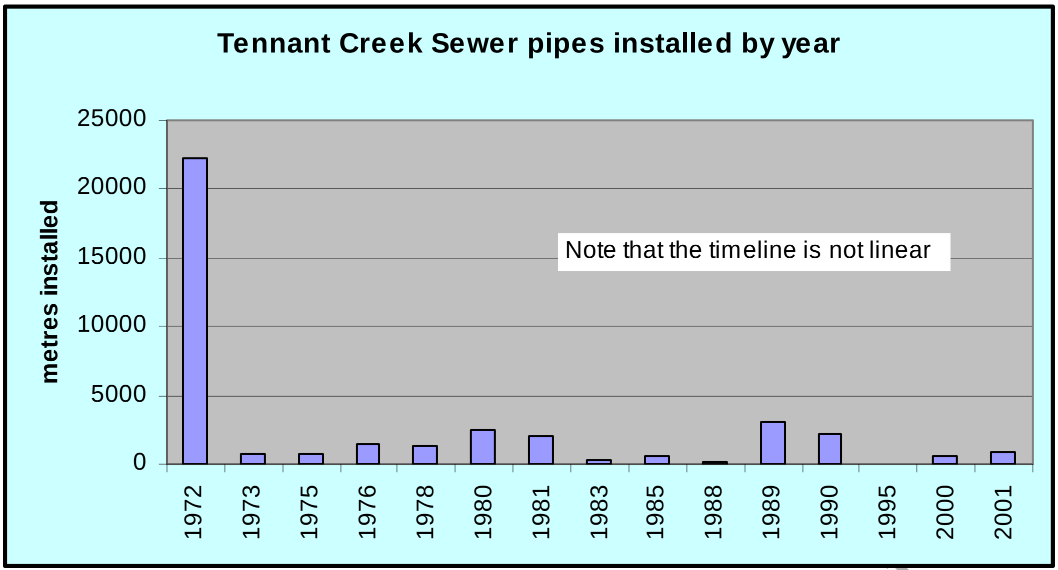


**Figure 76: Tennant Creek region sewer pipes installed by year**

Tennant Creek also has a significantly aged sewer pipe network, most of which was installed in the early 1970's as shown in Figure 76.

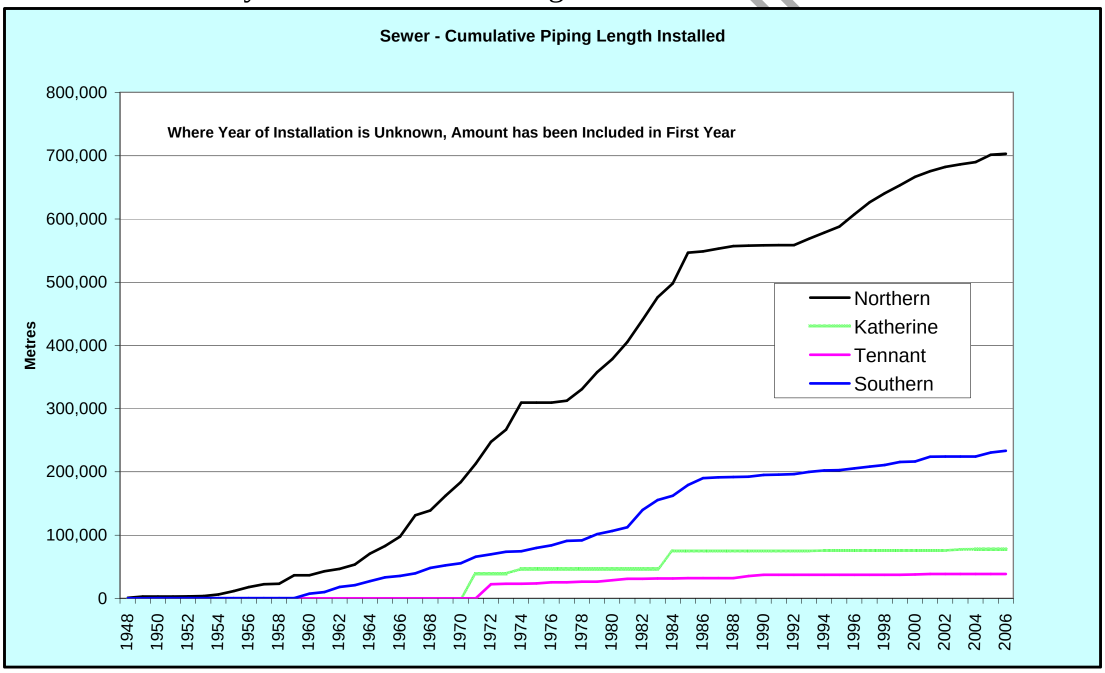


**Figure 77: Cumulative sewer pipes installed by year**

In summary in the Northern Territory the majority of pipelines are at or near the end of their economic lives. Up until the early 70's sewer pipes in the NT were constructed almost exclusively with cementitious products of either concrete or asbestos cement. In addition a significant proportion of AC was used up to 1985.

Most other major Australian cities ceased use of concrete in reticulation sewers in the early 30's or 40's. Some rural cities did utilise AC until its phase out in early 80's.

As a result the NT's sewerage systems are likely to be as poor as the poorest sewerage systems in major urban and rural Australian cities. The relining program, which has been and continues to be undertaken, was vital in order to ensure the ongoing integrity of the sewer reticulation system. This together with some strategic replacement will be required over the next 10 years. It should be remembered that over 250,000 metres of sewer pipes are at least 40 years old as can be seen in Figure 77.

# 9 Human Resources

## 9.1 Health and Safety Philosophy and practices

PWC has embarked upon an introduction of best practice Occupational Health and Safety (OHS) processes by the introduction, and certification of the AS4801 Occupational Health and Safety Management Systems. A lot of effort over the past 2 years has gone into developing the appropriate systems and promulgating them to the workforce.

Safety training has been carried out comprehensively across the whole organisation and Site Induction practices have been implemented across all of the operational sites. All personnel entering a site must receive an induction appropriate to the level of activity that will be undertaken at the site. The inductions carried out at the various sites that were visited were satisfactory and useful.

Hazard identification processes have been put in place although there is a risk that they may be seen as to bureaucratic by the workforce. There is some evidence that hazard identification is carried out after the job is completed, which rather defeats the purpose of the exercise. It is almost certainly a cultural issue in that the employees have been doing the same task for years, and are now asked to identify hazards. Despite the slight degree of lack of acceptance the overall processes are rigorous and should be welcomed in PWC.

Safety meetings are now in place and operating effectively. The Executive Management Committee holds a Health and Safety meeting each month, and there are 23 workplace health and safety committees in place. A sample examination of some minutes of consecutive safety committee meetings showed that there are real actions being taken on issues, however improvement is still required.

Incident reporting appears to be quite good however follow-up action or feedback on follow up action is still in need of improvement. Safe Act Observations (SAO's) have been introduced and a database of SAO's and corrective actions has been set up. While the observations are being carried out, there are currently 200 outstanding corrective actions not yet done. This area will need some attention to ensure that the process of SAO's does not fall into disrepute.
The performance of PWC in the past has not been very good in the Health and Safety area. The work done to implement best practice processes has improved both the focus and the performance of PWC in this vital area, however there is still limited "Buy in" from a number of staff. There has been sufficient training, now it is up to each of the employees to embrace the new safety oriented culture. In some areas there is still a belief in the invincibility of Territorians, and a "she'll be right mate" attitude.

This was one of the key areas that was required to be investigated by the review panel, and there has been a significant improvement in both the theory and the training for OHS in PWC: As such the only recommendation is to continue what is being done, and to work hard at keeping the processes simple and user friendly, while ensuring that appropriate safe working practices are encouraged and enforced.

## 9.2 Number and Age Profile of Field Staff in Network Area: -

The age profile of the field workforce in Networks is shown in Figure 78. Figure 79 and Figure 80 show the age profiles of the same type of workforce in Queensland's network businesses at the time of the major review in 2004. The age profile is very similar, and in fact is quite consistent with the profiles of all of the Australian and New Zealand utilities where there is an aging workforce with a real gap coming through in the early to mid 30's age group. This will create a shortage of skilled linesmen, and technical workers in the near future as those in the 46-50 age group reach the end of their effective working lives. Note that it is not common for linesmen to continue much past 50 in the field due to the high level of physical content in their day-to-day work.

It was good to see a reasonably large number of field workers in the 20 to 30 age group coming through; however it would be prudent to try to recruit some experienced line workers, technicians and electrical fitters in the 30 to 40 age group. This may prove to be quite a challenge because all thew Australian utilities are in a similar position and have been aggressively recruiting over the past 2 years.

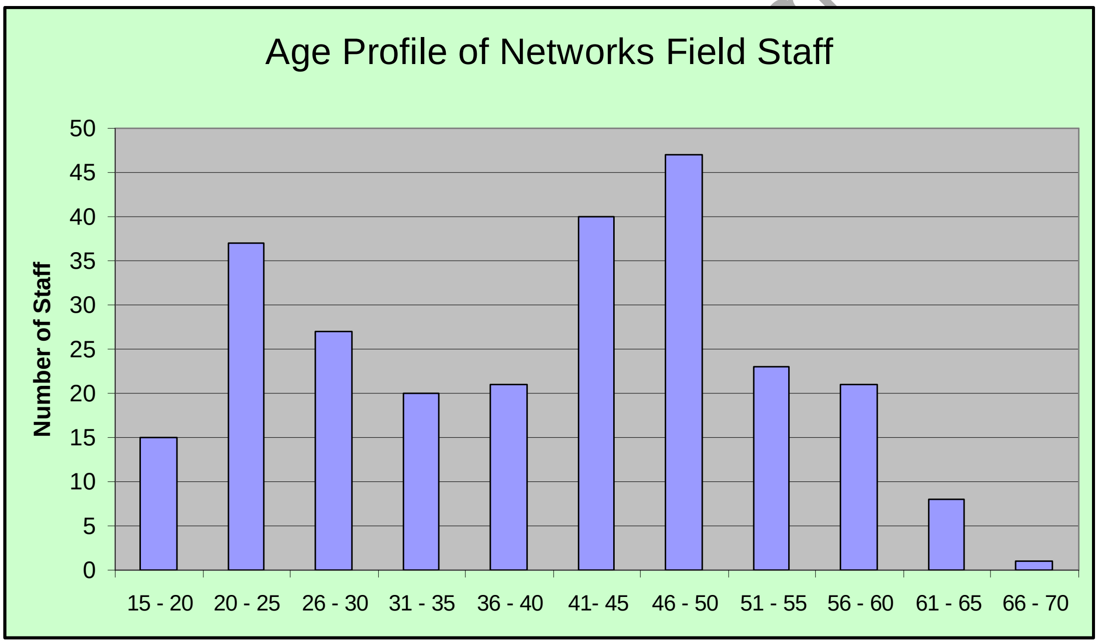

**Figure 78: Age profile of Networks Field Staff**

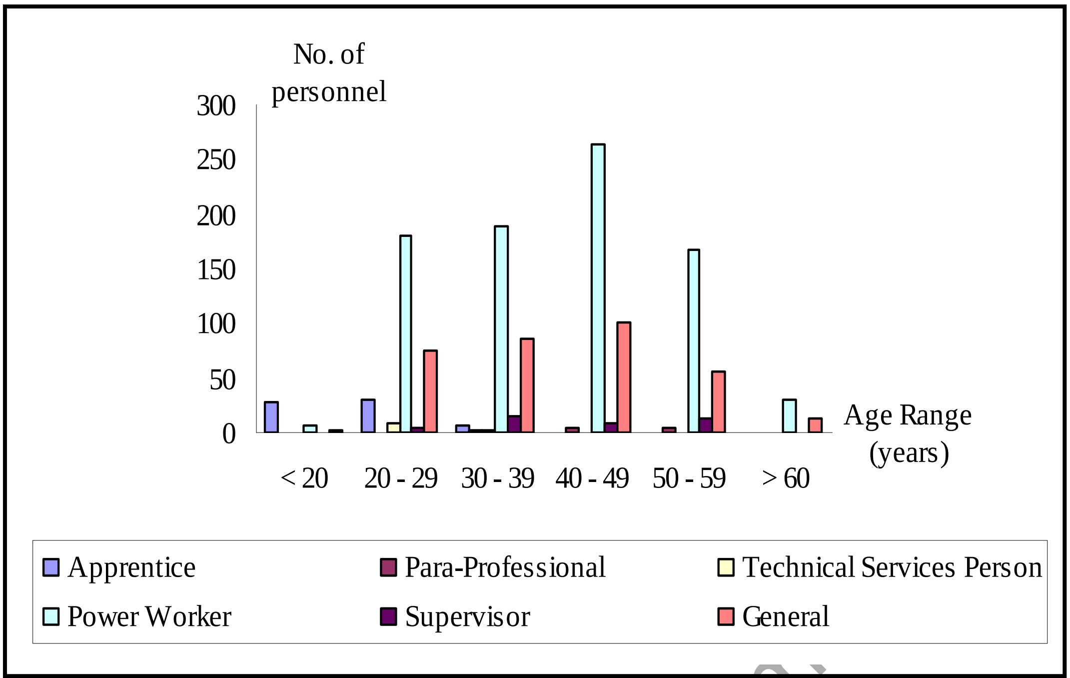


**Figure 79: Age profile of Ergon Core Field Workforce in 2004**[21]

Figure 79 show that the power workers (linesmen and electrical fitters) have a large number in the 40-60 age brackets in the Ergon Energy workforce. Both Ergon and Energex have been recruiting strongly in the past 2 years to redress this age imbalance.

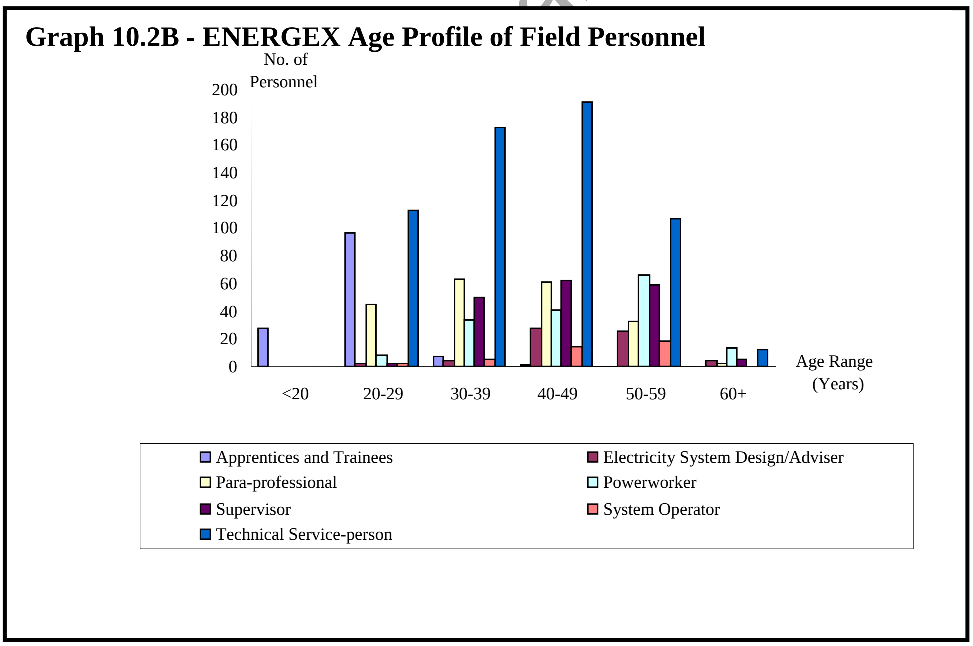


**Figure 80: Age profile of Energex Field workforce in 2004**[22]

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[21] Detailed Report of the Independent Panel "Electricity Distribution and service Delivery for the 21st Century" Queensland July 2004 ISBN 1 920920 72 2: page 187

[22] Detailed Report of the Independent Panel "Electricity Distribution and service Delivery for the 21st Century" Queensland July 2004 ISBN 1 920920 72 2: page 185

The age profile of the Energex workforce in Figure 80 shows that in the "technical service person" category, (which is where their linesmen are recorded), has a significant number of personnel in the 40-60 age bracket.

The table in Figure 81 shows the network field staff by location, skill type and average age. An analysis of this data indicates that there are some areas of real concern that need to be addressed. The 21 control systems staff has an average age of 49.47, the 42 linesmen have an average age of 40.52 and the specialist areas such as planners and technicians are averaging 50 years. Network management is well aware of these challenges and is working hard to recruit in a very competitive market, with a real shortage of appropriately skilled staff in the Australian market.

| Networks | Area | Location | Number | Average Age |
|---|---|---|---|---|
| | Linesmen | Darwin | 29 | 40.52 |
| | | Alice Springs | 4 | |
| | | Tennant Ck. | 3 | |
| | | Katherine | 6 | |
| | Electrical | Darwin | 39 | 40.5 |
| | | Alice Springs | 6 | |
| | | Tennant Ck. | 1 | |
| | | Katherine | 1 | |
| | | Yulara | 2 | |
| | Trade Assistants/Utility Workers | Darwin | 12 | 44.83 |
| | | Alice Springs | 2 | |
| | | Tennant Ck. | 1 | |
| | | Katherine | 3 | |
| | Supervisors/Coordinators | Darwin | 10 | 45.7 |
| | | Alice Springs | 6 | |
| | | Tennant Ck. | 0 | |
| | | Katherine | 3 | |
| | Technicians | Generally Darwin based | 4 | 50 |
| | Operators | | 47 | 41.04 |
| Engineers | Planners | | 2 | 50.5 |
| | Designers | | 15 | 43.16 |
| | Protection | | 3 | |
| | Control Systems | | 21 | 49.47 |
| | Apprentices | Darwin | 21 | |
| | | Alice Springs | 13 | |
| | | Tennant Ck. | 2 | |
| | | Katherine | 3 | |

**Figure 81: Network Field staff by location and average age**

## 9.3 Number and Age Profile of Field Staff in Generation Area: -

The age profile of the generation field workforce is shown in Figure 82 and Figure 83. The average age is clearly in the mid 40's. Given that the generation workforce is fairly stable, the age profile, while not ideal should not present any challenges in the next 5 years. However given that the profile reflects the initial hiring to staff up the power stations, the workforce and the power stations are aging together. There is a need to start recruiting some young people in the 20-35 age brackets to start learning the ropes, to eliminate a long-term risk of skill departure.

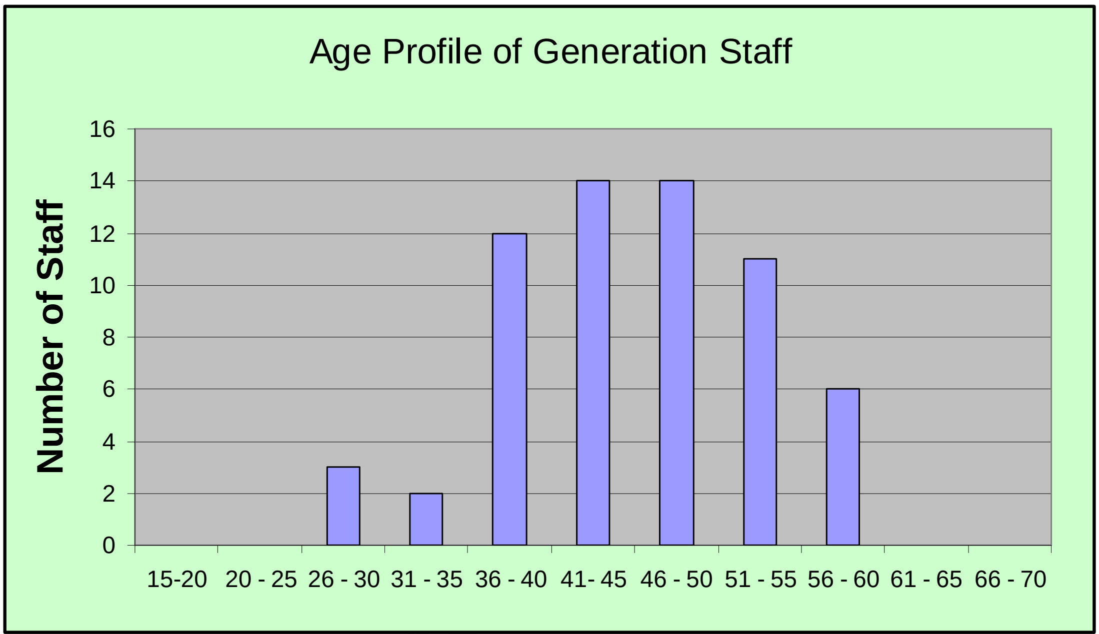


**Figure 82: Age profile of Generation Staff**

| Generation | Area | Location | Number | Average Age |
|---|---|---|---|---|
| | Operations | Darwin | 15 | 46.57 |
| | | Alice Springs | 13 | |
| | | Tennant Ck. | 2 | |
| | | Katherine | 2 | |
| | Maintenance | Darwin | 14 | 43.75 |
| | | Alice Springs | 10 | |
| | | Tennant Ck. | 0 | |
| | | Katherine | 0 | |
| | Specialists | | 6 | 43.33 |

**Figure 83: Generation Field staff by location and average age**

## 9.4 Number and Age Profile of Field Staff in Water and Sewerage Area: -

The water and Sewerage workforce is heavily dependent on external contractors for most of its field activities. The main role of the workforce is in supervision, first line maintenance and calls out, together with planning and design. The average ages shown in Figure 84 indicate that with 33 people in the field staff at an average age of 50.5 there is some cause for concern, and recruitment should be targeting younger people to fill vacancies as far as practicable. Similarly water specialists at an average age of 48.2 is a little to high. Figure 85 shows that of the 96 staff, 9 are at or very near retirement age, which does not sound like many, but it does represent 10% of the workforce. The profile clearly shows a bow wave coming through to retirement within the next 10-15 years, and while there is no cause for panic, action needs to be taken to recruit into the appropriate age group to improve the long-term profile.

| Water and Sewerage | Area | Location | Number | Average Age |
|---|---|---|---|---|
| | Field Staff | Darwin | 20 | |
| | | Alice Springs | 6 | 50.53 |
| | | Katherine | 3 | |
| | | Tennant Ck. | 3 | |
| | | Yulara | 1 | |
| | Coordinators (generally are in the field - use of many contractors) | Darwin | 13 | |
| | | Alice Springs | 3 | |
| | | Katherine | 4 | 45.68 |
| | | Tennant Ck. | 1 | |
| | | Yulara | 2 | |
| | System Controllers | | 5 | 44.8 |
| Engineers | Planners/Designers | | 30 | 36.11 |
| | Water Specialists | | 5 | 48.2 |

**Figure 84: Water and Sewerage Field staff by location and average age**

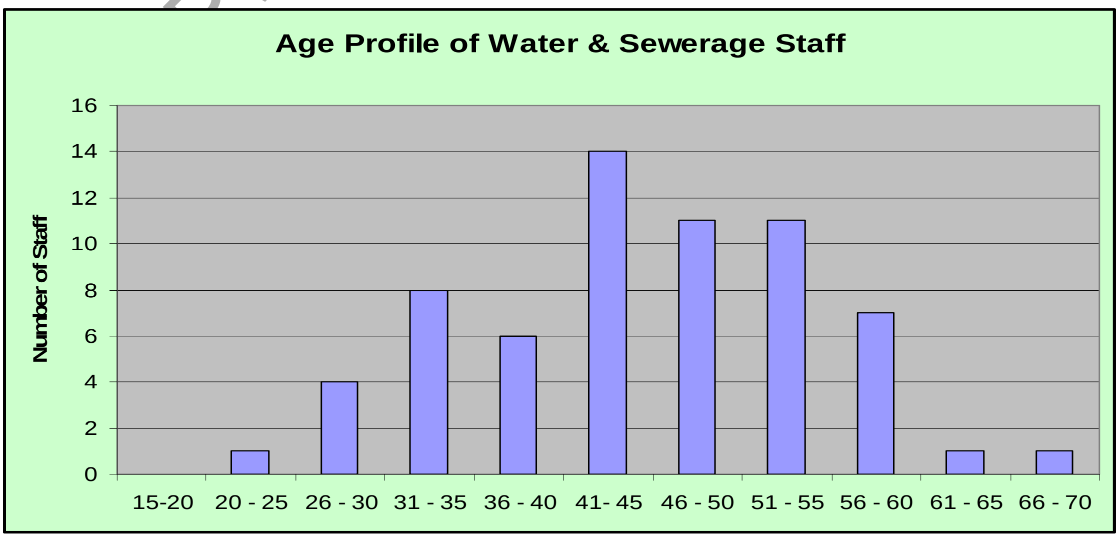


**Figure 85: Age profile of Water & Sewerage Field Staff**

## 9.5 Training Philosophy

The Training philosophy has been changed from a business unit approach of the past to a centralised approach, where the budget for training is set up and the provision of training is centralised within the Human Resources Department. A joint venture between Charles Darwin University and Connell Wagner (an engineering consulting company) has been set up to provide the full spectrum of training to PWC.

There is a generally held view within PWC that training has been less than effective over the past 3-5 years. It is expected that the new system will work more effectively, however for this to happen it will need at least the following issues to be addressed: -

- Needs to have input to course content from business units
- Needs to be kept up to date with real needs of the business units particularly in the technical areas
- Needs a practical bias to ensure that the training is directly usable in the field
- Specialist training may need to be sourced for other than the CDU/Connell Wagner joint venture
- Solutions need to be found to ensure that training is cost effectively provided to the more remote sites

In addition it is strongly recommended that training should be budgeted by the line, and managed by HR, to ensure that the line business units take ownership of training needs within their businesses, and that HR ensure that the most cost effective training can be provided to meet the business needs. The CDU/CW joint venture is on the right path, but it will be very important to ensure relevance of the offerings in order to achieve good value from the not insignificant training budget. As part of the budget review process HR needs to ensure that sufficient budget is allocated by each business unit to meet the long-term needs of PWC.

Training must be based on needs of the business as well as the individual and it is recognised that the use of training for the sake of chasing scale pay increases is not a good or effective process. The new approach based on a combination of individual needs with the needs of the job, (the job model) should lead to a much more effective use of the training budget.



### 9.5.1 Apprentices

There are currently 197 service workers in PWC, plus a further 83 technical (certificate level) workers. Apprentice numbers at this time total 39 and they are spread across the 3 line units as shown in the table in Figure 86. Of the total 21 are Darwin based, 13 are Alice Springs based, 3 are Katherine based and 2 are at Tennant Creek.

In overall terms there should be a larger number of apprentices in the workforce; however at Alice Springs in networks there are 7 apprentices and only 9 experienced tradesmen to supervise them. It is usually accepted within industry that a ratio of 2 tradesmen to 1 apprentice is as low as is practicable to ensure that apprentices receive both adequate training and supervision.

Networks have 29 apprentices with a service worker level of 101, plus 35 technical workers. It would be possible to increase this number without straining the existing resources unduly. Similarly Generation have 7 apprentices with 56 service workers and 13 technical workers, again it would not be an undue strain to increase apprentice numbers, however given the 3 shift operations of the power stations it would not be wise to increase the number of apprentices to much. Water has only 2 apprentices, but given that most of the field work is outsourced there is not as great a need to recruit additional apprentices, however with 40 service workers and 35 technical workers it would be possible to increase numbers if it was found to be beneficial.

| Apprentice Types | Number | Location | Business Unit |
|---|---|---|---|
| Engineering (Mechanical Trade) Cert.3 | 1 | Darwin Region | Water |
| Engineering (Mechanical Trade) Cert.3 | 1 | Darwin Region | Generation (Channel Island) |
| ESI Distribution (Powerline) Cert.3 | 6 | Darwin Region | Networks - Overhead |
| ESI Distribution (Powerline) Cert.3 | 1 | Darwin Region | Networks - Underground |
| Electrotechnology (Systems Electrician) Cert.3 | 7 | Darwin Region | Networks - Underground |
| Electrotechnology (Systems Electrician) Cert.3 | 1 | Darwin Region | Networks - Overhead |
| Electrotechnology (Communications) Cert.3 | 1 | Darwin Region | Technology Services |
| Electrotechnology (Systems Electrician) Cert.3 / Instrumentation Cert.3 | 1 | Darwin Region | Generation (Channel Island) |
| Electrical Lineworker Cert 3 | 1 | Darwin Region | Networks - Overhead |
| Plumbing, Draining & Gasfitting Cert.3 | 1 | Darwin Region | Water |
| Certificate 3 Automotive (Diesel Fitter) | 1 | Tennant Creek | Generation |
| Cert.3 in ESI (Powerline) | 1 | Tennant Creek | Networks |
| Cert 3 in ESI (Powerline) | 3 | Katherine | Networks |
| Electrotechnology (Systems Electrician) Cert.3 | 3 | Alice Springs | Distribution |
| Cert.2 Automotive (Vehicle Servicing) | 1 | Alice Springs | Generation |
| Cert.3 in ESI (Powerline) | 4 | Alice Springs | Distribution |
| Electrotechnology (Systems Electrician) Cert.3 | 1 | Alice Springs | Generation |
| Certificate 3 Automotive (Diesel Fitter) | 2 | Alice Springs | Generation |
| Cert.3 in ESI (Powerline) | 2 | Alice Springs | Power Networks |
| **Total Number of Apprentices** | **39** | | |

**Figure 86: Apprentices in PWC by type and location**

An external body provides apprentice training. A number of issues were raised by the workforce in relation to apprentice training including the failure to provide a basic tool kit, for periods of up to 18 months, difficulties in getting apprentices from remote areas to the training facilities, and the shortage of appropriate facilities for training of linesmen, such as poles and line hardware on which to learn the trade. It is noted that in Queensland the training facilities are now shared between the utilities and the TAFE bodies that provide the basic apprentice training.

## 9.6 Overtime

Overtime is generally a good indicator of the adequacy of manning levels. Excessive overtime usually implies an under manned workforce, however it is normal in utilities to have a reasonable amount of overtime to meet the needs of the networks and generation during abnormal events such as storms or plant breakdowns. No utility today carries a workforce that does not require some use of overtime, and indeed the workforce expects and looks forward to a reasonable amount of overtime and call-outs to supplement the base income. An analysis of the overtime worked over two 3-month periods one in the dry season and one in the wet season in 2006 shows that there has not been an excessive amount of overtime worked as can be seen in Figure 87. It should be noted that the paid overtime recorded in Figure 87 and the following analysis, is predominantly carried out by staff at the level below co-ordinator. There is an allowance for overtime of between 50 and 300 hours annually built into the pay structure for many of the positions above that level.

In the water and sewerage business unit there is an average overtime of 3.3% across the service and technical workers in the dry season and 3.1% in the wet season, which is not unduly high, however if it is not spread evenly across the workforce the individual workloads can be a lot higher.

In the Networks business the average overtime is 5.8% in the dry season and 8.7% in the wet season, again not unduly high but if not spread evenly workloads for some individuals would be high.

In the generation business the average overtime was 6.8% in the dry season and 5.5% in the wet season. This again is not excessive if evenly distributed across the workforce. However a detailed analysis of overtime over a 12-week period of the dry and wet season leads to a different result as will be found by reviewing the charts in Figure 88 to Figure 103.



| Overtime - Water and Sewerage | | |
|---|---|---|
| | **Dry Season**<br>29/06/06 - 20/09/2006 | **Wet season**<br>1/12/2005- 22/2/2006 |
| **Overtime Hours** | 1128 | 958 |
| **Overtime Cost** | $61,109.00 | $51,894.00 |
| **Overtime - Networks (Overhead and Underground)** | | |
| | **Dry Season**<br>29/06/06 - 20/09/2006 | **Wet season**<br>1/12/2005- 22/2/2006 |
| **Overtime Hours** | 3522 | 5348 |
| **Overtime Cost** | $183,422.00 | $287,353.00 |
| **Overtime - Generation** | | |
| | **Dry Season**<br>29/06/06 - 20/09/2006 | **Wet season**<br>1/12/2005- 22/2/2006 |
| **Overtime Hours** | 2108 | 1716 |
| **Overtime Costs** | $115,807.00 | $51,133.00 |

**Figure 87: Snapshot of overtime for 3 months Wet and Dry seasons 2006**

### 9.6.1 Generation Detailed Overtime Analysis

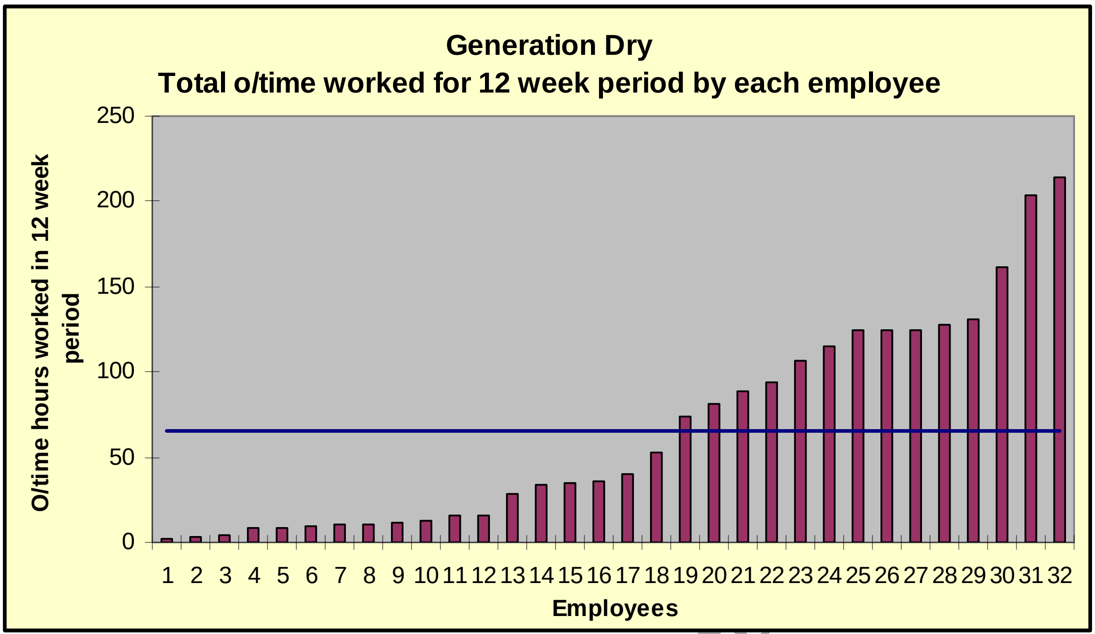


**Figure 88: Total overtime worked by each employee in Generation in 12-week period Dry Season**

A total of 32 employees worked overtime over a 12-week period in the dry season. As can be seen from the graph in Figure 88, there was a wide spread of hours worked, with the highest individual doing 214 hours (averaging 17.8 per week) and the lowest at 2 hours for the period. The overall average was 65.9 hours (averaging just 5.5 hours per week. The concern is that there was quite a few staff that worked excessive overtime over the period.

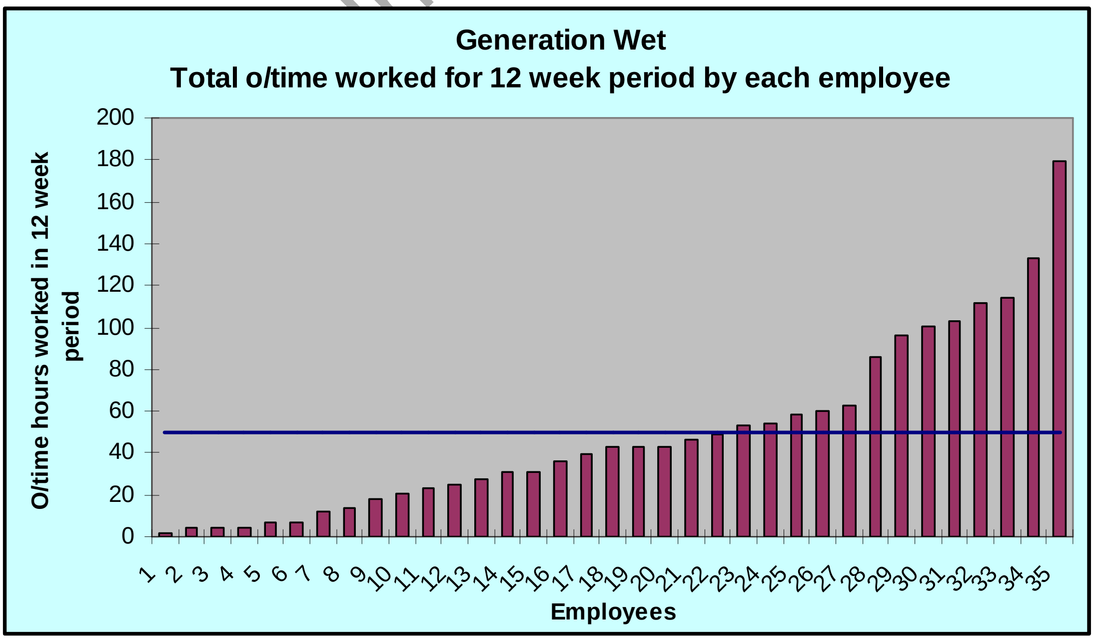


**Figure 89: Total overtime worked by each employee in Generation in 12-week period Wet Season**

In the wet season a total of 35 employees worked overtime over an equivalent 12-week period. As can be seen from the graph in Figure 89, the spread of hours was similar to the dry season, with a few staff working long hours, albeit at a lower level than in the dry season with the highest individual doing 179 hours. The average was 49.8 hours (averaging a lower 4.15 hours per week). Once again the workload is not evenly spread across the available workforce. This may of course be due to special skills required to deal with outages, and the like.

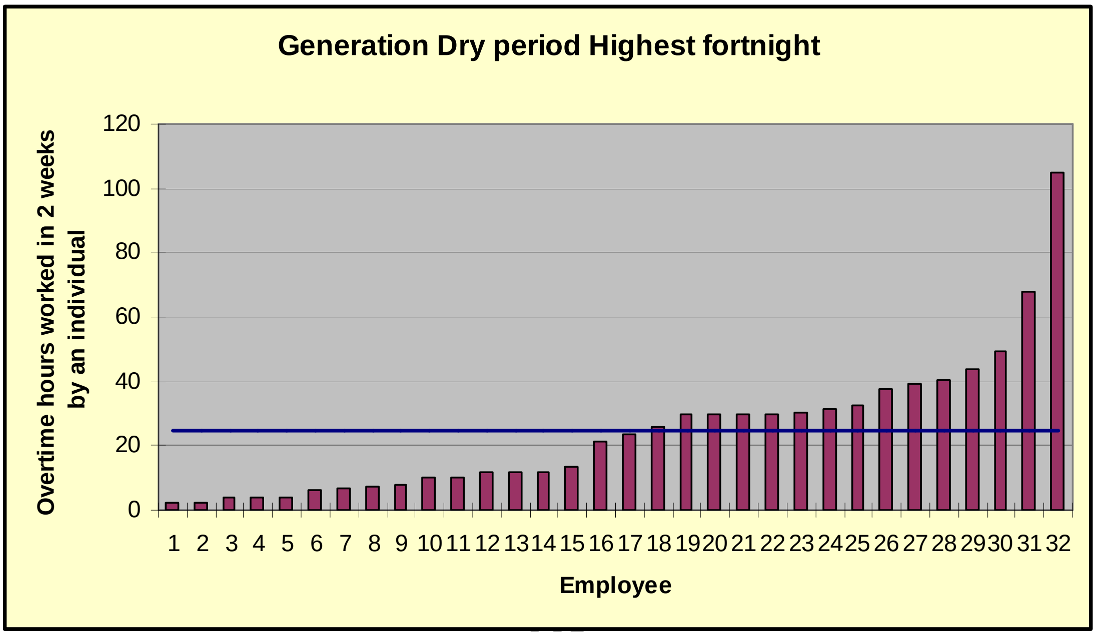


**Figure 90: Individual employee highest fortnight of overtime worked in Dry Season**

Figure 90 provides a more telling picture of the high level of overtime worked by some of the employees. The graph shows that at the top end one employee worked 105 hours in a fortnight while the average highest overtime worked in a fortnight by the 32 employees who worked overtime was 24.4 hours.

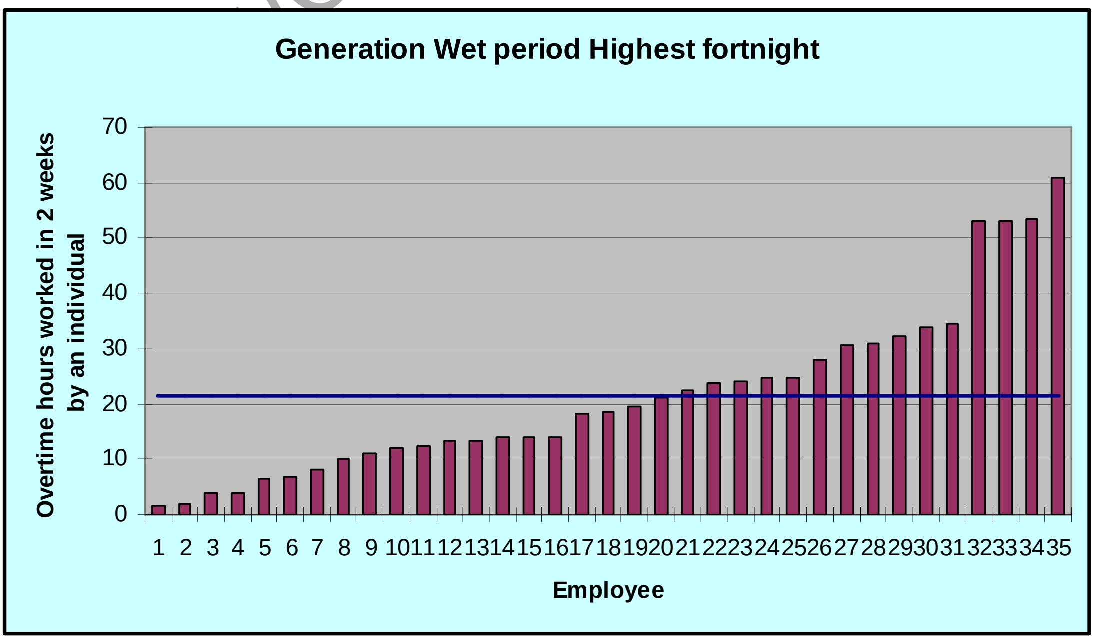


**Figure 91: Individual employee highest fortnight of overtime worked in Wet Season**

Figure 91 provides a further telling picture of the high level of overtime worked in the wet season and while the highest single fortnight's overtime worked was only 61 hours (compared with 105 in the dry) this is still excessive and there were more employees that worked long hours in a single fortnight. The average was 21.6 hours.

### 9.6.2 Water & Sewerage Detailed Overtime Analysis

There were 25 employees that worked overtime over a 12-week period in the dry season as shown in Figure 92. The highest total for the period was 84.25 hours and the average was 45.1 hours. While this was lower than in generation the lower number of staff available to share the overtime burden led to the average being only slightly below generation. The highest total averaged at 7.0 hours per week, which is acceptable.

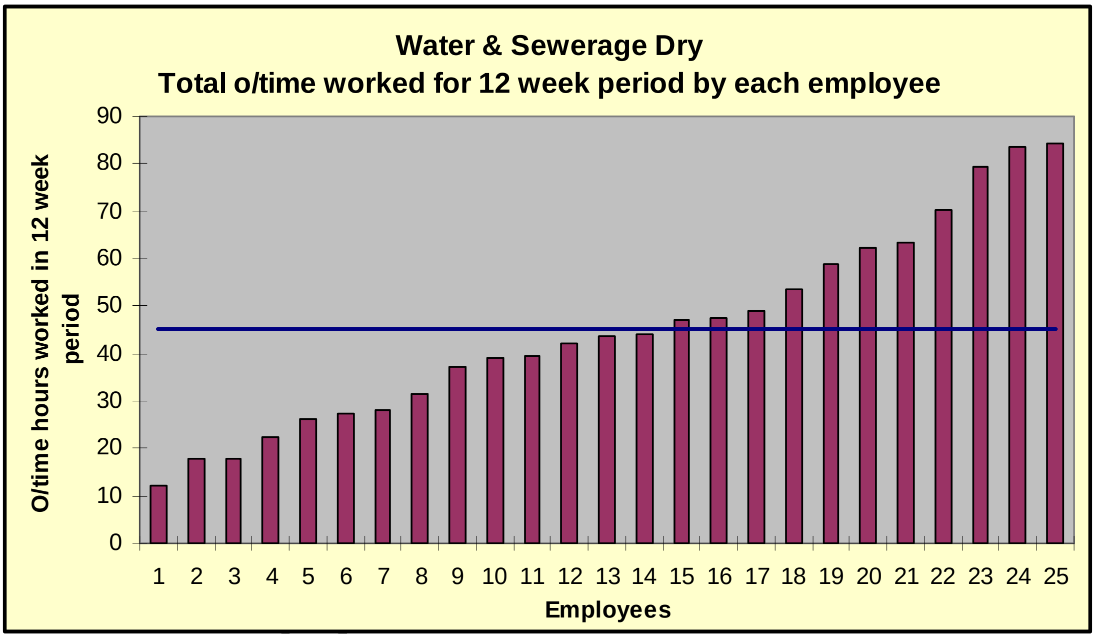


**Figure 92: Total overtime worked by each employee in Water & Sewerage in 12-week period Dry Season**

The overtime worked for the equivalent 12-week period in the wet season was quite similar to the dry season, however there were fewer employees (21) actually carrying out the overtime. The average as shown in Figure 93 was 45.6 and the highest individual total was 80.75, or an average of 6.7 hours per week. This again is not excessive provide the workload is spread fairly evenly across the 12 weeks.

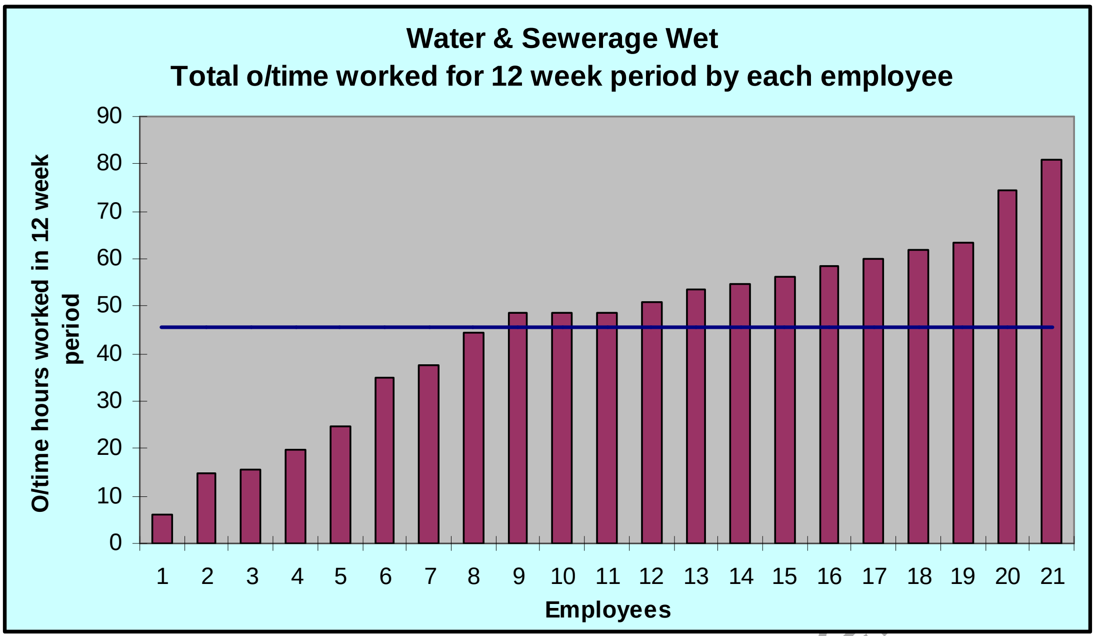


**Figure 93: Total overtime worked by each employee in Water & Sewerage in 12-week period Wet Season**

Figure 94 provides a picture of the high level of overtime worked by some of the employees. The graph shows that at the top end one employee worked 32.25 hours in a fortnight while the average highest overtime worked in a fortnight by the 25 employees who worked overtime was 17.3 hours. The spread of overtime was fairly even and not excessive however 32.25 hours in one fortnight is fairly onerous, particularly in the dry season.

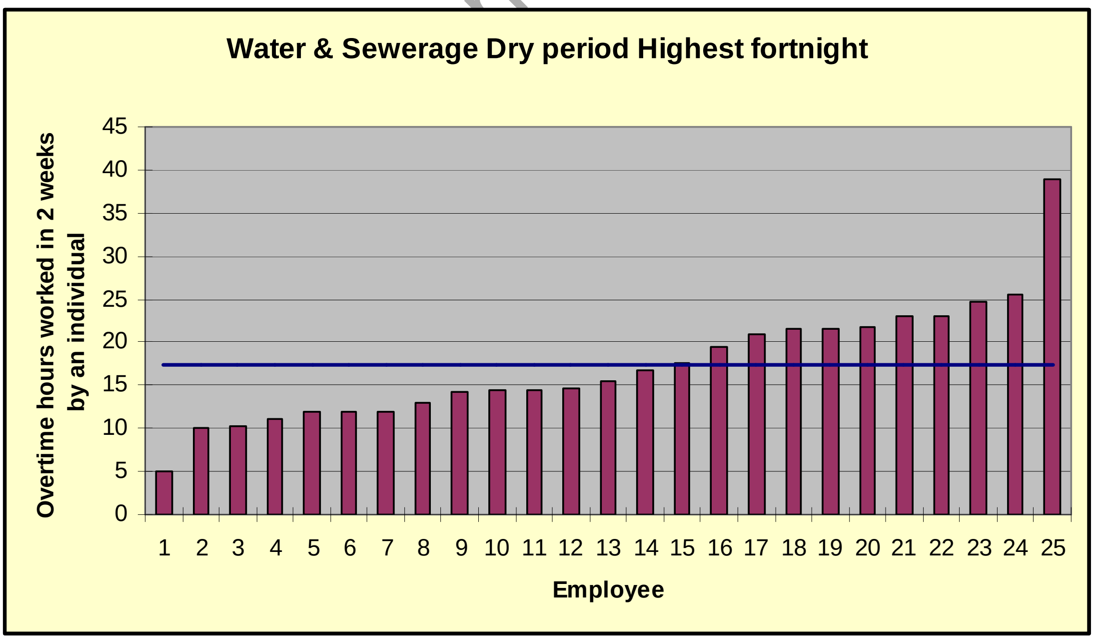


**Figure 94: Individual employee highest fortnight of overtime worked in Dry Season**

The highest fortnight overtime for Water and Sewerage in the wet season is shown in Figure 95. The highest was 32.25 hours and the average was 17.4, which again is not particularly excessive, and it indicates a reasonable sharing of the overtime among the 21 employees that worked overtime.

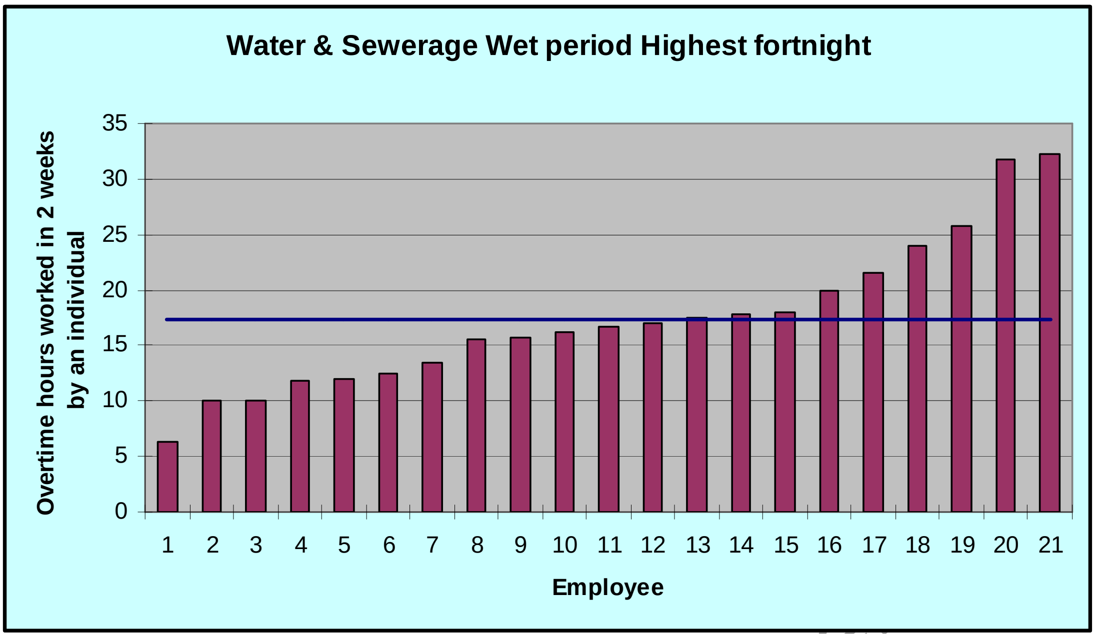


**Figure 95: Individual employee highest fortnight of overtime worked in Wet Season**

### 9.6.3 Networks Detailed Overtime Analysis

The networks overtime was analysed in the overhead and the underground sections separately as outlined below.

**1. Networks Overhead Section**

The total overtime worked by an individual (a linesman) over a 12 week period in the dry season was a very high 161.25 hours, and the average as shown in Figure 96 was 50.4 hours. Both these figures appear to be excessive and indicate a combination of a high frequency of faults together with a shortage of experienced linesmen.

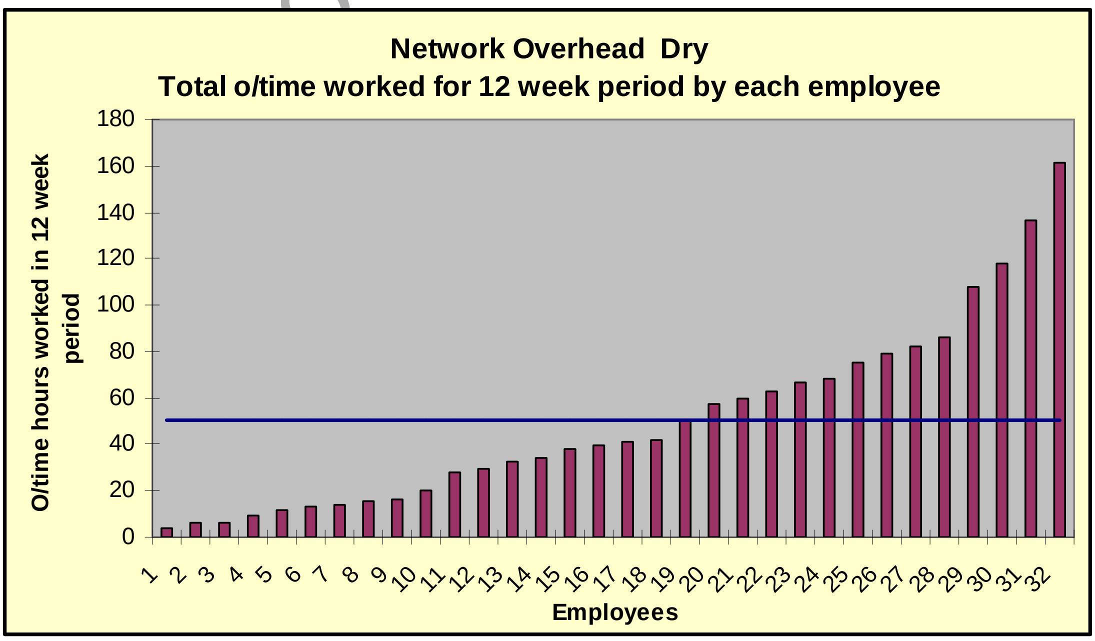


**Figure 96: Total overtime worked by each employee in Overhead Networks in 12-week period Dry Season**

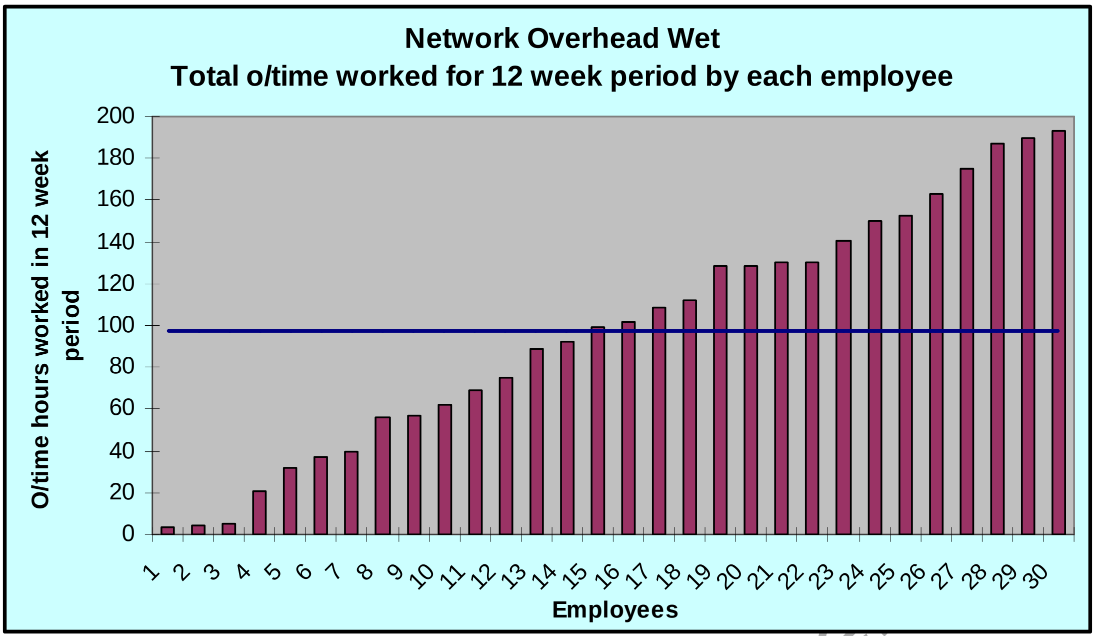


**Figure 97: Total overtime worked by each employee in Overhead Networks in 12-week period Wet Season**

The overtime worked in the wet season as shown in Figure 97, illustrates a number of very high amounts of overtime worked over the 12-week period. The highest total overtime worked was 193 hours and there were a cluster of employees that worked in excess of 100 hours. The average for the 30 employees that worked overtime was a very high 97.7 hours, which averages over 8 hours per week, and for the highest overtime employee it averaged 16 hours per week, which for a prolonged period would be considered excessive.

An evening more challenging position is shown in Figure 98 below where the highest fortnight‘s overtime by an individual employee in the dry season was a very high 87.5 hours and the average highest fortnight was a low 24.2.



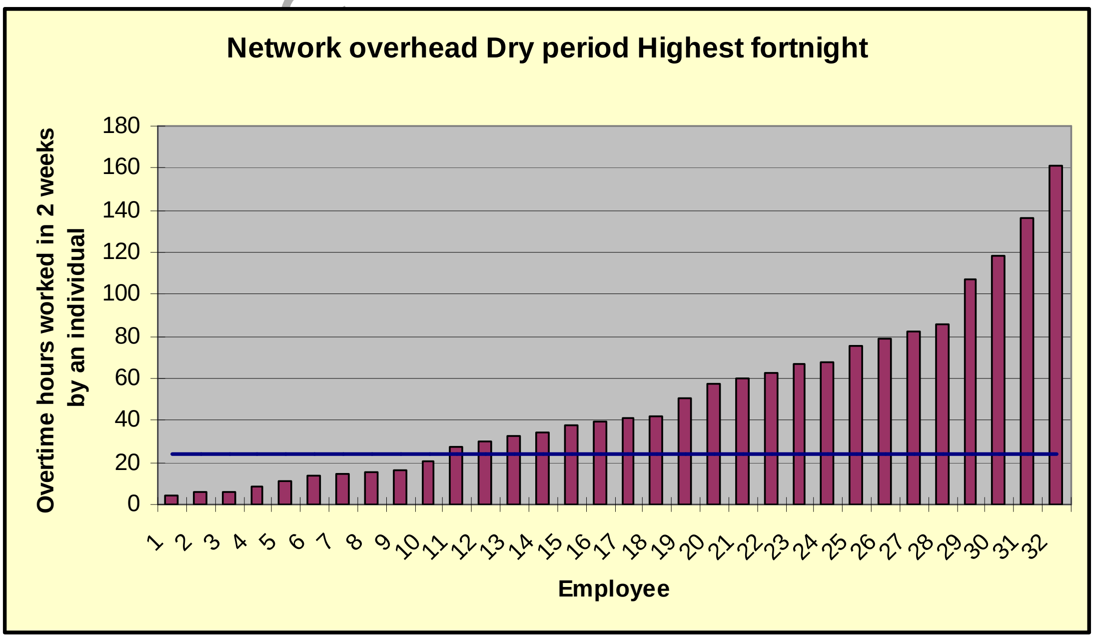


**Figure 98: Individual employee highest fortnight of overtime worked in Dry Season**

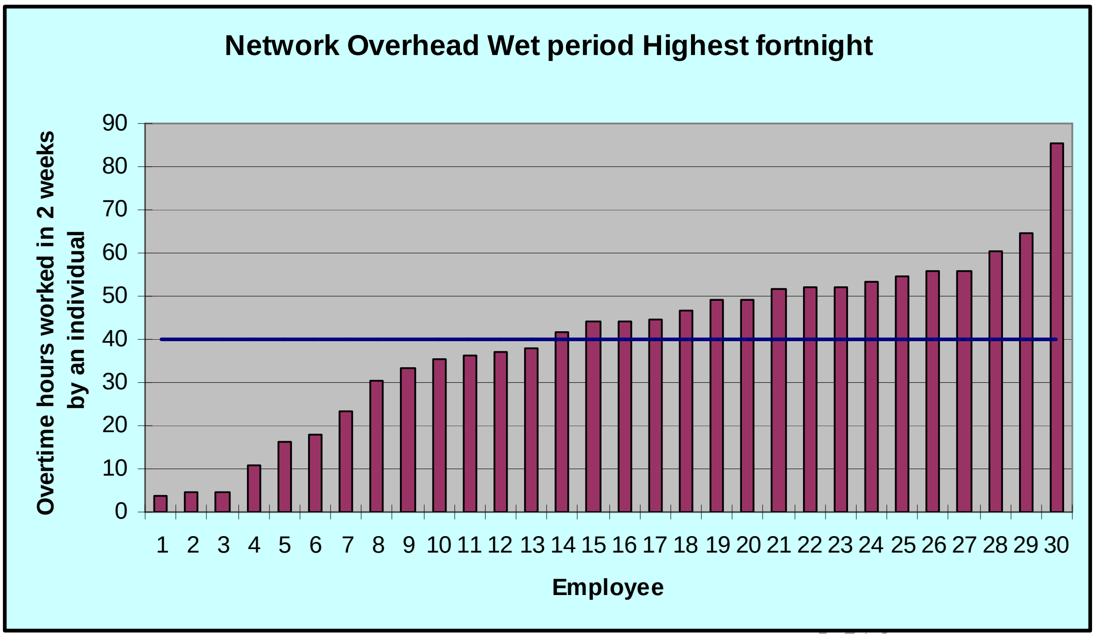


**Figure 99: Individual employee highest fortnight of overtime worked in Wet Season**

The overtime was uniformly higher in the wet season as can be seen from Figure 99, where the highest individual overtime worked in a fortnight was similar to the dry season at 85.5 hours, however the average highest fortnight in the wet was much higher at 39.9, indicating a higher spread of the overtime workload.

The overall summary of the networks overhead overtime indicates that there is a shortage of linesmen in the business, even with the expectation that linesmen will get a fairly high level of breakdown maintenance in a predominantly overhead system.



## 2. Networks Underground Section

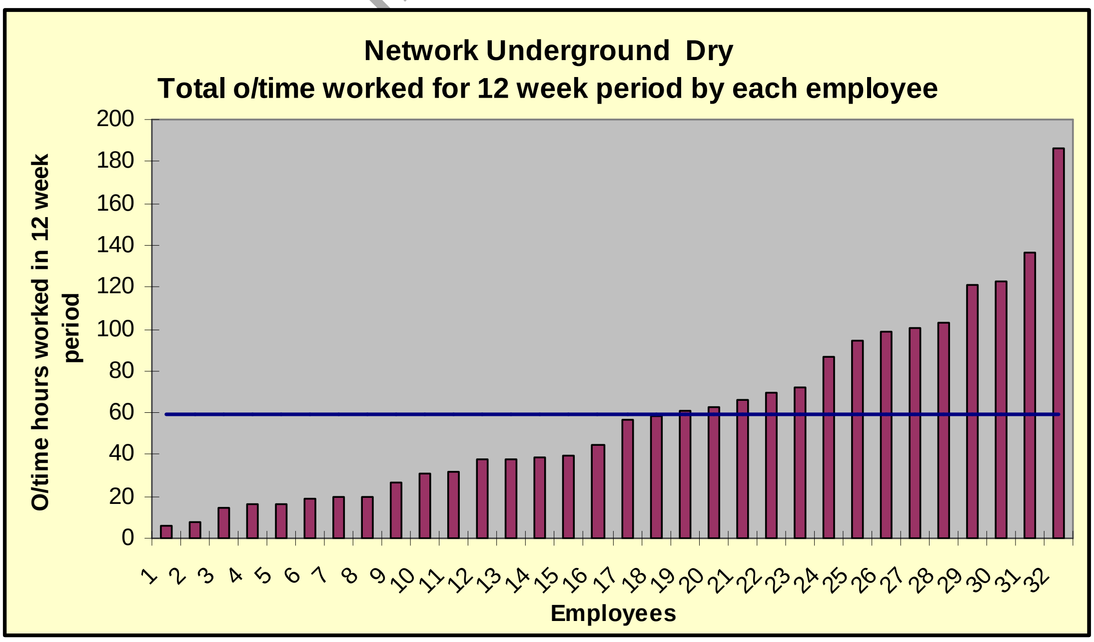


**Figure 100: Total overtime worked by each employee in Underground Networks in 12 week Period Dry Season**

An individual worked an astoundingly high level of overtime over a 12-week period in the dry season at 186.5 hours as shown in Figure 100. The average worked by the 32 employees that worked overtime was also a high 59.5 hours, which averages 5 hours per week. There were 7 out of the total of 32 that did around 100 hours plus in the 12-week period.

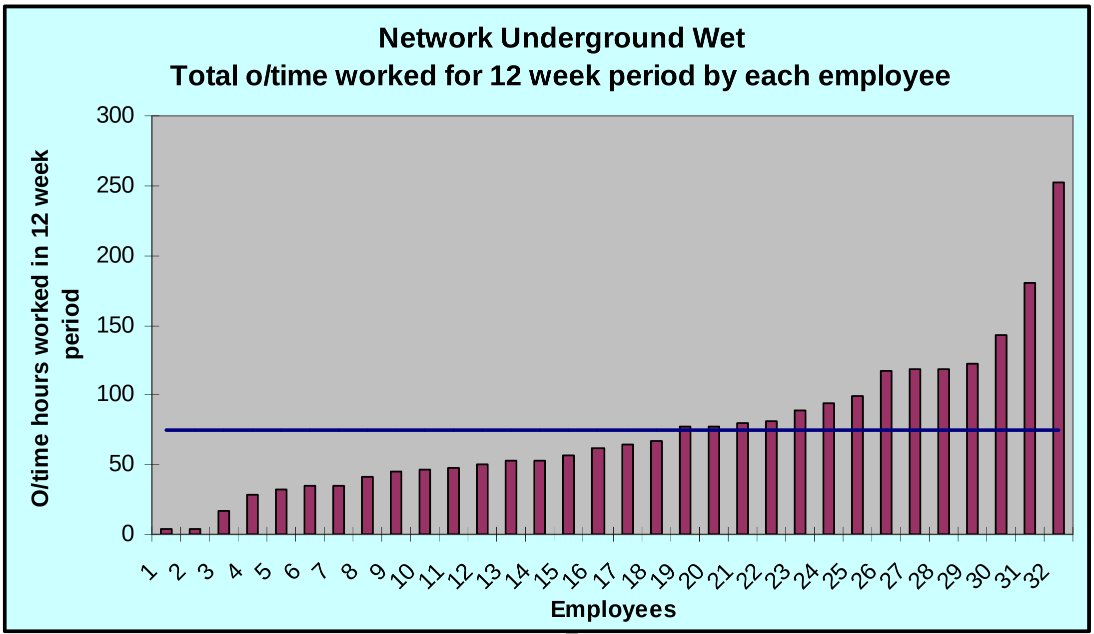


**Figure 101: Total overtime worked by each employee in Underground Networks in 12 week period Wet Season**

There was an even higher 252.25 hours worked by one employee over the 12 week period in the wet season, Figure 101, and the average was a high 74.7 hours which equates to 6 hours per week for each employee. Not surprisingly given the above there was a high individual overtime workload in a fortnight as shown in Figure 102.

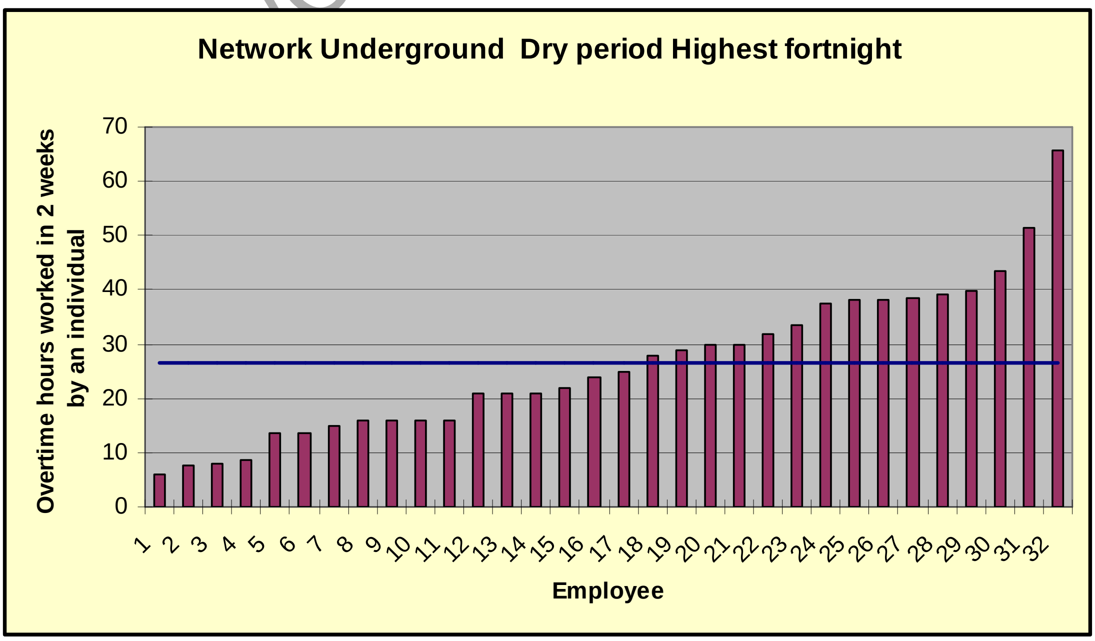


**Figure 102: Individual employee highest fortnight of overtime worked in Dry Season**

The highest fortnightly overtime worked by an individual was 65.75 hours and the average was 26.4 hours. This is again excessive, and would lead to problems if that workload were carried out for a prolonged period. The average of 13 hours per week is not excessive.

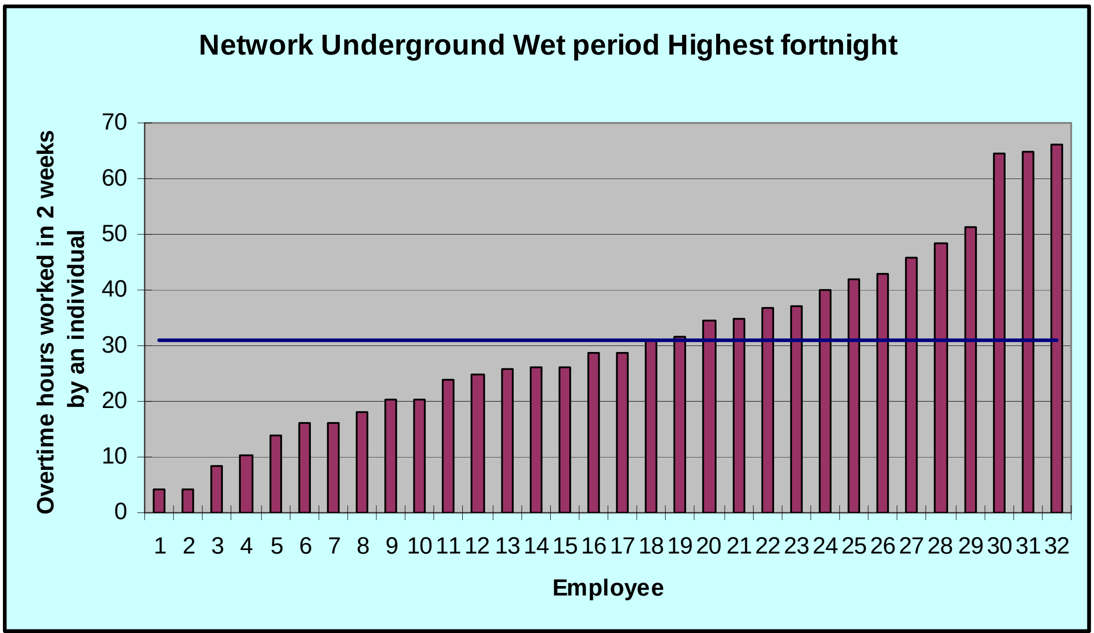


**Figure 103: Individual employee highest fortnight of overtime worked in Wet Season**

There were three employees at the highest individual workload in a fortnight between 64.5 and 66.25 hours as shown in Figure 103Figure 103. The average for the highest fortnight for all 32 employees that worked overtime was 30.9 hours, which is a little high indicating that almost all of the staff that work overtime put in a lot of overtime in at least one fortnight over the wet season.

In overall terms there is clearly some excessive overtime, but it is not as significant as in the Overhead section. There may be a shortage of specific skills leading to excessive overtime by some individuals, and there may be a need to increase the workforce marginally. It is also noted that the extensive undergrounding project that is occurring at this time is putting a strain on resources.

## 9.7 Staff Turnovers

Staff Turnovers are a real concern in PWC given the length of time needed to attract new staff to the Territory. There is no formal formula developed to ascertain the actual turnover rates, however a snapshot over 15 months has been calculated for the Networks area by Michelle Tinley of HR. Based on separations over a 15 month period compared to the actual staff in place as a percentage led to a figure of 14.55%. This is very similar to the turnover rates experienced on the east coast at this time, given the attractive packages being offered in some states, to attract and retain skilled service workers.

The vacancies in each of the line units in PWC are depicted in Figure 104. There are in increasing number of vacancies in the networks area, partly due to wage pressure and strong recruitment from the other states in Australia. There has been a fairly constant level of vacancies in the Generation, system control and Water business units. This is of particular concern in that these 3 units have a lower number of staff in their business units and as such vacancies lead to significant impact on the ability to get the critical work done.

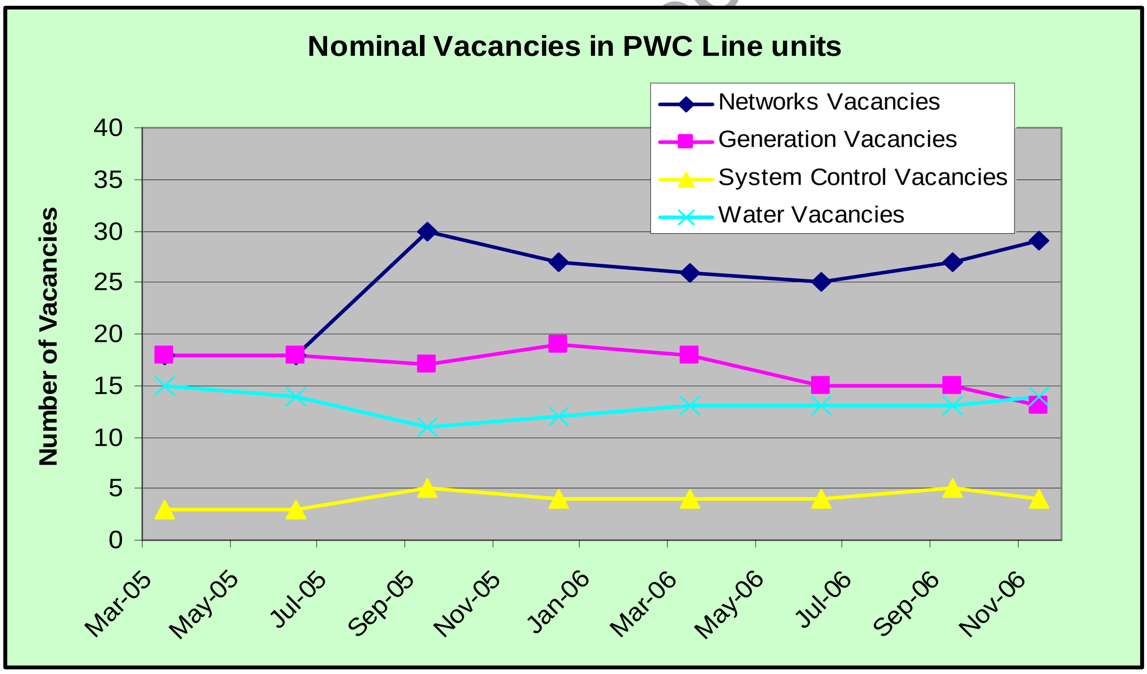


**Figure 104: Nominal Vacancies in PWC Line Units 2005/6**

Figure 105 shows the total number of positions in both approved and occupied positions for the line business units. There is n almost constant gap between approved and filled positions, as there is in any organisation, however with the difficulty that is inherent in recruiting personnel to the Northern Territory, and with the now tight staff numbers it is essential to reduce the gap between vacancies and filled positions to less than 5%.

The table in Figure 106 shows the relative impact of vacancies on the line business units. Generation has the biggest vacancy ratio at 15%, followed by Networks at 11%

and water at 8%, however for the smaller business units, water and generation the actual impact of vacancies is far greater and means in some cases that essential work cannot be carried out. It is recommended that PWC should actively over-recruit to redress this staff shortage, by carrying a number of supernumeries positions that can be transferred to establishment positions on the inevitable turnover of staff.

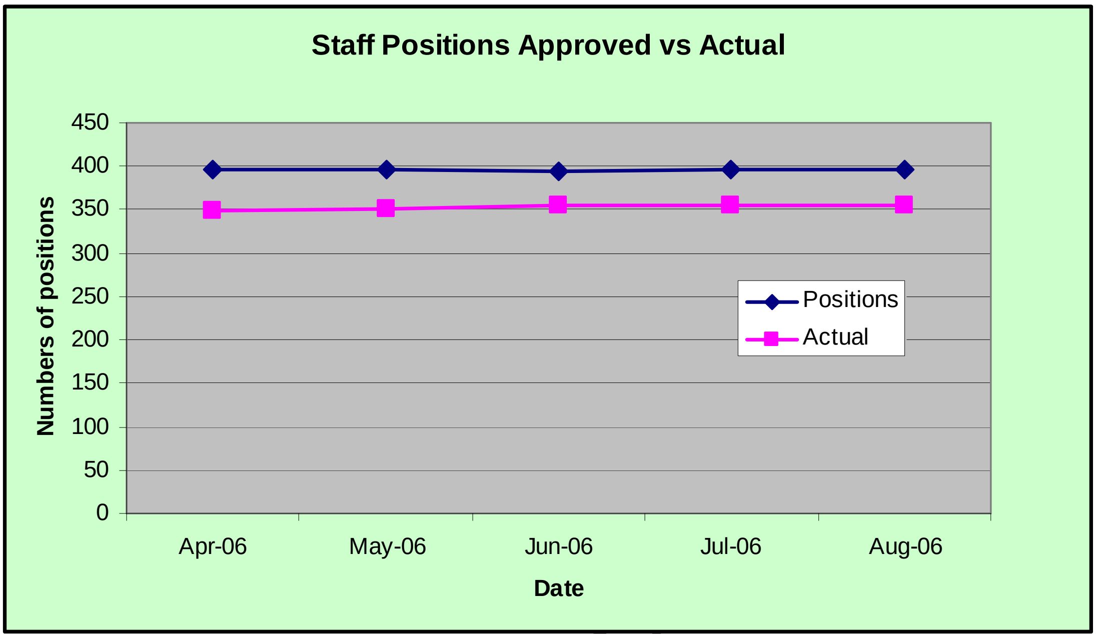


**Figure 105: Positions vacant compared to approved positions Line Units 2006**



| **Networks** | Positions | Actual | % Vacant |
|---|---|---|---|
| Executive | 6 | 6 | 0% |
| Professional | 8 | 8 | 0% |
| Administrative | 8 | 7.4 | 8% |
| Technical | 37.4 | 35.4 | 5% |
| Service Worker | 119 | 101.6 | 15% |
| **Total** | 178.4 | 158.4 | 11% |
| **Generation** | | | |
| Executive | 6 | 5.6 | 7% |
| Professional | 6 | 3.4 | 43% |
| Administrative | 5 | 5 | 0% |
| Technical | 17.2 | 13.6 | 21% |
| Service Worker | 65.8 | 57.8 | 12% |
| **Total** | 100 | 85.4 | 15% |
| **Water** | | | |
| Executive | 5 | 3.8 | 24% |
| Professional | 21.4 | 19.2 | 10% |
| Administrative | 12 | 11.8 | 2% |
| Technical | 38 | 35 | 8% |
| Service Worker | 41.4 | 39.4 | 5% |
| **Total** | 117.8 | 108.8 | 8% |
| **Line Units Totals** | 396.2 | 352.6 | 11% |

**Figure 106: Average Percent vacancies in line business 2006**

# 10 Additional Observations and Conclusions

## 10.1 Cost of Capital Works

A key factor is that the cost of labour and materials is going up rapidly. In particular there is a huge increase in Capital works and replacement works in the Eastern States of Australia. There is an approved capital expenditure of over $6B in Victoria over the next 5 years, and $6B in Queensland, together with large increases expected in New South Wales and South Australia. These increased capital works are the result of a combination of high load growth, and the need to catch up on underspend in the past 5 years as assets were driven beyond their appropriate capacities. This massive increase in capital expenditure is already starting to have an effect on prices for distribution equipment such as distribution transformers and circuit breakers. These cost increases are also being driven by the high worldwide demand for raw materials, such as transformer steel, copper and aluminium.

All of these factors are going to compound together to increase the cost of capital items. As such it is likely that the amounts outlined in the Asset Management Plans for capital works will be significantly understated. Any additional reduction in expenditure will see the average asset age increase, and the inherent increase in age related plant failures will occur. There is no doubt that capital and maintenance expenditure will need to increase over the next 5 years to well above the level of the past 5-10 years to meet the expected growth in demand and to ensure that the necessary capital reinvestment takes place to refurbish and replace aging assets in all areas of the business.



## 10.2 Use of cyclic ratings and dynamic ratings

The use of cyclic and dynamic ratings for PWC's assets is in its infancy. In the past, and to some extent currently, the assets have been rated on their nominal (nameplate) ratings. This is a conservative approach, and good industry practice is to use appropriate short-term ratings to maximise the utilisation of assets. Cables, lines and transformers all have significantly increased ability to handle short term loadings well in excess of their nameplate capacity without degradation, even taking into account the higher ambient temperatures prevalent in the Northern Territory.

Of course care needs to be taken, because increasing above well-defined short-term ratings can lead to catastrophic failure of assets. For example in the Queensland 2004 summer, some transformers were loaded well above their short term cyclic ratings, and Dissolved Gas Analysis (DGA) after the event found that transformer life had been reduced by 10 years in 2 days. This was an extreme case, but it does indicate that a sensible approach needs to be taken when using cyclic and dynamic ratings.

## 10.3 Conclusions

PWC is in the process of developing an adequate asset management strategy as outlined in the various 2005/6 asset management plans. The asset management plans in the water and Sewerage sector are fairly well developed however there are areas for improvement, as have been outlined in this report. In the networks area the asset management plans are more an explanation of what to do, rather than how to do it, and it is expected that a more detailed set of action plans will be put in place to advance the asset management strategy. Some key areas for improvement are: -

- More attention to poorer performing feeders
- Cost effective execution of capital works
- Effective use of cyclic and dynamic ratings
- Catch up on neglected assets in the outlying areas

However there is little doubt that underspends on capital and operations will lead to an increase in outages and a deterioration of performance.

I would like to thank the management and staff at PWC for their co-operation during this review. They have been helpful in providing timely information, and have always worked to answer queries in a professional and timely fashion.

# Appendix A – Structure of Review

Advisory Committee
Role:

- Overview of Review
- Direction of Technical advisory groups
- Consolidation of data
- Overall issue identification
- Development of recommendations
- Report preparation
- Delivery of Findings and recommendations



Technical Advisory Group 1
Generation
Role:

- Facilitate the collection of data
- Arrange site visits and interviews
- Develop issues for presentation to Advisory Committee
- Meet with Committee as required to provide technical advice
- Assist in verification of data as required

Technical Advisory Group 2
Transmission and Distribution
Role:

- Facilitate the collection of data
- Arrange site visits and interviews
- Develop issues for presentation to Advisory Committee
- Meet with Committee as required to provide technical advice
- Assist in verification of data as required

Technical Advisory Group 3
Water:
Role:

- Facilitate the collection of data
- Arrange site visits and interviews
- Develop issues for presentation to Advisory Committee
- Meet with Committee as required to provide technical advice
- Assist in verification of data as required

Technical Advisory Group 4
Human Resources:
Role:

- Facilitate the collection of data
- Arrange site visits and interviews
- Develop issues for presentation to Advisory Committee
- Meet with Committee as required to provide technical advice
- Assist in verification of data as required

Notes: - Technical Advisory groups (TAG) will be part time and will meet weekly as required by phone, or if necessary, face to face. There will be at least 1 management representative and 1 union representative on each TAG.

# Appendix B – Personnel Interviewed

| Name | Position Held | Business Unit |
|---|---|---|
| Andrew Kennedy | Maintenance Manager North | Generation |
| Ron Atwell | Production Manager North | Generation |
| Grahame Treloar | Manager Generation North | Generation |
| Ken Lewis | Manager System Control | System Control |
| John Linton | General Manager Generation | Generation |
| Ian Gibson | SIPS Maintenance Co-ordinator | Generation |
| Phil Brown | Mechanical Co-ordinator Channel Island Power Station | Generation |
| Craig Fawkner | Electrical Co-ordinator Generation North | Generation |
| Workshop staff at Channel Island | Tradespersons and Technicians | Generation |
| Bryan Walters | Katherine Maintenance Co-ordinator Generation North | Generation |
| Damien Williams | Katherine Electrical Maintenance Generation North | Generation |
| Steve Perry | Unit Operator Channel Island Generation North | Generation |
| Tim Ratcliffe | CIPS Operator Channel Island Generation North | Generation |
| Terry Kemp | External Training Provider Connell Wagner | External |
| Don Pidsley | Senior Engineer Asset Management Water | Water Facilities |
| John Mann | Senior water Systems Engineer | Water Facilities |
| Alex Donald | Senior Engineer (Scientist) Water Quality | Water Facilities |
| Noel McCarthy | Project manager Quality systems | Water Facilities |
| Mick Carr | Sewerage Reticulation Co-ordinator | Water Operations |
| Brent Josling | Service worker Sewerage systems | Water Operations |
| Douglas English | Wastewater treatment plant operator | Water Operations |

| Name | Position Held | Business Unit |
|---|---|---|
| Peter Clonaris | Sewerage Co-ordinator | Water Operations |
| Nick Frew | Services co-ordinator Instrumentation Water | Water Operations |
| Eric Boyle | Electrical Services Co-ordinator Water | Water Operations |
| Kieran Moran | Water systems Co-ordinator | Water Operations |
| Ben Hodgkinson | Mechanical Maintenance service worker | Water Operations |
| Nigel Gray | Mechanical Maintenance service worker | Water Operations |
| Cecil Chambers | System Co-ordinator Head works | Water Operations |
| Glen Prowse | Water Systems Controller | Water Operations |
| Cameron McKay | Manager Controls and Communications | Technology Services |
| Chris Chin | Protection | Technology Services |
| John Pudney | Manager Water Engineering | Water Facilities |
| Trevor Davey | Manager Engineering Services Water & Sewerage | Water Operations |
| Bertram Birk | General Manager Power Networks | Power Networks |
| Simon Copley | Asset Maintenance Co-ordinator WIMS | Water Operations |
| Ron Smith | Contracts Manager Networks | Power Networks |
| Bob Fishbourne | Electrical Fitter/mechanic | Power Networks |
| Belinda Hunt | Engineering and Testing | Technology Services |
| Ingvar Dyrting | Engineering and Testing | Technology Services |
| John Hines | Electrician HV Testing | Power Networks |
| Joe Monteiro | Field Testing | Technology Services |
| Chris Pemberton | Manger Network Engineering | Power Networks |
| Thanh Tang | Design Engineer Networks | Power Networks |
| Trevor Allwright | Manager Network Services | Power Networks |

| Name | Position Held | Business Unit |
|---|---|---|
| Ray Acimovic | Co-ordinator Oil Section | Power Networks |
| David Totham | Network Facilitator | Power Networks |
| Mal Tomes | Overhead Coordinator | Power Networks |
| Peter Kwong | Maintenance Engineer Networks | Power Networks |
| Mike Ashton | Senior Network Planning Engineer | Power Networks |
| Clive Scobey | Quality/Safety/Risk/Environment | Quality Safety and Environment |
| Kieran Ruane | Network Safety Adviser | Power Networks |
| Sharon Osborne | Manager Training | Human Resources |
| Karen Stoddard | Co-ordinator Organisational Development | Human Resources |
| Karen Irving | Training co-ordinator | Human Resources |
| Diem Tang | Financial accountant Assets | Finance |
| John Harpley | Adviser to system control centre staff | System Control |
| Mike Snell | Senior Controller , System Control | System Control |
| Robert Ross | Senior Controller , System Control | System Control |
| Rodney Baber | HV Operator | System Control |
| Ron Kirk | Senior Controller , System Control | System Control |
| Ken Lewis | Manager System Control | System Control |
| David Stuart | System Controller | System Control |
| Paul Heaton | A/General Manager Water Services | Water Facilities |
| Doug Lee | OH&S Manager | Quality Safety and Risk |
| Margaret Williams | Works Administration Officer Networks | Power Networks |
| Colin McKenzie | Remote Operations Tennant Creek | Remote Operations |
| Graham Norsworthy | Lineworker Tennant Creek | Power Networks |

| Name | Position Held | Business Unit |
|---|---|---|
| Garry Wilson | Water Operations Tennant Creek | Water Operations |
| Len Holbrook | Generation Tennant Creek | Generation |
| Paul Bastow | Service Worker Darwin | Power Networks |
| Chris Yam | Manager Network Maintenance | Power Networks |
| Jean-Luc Revel | Manager Generation South | Generation |
| Peter Willis | Plant operator Alice springs | Generation |
| Doug Minir | Plant operator Alice springs | Generation |
| Jenny Telfer | Human Resources Consultant Alice Springs | Human Resources |
| John Pengilly | Water Operations Alice Springs | Water Operations |
| Allan Whyte | Manager Water South | Water Operations |
| Darren Davies | Head works Co-ordinator South | Water Operations |
| Peter Lewis | Water and Sewerage Service Worker | Water Operations |
| Jim Gibbons | Regional Water Engineer | Water Facilities |
| Will Cormack | Water Systems Engineer South | Water Facilities |
| Jeffrey Morton | Water Systems Engineer South | Water Facilities |
| Daniel Owe-Young | Water Systems Engineer South | Water Facilities |
| Anton Van Heugten | Lineworker South | Power Networks |
| Mark Stansall | Lineworker South | Power Networks |
| David Lardner | Regional Co-ordinator Power Networks | Power Networks |
| Steve Baskerville | Systems Operations Officer | Power Networks |
| Bavadeen Habibullah | Regional Manager Power Networks | Power Networks |
| Jason Bird | Water Treatment Co-ordinator Katherine | Water Operations |
| Peter Hopkinson | Service worker maintenance water treatment Katherine | Water Operations |

| Name | Position Held | Business Unit |
|---|---|---|
| Ron Davidson | Service worker Water Katherine | Water Operations |
| David Hodd | Service worker Water Katherine | Water Operations |
| Wayne Russell | Network Co-ordinator Katherine | Power Networks |
| Steve Lamble | Lineworker Katherine | Power Networks |
| Brian Walters | Katherine Maintenance Co-ordinator | Generation |
| Damien Williams | Special Class tradesperson Katherine | Generation |
| Wayne Meehan | Tradesperson Katherine | Generation |
| Norm Cramp | Manager, Water Operations | Water Operations |

# Appendix C: References


1. Queensland Electricity Distribution and Service Delivery (EDSD) for the 21st Century Review Report, July 2004 by D Somerville, S Blanch & J Camp QNRME04165, ISBN 1 920920 72 2

2. Discussion Paper on Employment Arrangements, Power and Water Corporation, Mercer Human Resource Consulting 15 March 2006, page 14

3. "International Infrastructure Management Manual" by NAMS Group Version 2, 2002

4. Water Supply and Sewerage Services Asset Management Plans Feb 2006 (22 plans covering all water and sewerage assets

5. Power Networks Asset Management Plan Sep 2003 (updated 2006)

6. Power Networks Network Development Plan 2006-2026, Networks planning report No NPR0629 Sep 2006

7. Darwin Potable Water Supply System Asset Management Draft Plan-2006, Page 29

8. Power Networks Asset Management Plan September 2003, section 4.5, Page 28.

9. Darwin Potable Water Supply System Asset Management Draft Plan 2006, section 10.2, Page 48.

10. Darwin Sewerage Services System Asset Management Plan 2006, section 8, Page 35.

11. Emergency Response Procedure PowerWater 2006

12. Victorian Essential Services Commission Report 2005

13. "IEEE Guide for Electric Power Distribution Reliability Indices" IEEE Standard 1366 ISBN: 0-7381-3889-4 SH95193, 2003

14. Electricity Standards of Service: 2005-06, December 2006 Utilities Commission, Page 2 and Page 21

15. Power and Water Corporation Water Quality Report 2005 Page 8

16. Darwin Potable Water Supply System Asset Management Plan 2006, Page 48,49

17. Power and Water Corporation Wastewater Treatment, reuse and discharge Report 2005, Pages 21,22

# Appendix C - References


18. Darwin Potable Water Supply System Asset Management Plan 2006, Page 46

19. Queensland Electricity Distribution and Service Delivery (EDSD) for the 21st Century Review Report, July 2004, by D Somerville, S Blanch & J Camp QNRME04165, ISBN 1 920920 72 2, Pages 105 and 108

20. Detailed Report of the Independent Panel "Electricity Distribution and Service Delivery for the 21st Century" Queensland July 2004 ISBN 1 920920 72 2: Page 187

21. Detailed Report of the Independent Panel "Electricity Distribution and Service Delivery for the 21st Century" Queensland July 2004 ISBN 1 920920 72 2: Page 185

# Appendix D – CV of Reviewer

## Stephen Blanch

Steve Blanch is the CEO of Dellwind Australia – a specialist consulting company focussing on strategic advice in the Utility Industry. He was a member of the review panel (one of three) for the recent Queensland EDSD Review. Prior to that he recently returned from Saudi Arabia, where he was the Chief Operating Officer for the newly privatised Marafiq Utility – which produced and distributed water, wastewater and seawater for cooling, and electricity generation and distribution. He was formerly chairman of Energy Brix Australia Pty Ltd, a briquetting and cogeneration power business, and the first CEO of Eastern Energy (now TXU), and is currently a director of GEAC, the largest private generation company in Australia, the Chairman for the centre for Power Transformer Technology (a co-operative research centre), Chairman of Rowville Transmission Pty Ltd and Chairman of AMRS (a meter management company).

Steve Blanch was previously the Chairman of a Government Taskforce, to introduce full retail contestability to the Victorian Gas Market, and he also chaired the task force for the Victorian segment of the National Electricity Market.

Steve brings in excess of 45 years broad experience in the utility industry, both in Australia and Internationally. He has been a Chief Executive Officer in the utility industry for 13 years and has held senior and executive management positions in Retail, Distribution, Project Development, Project Management, Transmission Development, System Planning, Design Engineering and Computer Application Development in the electricity industry, and Operational Management in Water and Wastewater. In New Zealand he was Managing Director of the PowerDesignBuild Group providing design, construction, maintenance and operations services to the Transmission and general Utility Industry.

Mr Blanch holds a Masters Degree in Electrical Engineering; a First Class honours degree in Electrical Engineering, and a Diploma of Electrical Engineering. He was formerly a fellow of the Institute of Engineers of Australia and member of the Australian Institute of Company Directors.