IMPACTS ON THE LIFE CYCLE COSTS OF STORMWATER DRAINAGE ASSETS

Concrete Pipe Association of Australasia

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1.0 INTRODUCTION

This paper discusses the impact of life cycle costing analysis on the effective and efficient management of pipeline assets.

The creation of stormwater drainage systems has in the past been a reasonably straight forward process. Drainage has been required due to the development of an urbanised environment and design has been undertaken based on the hydraulic requirements and terrain restraints of the area in question.

In terms of material selection, the original asset creation costs have been the only consideration affecting the choice of pipe material.

This single focus approach is no longer an acceptable practice. The costs which were overlooked by designers and managers of the past can no longer be ignored. The costs of managing an asset throughout its life must be acknowledged from the outset. The choice of pipe material will have a major impact on these life cycle costs. The life cycle cost considerations are:

- the cost of materials and installation
- the cost over the projected life cycle of the facility, and
- the cost of maintaining the facility.

All these costs need to be brought to a present cost to assess the comparative worth of various design options.

One of the greatest difficulties facing asset managers and associated decision makers is in assessing the performance of new materials and assets.

This is particularly the case with life cycle asset management where many of the key factors that will justify a particular new product usage (ie. lowest life cycle cost) have not been proven and have not withstood the test of time.

It must be realised that the adoption of new and as yet unproven technologies does represent a considerable risk for individual asset owners and this needs to be taken into account when completing project evaluation assessments.

2.0 STRUCTURAL INTEGRITY

Asset management analysis has highlighted the benefit of a rehabilitation process which extends the life of assets. This benefit can not be derived if the asset concerned has:

- deteriorated to such an extent that remedial technologies can not restore the asset cost effectively, or
- has failed (collapsed) to such an extent that no rehabilitation can be contemplated.

Both of these factors basically depend on the overall structural integrity of the asset and this is of course dependant on its original makeup.

Some materials decay over a long period and show multiple signs of distress which can be easily identified through appropriate condition monitoring activities. Other materials do not display these features and often fail with less warning and in such a way as to render rehabilitation a non-viable option.

When considering various materials options issues such as probable effective lives and likely failure modes are assessed and the sensitivity of the assumptions validated against the known performance of older technologies.

This paper indicates the range of issues which need to be considered when assessing the true risks of adopting unproven technologies and concepts.

The process of selecting pipe materials requires an understanding not only of the costs associated with the purchase and installation of the pipeline materials, but also of the conditions under which the asset will be expected to function.

3.0 STAGES IN LIFE CYCLE WHERE COSTS ARE INCURRED

The key elements effecting the costs associated with the provision of an asset are:

(i) **Asset development, planning and design** - This process of concept development, evaluation, design, documentation and tendering can vary greatly in cost depending upon the type of pipe material used.

(ii) **Asset creation** - this is influenced by the site, for example when comparing installation in a new subdivision as opposed to backlog or augmentation works in existing areas.

It must be noted that the lowest cost for installation will not necessarily guarantee the lowest life cycle costs when all other factors are considered.

(iii) **Asset maintenance** - Asset maintenance costs are affected by the:

- ***Frequency of corrective pipeline maintenance*** - The types of maintenance work carried out on a pipeline may cause it to need increased future maintenance.

- ***Corrective maintenance costs*** - Particular maintenance repair or rehabilitation techniques will have an impact on life cycle costs. Some techniques may be less expensive but as a result do not appreciably extend the effective life of the pipe.

- ***Frequency of pipeline failure***. This brings in elements of risk and consequences of failure. Assets will generally age to a point where the frequency of failure makes the existing repair regime ineffective and costly.

(iv) **Pipeline rehabilitation and renewal costs** - The particular option chosen and the timeliness of intervention impact greatly on overall life cycle costs.

(v) **Effective life** - The effective life of the asset represents the period over which the asset will perform cost effectively to the standards required. This is dependent upon a number of factors, the most significant being the pipeline material used.

The conditions under which the pipeline will operate provide the key determinates for pipe material selection. These conditions can broadly be grouped into five areas:

1. Site Conditions
2. Ground Conditions
3. Climatic Conditions
4. Service Conditions
5. Pipeline (Material) Issues.

4.0 ANALYSIS OF CONDITIONS EFFECTING LIFE CYCLE COSTS

Having established the major life cycle costs for an asset, an analysis should then be performed on the influence pre-existing and future conditions will have on these costs at various stages during the life of the asset.

4.1 ASSET DEVELOPMENT, PLANNING AND DESIGN

The process from concept inception and development to a documented design and tender can be both lengthy and costly. This is more so when new technology and pipe materials are involved as

- Research and development costs,
- design costs, and
- project and product evaluation costs

need to be included in the analysis.

Research and development costs associated with the utilisation of new pipe materials may outweigh any potential savings to be made in the cost of materials. The same is also true if specific design techniques are required for these newer products.

4.2 ASSET CREATION

Costs associated with pipeline installation are site specific and can greatly impact on the whole of life costs even though incurred at the inception of the project. Some of these cost generators are:

4.2.1 SITE CONDITIONS

Existing site conditions which include:

- high density development,
- major road/rail networks,
- underground service networks,
- sensitive environmental areas, and
- heritage assets

all impact on the installation costs of a pipeline.

4.2.2 GROUND CONDITIONS

The presence of:
- rock,
- waterbearing ground,
- variable strata, and
- floaters

will effect the installation costs for drainage pipelines. While drainage pipes are not usually laid at great depths, the diameters of the pipes are generally large enough for the excavation costs to escalate rapidly with the presence of such ground conditions.

Expansive soils are of great concern in the construction and future operation of pipelines. Expansive soils can be affected to depths in excess of 2 m and may result in surface movements in excess of 70 mm. These movements can create extremely high swelling pressures which are greater for soils with a low natural water content. References indicate these pressures can exceed 300 kPa.

The corrosive nature of the surrounding ground or bedding material will also impact upon material choice.

4.2.3 CLIMATIC CONDITIONS

Rainfall is the major climatic factor which will influence the installation cost of a pipeline.

4.2.4 PIPELINE (MATERIAL) ISSUES

- Material type,
- diameter,
- special requirements,
- the availability of bedding and backfill material,
- the excavation depth, and
- the terrain

must all be considered when a pipeline is installed.

4.2.5 CONSTRUCTION TECHNIQUES

In some cases the greatest stress that will ever be placed on an asset is at the time of construction.

It is vital that this aspect is properly thought through during the option evaluation phase otherwise there may be additional costs which will reduce the effective life.

These potential costs can limit the use of construction techniques and can greatly impact on the cost of installation through disruption to traffic and consequent restoration works.

When using pipeline materials which are particularly sensitive to the above issues contractor performance becomes more critical to the long term success of the asset installation and it follows that the level of supervision detail and cost must also increase.

4.3 MAINTENANCE COSTS

Costs associated with maintenance works are influenced by:

- Frequency of maintenance
- Cost of maintenance
- Frequency of failure.

4.3.1 FREQUENCY OF CORRECTIVE PIPELINE MAINTENANCE

The frequency of maintenance works generally increases with asset age. Particular types of failures, for example root intrusion, may cause structural damage to joints increasing the frequency of future failure. This frequency is influenced by the type of repair techniques implemented which is dependent upon the material type originally installed.

The frequency of maintenance is linked to an awareness of:

- the consequences of failure, and
- the costs associated with failure.

The relative importance of these two issues will determine the routine maintenance regime required.

Conditions influencing maintenance frequency for a pipeline include:

- incidents of vandalism
- illegal dumping of waste
- environmental sensitivity
- traffic loading
- incidents/history of root intrusion
- groundwater conditions
- intensity and frequency of rainfall.

4.3.1.1 Site Conditions

Vibrations from heavy traffic or adjacent construction activities are also factors to be considered when maintenance frequency is considered.

Criticality of a pipeline within a drainage network will also increase the need for routine maintenance.

Where assets are located within road reserves or under road pavements the expected traffic volumes and loadings envisaged during the design phase have generally proven to be inadequate during the life of the asset because of:

- The increases that are being allowed in actual loadings.

- The increases in the equivalent standard axles movements due to the introduction of larger transport vehicles and their increased number resulting in significant loading patterns.

- The increase in road traffic in general and the utilisation of these pavement assets.

It is desirable that any economic evaluation takes into account the probability of different options being capable of meeting these future changes without the need for upgrading or replacement.

4.3.1.2 Ground Conditions

High salinities and sulfate levels in groundwater particularly in association with low dissolved oxygen levels increases the rate of corrosion especially for unprotected metal pipelines.

These conditions may also adversely affect untreated concrete pipes and access pits and may contribute to reducing the effective life of these assets.

Industrial wastes both in groundwater and illegally dumped into drainage systems can badly effect the pipeline condition. Some of the contaminants in this waste are aggressive to metals and concrete and could therefore contribute to the accelerated deterioration of these materials.

4.3.1.3 Climatic Conditions

Generally, rainfall is the element which most greatly influences asset failure frequency. Rain can result in the ingress of backfill material if the pipe has been damaged. This can result in the failure of flexible pipe systems under high load conditions.

4.3.1.4 Service Conditions

Illegal dumping of both solids and liquids into stormwater drainage can increase the risk of failure. If a leak occurs in a pipeline, the environmental impact can be severe through leakage to groundwater. Once illegal discharge has been detected, the current condition of the pipe must be ascertained to determine whether any such repairs are required.

Due to the low grade at which large diameter pipes are laid, incorrect construction techniques may cause ponding of water or build up of organic material in the invert of the main. The humic content of this matter is a potential fire risk especially if left for extended periods. Fire impact upon HDPE and uPVC pipelines is significant. The selection of such pipe material may require an increased routine maintenance schedule to reduce this risk.

4.3.1.5 Pipeline Material Issues

As a pipe ages, its failure frequency increases. This failure rate is influenced by:

- ***Material type***
  Different pipe types having different effective lives.

- ***Joint type***
  Well installed rubber ring joints or solvent welded uPVC pipes can help increase resistance to root intrusion.

- ***Pipe condition***
  A comparison between pipes of the same age may reveal them to be in completely different condition. Thus it becomes important that statistics be developed on pipes to reveal operating performance and condition over the life of the asset. From this an appropriate level of routine condition inspections can be scheduled.

- ***Original Construction Quality***
  The original quality of workmanship during installation of the pipeline significantly contributes to the subsequent lifelong performance and cost of the system.

4.3.2 COST OF MAINTENANCE

4.3.2.1 Site Conditions

The restrictions imposed by high density development and traffic volumes will impact upon maintenance costs. Underground services may also impinge upon augmentation works or general trenching.

The use of trenchless options must be considered. These can be an appropriate option in stormwater drainage applications where there is access to large diameter pipes by maintenance staff. Occupational Health and Safety issues must alway be a consideration in these restricted access situations.

4.3.2.2 Ground and Climatic Conditions

The presence of groundwater will increase the cost of trench based maintenance and may also inhibit some trenchless repair options.

4.3.2.3 Service Conditions and Pipeline Material Issues

Rehabilitation options will be largely influenced by the aggressiveness of the pipe contents.

The rejoining technology available for the replacement of sections of main may also impact greatly on the cost of repairing some newer pipe types.

4.3.3 FREQUENCY OF FAILURE

When considering frequency of failure the following issues must be considered:

- What is the mode of failure?
- What warning of failure is available?
- What are the consequences and costs associated with failure? (Risk Management)

In order to assess these issues, condition assessment is required.

Programmed routine inspection of assets which have reached 80% of anticipated effective life along with an analysis of the maintenance history of more recent assets can identify those assets most at risk.

The failure modes expected in rigid pipe while potentially more catastrophic, will generally present ample early warning signs to allow intervention before collapse.

Infiltration of water carrying bedding material can place flexible pipe at great risk of collapse with far less warning.

These issues must be considered prior to the installation of pipelines at points of high criticality in the network. The failure of such pipelines would cause major community and environmental impact.

4.3.3.1 Site Conditions

The site conditions affecting failure frequency include:

- Heavy vehicular traffic and vibration,
- Stray current induced corrosion (in metal, metal composite or reinforced concrete pipes near transmission cabling), and
- The impact of adjacent construction activities.

4.3.3.2 Ground and Climatic Conditions

Expansive soils, waterbearing ground and tree roots all affect failure frequency especially in recurrent incidents if the initial damage has not been effectively repaired.

Rainfall will also influence failure frequency in these instances by increasing grit carrying water infiltration.

4.3.3.3 Service and Pipeline Conditions

Degrees of internal and external corrosion determined through the regular inspection of the system will indicate when failure is likely. If severe infiltration has occurred at joints, sonar investigation of potential voids may also be undertaken.

As with other life cycle issues, the quality of the original construction has a great impact on life cycle costing.

4.4 RENEWAL/REHABILITATION

Optimised Renewal Decision Making (ORDM) is a process that assists organisations to assess the optimal renewal technique or activities that are available to extend, augment or reduce the service delivered by infrastructure assets, in line with business objectives.

The key elements when performing ORDM are:

- Identifying and analysing the modes of failure
- Identifying viable treatment options
- Undertaking an economic evaluation of these options
- Selecting the most strategically cost effective option for the organisation.

In a stormwater drainage system, the potential modes of failure are:

- Capacity/Utilisation
- Performance/Reliability/Availability
- Structural Integrity
- Cost of Service.

The ORDM options available are summarised in tables 1-4 in Appendix I.

Improvement initiatives include:

- Investigating the use of automated control devices to reduce time to detect failure.

- Assessing the consequences of failure for all assets in appropriate economic terms. This requires the development of a suitable computerised model that will allow staff to determine a value for each asset based on:
  - The additional direct repair costs for emergency failures over and above planned corrective activity.
  - The ancillary failure costs of damage to other assets and public liability.
  - The impact on customers who suffer as a result of asset failure.

- Determining the economic intervention levels at which planned corrective maintenance activities are viable.

- Accelerating R&D programmes to determine the most appropriate asset rehabilitation and maintenance scenarios including:
  - Channel weed clearing and control
  - Vermin control
  - Improving concrete patching
  - Attention to earthen channel waterline erosion problems
  - Reuse of drainage water
  - Subsurface drain cleaning equipment
  - Condition monitoring of pipe
  - Remodelling of earthen banks at the end of their effective life
  - Aquatic weed control techniques
  - Additional control elements to improve system isolation capability
  - Continuing to improve design and manufacture of meter systems.

- Investigating the value of installing the following systems as a means of improving operational efficiency:
  - Computerised maintenance management systems
  - Life cycle (predictive) asset management systems
  - Geographic information systems
  - SCADA (system control and data acquisition) system
  - Job/resource management systems
  - Inventory control systems

4.5 CONCLUSIONS

The following are identified as the key elements effecting asset life cycle costs and performance:

1. Initial cost of creation
2. Effective life
3. Ability to renovate
4. Maintenance costs
5. Others: Consequence of failure
Structural integrity/failure mode.

It is through the understanding of material performance that these issues can be quantified and evaluated. The result of this evaluation will be a pipe material selection based on responsible asset management and whole of life cycle costing.

5.0 OVERALL COSTS ASSESSMENT

The minimisation of Life Cycle Costs for pipeline assets lies in the ability to predict with confidence the probability of expenditure levels at the various stages of an assets life.

Costs are accrued throughout the life cycle of an asset as indicated in the **Figure 5.1**.

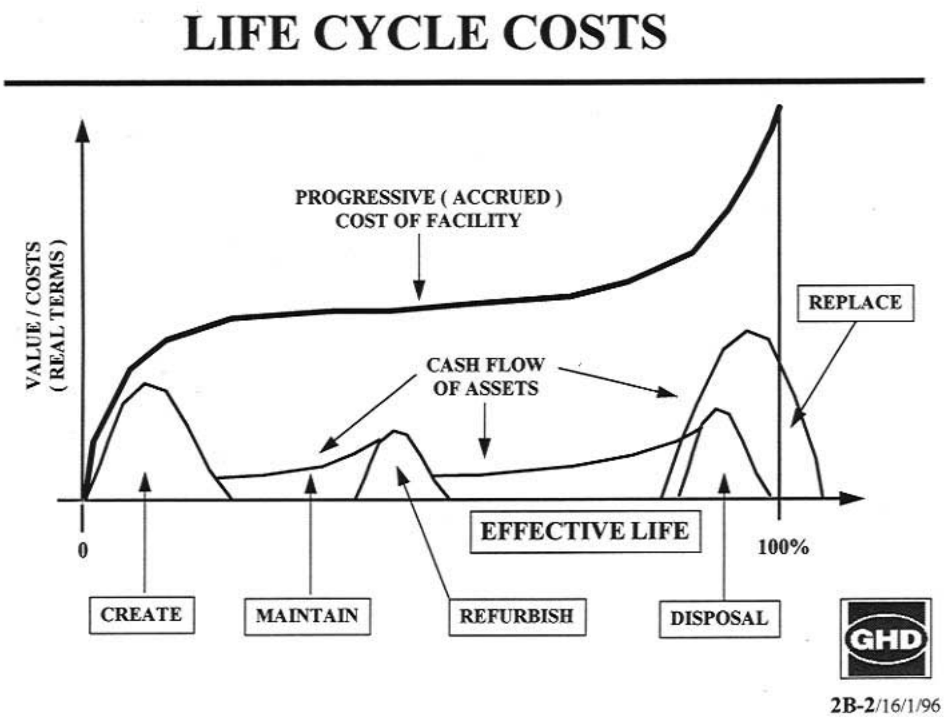

FIGURE 5.1

5.1 PROBABILITY ANALYSIS

Table 5.1 represents the percentage confidence with which the costs associated with each phase of an assets life can be predicted.

TABLE 5.1

Element	Probability/Confidence Level	
	New Product	Proven Product
Construction Cost	90%	95%
Operational Costs	70%	70%
Maintenance Costs	25%	40%
Renewal Cost	50%	80%
Renewal Timing	50%	75%
Replacement Cost	95%	100%
Replacement Timing	50%	80%
Disposal	70%	90%

5.1.1 FACTORS EFFECTING CONFIDENCE LEVELS

The factors which cause variation of costs across the life cycle of an asset are summarised in **Figure 5.2.**

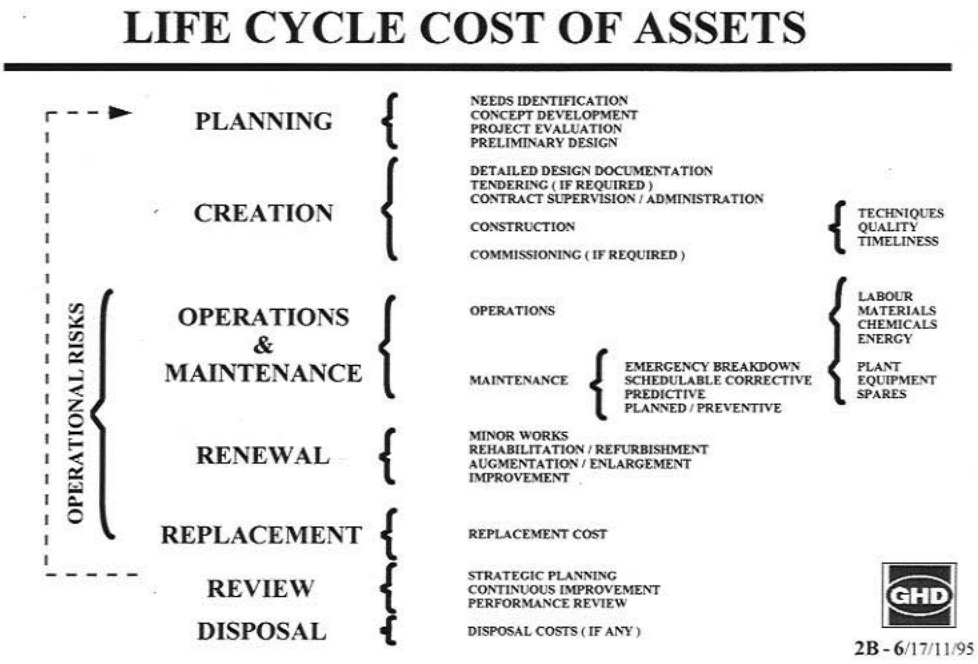

FIGURE 5.2

5.1.2 CONSTRUCTION COSTS

There is high confidence in the prediction of construction costs. This is usually only varied by:

- Material cost - including pipe, bedding and refill
- Site conditions
- Weather
- Contractor performance - including cost, efficiency, effectiveness and quality
- Supervision quality and cost.

The unpredictable weather component is the only variable over which no control can be exercised.

In general the cost of the pipe material may vary significantly however when considered as part of the total asset creation cost it will rarely exceed a 15% difference.

5.1.3 OPERATIONAL AND MAINTENANCE COSTS

These costs are influenced by:

- Labour
- Maintenance materials
- Chemicals
- Energy
- Rate of asset decay
- Consequences of failure
- Cost of maintenance.

There are predicted conditions which will influence maintenance costs irrespective of material used.

The consequences of failure can vary throughout the life of an asset. Assets which were installed in ‘green field' sites will experience a change in the consequences of failure later in life due to adjacent development and densification.

The criticality of this pipeline within the drainage network will also be a consideration with regard to the maintenance requirements of the asset irrespective of pipe material.

Issues related to pipe material are:

- the knowledge and skills required of maintenance staff to handle new pipe maintenance techniques

- the cost and availability of materials

- the rate of decay of the asset which is difficult to predict in the long term.

5.1.4 RENEWAL AND REPLACEMENT COSTS AND TIMING

Factors influencing costs and timing of these major renovations include:

- Structural integrity
- Failure indication
- Renewal capability
- Effective life of the pipeline material.

Renewal costs for newer pipe products are more difficult to predict due to the unknown nature of materials and techniques required.

The rate of decay and mode of failure of steel reinforced concrete pipe makes prediction of intervention timing easier. Issues such as long term rigidity diminish confidence in HDPE pipe failure prediction. This accounts for the percentage variation in intervention timing confidence for both renewal and replacement.

This is also the case with disposal. The predicability of the end of the functional life of a steel reinforced concrete pipe enables greater confidence in managing this aspect of the asset life cycle.

An analysis must be based on the continual provision of the intended functionality which in most cases is a period of several life times of some pipe products. It is of little economic benefit if all other costs are minimised and the effective life is so short that no real cost savings are gained.

5.2 CONCLUSIONS

The above analysis is not based on the exclusion of new pipe materials and techniques when selecting a pipeline. The concern is in having the ability to gain an adequate awareness of the life cycle requirements of the asset and to confidently evaluate the appropriateness of a particular pipe material.

Where confidence is low for a particular aspect of life cycle costing, a sensitivity analysis may be necessary. This form of analysis can indicate the impact such a lack of confidence will have on the overall life cycle costing and facilitate the best decision based on a wide range of factors.

6.0 ECONOMIC ANALYSIS

Studies have shown that the installation cost of steel reinforced concrete pipe in a particular environment is approximately 9% higher than the price for HDPE Steel Composite pipe. With this in mind, an economic evaluation of the life extension required to compensate for the initial cost of the steel reinforced concrete pipe has been conducted.

6.1 METHODOLOGY

This process involves the examination of a "trial asset" representing an HDPE/steel composite pipe. The Net Present Value (NPV) formula was used:

$$P = \frac{A(1 + r)^n}{(1 + r)^n + 1}$$

A comparison was made between this trial asset and a series of steel reinforced concrete pipes each at a higher cost.

Using the above formula, the NPV of the trial asset was calculated using two different discount rates for three different effective life predictions.

This NPV was used as the basis for determining the effective life required for each steel reinforced concrete pipe scenario to justify the additional initial construction cost.

The results of this analysis are in Appendix II.

The following is a summary of the assumptions used:

- A trial asset cost of $1000 has been used to represent the current replacement of the HDPE Steel composite pipe.

- Four price differences have been run against this trial value: 5%, 10%, 15% and 20% higher than the cost for the HDPE Steel Composite pipe.
- Two discount rates were chosen for comparison. These are 2% and 4%.
- The assumption regarding maintenance is that it is either a "do nothing" scenario until the end of the effective live of the pipe or the expenditure on maintenance is approximately the same for both pipe types.

6.2 ANALYSIS OF RESULTS

The objective of this analysis is to determine the additional effective life required of the steel reinforced concrete pipe to justify the additional "up front" installation expenditure.

The effective life of the HDPE/PVC or plastic steel composite pipe materials is claimed to be 50 years. Applications using HDPE material in combination with steel banding to form a composite pipe is a recent innovation. Consequently, two other analyses have been performed with the pipe's effective life being shortened to 45 and 40 years.

Only in the economic worst case (4% discount rate, 20% higher price) is the steel reinforced concrete pipe bordering on being less competitive. For all other scenarios, the steel reinforced concrete pipe while performing well within its known effective life parameters will surpass the composite pipe. For example, a composite pipe lasting 50 years is economically equivalent to a steel reinforced concrete pipe costing 15% more initially if the concrete performs for a minimum of 64.8 years (based on 2% discount rate).

7.0 OVERALL CONCLUSIONS

The following key elements are the basis of economic and technical assessment of life cycle costing for stormwater drainage assets:

- Initial creation cost
- Effective life (to future replacement)
- Ability to renovate
- Maintenance costs
- Others - Consequence of failure
  - Structural Integrity/failure mode.

If we are unsure of our ability to predict the performance of the asset in any of these areas then we need to assess the sensitivity of our assumptions on the choices that we are making.

A sensitivity analysis should be carried out on areas in which confidence is low, namely the prediction of effective lives and maintenance costs.

This sensitivity analysis may reveal that the impact of this initial saving on the overall asset life may be minimal and as a result, a more expensive installation option could be warranted.

Asset managers and designers/constructors should consider every option to reduce costs, however this needs to be done in the full realisation of the life cycle cost implications.

An examination of the costs associated with the various stages during the life of an asset should strongly influence material choice.

Responsible asset management means being aware of these issues and the manner in which they should be assessed.

APPENDIX I

FAILURE MODE - COST OF SERVICE
DRAINAGE PIPELINES AND CHANNELS

ORDM PROCESSES	COST OF SERVICE (Inadequate Return on Asset)
Causes	• Excessive maintenance costs • High number of failures due to poor condition • Future liabilities, rehabilitation or replacement works necessary • High operating costs due to poor condition • Equipment or asset obsolete - Repairs and spare parts costly or not available - New asset would be more efficient, save money
Effect	• Non profitable operations • Excessive subsidies required • Drain on recurrent cashflow • Future liabilities for renewal works • Higher operating costs
Degree of Criticality (Significance)	• Degree to which costs exceeded income generated (return on asset) • Business viability. Ability to carry non performing assets or raise additional income
Treatment Options	• Raise income derived from asset, depends on: - Customer response - Present cost levels - Predictive cost increases • Reduce high cost activities, maintenance and operations • Negotiate lower level of service, performance, reliability etc. • Defer all capital investment • Mothball asset • Dispose of asset • Transfer asset
Evaluation	• Complete ORDM evaluation on various treatment options • Asses and determine strategy in the light of total business picture

APPENDIX I

FAILURE MODE - PERFORMANCE/RELIABILITY/AVAILABILITY
DRAINAGE PIPELINES AND CHANNELS

ORDM PROCESSES	PERFORMANCE/RELIABILITY/AVAILABILITY
Causes	• Decay of asset condition • Failure of component (eg. joint/connection) • Failure of associated unit (secondary failure) • Blockages caused by: - Roots - Refuse - Silt - Rubbish - Damage
Effects	• Interruption of supply or service (blockage) • Overflow of asset. Flooding damage to property etc. • Reduced level of service (reliability/partial service)
Degree of Criticality (Significance)	• Degree to which service is effected • Number of customers effected and time • Consequences of failure eg. safety/damage
Treatment Options	• Improve planned maintenance/condition monitoring • Reduce repair time • Install redundancy/back up standby/overland flow/rerouting • Improve condition monitoring • Install warning devices/predictive model • Overhaul (or rehabilitate) asset to achieve necessary reliability • Replace asset • Complete emergency routine to suit storm events
Evaluation	• Evaluate cost - benefits including business consequences of not meeting reliability standards • Equate costs of consequences of failure to probability • Rank cost - benefit against all opportunities for investment

APPENDIX I

FAILURE MODE - STRUCTURAL INTEGRITY
DRAINAGE PIPELINES AND CHANNELS

ORDM PROCESSES	STRUCTURAL INTEGRITY/ASSET MORTALITY End of Physical Life
Causes	• Structural integrity of asset has decayed below level requirement to meet normal working stresses • Loading on asset exceeds capacity: - internal pressure - external pressure
Effects	• Leaks/inflow (voids created) • Collapse • Property damage • Personal damage (see Risk Management/Consequence of Failure)
Degree of Criticality (Significance)	• Degree of damage caused • Risk to life • Effect on customers • Consequences of failure
Treatment Options	• Reduce loading on asset (divert flows) • Improve ability to repair quickly • Rehabilitate asset before failure • Replace asset
Evaluation	• Evaluate costs - benefits of each option • Benefits to include all consequences of failure costed to probability of failure • Rank cost - benefit against all opportunities for investment

APPENDIX I

FAILURE MODE - CAPACITY/UTILISATION
DRAINAGE PIPELINES AND CHANNELS

ORDM PROCESSES	CAPACITY/UTILISATION	
	Exceeds Design Capacity	Inadequate Utilisation Return on Asset
Causes	• Increased area being drained • Changes in rainfall and/or groundwater levels • Changes in catchment topography • Increased customer expectations, demands for service • Blockage of service (silt etc.)	• Decline in demand • Loss of area being drained • System changes • Reduced intensities
Effects	• Inability to meet demands on system	• Cost of operating assets is above customers ability to pay
Degree of Criticality (Significance)	• Degree to which capacity is exceeded (flooding impact) • Number of customers effected • Risk involved, safety etc.	• Is it an unwarranted burden on the business (not core activity/non performing asset)
Treatment Options	• Operate system differently - interconnection - rerouting catchment and transfer • Boost asset capacity (pump) • Augment asset/duplicate • Replace asset/enlarge • Reduce levels of service • Build new asset	• Mothball assets • Dispose of assets - rationalisation • Identify cost as CSO and derive other income • Transfer liability to others
Evaluation	• Evaluate costs-benefits/income of each option • Benefit - consequence of failing to meet demands against probability of occurrence • Rank cost - benefit against all opportunities for investment	• Overall impact on business of organisation

APPENDIX II

LIFE EXTENSIONS REQUIRED TO COVER DIFFERENT
INITIAL COSTS AT DIFFERENT DISCOUNT RATES

Assumptions:
TRIAL POLYETHYLENE ASSET OPTION = $1000
EFFECTIVE LIFE = 50 YEARS

ALTERNATIVE PRICES FOR CONCRETE OPTIONS:		
		REP COST
OPTION A	5% INCREASE	$1,050
OPTION B	10% INCREASE	$1,100
OPTION C	15% INCREASE	$1,150
OPTION D	20% INCREASE	$1,200

SCENARIO 1: DISCOUNT RATE = **2%**

PE PIPE	CURRENT REPLACEMENT COST OF ASSET	EFFECTIVE LIFE SCENARIO 1A	EFFECTIVE LIFE SCENARIO 1B	EFFECTIVE LIFE SCENARIO 1C
		50	45	40
		NET PRESENT VALUE OF REPLACEMENT COST		
TRIAL ASSET	$1,000	$1,591	$1,695	$1,828
CONCRETE PIPE		LIFE REQUIRED TO ACHIEVE SAME NPV		
TRIAL ASSET + 5%	$1,050	54.5	48.9	43.1
TRIAL ASSET + 10%	$1,100	59.4	52.9	46.5
TRIAL ASSET + 15%	$1,150	64.8	57.3	50
TRIAL ASSET + 20%	$1,200	70.9	62.2	54

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		REP COST
OPTION A	5% INCREASE	$1,050
OPTION B	10% INCREASE	$1,100
OPTION C	15% INCREASE	$1,150
OPTION D	20% INCREASE	$1,200

SCENARIO 2: DISCOUNT RATE = **4%**

PE PIPE	CURRENT REPLACEMENT COST OF ASSET	EFFECTIVE LIFE SCENARIO 2A	EFFECTIVE LIFE SCENARIO 2B	EFFECTIVE LIFE SCENARIO 2C
		50	45	40
		NET PRESENT VALUE OF REPLACEMENT COST		
TRIAL ASSET	$1,000	$1,164	$1,207	$1,263
CONCRETE PIPE		LIFE REQUIRED TO ACHIEVE SAME NPV		
TRIAL ASSET + 5%	$1,050	59	52	45.5
TRIAL ASSET + 10%	$1,100	74	61.6	52.3
TRIAL ASSET + 15%	$1,150	113	78	61.5
TRIAL ASSET + 20%	$1,200	-	130	76

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