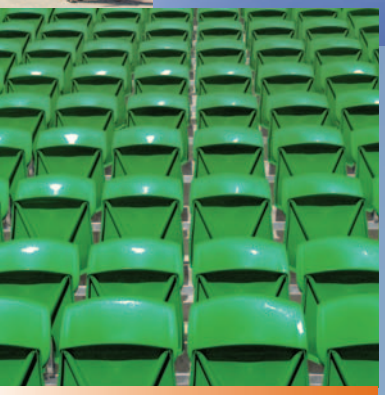
Life Cycle Cost Guidelines

SPORT AND RECREATION FACILITIES

MAY 2005



A guide for sport and recreation facilities owners and managers

Department of Sport and Recreation
Government of Western Australia

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MAY 2005

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May 2005

ISBN: 0-9752115-3-6

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This booklet was prepared with a view to outlining the Department of Sport and Recreations' requirements for LCC reporting. However, any opinions, findings, conclusions, or recommendations expressed herein are guidelines only and should not be expressly relied on by project proponents.

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Foreword

Western Australia's high quality, well–planned sport and recreation facilities give everyone an opportunity to be physically active and to be a part of our vibrant community.

Most sport and recreation facilities are established by local governments in partnership with sporting organisations and frequently with financial assistance from the State Government.

Historically, most of the effort goes towards raising the money to build, buy or refurbish a facility. But once the facility is in place a new phase begins – managing and maintaining it in a sustainable way to get the most out of the community's investment.

Too often little thought is given to the ongoing costs associated with managing a facility, alternative designs or ways to reduce the long–term maintenance and operating costs.

The purpose of these Life Cycle Cost Guidelines (LCCG) is to help facility owners, architects, engineers and sporting groups to understand the full cost impact of owning and managing a facility.

Life cycle costing will help you to get the most out of your facility by making sure construction, redevelopment, or asset replacement is achieved at the lowest "whole of life" cycle cost.

Life cycle cost analysis may mean you trade higher initial construction or plant costs for lower future operating costs.

The ultimate purpose is help you to gather the information you need that more accurately portrays the true cost of a project alternative rather than the initial cost alone.

Ron Alexander

Director General

Department of Sport and Recreation

April 2005

THIS GUIDE

Most sport and recreation facilities in Western Australia are built or refurbished with funding from the Department of Sport and Recreation (DSR).

An important part of the funding process is to make sure the community can bear the true cost of running and maintaining a facility well into the future.

These *Life Cycle Cost Guidelines* provides facility owners, architects and engineers with the tools they need to develop life cycle cost reports that will be used by DSR as it considers publicly owned or funded facilities.

The guidelines mean analysis and reporting can be standardised to ensure a timely and accurate technical review of your facility or project.

LIFE CYCLE COST PRINCIPLES

There are four primary principles to consider when assessing life cycle costs.

- Recognise that a facility development project begins at the concept and preplanning stage and is complete when the asset is sold or the site returned to its original condition.
- Examine the full cost of each project component across the life of a project rather than choose the cheapest option. This may mean a higher initial outlay but lead to reduced ongoing operational, maintenance and disposal costs and a net lower total ownership cost.
- LCCG considers all of the economic and financial costs associated with constructing, procuring and operating a facility at a level for which it was originally planned.
- Developing a life cycle cost analysis is an intrinsic part of your overall asset management strategy.

The Department of Sport and Recreation is committed to pursuing the most desirable project outcomes that reduce the cost to the sport and recreation industry and the broader community.

Developing a life cycle cost approach when considering your project's parameters will provide you with a solid and informed base from which to make the most effective financial, economic and operationally sustainable decisions.

PRINCIPLE ISSUES

1.1 WHAT IS LIFE CYCLE COSTING?

Life cycle costing is a key asset management tool that takes into account the *whole of life* implications of planning, acquiring, operating, maintaining and disposing of an asset.

The process is an evaluation method that considers all ownership and management costs. These include;

- Concept and definition;
- Design and development;
- Manufacturing and installation;
- Maintenance;
- Support services; and
- Retirement, remediation and disposal costs.

One way to express the total life cycle cost is in the form of a mathematical equation.[1]

Total Life Cycle Cost (LCC) =	Initial asset acquisition /capital cost **(AC)**	Less
	Tax depreciation entitlements **(TD)**	Plus
	Operating and maintenance costs **(OC)**	Plus
	Replacement / disposal / upgrade costs **(RC)**	Less
	Residual / salvage value **(RV)**	= LCC

So a typical life cycle cost for new sport and recreation facilities could be represented in the following equation:

$$LCC = (AC – TD) + (OC + RC) –RV$$

You would have to factor in an additional component – deferred maintenance (DM) – for refurbishment or redevelopment projects.

$$LCC = (AC – TD) + (DM)+ (OC + RC) –RV$$

A key question is "which costs are included within the life cycle equation?"

Put simply, the costs to be included within the LCC equation are those that are directly attributed to the ownership, management and operation of an asset.

An example would be air conditioning where you have installation, operation and replacement expenses. Costs such as annual staff salaries, service provision, training associated with corporate functions would not be included.

1.2 THE EFFECTS OF DEFERRED MAINTENANCE

Local governments own or manage the majority of sporting and recreational facilities in Western Australia, so management is often exposed to a highly competitive and localised budgetary process.

With few exceptions, facility management within local government has not been exposed to the rigour of consolidated asset management planning processes and the associated financial systems.

Maintenance competes for funding with other programs and is often deferred when other projects receive a higher priority. The cost is the increased risk of components failing and potentially increased safety hazards, poor service to the public, higher costs in the future and inefficient operations.

In many cases the deferral of routine scheduled maintenance will mean your asset will deteriorate faster, making it harder for you to meet the deferred maintenance costs.

In terms of the life cycle cost process, deferred maintenance is understood to be the cost of maintenance not committed to maintaining the assets original or desired level of service.

In this context, deferred maintenance is not considered capital renewal.

Overall, the need to identify deferred maintenance will help you to establish the funding responsibilities of all parties in the project proposal.

The process of identifying and quantifying the true cost of deferred maintenance is detailed in Section 2.3 of this document.

1 Ballesty, S., Orlovic, M. (2004). Lifecycle costing and facility management. Facility management 12 (2), p.28.

1.3 WHEN SHOULD A LIFE CYCLE COST BE APPLIED?

From DSR's viewpoint there may be times when it requires a facility project to include a LCCA in the project criterion.

The LCCA may be required when applying for grant funding through either the State Sporting Facilities Plan (SSFP) or the Community Sporting and Recreation Facilities Fund (CSRFF).

As such, these definitions apply:

- **Facility** — a building having 500 square meters or more of usable floor space that is heated or cooled by a mechanical/electrical system or any building, system or physical operation which consumes more than 1500 Megajoules (MJ) per square meter per year."
- **Project** — any works undertaken to design, construct, modify or alter existing or new facilities or plant where the proponent is seeking a grant component for a project total cost in excess of $300 000.
- **Renovation** — a project where additions or alterations exceed 25 per cent of the value or size of a facility, particularly if it will affect an energy system.
- **Energy system** — includes, but is not limited to, equipment or measures used to heat or cool the facility, heat water, or generate electricity.

It is up to the public agency or sporting organisation to comply with these requirements.

1.4 TIMING OF A LIFE CYCLE COST ANALYSIS

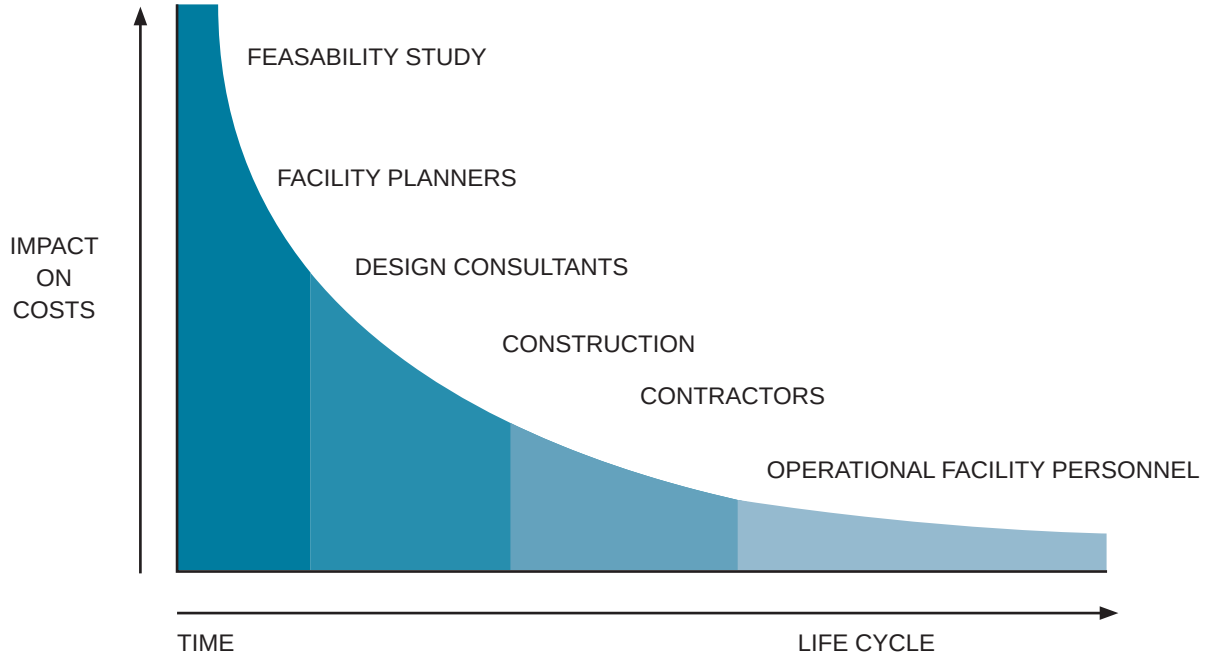
The timing of a LCCA is crucial to the long–term success of a facility. In contemporary project management the concept and design stages are the greatest opportunities to influence a successful facility structure and operation. The further a project develops, the further opportunities diminish.

For a LCCA to successfully guide decisions about building design or asset replacement it must be completed before systems are selected and approved and construction tenders are awarded.

- Future facilities proposals submitted seeking CSRFF support of more than $100 000 are likely to be required to submit a LCCA to support the application.
- All State Sporting Facilities Plan projects will also need to submit a LCCA.

The image depicted at figure 1.0 demonstrates the optimum time to positively reduce life cycle and project costs associated with any project is at the feasibility study stage. This opportunity greatly diminishes as we move along the life cycle axis. It can be seen from this schematic that effort focused at the feasibility and planning stages can greatly improve the "over the life" performance of an asset.

FIGURE 1.0[2]



2 Ballsty, S., Orlovic, M. (2004). Lifecycle costing and facility management. Facility Management 12 (2), p.32.

1.5 REQUIREMENTS IN FUNDING APPLICATIONS

The aim of this guide is to reinforce the concept of *whole of life* costs for the practitioner to deliver better project decisions. LCC is a valuable and powerful tool that can be used to gain support for the preferred project option.

Many people across the sport and recreation industry have considered the lowest construction cost as being the best alternative. The LCC approach encourages proponents to focus decisions on a developed life cycle cost regime to reduce energy consumption, maintenance requirements and ongoing operational costs.

The adoption of a life cycle cost approach will be necessary when applying for public funds to assist in your project, renovation or construction. An analysis should conform to the requirements set down in this guide before a contract is let for an improvement or construction of a public facility. Should an analysis not be possible, a written submission should be lodged with DSR outlining the circumstances.

The minimum measures to be analysed in a life cycle cost analysis will include;

(1) the equipment used to heat or cool the facility;

(2) equipment used to heat and/or treat water;

(3) on–site electric/gas/other generating equipment;

(4) the building fabric;

(5) the equipment used to maintain the surface/s; and

(6) any major plant or equipment.

2.1 ANALYSIS PROCEDURE

The life cycle cost analysis procedure considers the option of selecting from a set of alternatives, the building design or plant with the lowest whole of life cycle cost.

The design and development aspect of the project analysis procedure recognises that many of the facilities that will provide future sporting and recreational services already exist.

Consideration of funding applications for sport or recreation facilities will fall into two categories:

1. **New sporting or recreation facilities (Greenfields).**
2. **Refurbished or redeveloped sporting or recreation facilities (Brownfields).**

2.2 NEW SPORTING OR RECREATION FACILITIES

A Greenfields project for new facilities provides the facility owner the greatest opportunity to minimise the total cost for construction, operation and maintenance through total asset management strategies.

This can be achieved through the adoption of an integrated facility asset management program early in the development stage of a new facility (see figure 1.0). The issue of deferred maintenance typically does not encumber Greenfields projects and consequently the project manager can adopt maintenance and budgetary projections with a greater level of confidence.

The format for LCCA reports shall be similar to the format of these guidelines that have been adapted from Australian Standard for Life Cycle Costing[3]. Information is to be clearly presented and understandable to all parties in the process (facility, financial and technical). LCCA reports are to be stand–alone documents containing all support documentation and be capable of independent review.

The analysis process for either a new or refurbished facility must factor all of the costs associated with the concept planning, design, documentation, tendering, construction/modification, operation, maintenance and eventual decommissioning of the facility. The Greenfields application will clearly identify rights and responsibilities of all parties involved in the project and detail all estimated cost exposures over the life of the project.

2.3 REFURBISHED OR REDEVELOPED SPORTING OR RECREATION FACILITIES

Brownfields projects are those where submissions are made for existing facilities to be upgraded or refurbished or a new facility developed on a site currently being used for other purposes,

Facilities funding processes (both capital and operating) for existing local government facilities are typically exposed to the pressures of annual budget bids in a very competitive financial environment. Exposing existing facilities to this style of budgetary process may lead to inadequate maintenance funding that ultimately results in their premature deterioration.

The dangers of a competitive budgetary process might include a lowering of priorities being placed on routine and scheduled maintenance for existing facilities, and as a result – a "*deferred maintenance*" debt.

When calculating the deferred maintenance exposure, a facility manager needs to undertake a facility condition assessment (refer to the Asset Management Guide for a sample template).[4]

This process begins with a multi–disciplined team conducting a thorough inspection of the facility. If all systems of the facility are being included in the facility plan, the team should include an architectural representative and structural, mechanical and electrical engineers. Where this is not practical due to budgetary constraints, qualified staff within your organisation should conduct the process.

If the scope of the plan is being limited, then a representative of only those disciplines to be included is required. In all cases, the inspection team can be the owner's personnel, external consultants or a combination of the two. The scope of the plan can also be expanded to include room fixtures, fittings and equipment where knowledgeable personnel are available. Other specialists such as gas testing specialists or roofing inspectors may also be added to the team as appropriate. In all cases, the inspectors must be experienced and knowledgeable practitioners in their field.

In most cases, the inspection is entirely visual and therefore the inspectors are called upon to make value judgements by extrapolation from their observations. Where necessary, more invasive and preferably non–destructive methods may be employed to gain better insight into the condition of the facility.

3 Standards Australia. (1999). Life cycle costing. (ANZS 4536:1999). Sydney, New South Wales: Standards Australia.
4 Department of Sport and Recreation. (2004). Asset management guide: a guide for sport and recreation facility owners and managers. Perth, Western Australia: Department of Sport and Recreation.

For ease of inspection, each discipline (i.e. architectural, mechanical) is divided into a number of individual components. The mechanical systems for example can be divided into eight basic components that are;

M01	Site Services	M05	Cooling
M02	Plumbing	M06	Fire Protection
M03	Heating	M07	Gases
M04	Ventilation	M08	Miscellaneous

Each of these components is then further divided into sub–components. Plumbing for example could have the following components;

M02	Plumbing	M0213	Storm Drainage
		M0214	Plumbing Fixtures
		M0215	Special Systems

The data gathered with respect to the deferred maintenance deficiencies will include building component and sub–component which includes a sequential reference number and a deficiency rating, location and description. A deficiency repair cost will be added later.

The deficiency rating system is flexible and can be adjusted to meet specific project needs. Typically, a process would use a rating system from one to five based upon the relative level of disrepair and the effects on the overall facility, with one being poor to catastrophic and five being in a good state of repair. A numeric rating of one would be for aspects that contravene code, health, and regulation or Act violations – thus requiring immediate attention.

The costs apportioned for remedial repair (including regional adjustments) are to be provided by a quality surveyor or qualified contractor and have the capacity to be reviewed in accordance with a recognised industry building estimates publication such as *Rawlinsons Australian Construction Handbook*[5].

The purpose of undertaking this procedure is to identify the true cost exposure for the various funding bodies and also gather valuable baseline data for the formulation of a fully integrated asset management plan.

In each case the analyst has to consider design alternatives for the domestic/commercial hot water system, lighting system, combinations of building envelope–HVAC (heating, ventilation, and air–conditioning) systems, pool design, pool heating, court surfaces etc.

When applicable, the analyst is to consider design alternatives for on–site electricity generation. Each analysis is to be based on a 20–year study period. In order to be considered as an effective investment, an energy application project should have a simple payback period of five years or less.

The analysis methodology must consider the relationship between energy–using systems. When the amount of energy consumed by one system impacts the energy consumed by another, this interaction must be carefully considered in the analysis. The accepted methodology is for the analysis to first evaluate independent systems, followed by those systems that interact. A particularly useful reference for life cycle costing procedures is the Australian Standard for Life–Cycle Costing[6].

2.4 TIME VALUE OF MONEY

A key concept of the life cycle analysis equation is that of the time value of money.

The challenge in determining the best *whole of life* financial option is to achieve a position where the various options under consideration can be fairly evaluated. When considering various proposals, you will be faced with comparing capital and operating costs that are expended at different times. In evaluating the financial impacts of the various alternatives all costs for each option under consideration are expressed in "*today's dollar value*". This provides the basis to accurately judge the costs and benefits associated with various alternatives.

The definition given on page 21 "A concept that acknowledges that money changes value over a period of time; that a sum of money today is worth more that the same sum of money at a future date, because of the fact that the money received now can be invested to earn interest" considers the value of money invested in future cash flows.

In order to better understand the issue, examples have been provided at page 25. Each option considers the replacement of an air conditioner and factors the purchase cost and the life cycle annual maintenance and running costs. The present values chart at page 36 shows the future value of a dollar at a nominated discount rate.

The example cites a discount rate of 12% for air conditioners of varying qualities. Option one considers an air conditioner of lesser quality that requires replacement at more frequent intervals and has a higher annual running and maintenance cost. Conversely, option two considers a more expensive unit requiring a lesser level of annual maintenance and running costs. Due to reliability, over the period considered (30 years) option two requires replacement once at year 15.

The result demonstrates that the total present value of installing, operating and maintaining an air conditioner of the size considered is significant over a thirty–year period.

Option 1 demonstrates that the lesser value investment system costs at present day values a total life cycle cost of $468 013. Option 2, whilst being a high initial cost demonstrates a life cycle cost of $413 689. These examples shows that option 2 delivers a better whole of life cost benefit of $54 324.

The aim of these examples demonstrates the time value of money and how investments may be fairly compared using an appropriate discount factor at today's dollar value.

5 Rawlinsons Construction Cost Consultants and Quantity Surveyors. (Ed.). (2005). Australian construction handbook 2005. Perth, Western Australia: Rawlhouse Publishing Pty Ltd.
6 Standards Australia. (1999). Life cycle costing: an application guide (ANZS 4536:1999). Sydney, New South Wales: Standards Australia.

3.0 Standard format for Life Cycle Cost reports

The order of sections and appendices are:

1. Certification
2. Executive Summary
3. Project Scope
4. Life–Cycle Cost Model Description
5. Life–Cycle Cost Analysis
   - A. Building Fabric
   - B. Domestic / Commercial Hot Water
   - C. Lighting
   - D. Building Envelope and HVAC System
   - E. On–Site Electric Generation
   - F. Water Sourcing / Treatment
   - G. Flooring / Surface
   - H. Recommended Systems
6. Appendix

The first form required is the Certificate of Responsibility. The report must be certified by the Project Principal and notarised by either a registered Architect or a licensed Professional Engineer in Australia.

DSR has adopted the codified version of ASHRAE Standard 90.1–2001 as its energy code for recreational buildings, so this is the base case for each alternative studied. The analyst is to answer the question at the bottom of the form to verify that all design options in the report comply with the energy code.[7]

TABLE 1.0

CERTIFICATE OF RESPONSIBILITY

SEAL	I hereby certify that this Life Cycle Cost document was prepared by me or under my direct personal supervision and that I am the **Project Principal** or **Principals Representative.** Signature:…… Printed name:…… Date:…… As a duly licensed **Professional Engineer** or **Registered Architect** under the laws of the State of Western Australia, I certify that the Life Cycle Cost document has been completed in accordance with the provisions of ASHRAE Standard 90.1–2001 Signature:…… Printed name:…… Date:…… My license/ Registration renewal date is:…… Pages or sheets covered by this seal:…… Organisation:…… Address:…… Contact:……

Do the designs presented in this report meet energy code requirements as adopted from ASHRAE Standard 90.1?

____ Yes ____ No

If not – explain why:……

7 American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2001). Energy standard for building except low-rise residential buildings. United States: ASHRAE.

Section 2: Executive Summary

The Executive Summary is to include a brief synopsis of the purpose of the report, a summary of important findings of the report, a description of important assumptions and special design considerations used in the analysis and system selection recommendations based on lowest life cycle cost.

The Executive Summary must also provide an annual energy budget for the facility based on the assumptions outlined in table 3.3. The LCCA Summary Form must be provided in the Executive Summary (refer to the next page).

The LCCA Summary Form tabulates the findings of each system alternative evaluated in the report. The LCCA Summary Form also provides the derivation for the annual energy budget for the base case and for the facility alternatives yielding the lowest life cycle cost. The derivation of the annual energy budget should not double count energy consumption data, such as lighting energy that is often also included in HVAC energy consumption calculations.

Specifically with regard to asset renewal, refurbishment or reconstruction projects the Executive Summary must identify the deferred maintenance backlog calculations to establish the baseline funding position.

TABLE 2.0

Building Area _____ square metres

System	Description	Option Number	Electricity (kWh) 1kwh = 3.6 mj	Natural Gas (Therms) 1M3 = 38.2 mj	Annual Electricty Cost	Annual Gas Cost	Total Annual Energy Cost ($)	Greenhouse Gas Emmissions	Life Cycle Cost ($)	Initial Cost ($)
Lighting / Electrical		1 2 3								
Domestic Hot Water		1 2 3								
Envelope & HVAC Combinations		1A 1B 1C 2A 2B 2C 3A 3B 3C								
Electricity Generation		1 2 3								
							Base Case Totals			
							Recommended Systems Totals			
							Difference (Base Case minus Recommended)			

Notes:

1. Designate each recommended system.
2. The Base Case is generally the system with the lowest initial cost.

Section 3: Project Scope

This section defines the scope of the project (refer to the following page). The project identification form is divided into four topic areas including a project summary, organisation contact information, design professional contact information and special design considerations.

Information that is provided is to be as complete and accurate as possible.

The Project Summary section includes general information about the facility such as the location as well as specific building design information. Many of the items are self–explanatory and some only require a yes or no answer, however, an explanation for a few of the items is provided below.

- Building Type — describe the use of the building (such as aquatic, hall, courts etc.).
- Slab–on–ground — does the building consist of slab–on–ground construction?
- Levels below ground — does the building have a basement or a partially exposed basement?
- Mechanical cooling — is the building mechanically cooled?
- Renewable resources used — are solar collectors (photovoltaic or solar thermal), wind turbines, etc. intended for the project?
- On–site electric generation — is electric generation intended for the project, including engine generators, wind turbines, etc.?
- Estimated annual occupancy hours – what is the intended annual occupancy hours of the primary tenant? If there is no primary tenant, estimate total tenant occupancy hours.

The final section provides space to describe special design considerations requested by the proponent organisation (Local Government Authority/Sporting Organisations). Design constraints that affect system alternatives selection must be documented here as well as in the report. This section should also include a statement of the analysis objective, operating and support scenarios, assumptions, constraints and alternative courses of action considered.

TABLE 3.0

PROJECT IDENTIFICATION

PROJECT SUMMARY

PROJECT NAME

ORGANISATION NAME

CITY/TOWN STATE POSTCODE

BUILDING TYPE BUILDING SQUARE METRES

NUMBER OF FLOORS ESTIMATED NUMBER OF OCCUPANTS

SLAB–ON–GROUND YES ☐ NO ☐ LEVELS BELOW GROUND YES ☐ NO ☐

MECHANICAL COOLING YES ☐ NO ☐ MECHANICAL VENTILATION YES ☐ NO ☐

RENEWABLE RESOURCES USED YES ☐ NO ☐ ON–SITE POWER GENERATION YES ☐ NO ☐

ESTIMATED ANNUAL OCCUPANCY HOURS

ORGANISATION CONTACT

CONTACT PERSON TITLE

TELEPHONE FAX

DESIGN PROFESSIONAL CONTACTS

ARCHITECTURAL FIRM

ARCHITECT NAME TITLE

SUPPORT STAFF NAME TITLE

CITY/TOWN STATE POSTCODE

TELEPHONE FAX

ENGINEERING FIRM

ENGINEER NAME TITLE

SUPPORT STAFF NAME TITLE

CITY/TOWN STATE POSTCODE

TELEPHONE FAX

SPECIAL DESIGN CONSIDERATIONS

ANALYSIS OBJECTIVE

PROJECT DESCRIPTION

OPERATING/SUPPORT SCENARIOS

CONSTRAINTS/ALTERNATIVES

The Assumptions Form Table 4.0 provides a central location for documenting assumptions made in the analysis.

Information that forms the basis for inclusion on the assumptions form considers the expected recurrent (operating) cost for the LCC and briefly identifies how the building design has been managed to reduce these costs or enhance service provision. Assumptions regarding initial energy rates used in the analysis are also to be provided. The energy rates should be entered for both summer and winter as applicable. On–site electricity generation should also include information about utility buyback rates.

The next area provides a location to document other assumptions made in the analysis. Examples of other assumptions include the quantity of domestic hot water used annually, maintenance costs, residual value or salvage costs.

The final area on the Assumptions Form provides a location to document references used. These references include, but are not limited to, those used to perform calculations and those used to estimate construction costs. Additional pages may be added as necessary to list all of the assumptions and references.

ASSUMPTIONS FORM

Net Annual Recurrent Cost Projections

ADDITIONAL OPERATING COSTS:

INCREASED REVENUE CAPACITY (LESS INCREMENTAL COSTS):

NET FIXED OVERHEADS:

NET VARIABLE OVERHEADS:

DEPRECIATION / INTEREST COSTS

Estimated Average Initial Fuel Costs:

(INCLUDED ABOVE THOUGH QUANTIFIED BELOW)

	SUMMER	WINTER
NATURAL GAS ($/UNIT)		
ELECTRICITY ($/KILOWATT)		
ELECTRICITY ($/KILOWATT DEMAND)		
LIQUEFIED PETROLEUM GAS (LPG)		
DIESEL FUEL ($/LITRE)		
OTHER (SPECIFY)		

ASSUMPTIONS RELATING TO FUEL COSTS

OTHER ASSUMPTIONS
1.
2.
3.

REFERENCES
1.

The analysis of each option must consider all of the phases associated with the development and delivery of the project and include costs associated with:

1. **Concept and Definition Stage** includes market, research, project management, concept and design analysis product specification analysis.
2. **Design and Development Stage** includes costs for project management, system and design engineering, design documentation, prototype fabrication, testing and evaluation, productivity engineering and planning, vendor selection, demonstration and validation, quality management and design and development.
3. **Manufacturing and Installation** includes costs associated with non–recurring manufacturing or installation costs, engineering and operational analysis, construction or purchase, production tooling and test equipment and operational totals.
4. **Maintenance** includes costs associated with training, spare parts and consumables, equipment and facilities, contract services, IT support, routine maintenance, major programmed maintenance and breakdown maintenance.
5. **Support Services** includes corporate management, administrative overheads, insurances, general support services, system shutdowns, disassembly and removal, recycling or safe disposal, site remediation and product residual value.
6. **Residual Value or Salvage** is the value of the asset at the completion of the life cycle. The residual value is considered the net position of the income generated by the sale of the asset, less the cost of site remediation. The residual value can either be the agreed value (asset left 'in–situ') or the realised value of the asset ('removal of asset'). Salvage is considered the realised value of the unimproved asset.

LIFE CYCLE COST ANALYSIS (LCCA) MODEL

An example of the Life Cycle Cost Analysis model is appended at pages 26 to 35. The LCCA has been formed on the basis of the following conventions and concepts.

The base convention is that the model provided by DSR does not incorporate any direct capital costs. The costs entered into the model that affect the financial result should only be operating costs and be directly related to the costs of the management and maintenance of the facility or asset.

Each of the component cost option sheets has been developed to reflect the project's life cycle phases, including concept and definition, design and development, manufacturing and installation, maintenance, support services and gross revenues. Each of these areas has been further identified into costs areas identified by either capital costs or operating costs.

Concept Definitions

Operating Costs: The day–to–day expenses incurred in the running of an organisation such as sales and administration, maintenance and training. These costs are also variable and do not add to the *book value* of an asset.

Capital Costs: Typically those costs applying to the physical (substantial) assets of the organisation. Traditionally this was the accommodation and machinery necessary to produce the enterprise's products or services. Capital Costs are the purchase or major enhancement of fixed assets, for example computer equipment (building and plant) and are often also referred to as *'one–off'* costs.

Time Value of Money: A concept that acknowledges that money changes value over a period of time; that a sum of money today is worth more that the same sum of money at a future date, because of the fact that the money received now can be invested to earn interest.

Life Cycle Cost: Encompasses all costs associated with the product's life cycle. These include all costs involved in acquisition (research and development, design, production and construction and phase–in), operation, support and disposal of the product.

The model has been developed on a multi sheet MS Excel spreadsheet format. Data provided and developed for the options under consideration are entered under the individual "Component Cost Option" sheets. The consolidated LCCA model is a protected work sheet that serves to reflect the consolidation of each of the component costs option sheets.

Before we consider the model, we must understand the concept of Net Present Value (NPV).

Consider the following.

"When you wish to know the value of a used car, you would look at prices in the second–hand car market. Similarly, when you wish to know the value of a future cash flow, you would look at prices quoted in the capital markets, where claims to future cash flows are traded. (Just remember that those high profile Investment Bankers are just second–hand cash flow dealers. If you can buy cash flows for your shareholders at a cheaper price than they would have to pay in the capital market, you have increased the value of their investment".

The example provided is that of a typical recreation centre under consideration by a Local Government Authoruty. The example is based upon the premise that total funding for the centre will be provided by the local government from reserves.

The LCCA demonstrates that the cost of a facility commences at the preplanning stage with the concept and definition. The period between the concept stage and the commencement of operations of the facility is nominally three years.

The LCCA example provided considers three options.

Option one; provides the base case with initial capital construction costs of $1 985 000 and a 25% refurbishment of the facility at year 10.

Option two; provides a 10 percent increase in initial capital costs ($2 183 000) with a 25% refurbishment at year 15. The increase in initial capital costs assumes the use of higher quality components (e.g. air conditioning) and therefore a reduced requirement for refurbishment until a later period.

Option three; considers a 10% reduction in initial capital cost ($1 786 500) with an expanded refurbishment program. Option three assumes a commitment to lesser quality components and therefore delivers a requirement to refurbish at year seven and again at year 17.

Net revenues are entered into each component costs option, providing an annual figure of cost centre income less the annual operating costs for that cost centre. For the example, under consideration the "*cost centre*" is the recreation centre. The costs do not include either the facility management costs or the corporate overheads as they are a direct facility consequential cost and are recorded separately in the model.

Each refurbishment delivers additional net revenue income of $30 000 per annum as this anticipates improved services.

It will be noted that the model features a series of input cells that are colour coded green. This denotes that these costs (typically capital) are not included within the model analysis.

Input data is considered for each of the life cycle phases and entered at each option input sheet. For this example, the annual costs included in the input data are kept consistent across the life of the asset. Careful consideration needs to given to the classification of the cost being entered into the model. It is considered fundamental that the cost must be identified as either capital or operating prior to entry into the model. As this model is based on the NPV result and does not consider the direct capital costs (rather the amortised interest and depreciation costs) it is vital that the operating costs relate directly to the management of the building without providing any betterment to the value of the asset. Should the cost apportioned result in an improvement to the facility asset or structure, this cost would be considered capital.

The model has provided for the inclusion of interest charges that is based upon the position that equivalent opportunity costs for the funds employed for the project must be recorded. As the NPV does not consider the initial capital costs, annual interest equivalents must be included. This is irrespective of the origin of the capital employed for the project, whether from reserves, borrowings or investor subscriptions. Similarly, depreciation charges are apportioned for the replacement costs associated for both the building fabric and the consolidated internal asset component that make up the building fabric. It should be noted that at each refurbishment event for each option, the interest and depreciation costs are increased to reflect the additional investment. An accurate reflection of the depreciation of any building under consideration may be sourced in the Rawlinsons Australian Construction Handbook[8].

The model demonstrates the cash flows associated with the development, management and refurbishment of the facility.

The cost projections automatically feed into the consolidated LCC model initially to the consolidated option values section of the page. At this stage, these figures remain uninflated. These figures are then exposed to the inflation component of the model, which in essence are the operating cost, less net revenues multiplied by the inflation rate at the value of the period in which the costs are considered. This process occurs for all of the costs and revenues for each option over the asset life period being considered. These figures are then exposed to the effects of the nominated discount rate, which may be changed on the consolidated LCC model. This model also provides for NPV calculations that consider project sensitivities. Considerations of these sensitivities or risks are undertaken by the application of higher and lower discount rates.

The following observations are made of the example provided.

As the NPV provides information about the net increase in worth provided by the project (exclusive of the capital costs), the cash flows under support services for each option includes interest and depreciation costs.

Observations also reveal that major programmed maintenance is calculated under the **Maintenance** category. This operational requirement similarly reduces net revenues in those periods by $30 000.

The net result of these options recommends that a commitment to option two would provide the best result for the council. The option suggests a higher capital cost, though a reduced requirement for refurbishment until year 15. The result is that option two at a discount rate of 12 percent delivers an NPV of –$859 102. This figure represents the net difference between the inflated and discounted costs and revenues accumulated over the period of the life cycle.

8 Rawlinsons Construction Cost Consultants and Quantity Surveyors. (Ed.) (2005). Australian construction handbook 2005. Perth, Western Australia: Rawlhouse Publishing Pty Ltd.

The life cycle cost calculations for each alternative are to be presented in this section of the report. The analyst has the option of using the form provided in the Appendices of these guidelines or providing a printout of computer analysis for each case.

DSR has developed a multi–layered spreadsheet that provides the primary shell to create a three–option comparison of alternatives. The spreadsheet provides for the development of project costs, delivering the net present value of each option in addition to two sensitivity tests.

Within the manufacturing and installation segment of the LCC analysis, the following calculations need to be factored with respect to water treatment, lighting, building envelope and HVAC systems and electricity generation.

The analysis of each structure/system (facility, domestic hot water, lighting, envelope/HVAC, and electricity generation) should begin with a base case that would be expected to provide the lowest constructed/installed cost but, due to lower efficiency, usually result in high operating and life cycle costs. The other options should provide a tradeoff of higher constructed/installed cost for lower operating and (potentially) lower life cycle costs. In each case, the system with the lowest life cycle cost must be recommended.

COMMERCIAL AND/OR DOMESTIC HOT WATER

Select three commercial/domestic hot water systems and document the rationale used to justify their consideration for the facility. Systems selection could compare varying efficiency levels, systems using different fuels, a central system versus a distributed system, a solar–assisted versus a non–assisted system, a variety of control strategies, or large equipment versus a modular installation, for example.

LIGHTING

Choose three lighting systems for the primary use of the building (offices, courts or gym rooms for example) and document the rationale used to justify their consideration for the facility. Include a variety of lamp types, ballast features, and control strategies.

BUILDING ENVELOPE AND HVAC (HEATING, VENTILATION AND AIR CONDITIONING) SYSTEMS

Choose three building envelope types and three HVAC systems and document the rationale used to justify their consideration for the facility. A total of nine building / HVAC combinations should be studied unless this can be shown to be impractical. The design alternatives recommended previously for the domestic hot water system and for the lighting system should be used in the analysis of the envelope and HVAC systems.

Building envelope parameters may vary wall and roof insulation type, thickness and window type. HVAC system parameters may vary system type, modular equipment, distribution system type, control strategies, etc.

ON–SITE ELECTRICITY GENERATION

When applicable, use all of the recommended building systems to evaluate three design alternatives for on–site electricity generation. Potential alternatives include engine generators, micro–turbines, fuel cells, steam turbines, wind turbines, solar arrays (photovoltaic), etc. Alternatively, consideration should be given to purchase electricity from providers that generate green electricity from alternative technologies such as conversion of landfill methane gases to electricity.

RECOMMENDED SYSTEMS

Briefly note each of the recommended systems, however, most of this discussion should be provided in the Executive Summary. The set of combined systems should be used to find the detailed energy use prediction on the LCCA form in the Executive Summary.

The report appendix is to include supporting information. The contents of the appendix should include sketches of the planned building layout, energy use calculations, and any other pertinent information necessary to document the recommendations made.

APPENDIX A

Equipment Service Lives

Suggested Economic Lifetimes of Various Mechanical Systems

EQUIPMENT ITEM	ECONOMIC LIFE (YEARS)
ABSORPTION LIQUID CHILLING SYSTEM	20
AIR COMPRESSORS	20
AIR CONDITIONER SINGLE PACKAGE, AIR–COOLED, HERMETIC	10
AIR CONDITIONER WITH REMOTE AIR–COOLED CONDENSER	10
AIR–COOLED SPLIT SYSTEM AIR CONDITIONERS	10
AIR HANDLING UNITS HORIZONTAL AND VERTICAL	20–25
BOILERS	20–25
BURNERS	10
CENTRAL STATION UNITS	20
CENTRIFUGAL CHILLERS	20–30
CENTRIFUGAL COMPRESSORS, MULTISTAGE	15–20
CENTRIFUGAL COMPRESSORS, SINGLE STAGE	20
CENTRIFUGAL LIQUID CHILLING SYSTEMS	20–30
CHILLERS, ABSORPTION	20
CHILLERS, RECIPROCATING, UP TO 150 TR	15–20
CHILLERS, RECIPROCATING, 150 TR AND UP	15–20
COILS, HEATING AND COOLING	30
COMM. AIR CONDITIONERS, REMOTE A.C. CONDENSER	10
COMM. WATER–COOLED CONDITIONERS, SINGLE PACKAGE	10
COMPRESSORS, RECIPROCATING V/W, HERMETIC	12
COMPRESSORS, RECIPROCATING V/W, OPEN	14
COMPRESSOR UNITS, VERTICAL SINGLE–ACTING	30
CONDENSERS, EVAPORATIVE	20
CONDENSERS, HORIZONTAL SHELL AND TUBE	20
CONDENSERS, REMOTE AIR–COOLED	12
CONDENSING UNITS, RECIPROCATING V/W, HERMETIC	12
CONDENSING UNITS, RECIPROCATING V/W, OPEN	14
CONDENSING UNITS, VERTICAL SINGLE–ACTING	30
CONTROLS, ELECTRIC AND PNEUMATIC	20
COOLING COILS	30
COOLING TOWERS, MASONRY FILL	45
COOLING TOWERS, METAL FILL	15–20
COOLING TOWERS, WOOD FILL	15–20
DIESEL ENGINES	10–12
ELECTRIC FURNACES	10
ELECTRIC HEATING, ADD ON	10
ELECTRIC MOTORS	20–25
FANS, BACKWARD CURVED (AIRFOIL)	20
FANS, COIL MULTIPLE SPACE CONDITIONS	20
FANS, COIL MULTIPLE SPACE CONDITIONS	20
FAN COIL ROOM CONDITIONS	20
FANS, FORWARD CURVED	20
FANS, UTILITY SETS	20
FURNACES, GAS FIRED	10–15
FURNACES, OIL FIRED	10–15
GASOLINE ENGINES	10
HEAT PUMPS, SINGLE PACKAGE, AIR–TO–AIR	20
HEAT PUMPS, SINGLE PACKAGE, WATER–TO–AIR	20
HEAT PUMPS, SPLIT SYSTEM, AIR–TO–AIR	20
HIGH PRESSURE RECEIVERS	30
HORIZONTAL SHELL AND TUBE CONDENSERS	30
INDUCTION ROOM AIR UNITS	30
LIQUID CHILLING SYSTEMS, CENTRIFUGAL	20
LIQUID COOLERS, HORIZONTAL SHELL AND TUBE	30
LOW TEMPERATURE COMPRESSOR UNITS, RECIP. V/W, HERMETIC	12
LOW TEMPERATURE COMPRESSOR UNITS, RECIP, V/W, OPEN	14
MULTISTAGE TURBO COMPRESSORS	20
MULTIZONE CENTRAL STATION UNITS	20
MULTIZONE ROOFTOP UNITS	10
MULTIPLE SPACE FAN COIL UNITS	20
OIL FIRED FURNACES	10
OIL RECEIVERS	5–10
PACKAGED REFRIGERATION UNITS	12
PACKAGED TERMINAL UNITS	10
PLUG TYPE, REFRIGERATION UNITS	12
PRODUCE STORAGE UNITS	12
PRODUCT COOLERS	20
PRODUCT COOLERS, AMMONIA	20
PUMPS, CENTRIFUGAL	20–25
RESIDENTIAL WATER–COOLED CONDITIONERS, SINGLE PACKAGE	10
REMOTE AIR–COOLED CONDENSER	12
ROOM AIR CONDITIONERS	8
ROOM UNITS	8
TURBINES (STEAM)	10–30

AIR CONDITIONING EXAMPLE – LIFE CYCLE COST ANALYSIS OPTION 1

Yr	Details	Cash outflow	Cash inflow	Net cashflow	PV $1	Discount rate of net cashflow
0	**Install air conditioner**	–115 600		–115 600	1.0000	–115 600
1	Annual running and maintenance costs	–37 800		–37 800	0.8929	–33 750
2	Annual running and maintenance costs	–37 800		–37 800	0.7972	–30 134
3	Annual running and maintenance costs	–37 800		–37 800	0.7118	–26 905
4	Annual running and maintenance costs	–37 800		–37 800	0.6355	–24 023
5	Annual running and maintenance costs	–37 800		–37 800	0.5674	–21 449
6	Annual running and maintenance costs	–37 800		–37 800	0.5066	–19 151
7	Annual running and maintenance costs	–37 800		–37 800	0.4523	–17 099
8	Annual running and maintenance costs	–37 800		–37 800	0.4039	–15 267
9	Annual running and maintenance costs	–37 800		–37 800	0.3606	–13 631
10	**Replace air conditioner**	–115 600		–115 600		
	Salvage value original air conditioner		3000			
	Annual running and maintenance costs	–37 800		–150 400	0.3220	–48 425
11	Annual running and maintenance costs	–37 800		–37 800	0.2875	–10 867
12	Annual running and maintenance costs	–37 800		–37 800	0.2567	–9702
13	Annual running and maintenance costs	–37 800		–37 800	0.2292	–8663
14	Annual running and maintenance costs	–37 800		–37 800	0.2046	–7735
15	Annual running and maintenance costs	–37 800		–37 800	0.1827	–6906
16	Annual running and maintenance costs	–37 800		–37 800	0.1631	–6166
17	Annual running and maintenance costs	–37 800		–37 800	0.1456	–5505
18	Annual running and maintenance costs	–37 800		–37 800	0.1300	–4915
19	Annual running and maintenance costs	–37 800		–37 800	0.1161	–4389
20	**Replace air conditioner**	–115 600				
	Salvage value original air conditioner		3000			
	Annual running and maintenance costs	–37 800		–150 400	0.1037	–15 591
21	Annual running and maintenance costs	–37 800		–37 800	0.0926	–3499
22	Annual running and maintenance costs	–37 800		–37 800	0.0826	–3124
23	Annual running and maintenance costs	–37 800		–37 800	0.0738	–2789
24	Annual running and maintenance costs	–37 800		–37 800	0.0659	–2490
25	Annual running and maintenance costs	–37 800		–37 800	0.0588	–2224
26	Annual running and maintenance costs	–37 800		–37 800	0.0525	–1985
27	Annual running and maintenance costs	–37 800		–37 800	0.0469	–1773
28	Annual running and maintenance costs	–37 800		–37 800	0.0419	–1583
29	Annual running and maintenance costs	–37 800		–37 800	0.0374	–1413
30	Annual running and maintenance costs	–37 799		–37 799	0.0334	–1262
				Total Present Value		**–468 013**

AIR CONDITIONING EXAMPLE – LIFE CYCLE COST ANALYSIS OPTION 2

Yr	Details	Cash outflow	Cash inflow	Net cashflow	PV $1	Discount rate of net cashflow
0	Install air conditioner	-158 800		-158 800	1.0000	-158 800
1	Annual running and maintenance costs	-28 200		-28 200	0.8929	-25 179
2	Annual running and maintenance costs	-28 200		-28 200	0.7972	-22 481
3	Annual running and maintenance costs	-28 200		-28 200	0.7118	-20 072
4	Annual running and maintenance costs	-28 200		-28 200	0.6355	-17 922
5	Annual running and maintenance costs	-28 200		-28 200	0.5674	-16 001
6	Annual running and maintenance costs	-28 200		-28 200	0.5066	-14 287
7	Annual running and maintenance costs	-28 200		-28 200	0.4523	-12 756
8	Annual running and maintenance costs	-28 200		-28 200	0.4039	-11 390
9	Annual running and maintenance costs	-28 200		-28 200	0.3606	-10 169
10	Annual running and maintenance costs	-28 200		-28 200	0.3220	-9080
11	Annual running and maintenance costs	-28 200		-28 200	0.2875	-8107
12	Annual running and maintenance costs	-28 200		-28 200	0.2567	-7238
13	Annual running and maintenance costs	-28 200		-28 200	0.2292	-6463
14	Annual running and maintenance costs	-28 200		-28 200	0.2046	-5770
15	Replace air conditioner	-158 800		-158 800		
	Salvage value original air conditioner		7000			
	Annual running and maintenance costs	-28 200		-180 000	0.1827	-32 885
16	Annual running and maintenance costs	-28 200		-28 200	0.1631	-4600
17	Annual running and maintenance costs	-28 200		-28 200	0.1456	-4107
18	Annual running and maintenance costs	-28 200		-28 200	0.1300	-3667
19	Annual running and maintenance costs	-28 200		-28 200	0.1161	-3274
20	Annual running and maintenance costs	-28 200		-28 200	0.1037	-2923
21	Annual running and maintenance costs	-28 200		-28 200	0.0926	-2610
22	Annual running and maintenance costs	-28 200		-28 200	0.0826	-2331
23	Annual running and maintenance costs	-28 200		-28 200	0.0738	-2081
24	Annual running and maintenance costs	-28 200		-28 200	0.0659	-1858
25	Annual running and maintenance costs	-28 200		-28 200	0.0588	-1659
26	Annual running and maintenance costs	-28 200		-28 200	0.0525	-1481
27	Annual running and maintenance costs	-28 200		-28 200	0.0469	-1322
28	Annual running and maintenance costs	-28 200		-28 200	0.0419	-1181
29	Annual running and maintenance costs	-28 200		-28 200	0.0374	-1054
30	Annual running and maintenance costs	-28 200		-28 200	0.0334	-941
				Total Present Value		-413 689

PV = Present Value

3.0D Life Cycle Analysis Model — Results Page 1

Calculations	
Year	2005
Periods	20
Inflation Rate	3.10%
Discount Rate	11.90%
Sensitivity 1	9.00%
Sensitivity 2	15.00%
(all values in $A)	

Net Present Value Result	
Discount Rate	11.90%
Inflation Rate	3.10%
Option 1	–$930 204
Option 2	–$866 831
Option 3	–$991 172

Sensitivity Test 1	
Sensitivity	9.00%
Inflation Rate	3.10%
Option 1	–$1 214 511
Option 2	–$1 140 870
Option 3	–$1 298 137

Sensitivity Test 2	
Sensitivity	15.00%
Inflation Rate	3.10%
Option 1	–$718 930
Option 2	–$666 580
Option 3	–$764 981

Inflated Values

Year	0	1	2	3	4	5	6	7	8	9	
Option 1 – Capital	$0	–$51 034	–$2 109 978	$0	$0	$0	$0	$0	$0	–$16 288	
Option 2 – Capital	$0	–$56 138	–$2 320 444	$0	$0	$0	$0	$0	$0	$0	
Option 3 – Capital	$0	–$45 931	–$1 898 980	$0	$0	$0	–$13 376	–$553 036	$0	$0	

Year	0	1	2	3	4	5	6	7	8	9	
Option 1 – Operating	–$17 700	–$93 305	$0	–$149 378	–$97 939	–$100 975	–$104 105	–$163 054	–$116 309	–$143 869	
Option 2 – Operating	–$17 700	–$93 305	$0	–$149 378	–$97 939	–$100 975	–$104 105	–$163 054	–$110 659	–$114 090	
Option 3 – Operating	–$17 700	–$93 305	$0	–$149 378	–$97 939	–$106 129	–$131 278	–$377 348	–$133 717	–$137 862	

Uninflated Values

Option 1											
Capital Costs	$0	–$49 500	–$1 985 000	$0	$0	$0	$0	$0	$0	–$12 375	
Operating Costs	–$17 700	–$90 500	$0	–$396 305	–$346 680	–$346 680	–$346 680	–$361 680	–$351 105	–$369 305	
Revenues	$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$230 000	$260 000	$260 000	

Option 2											
Capital Costs	$0	–$54 450	–$2 183 000	$0	$0	$0	$0	$0	$0	$0	
Operating Costs	–$17 700	–$90 500	$0	–$396 305	–$346 680	–$346 680	–$346 680	–$361 680	–$346 680	–$346 680	
Revenues	$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$230 000	$260 000	$260 000	

Option 3											
Capital Costs	$0	–$44 550	–$1 786 500	$0	$0	$0	–$11 138	–$446 625	$0	$0	
Operating Costs	–$17 700	–$90 500	$0	–$396 305	–$346 680	–$351 105	–$369 305	–$404 741	–$404 741	–$404 741	
Revenues	$0	$0	$0	$260 000	$260 000	$260 000	$260000	$100 000	$300 000	$300 000	

	10	11	12	13	14	15	16	17	18	19	20
	–$673 422	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	–$20 872	–$862 728	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	–$18 152	–$750 482	$0	$0	$0

	10	11	12	13	14	15	16	17	18	19	20
	–$422 295	–$155 568	–$225 302	–$165 363	–$170 489	–$175 774	–$181 223	–$262 457	–$192 633	–$198 605	–$204 762
	–$117 627	–$121 273	–$189 943	–$135 489	–$167 595	–$502 109	–$191 711	–$273 270	–$203 782	–$210 099	–$216 612
	–$142 136	–$146 542	–$215 996	–$155 769	–$160 598	–$172 571	–$207 584	–$349 179	–$282 044	–$290 787	–$299 802

	–$496 250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	–$411 193	–$411 193	–$426 193	–$411 193	–$411 193	–$411 193	–$411 193	–$426 193	–$411 193	–$411 193	–$411 193
	$100 000	$300 000	$270 000	$300 000	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000

	$0	$0	$0	$0	–$13 613	–$545 750	$0	$0	$0	$0	$0
	–$346 680	–$346 680	–$361 680	–$351 105	–$369 305	–$417 628	–$417 628	–$432 628	–$417 628	–$417 628	–$417 628
	$260 000	$260 000	$230 000	$260 000	$260 000	$100 000	$300 000	$270 000	$300 000	$300 000	$300 000

	$0	$0	$0	$0	$0	$0	–$11 138	–$446 625	$0	$0	$0
	–$404 741	–$404 741	–$419 741	–$404 741	–$404 741	–$409 166	–$427 366	–$477 803	–$462 803	–$462 803	–$462 803
	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000

3.0D Life Cycle Analysis Model — Results Page 2

Consolidated Option Values

Option 1

Concept and Definition	–$17 700	$0	$0	$0	$0	$0	$0	$0	–$4425	$0
Design and Development	$0	–$140 000	$0	$0	$0	$0	$0	$0	$0	–$35 000
Manufacture and Installation	$0	$0	–$1 985 000	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	–$42 750	–$42 750	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750
Support Service	$0	$0	$0	–$353 555	–$303 930	–$303 930	–$303 930	–$303 930	–$303 930	–$303 930
Revenues	$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$230 000	$260 000	$260 000
Total	–$17 700	–$140 000	–$1 985 000	–$136 305	–$86 680	–$86 680	–$86 680	–$131 680	–$91 105	–$121 680

Option 2

Concept and Definition	–$17 700	$0	$0	$0	$0	$0	$0	$0	$0	$0
Design and Development	$0	–$144 950	$0	$0	$0	$0	$0	$0	$0	$0
Manufacture and Installation	$0	$0	–$2 183 000	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	–$42 750	–$42 750	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750
Support Service	$0	$0	$0	–$353 555	–$303 930	–$303 930	–$303 930	–$303 930	–$303 930	–$303 930
Revenues	$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$230 000	$260 000	$260 000
Total	–$17 700	–$144 950	–$2 183 000	–$136 305	–$86 680	–$86 680	–$86 680	–$131 680	–$86 680	–$86 680

Option 3

Concept and Definition	–$17 700	$0	$0	$0	$0	–$4425	$0	$0	$0	$0
Design and Development	$0	–$135 050	$0	$0	$0	$0	–$33 763	$0	$0	$0
Manufacture and Installation	$0	$0	–$1 786 500	$0	$0	$0	$0	–$446 625	$0	$0
Maintenance	$0	$0	$0	–$42 750	–$42 750	–$42 750	–$42 750	–$42 750	–$42 750	–$42 750
Support Service	$0	$0	$0	–$353 555	–$303 930	–$303 930	–$303 930	–$361 991	–$361 991	–$361 991
Revenues	$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$100 000	$300 000	$300 000
Total	–$17 700	–$135 050	–$1 786 500	–$136 305	–$86 680	–$91 105	–$120 443	–$751 366	–$104 741	–$104 741

	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	–$496 250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750	–$42 750
	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443	–$368 443
	$100 000	$300 000	$270 000	$300 000	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000
	–$807 443	–$111 193	–$156 193	–$111 193	–$111 193	–$111 193	–$111 193	–$156 193	–$111 193	–$111 193	–$111 193

	$0	$0	$0	–$4425	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	–$36 238	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	–$545 750	$0	$0	$0	$0	$0
	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750	–$42 750
	–$303 930	–$303 930	–$303 930	–$303 930	–$303 930	–$374 878	–$374 878	–$374 878	–$374 878	–$374 878	–$374 878
	$260 000	$260 000	$230 000	$260 000	$260 000	$100 000	$300 000	$270 000	$300 000	$300 000	$300 000
	–$86 680	–$86 680	–$131 680	–$91 105	–$122 918	–$863 378	–$117 628	–$162 628	–$117 628	–$117 628	–$117 628

	$0	$0	$0	$0	$0	–$4425	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	–$33 763	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	–$446 625	$0	$0	$0
	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750	–$42 750	–$42 750	–$57 750	–$42 750	–$42 750	–$42 750
	–$361 991	–$361 991	–$361 991	–$361 991	–$361 991	–$361 991	–$361 991	–$420 053	–$420 053	–$420 053	–$420 053
	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000
	–$104 741	–$104 741	–$149 741	–$104 741	–$104 741	–$109 166	–$138 504	–$654 428	–$162 803	–$162 803	–$162 803

3.0D Life Cycle Analysis Model — Option 1

Cost Generating Activities	Capital or Operating	Year O	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Life Cycle Phases										
Concept and definition										
Market research	Op	500								125
Project management	Op	7500								1875
Concept and design analysis	Op	1200								300
Product requirement spec. preparation	Op	8500								2125
Total		–17 700	0	0	0	0	0	0	0	–4425
Design and development										
System and design engineering	Cap		7500							
Prototype fabrication testing and evaluation	C ap		2000							
Legal and compliance fees	Cap		25 000							
Productivity engineering and planning	Cap		15 000							
Project management	Op		55 000							
Design documentation	Op		8000							
Tender preparation and vendor selection	Op		17 000							
Demonstration and validation	Op		3000							
Quality management	Op		7500							
Total		0	–140 000	0	0	0	0	0	0	0
Manufacturing and installation										
Civil works	Cap			250 000						
Engineering and operational analysis	Cap			60 000						
Construction/Purchase/Manufacture	Cap			1 500 000						
Production tooling and test equipment	Cap			55 000						
Mobilisation / Demobilisation	Cap			45 000						
Project superintendance and contract management	Cap			75 000						
Total		0	0	–1 985 000	0	0	0	0	0	0
Maintenance										
Spare parts and consumables	Op				2000	2000	2000	2000	2000	2000
Equipment and facilities	Op				4000	4000	4000	4000	4000	4000
Routine maintanence	Op				2500	2500	2500	2500	2500	2500
Major programmed maintenance	Op								15 000	
Unscheduled maintenance	Op				1250	1250	1250	1250	1250	1250
Training	Op				2500	2500	2500	2500	2500	2500
Contract services	Op				25 000	25 000	25 000	25 000	25 000	25 000
IT support	Op				5500	5500	5500	5500	5500	5500
Total		0	0	0	–42 750	–42 750	–42 750	–42 750	–57 750	–42 750
Support services										
Disassembly recycling or safe disposal	Op									
Facility training Industry levies and Doc Management	Op				49 625					
Corporate management	Op				4500	4500	4500	4500	4500	4500
Administrative overheads	Op				110 000	110 000	110 000	110 000	110 000	110 000
Insurance	Op				9000	9000	9000	9000	9000	9000
Depreciation and interest Costs	Op				115 130	115 130	115 130	115 130	115 130	115 130
System shutdown	Op				1500	1500	1500	1500	1500	1500
Utilities cleaning and fees	Op				63 800	63 800	63 800	63 800	63 800	63 800
Total		0	0	0	–353 555	–303 930	–303 930	–303 930	–303 930	–303 930

Total Capital Costs		$0	$49 500	$1 985 000	$0	$0	$0	$0	$0	$0
Total Operating Costs		$17 700	$90 500	$0	$396 305	$346 680	$346 680	$346 680	$361 680	$351 105
Gross Revenues		$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$230 000	$260 000
Nett Gain / Subsidy		$17 700	$140 000	$1 985 000	$136 305	$86 680	$86 680	$86 680	$131 680	$91 105

	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	
	0	0	0	0	0	0	0	0	0	0	0	0	–22 125
	1875												
	500												
	6250												
	3750												
	13 750												
	2000												
	4250												
	750												
	1875												
	–35 000	0	0	0	0	0	0	0	0	0	0	0	–175 000
		62 500											
		15 000											
		375 000											
		13 750											
		11 250											
		18 750											
	0	–496 250	0	0	0	0	0	0	0	0	0	0	–2 481 250
	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	
	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
				15000					15000				
	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	
	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	
	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	
	–42 750	–42 750	–42 750	–57 750	–42 750	–42 750	–42 750	–42 750	–57 750	–42 750	–42 750	–42 750	–814 500
	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	
	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	
	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	
	115 130	179 643	179 643	179 643	179 643	179 643	179 643	179 643	179 643	179 643	179 643	179 643	
	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	
	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	
	–303 930	368 442.5	368 442.5	–368 442.5	368 442.5	–368 442.5	–368 442.5	–368 442.5	–368 442.5	–368 442.5	–368 442.5	–3 684 42.5	–6 230 002.5

	$12 375	$496 250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
	$369 305	$411 193	$411 193	$426 193	$411 193	$411 193	$411 193	$411 193	$426 193	$411 193	$411 193	$411 193	
	$260 000	$100 000	$300 000	$270 000	$300 000	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000	$4 830 000
	$121 680	$807 442	$111 192	$156 192	$111 192	$111 192	$111 192	$111 192	$156 192	$111 192	$111 192	$111 192	$4 892 877

3.0D Life Cycle Analysis Model — Option 2

Cost Generating Activities	Capital or Operating	Year O	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Life Cycle Phases										
Concept and definition										
Market research	Op	500								
Project management	Op	7500								
Concept and design analysis	Op	1200								
Product requirement spec. preparation	Op	8500								
Total		–17 700	0	0	0	0	0	0	0	0
Design and development										
System and design engineering	Cap		8250							
Prototype fabrication testing and evaluation	Cap		2200							
Legal and compliance fees	Cap		27 500							
Productivity engineering and planning	Cap		16 500							
Project management	Op		55 000							
Design documentation	Op		8000							
Tender preparation and vendor selection	Op		17 000							
Demonstration and validation	Op		3000							
Quality management	Op		7500							
Total		0	–144 950	0	0	0	0	0	0	0
Manufacturing and installation										
Civil works	Cap			275 000						
Engineering and operational analysis	Cap			66 000						
Construction/Purchase/Manufacture	Cap			1 650 000						
Production tooling and test equipment	Cap			60 000						
Mobilisation / Demobilisation	Cap			49 500						
Project superintendance and contract management	Cap			82 500						
Total		0	0	–2 183 000	0	0	0	0	0	0
Maintenance										
Spare parts and consumables	Op				2000	2000	2000	2000	2000	2000
Equipment and facilities	Op				4000	4000	4000	4000	4000	4000
Routine maintanence	Op				2500	2500	2500	2500	2500	2500
Major programmed maintenance	Op								15000	
Unscheduled maintenance	Op				1250	1250	1250	1250	1250	1250
Training	Op				2500	2500	2500	2500	2500	2500
Contract services	Op				25 000	25 000	25 000	25 000	25 000	25 000
IT support	Op				5500	5500	5500	5500	5500	5500
Total		0	0	0	–42 750	–42 750	–42 750	–42 750	–57 750	–42 750
Support services										
Disassembly recycling or safe disposal	Op									
Facility training Industry levies and Doc Management	Op				49 625					
Corporate management	Op				4500	4500	4500	4500	4500	4500
Administrative overheads	Op				110 000	110 000	110 000	110 000	110 000	110 000
Insurance	Op				9000	9000	9000	9000	9000	9000
Depreciation and interest Costs	Op				115 130	115 130	115 130	115 130	115 130	115 130
System shutdown	Op				1500	1500	1500	1500	1500	1500
Utilities cleaning and fees	Op				63 800	63 800	63 800	63 800	63 800	63 800
Total		0	0	0	–353 555	–303 930	–303 930	–303 930	–303 930	–303 930
Total Capital Costs		$0	$54 450	$2 183 000	$0	$0	$0	$0	$0	$0
Total Operating Costs		$17 700	$90 500	$0	$396 305	$346 680	$346 680	$346 680	$361 680	$346 680
Gross Revenues		$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$230 000	$260 000
Nett Gain / Subsidy		$17 700	$144 950	$2 183 000	$136 305	$86 680	$86 680	$86 680	$131 680	$86 680

	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	
					125								
					1875								
					300								
					2125								
	0	0	0	0	–4425	0	0	0	0	0	0	0	–22 125
						2063							
						550							
						6875							
						4125							
						13 750							
						2000							
						4250							
						750							
						1875							
	0	0	0	0	0	–36 237.5	0	0	0	0	0	0	–181 187.5
							68 750						
							16 500						
							412 500						
							15 000						
							12 375						
							20 625						
	0	0	0	0	0	0	–545 750	0	0	0	0	0	–2 728 750
	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	
	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
				15 000					15 000				
	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	
	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	
	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	
	–42 750	–42 750	–42 750	–57 750	–42 750	–42 750	–42 750	–42 750	–57750	–42 750	–42 750	–42 750	–814 500
	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	
	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	
	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	
	115 130	115 130	115 130	115 130	115 130	115 130	186 078	186 078	186 078	186 078	186 078	186 078	
	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	
	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	
	–303 930	–303 930	–303 930	–303 930	–303 930	–303 930	–374 877.5	–374 877.5	–374 877.5	–374 877.5	–374 877.5	–3748 77.5	–5 946 050
	$0	$0	$0	$0	$0	$13 613	$545 750	$0	$0	$0	$0	$0	
	$346 680	$346 680	$346 680	$361 680	$351 105	$369 305	$417 628	$417 628	$432 628	$417 628	$417 628	$417 628	$6 895 800
	$260 000	$260 000	$260 000	$230 000	$260 000	$260 000	$100 000	$300 000	$270 000	$300 000	$300 000	$300 000	$4 630 000
	$86 680	$86 680	$86 680	$131 680	$91 105	$122 917	$863 377	$117 627	$162 627	$117 627	$117 627	$117 627	$5 062 612.50

3.0D Life Cycle Analysis Model — Option 3

Cost Generating Activities	Capital or Operating	Year O	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Life Cycle Phases										
Concept and definition										
Market research	Op	500					125			
Project management	Op	7500					1875			
Concept and design analysis	Op	1200					300			
Product requirement spec. preparation	Op	8500					2125			
Total		–17 700	0	0	0	0	–4425	0	0	0
Design and development										
System and design engineering	Cap		6750					1688		
Prototype fabrication testing and evaluation	Cap		1800					450		
Legal and compliance fees	Cap		22 500					5625		
Productivity engineering and planning	Cap		13 500					3375		
Project management	Op		55 000					13 750		
Design documentation	Op		8000					2000		
Tender preparation and vendor selection	Op		17 000					4250		
Demonstration and validation	Op		3000					750		
Quality management	Op		7500					1875		
Total		0	–135 050	0	0	0	0	–33 762.5	0	0
Manufacturing and installation										
Civil works	Cap			225 000					56 250	
Engineering and operational analysis	Cap			54 000					13 500	
Construction/Purchase/Manufacture	Cap			1 350 000					337 500	
Production tooling and test equipment	Cap			49 500					12 375	
Mobilisation / Demobilisation	Cap			40 500					10 125	
Project superintendance and contract management	Cap			67 500					16 875	
Total		0	0	–1 786 500	0	0	0	0	–446 625	0
Maintenance										
Spare parts and consumables	Op				2000	2000	2000	2000	2000	2000
Equipment and facilities	Op				4000	4000	4000	4000	4000	4000
Routine maintanence	Op				2500	2500	2500	2500	2500	2500
Major programmed maintenance	Op								0	
Unscheduled maintenance	Op				1250	1250	1250	1250	1250	1250
Training	Op				2500	2500	2500	2500	2500	2500
Contract services	Op				25 000	25 000	25 000	25 000	25 000	25 000
IT support	Op				5500	5500	5500	5500	5500	5500
Total		0	0	0	–42 750	–42 750	–42 750	–42 750	–42 750	–42 750
Support services										
Disassembly recycling or safe disposal	Op									
Facility training Industry levies and Doc Management	Op				49 625					
Corporate management	Op				4500	4500	4500	4500	4500	4500
Administrative overheads	Op				110 000	110 000	110 000	110 000	110 000	110 000
Insurance	Op				9000	9000	9000	9000	9000	9000
Depreciation and interest Costs	Op				115 130	115 130	115 130	115 130	173 191	173 191
System shutdown	Op				1500	1500	1500	1500	1500	1500
Utilities cleaning and fees	Op				63 800	63 800	63 800	63 800	63 800	63 800
Total		0	0	0	–353 555	–303 930	–303 930	–303 930	–361991.25	–361991.25
Total Capital Costs		$0	$44 550	$1 786 500	$0	$0	$0	$11 138	$446 625	$0
Total Operating Costs		$17 700	$90 500	$0	$396 305	$346 680	$351 105	$369 305	$404 741	$404 741
Gross Revenues		$0	$0	$0	$260 000	$260 000	$260 000	$260 000	$100 000	$300 000
Nett Gain/Subsidy		$17 700	$135 050	$1 786 500	$136 305	$86 680	$91 105	$120 442	$751 366	$104 741

	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	
							125						
							1875						
							300						
							2125						
	0	0	0	0	0	0	–4425	0	0	0	0	0	–26 550
								1688					
								450					
								5625					
								3375					
								13 750					
								2000					
								4250					
								750					
								1875					
	0	0	0	0	0	0	0	–33 762.5	0	0	0	0	–20 2575
									56 250				
									13 500				
									337 500				
									12 375				
									10 125				
									16 875				
	0	0	0	0	0	0	0	0	–446 625	0	0	0	–2 679 750
	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	
	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
				15 000					15 000				
	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	
	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	
	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000	25 000
	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	
	–42 750	–42 750	–42 750	–57 750	–42 750	–42 750	–42 750	–42 750	–57 750	–42 750	–42 750	–42 750	–799 500
	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	
	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	
	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000	
	173 191	173 191	173 191	173 191	173 191	173 191	173 191	173 191	231 253	231 253	231 253	231 253	
	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	
	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	63 800	
	–361991.25	–361991.25	–361991.25	–361991.25	–361991.25	–361991.25	–361991.25	–361991.25	–420 052.5	–420 052.5	–420 052.5	–420 052.5	–6 565 467.5
	$0	$0	$0	$0	$0	$0	$0	$11 138	$446 625	$0	$0	$0	
	$404 741	$404 741	$404 741	$419 741	$404 741	$404 741	$409 166	$427 366	$477 803	$462 803	$462 803	$462 803	
	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000	$300 000	$270 000	$300 000	$300 000	$300 000	$4 980 000
	$104 741	$104 741	$104 741	$149 741	$104 741	$104 741	$109 166	$138 503	$654 427	$162 802	$162 802	$162 802	$5 293 842

TABLE 8.0

	Present Value $ - Rate Per Year																			
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
1	0.990	0.980	0.970	0.961	0.952	0.943	0.934	0.925	0.917	0.909	0.900	0.892	0.885	0.877	0.869	0.862	0.854	0.847	0.840	0.833
2	0.980	0.961	0.942	0.924	0.907	0.89	0.873	0.857	0.841	0.826	0.811	0.797	0.783	0.769	0.756	0.743	0.730	0.718	0.706	0.694
3	0.970	0.942	0.915	0.889	0.863	0.839	0.816	0.793	0.772	0.751	0.731	0.711	0.693	0.675	0.657	0.640	0.624	0.608	0.593	0.578
4	0.961	0.923	0.888	0.854	0.822	0.792	0.762	0.735	0.708	0.683	0.658	0.635	0.613	0.592	0.571	0.552	0.533	0.515	0.498	0.482
5	0.951	0.905	0.862	0.821	0.783	0.747	0.713	0.680	0.649	0.620	0.593	0.567	0.542	0.519	0.497	0.476	0.456	0.437	0.419	0.401
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.534	0.506	0.480	0.455	0.432	0.410	0.389	0.370	0.352	0.334
7	0.932	0.870	0.813	0.759	0.710	0.665	0.622	0.583	0.547	0.513	0.481	0.452	0.425	0.399	0.375	0.353	0.333	0.313	0.295	0.279
8	0.923	0.853	0.789	0.730	0.676	0.627	0.582	0.540	0.501	0.466	0.433	0.403	0.376	0.350	0.326	0.305	0.284	0.266	0.248	0.232
9	0.914	0.836	0.766	0.702	0.644	0.591	0.543	0.500	0.460	0.424	0.390	0.360	0.332	0.307	0.284	0.263	0.243	0.225	0.209	0.193
10	0.905	0.820	0.744	0.675	0.613	0.558	0.508	0.463	0.422	0.385	0.352	0.322	0.294	0.269	0.247	0.226	0.208	0.191	0.175	0.161
11	0.896	0.804	0.722	0.649	0.584	0.526	0.475	0.428	0.387	0.350	0.317	0.287	0.260	0.236	0.214	0.195	0.177	0.161	0.147	0.134
12	0.887	0.788	0.701	0.624	0.556	0.497	0.444	0.397	0.355	0.318	0.285	0.256	0.230	0.207	0.186	0.168	0.152	0.137	0.124	0.112
13	0.878	0.773	0.681	0.600	0.530	0.468	0.415	0.367	0.326	0.289	0.257	0.229	0.204	0.182	0.162	0.145	0.129	0.116	0.104	0.093
14	0.87	0.757	0.661	0.577	0.505	0.442	0.387	0.340	0.299	0.263	0.232	0.204	0.180	0.159	0.141	0.125	0.111	0.098	0.087	0.077
15	0.861	0.743	0.641	0.555	0.481	0.417	0.362	0.315	0.274	0.239	0.209	0.182	0.159	0.140	0.122	0.107	0.094	0.083	0.073	0.064
16	0.852	0.728	0.623	0.533	0.458	0.393	0.338	0.291	0.251	0.217	0.188	0.163	0.141	0.122	0.106	0.093	0.081	0.070	0.061	0.054
17	0.844	0.714	0.605	0.513	0.436	0.371	0.316	0.270	0.231	0.197	0.169	0.145	0.125	0.107	0.092	0.080	0.069	0.06	0.052	0.045
18	0.836	0.700	0.587	0.493	0.415	0.350	0.295	0.250	0.212	0.179	0.152	0.13	0.110	0.094	0.080	0.069	0.059	0.050	0.043	0.037
19	0.827	0.686	0.570	0.474	0.395	0.330	0.276	0.231	0.194	0.163	0.137	0.116	0.098	0.082	0.070	0.059	0.050	0.043	0.036	0.031
20	0.819	0.673	0.553	0.456	0.376	0.311	0.258	0.214	0.178	0.148	0.124	0.103	0.086	0.072	0.061	0.051	0.043	0.036	0.030	0.026
21	0.811	0.659	0.537	0.438	0.358	0.294	0.241	0.198	0.163	0.135	0.111	0.092	0.076	0.063	0.053	0.044	0.037	0.030	0.025	0.021
22	0.803	0.646	0.521	0.422	0.341	0.277	0.225	0.183	0.150	0.122	0.100	0.082	0.068	0.056	0.046	0.038	0.031	0.026	0.021	0.018
23	0.795	0.634	0.506	0.405	0.325	0.261	0.210	0.170	0.137	0.111	0.090	0.073	0.060	0.049	0.040	0.032	0.027	0.022	0.018	0.015
24	0.787	0.621	0.491	0.390	0.310	0.247	0.197	0.157	0.126	0.101	0.081	0.065	0.053	0.043	0.034	0.028	0.023	0.018	0.015	0.012
25	0.779	0.609	0.477	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.073	0.058	0.047	0.037	0.030	0.024	0.019	0.016	0.012	0.010
26	0.772	0.597	0.463	0.360	0.281	0.219	0.172	0.135	0.106	0.083	0.066	0.052	0.041	0.033	0.026	0.021	0.016	0.013	0.010	0.008
27	0.764	0.585	0.450	0.346	0.267	0.207	0.160	0.125	0.097	0.076	0.059	0.046	0.036	0.029	0.023	0.018	0.014	0.011	0.009	0.007
28	0.756	0.574	0.437	0.333	0.255	0.195	0.150	0.115	0.089	0.069	0.053	0.041	0.032	0.025	0.02	0.015	0.012	0.009	0.007	0.006
29	0.749	0.563	0.424	0.320	0.242	0.184	0.140	0.107	0.082	0.063	0.048	0.037	0.028	0.022	0.017	0.013	0.010	0.008	0.006	0.005
30	0.741	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057	0.043	0.033	0.025	0.019	0.015	0.011	0.009	0.007	0.005	0.004

TABLE 8.0

Future Value of $1																				
Yr	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
1	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.1	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.2
2	1.02	1.04	1.06	1.08	1.1	1.12	1.14	1.17	1.19	1.21	1.23	1.25	1.28	1.3	1.32	1.35	1.37	1.39	1.42	1.44
3	1.03	1.06	1.09	1.12	1.16	1.19	1.23	1.26	1.3	1.33	1.37	1.4	1.44	1.48	1.52	1.56	1.6	1.64	1.69	1.73
4	1.04	1.08	1.13	1.17	1.22	1.26	1.31	1.36	1.41	1.46	1.52	1.57	1.63	1.69	1.75	1.81	1.87	1.94	2.01	2.07
5	1.05	1.1	1.16	1.22	1.28	1.34	1.4	1.47	1.54	1.61	1.69	1.76	1.84	1.93	2.01	2.1	2.19	2.29	2.39	2.49
6	1.06	1.13	1.19	1.27	1.34	1.42	1.5	1.59	1.68	1.77	1.87	1.97	2.08	2.19	2.31	2.44	2.57	2.7	2.84	2.99
7	1.07	1.15	1.23	1.32	1.41	1.5	1.61	1.71	1.83	1.95	2.08	2.21	2.35	2.5	2.66	2.83	3	3.19	3.38	3.58
8	1.08	1.17	1.27	1.37	1.48	1.59	1.72	1.85	1.99	2.14	2.3	2.48	2.66	2.85	3.06	3.28	3.51	3.76	4.02	4.3
9	1.09	1.2	1.3	1.42	1.55	1.69	1.84	2	2.17	2.36	2.56	2.77	3	3.25	3.52	3.8	4.11	4.44	4.79	5.16
10	1.1	1.22	1.34	1.48	1.63	1.79	1.97	2.16	2.37	2.59	2.84	3.11	3.39	3.71	4.05	4.41	4.81	5.23	5.69	6.19
11	1.12	1.24	1.38	1.54	1.71	1.9	2.1	2.33	2.58	2.85	3.15	3.48	3.84	4.23	4.65	5.12	5.62	6.18	6.78	7.43
12	1.13	1.27	1.43	1.6	1.8	2.01	2.25	2.52	2.81	3.14	3.5	3.9	4.33	4.82	5.35	5.94	6.58	7.29	8.06	8.92
13	1.14	1.29	1.47	1.67	1.89	2.13	2.41	2.72	3.07	3.45	3.88	4.36	4.9	5.49	6.15	6.89	7.7	8.6	9.6	10.7
14	1.15	1.32	1.51	1.73	1.98	2.26	2.58	2.94	3.34	3.8	4.31	4.89	5.53	6.26	7.08	7.99	9.01	10.15	11.42	12.84
15	1.16	1.35	1.56	1.8	2.08	2.4	2.76	3.17	3.64	4.18	4.78	5.47	6.25	7.14	8.14	9.27	10.54	11.97	13.59	15.41
16	1.17	1.37	1.6	1.87	2.18	2.54	2.95	3.43	3.97	4.59	5.31	6.13	7.07	8.14	9.36	10.75	12.33	14.13	16.17	18.49
17	1.18	1.4	1.65	1.95	2.29	2.69	3.16	3.7	4.33	5.05	5.9	6.87	7.99	9.28	10.76	12.47	14.43	16.67	19.24	22.19
18	1.2	1.43	1.7	2.03	2.41	2.85	3.38	4	4.72	5.56	6.54	7.69	9.02	10.58	12.38	14.46	16.88	19.67	22.9	26.62
19	1.21	1.46	1.75	2.11	2.53	3.03	3.62	4.32	5.14	6.12	7.26	8.61	10.2	12.06	14.23	16.78	19.75	23.21	27.25	31.95
20	1.22	1.49	1.81	2.19	2.65	3.21	3.87	4.66	5.6	6.73	8.06	9.65	11.52	13.74	16.37	19.46	23.11	27.39	32.43	38.34
21	1.23	1.52	1.86	2.28	2.79	3.4	4.14	5.03	6.11	7.4	8.95	10.8	13.02	15.67	18.82	22.57	27.03	32.32	38.59	46.01
22	1.24	1.55	1.92	2.37	2.93	3.6	4.43	5.44	6.66	8.14	9.93	12.1	14.71	17.86	21.64	26.19	31.63	38.14	45.92	55.21
23	1.26	1.58	1.97	2.46	3.07	3.82	4.74	5.87	7.26	8.95	11.03	13.55	16.63	20.36	24.89	30.38	37.01	45.01	54.65	66.25
24	1.27	1.61	2.03	2.56	3.23	4.05	5.07	6.34	7.91	9.85	12.24	15.18	18.79	23.21	28.63	35.24	43.3	53.11	65.03	79.5
25	1.28	1.64	2.09	2.67	3.39	4.29	5.43	6.85	8.62	10.83	13.59	17	21.23	26.46	32.92	40.87	50.66	62.67	77.39	95.4
26	1.3	1.67	2.16	2.77	3.56	4.55	5.81	7.4	9.4	11.92	15.08	19.04	23.99	30.17	37.86	47.41	59.27	73.95	92.09	114.48
27	1.31	1.71	2.22	2.88	3.73	4.82	6.21	7.99	10.25	13.11	16.74	21.32	27.11	34.39	43.54	55	69.35	87.26	109.59	137.37
28	1.32	1.74	2.29	3	3.92	5.11	6.65	8.63	11.17	14.42	18.58	23.88	30.63	39.2	50.07	63.8	81.13	102.97	130.41	164.84
29	1.33	1.78	2.36	3.12	4.12	5.42	7.11	9.32	12.17	15.86	20.62	26.75	34.62	44.69	57.58	74.01	94.93	121.5	155.19	197.81
30	1.35	1.81	2.43	3.24	4.32	5.74	7.61	10.06	13.27	17.45	22.89	29.96	39.12	50.95	66.21	85.85	111.06	143.37	184.68	237.38

Glossary of terms

Appreciated historical value	The calculation of the historic value of an asset expressed in current dollar values.
Betterment	An improvement of properties that materially increases the property's serviceability or useful life and as a consequence asset register value.
Building element	An integral part of a building — such as a roof, wall or service (electrical, plumbing etc.)
Capital renewal	The application of capital funding to restore an asset to an agreed service standard
Capital replacement value	The expressed value of the current cost of replacing an asset
Condition assessment report	A reporting process that critically reviews the condition and performance of assets and sub assets
Deferred maintenance	Maintenance that was not performed when it should have been or was scheduled to be which, therefore, is put off or delayed for a future period.
Deprival cost	The cost an organisation would incur if it were *deprived* of an asset and was required to continue delivering the service or program otherwise using the asset.
Discount rate	Rate used to calculate the present values of future cash flows.
Financial condition index	Defines the related costs of required repairs identified in a condition assessment report.
Gross Floor Area (GFA)	The total constructed area of a building measured from exterior walls.
Historical asset value	The original *book value* of the asset under consideration.
Maintenance	Described as the act of keeping fixed assets in an acceptable condition. It includes preventative maintenance, normal repairs, replacement of parts and structural components or other activities needed to ensure preservation of the asset in a condition that continues to provide an acceptable level of service.
Net present value	A projects net contribution to wealth i.e. present value minus initial investment (capital).
Opportunity cost	Expected return that is foregone by investing in a project rather than comparable financial securities
Safe and acceptable	Accommodation that complies with current health and safety standards and requirements for modern standards of sports provision.
Present value	Discounted value of future cash flows
Technical condition index	Refers to the technical condition of an asset or sub asset in a condition assessment report.

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (1989). Energy efficient design of new buildings except low-rise residential buildings. United States: ASHRAE.

Ballesty, S., Orlovic, M. (2004). Lifecycle costing and facility management. Facility Management 12 (2), 28-32.

Department of Sport and Recreation. (2004). Asset management guide: a guide for sport and recreation facility owners and managers. Perth, Western Australia: Department of Sport and Recreation.

Rawlinsons Construction Cost Consultants and Quantity Surveyors. (Eds.) (2005). Australian construction handbook 2005. Perth, Western Australia: Rawlhouse Publishing Pty Ltd.

Standards Australia. (1999). Life cycle costing: an application guide. (ANZS 4536:1999). Sydney, New South Wales: Standards Australia.

Notes