Gold Coast Water

Unit Rates Review - 2008

Contract No. 178/07/01

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Report no: FINAL v1.0

Hyder

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1 Introduction

Cost estimates for the delivery of water and wastewater infrastructure are typically based on a set of unit rates for pre-defined asset types, with an allowance for variations in cost affecting factors such as soil type. These rates are typically used in a wide range of cost estimation applications, including infrastructure planning and income modelling requirements. Recognising the importance of these rates to planning and infrastructure delivery outcomes Gold Coast Water (GCW) is seeking a revision to its existing unit rates for use in infrastructure planning and other applications. The outcomes of this Project are designed to minimise the likelihood that GCW will be faced with significant discrepancies between budgeted infrastructure costs (e.g. such as those passed on to developers) and actual infrastructure delivery costs.

Key aspects of the project are:

- Data Collection / Review;
- Review of historical (i.e. actual) infrastructure delivery costs;
- Development of "first principles" unit rates for relevant infrastructure items;
- Recommendation of unit rates for use in priority infrastructure planning, asset valuation and emergent planning, including adjustment factors for different site parameters; and
- Recommendation of an appropriate indexation methodology to enable GCW to periodically revise unit rates to take into account general inflation and changes in infrastructure delivery costs.

Review Comments

This final report includes amendments and responses to various GCW comments provided and discussed at a meeting held on 20 November 2008 at GCW offices. Subsequent clarifications provided in an email dated 25 November 2008 are also addressed.

2 Scope of Work

2.1 Priority Infrastructure Plan

Gold Coast City Council (GCCC) is required to develop a Priority Infrastructure Plan (PIP) in accordance with the *Integrated Planning Act*, 1997 (IPA), IPA Infrastructure Guidelines 1/04 (PIP) and 2/04 (Infrastructure Charges Schedule). A PIP enables GCCC to levy infrastructure charges on developments which place a demand on its trunk infrastructure networks. GCCC developed and adopted a PIP in January 2007 for transport, parks and recreation, and storm water sectors.

GCW is responsible for amendments that are currently being undertaken to include the water supply and wastewater networks and are scheduled to be adopted in late 2008.

Both GCCC and GCW recognise that accurate costing and financial modelling is a key component of the PIP process for levying of infrastructure charges. Inaccurate costing data can lead to inappropriate infrastructure charges which in turn can result in potentially adverse consequences such as unplanned borrowing to fund infrastructure and/or debt serving and/or unnecessary barriers to private investment.

2.2 Unit Rates Development – Past Reports

Development of infrastructure charges for water supply and wastewater infrastructure currently uses unit rates derived from various revisions of consulting reports commissioned by GCW since 2002. As set out in the Docpak prepared by GCW, the unit rates currently used by GCW were developed in the following manner:

2002	Cardno MBK	*Report GCW004* – Unit rates report for water supply and sewerage infrastructure.
2004	KBR	Unit cost report for the valuation of future potable water, recycled water and sewer works for its infrastructure charge plans
2005	KBR	Rectification of errors.
2005	Tenix Alliance	Review and compare results of KBR Report (2004) and Cardno Report (2002, with prices updated to 2004).
2006	Cardno MBK	Valuation exercise for water and sewer assets to provide GCW with an updated fixed asset register.
2006	KBR	*BEG414-W-REP-001 Rev.D* – Review and update of 2004 report following Tenix Review.

The amended report *Water Supply and Sewerage Networks* (KBR, 13 September 2006) is currently being used by GCW's Infrastructure Planning Branch for costing of planned infrastructures using a general Consumer Price Index (CPI) measure for indexation.

2.3 Review of Unit Rates

GCW has commissioned the current project, which includes the review of unit costs and update of PIP costs, as part of its PIP planning and asset valuation process.

The PIP is currently being reviewed by Queensland Competition Authority and Department of Infrastructure and Planning. During the review process, it was found that estimated costs for recently built infrastructure in the PIP were significantly lower than actual costs. A continuation in this identified discrepancy between income (i.e. charges levied on development) and expenditure (i.e. costs incurred in the delivery of infrastructure projects) has the potential to adversely affect the timely provision of infrastructure, with potential flow on effects in terms of development approval delays and/or failure to meet target levels of service.

GCW also recognises that the CPI may not be the most appropriate index for revision of cost estimates and is seeking a refined indexation methodology as part of this brief.

2.4 Consultancy Objectives

A summary of the Project objectives is presented below, noting that objective two has been modified to reflect the intention that the outcomes of this review process are intended to facilitate a GCW review and update of the fixed asset register (FAR).

Objective 1 To determine unit cost rates for valuation of future potable water, recycled water and sewer works for its Infrastructure Charges Plans.

Objective 2 To facilitate the review and update of the fixed asset register (FAR).

Objective 3 To ensure that the unit cost rates used by GCW to estimate its planned infrastructure have a high level of correlation with the actual costs of constructing the infrastructure.

Objective 4 To determine suitable adjustment factors to be applied to normal unit rates due to varying degrees of difficulties e.g. location, geological conditions, water table, type of soil etc.

Objective 5 To determine appropriate index or indices to be used for future interim revaluations, identify the cumulative unit rate movement since the last full revaluation, and determine appropriate indexation factor.

3 Project Methodology

The revised Project methodology, outlined below and summarised in **Table 3-1**, has been adopted in the delivery of this consultancy and incorporates various review comments provided by GCW throughout the development of this final report.

Table 3-1 Revised Methodology - Overview

STAGE	Details
1. Data Collection/Review	GCW data and industry experience.
2. Development of Appropriate Indexation Methodology	Derive an appropriate indexation methodology taking into account relative changes in costs of factors of production such as labour and materials.
3. Analysis of Historical Data	▪ Previous Consulting Reports (e.g. Cardno, KBR). ▪ GCW data – past quotations &/or incurred costs. ▪ Identify assets against which Unit Rates can be assessed and derived. ▪ Analyse relevant adjustment factors (e.g. soil type, economies of scale).
4. Derivation of “First Principles" Unit Rates	Unit rates to be derived from relevant factors of production (i.e. labour and materials). Base case for derivation of unit rates to be clearly delineated (e.g. 500 m length of potable water pipeline for varying pipeline diameters within sandy/good soil in urban area).
5. Comparative Analysis of Unit Rates	Compare “First Principles" Unit Rates against historical data (e.g. incurred project costs – *where available*), including analysis and comment on discrepancies.
6. Reporting – including recommendation of appropriate unit rates and indexation methodology	Following analysis of unit rates prepare comprehensive set of unit rates for adoption by GCW. Recommendation to include methodology for indexation.

3.1 Data Collection/Review

The following were provided by GCW for review as part of this Project:

a Unit Costs Report – *Water Supply and Sewerage Networks* prepared by KBR, September 2006;

b Water and Sewer Assets Valuation prepared by Cardno (September 2006);

c ICP unit costs Peer Review by GHD (March 2005);

d Fixed Asset Register (CD provided 11 June 2008);

e Historical Cost Data (CD provided 11 June 2008);

f Additional items for unit cost review.doc (CD provided 11 June 2008);

g Hardcopy data sheets – various works programmes between September 2004 and April 2008.

Communications with GCW (Senior Planning Engineer pers comm. 24 June 2008) confirmed that the hardcopy datasheets (Item g) above) reflect quotations from three separate unidentified suppliers, whilst the historical cost data provided on the CD (Item e) above) reflects a mixture of "as constructed" costs and "immediately prior to construction" cost estimates.

Additional data was provided by GCW in digital format on Friday 11 July 2008.

Assets identified during the review of these documents are listed below in **Table 3-2**.

Table 3-2 Summary of Assets for Inclusion in Unit Rate Review

Asset Category		Primary Variables
Pipelines	Potable Water	Ø
	Recycled Water	Ø
	Rising Mains (Sewage)	Ø
	Gravity Mains (Sewage) Reduced Infiltration Gravity Sewers Vacuum Sewer Mains	Ø & Depth
Manholes	Manholes	Ø & Depth
Drilling	Directional Drilling	Ø & Drill pit depth
Pipe Jacking	Enveloper	Ø & Drill pit depth
	Carrier Pipe	Ø
Water Pump Stations	Civil	Pump motor size ($/kW)
	P/wk & Equip	
	Mechanical	
	Elec & Telemetry	
Sewage Pump Stations	Civil	Volume
	P/wk & Equip	Pump motor size ($/kW)
	Mechanical	
	Elec & Telemetry	
Reservoirs	Elevated Ground Level	Volume (ML) Material Roof structure
Valves/Meters	Pressure Reducing Valves	Ø
	Water Meters	Meter size
Administration Costs		Stage of Project

3.2 Development of Appropriate Indexation Methodology

Hyder recognises the importance of a robust indexation methodology to enable GCW and GCCC to adjust unit rates to accurately reflect infrastructure delivery costs. As outlined in the Contract (No. 178/07/01) failure to take into account changing prices whether caused by general inflationary pressures or changes in market price directly affects GCW's ability to fund water and sewerage related infrastructure.

Indexation is discussed in **Section 4** and includes a review of available indices their applicability for use in the adjustment of unit rates. Consideration is also given to the frequency at which indexation should be applied and appropriate triggers for future reviews of the GCW's adopted unit rates.

3.3 Analysis of Historical Data

Available data, including GCW, industry and Australian Bureau of Statistics (ABS) data (where relevant), was analysed to enable:

- Comparison of historical costs against the "first principles" unit rates.
- Identification of changes in the previous unit cost estimates and incurred costs over time.
- Identification of changes in pricing levels across the economy, including with particular reference to general price levels, labour costs and material costs.

Objectives of this analysis included the identification of base costs for comparison against "first principles" unit rates as well as identification of relevant pricing indices for subsequent use in the development of an indexation methodology.

3.4 Derivation of First Principles Rates/Adjustment Factors

"First principles" unit rates were then developed for each of the asset classes listed in **Table 3-2**. The detailed methodology adopted for the derivation of first principles unit rates and adjustment factors is presented in **Section 6.1** and focussed on the sourcing of competitive market rates for asset classes. The methodology presented in **Section 6.1** incorporates various comments and refinements requested by GCW.

3.5 Comparative Analysis of Unit Rates

Prior to the recommendation of unit rates for adoption by GCW historical unit costs were analysed against the derived "First Principles" unit rates to identify significant anomalies/discrepancies. A comparative analysis of the "first principles" unit rates against the incurred cost data provided by GCW is presented in **Section 7**.

3.6 Project Milestones/Reporting

The following section outlines project milestones and provides an indication of timing for delivery of reporting, taking into account the timing of factors such as project commissioning, project start-up meeting and receipt of background data. Project milestones are summarised in **Table 3-3**.

Table 3-3 Summary of Project Milestones/Timing

Milestone	Summary Description of Milestone
Inception Report *(Milestone 1)*	Focus on the provision of a detailed project methodology to GCW, taking into account review comments and refinements provided by GCW officers.
Interim Report *(Milestone 2)*	Focus on "first principles" unit rates and outline of the methodology adopted in their derivation, along with relevant assumptions and references. *Provided to GCW in electronic format only.*
Draft Report *(Milestone 3)*	Detailed methodologies used to review and derive unit rates and presentation of relevant supporting documentation. Important elements of the Draft Report include: ▪ relevant data on selected GCW infrastructure and historical costs; ▪ identification of derived ("first principles") and actual (historical) unit rates, with additional cost factors such as indirect costs and anticipated profit added to derived unit rates for comparison purposes; ▪ cost breakdowns typically including justification for adopted values; and ▪ draft recommendation of appropriate unit rates including ranges and justifications and an appropriate indexation methodology.
Final Report *(Milestone 4)*	A Final Report will be prepared following the receipt of final comments from GCW officers. *Provision has also been made for a one day workshop to train GCW officers in the use of the methodologies presented in the Final Report.*

Reporting has been undertaken in stages to provide opportunities for review and refinement of scope as outlined below.

4 Indexation

4.1 Existing GCW Approach

Information posted on the GCCC website, and confirmed by GCW (Senior Planning Engineer, pers comm., 07 July 2008), states that infrastructure charge rates (for both PIP and developer contribution policies) are indexed on a quarterly basis[1]. The developer contribution policy charge rates are indexed by reference to the CPI (Brisbane All Groups, ABS Cat No 6401.0) issued by the ABS.

4.1.1 Consumer Price Index – Introduction

As outlined above the existing indexation methodology relies solely on the CPI (ABS, 2008a).

Basket of Goods

The ABS (2005) states that:

> *"the Australian CPI is specifically designed to provide a general measure of price inflation for the household sector as a whole. It measures changes over time in the prices of consumer goods and services acquired by Australian households".*

As an economic indicator the CPI measures quarterly changes in the price of a 'basket' of goods and services which account for a high proportion of expenditure by the population group (i.e. metropolitan households). This 'basket' covers a wide range of goods and services, arranged in the following eleven groups:

- Food
- Alcohol and tobacco
- Clothing and footwear
- Housing
- Household contents and services
- Health
- Transportation
- Communication
- Recreation
- Education
- Financial and insurance services.

[1] http://www.goldcoast.qld.gov.au/t_standard2.aspx?pid=7080 (accessed 07/07/08)

Typical Applications

The ABS (2005) suggests that the CPI is appropriate in circumstances where a measure of general price inflation is required and cites typical indexation applications such as:

- pension and superannuation payments;
- taxes and charges;
- indexed government bonds; and business contracts.

Publication Frequency

CPI figures are produced by the ABS for each quarter (three months ending March, June, September and December) and are typically released within one month of the end of the quarter. They appear in the publication *Consumer Price Index, Australia* (cat. no. 6401.0).

A summary of the CPI measures for Brisbane, All Groups (ABS Cat No. 6401.0) (both index numbers and percentage change from previous period) for the past five years is presented in **Table 4-1**.

Table 4-1 Consumer Price Index – Brisbane, All Groups

Series ID *A2325816R*	**Index Numbers**	**% Change** From Previous Period	**% Change** From Corresponding Quarter of Previous Year
Mar-2004	145.4	0.8%	2.5%
Jun-2004	146.3	0.6%	3.2%
Sep-2004	146.8	0.3%	2.4%
Dec-2004	148.0	0.8%	2.6%
Mar-2005	149.2	0.8%	2.6%
Jun-2005	150.0	0.5%	2.5%
Sep-2005	150.9	0.6%	2.8%
Dec-2005	152.1	0.8%	2.8%
Mar-2006	153.5	0.9%	2.9%
Jun-2006	156.2	1.8%	4.1%
Sep-2006	157.5	0.8%	4.4%
Dec-2006	157.3	-0.1%	3.4%
Mar-2007	158.0	0.4%	2.9%
Jun-2007	160.2	1.4%	2.6%
Sep-2007	161.7	0.9%	2.7%
Dec-2007	163.4	1.1%	3.9%
Mar-2008	165.6	1.3%	4.8%

Source: ABS Cat No 6401.0 (Tables 1 and 2)

4.1.2 Issues with Current Approach

The CPI is not designed to isolate price changes in the delivery of water and wastewater infrastructure assets. In focussing on a metropolitan household basket of goods, the CPI does not capture price changes in the factors of production (i.e. labour and materials) for these assets.

A report by the Auditor-General (Queensland Audit Office (QAO), 2008) suggests that infrastructure projects across Queensland public sector entities are subjected to an average cost escalation percentage of 6.4% for the 2007/08 period.

The GCW approach results in a 4.8% price increase for the period March 2007 to March 2008 (**Table 4-1**), which compares with 6.2% for the Queensland Producer Price Index – General Construction, which is recommended by the Auditor-General for public sector infrastructure projects. These results demonstrate a considerable degree of underestimation in infrastructure delivery costs arising from the GCW indexation methodology. This 1.4% difference equates to an underestimation of almost $3 million for the GCW 2008 capital works budget ($205,699,125.15 – value taken from Hyder (2008)).

This discussion confirms GCW's suggestion that an alternative indexation methodology is required.

4.2 Alternative Indexation Approaches

Alternative measures of inflation produced by the ABS are grouped under the Producer Price Index and Labour Price Index. These indexes are discussed below along with their potential application to the GCW unit rates for water and wastewater infrastructure delivery.

4.2.1 Producer Price Index

The following discussion relates to the Producer Price Indexes published by the ABS (Cat. No. 6427.0) (ABS, 2008b).

Basket of Goods

The ABS constructs producer price indexes as either output or input measures, with output indexes measuring changes in the prices of sales by a defined sector of the economy and input indexes measuring changes in the price of purchases by a particular economic sector (ABS, 2008b).

Pricing data is sourced from a sample of businesses on a quarterly basis and construction industry producer price indexes relate to the principal outputs (e.g. buildings) and the inputs (i.e. materials used) within designated sectors of the Australian construction industry.

Currently output indexes are calculated on the reference base 1998-99=100, noting that this base is subject to periodic revision.

The general construction index is an output measure which is based upon an evaluation of basic prices, “defined as the amount received by the producer exclusive of any takes on products and transport and trade margins (i.e. the pricing point is ex-factory, ex-farm, ex-service provider etc)” (ABS, 2008b). This derivation therefore takes into account changes in the cost of input factors such as labour, equipment and materials.

Typical Applications

As outlined above the Auditor-General Queensland (QAO, 2008) identifies the ABS’s Queensland Producer Price Index – General Construction as an appropriate measure of cost increases for public sector infrastructure projects.

Publication Frequency

Producer Price Index figures are produced by the ABS for each quarter (months ending March, June, September and December) and are typically released within one month of the end of the quarter. They appear in the publication *Producer Price Indexes, Australia* (cat. no. 6427.0).

Relevant Indexes

The ABS generally collects data against the classes defined by the Australian and New Zealand Standard Industrial Classification (ANZSIC). Division E of ANZSIC currently includes the following classes:

General Construction (41);

- Building construction (411);
  - House construction (4111);
  - Residential building construction n.e.c. (4112);
  - Non-residential building construction (4113);
- Non-building construction (412);
  - Road and bridge construction (4121); and
  - Non-building construction n.e.c. (4122).

Of these classes, the Non-building construction n.e.c. (4122) includes the relevant primary activities of sewage treatment plant construction and sewage or stormwater drainage systems construction (ABS, 1993). An index based on this class would therefore be appropriate for water and sewage construction works.

Current ABS index coverage for the construction industry (division E of ANZSIC) however, is limited to the output of the following ANZSIC classes (ABS, 2008b[2]):

- House construction (4111);
- Residential building construction n.e.c. (4112);

[2] http://www.abs.gov.au/Ausstats/abs@.nsf/exnote/6427.0

- Non-residential building construction (4113); and
- Road and bridge construction (4121).

As the Building construction (411) and Non-building construction (412) classes are aggregates of the lower level classes, the non-building construction (412) class is effectively the road and bridge construction (4121) class and is therefore not considered appropriate for adoption by GCW.

The General Construction (Queensland) (41) class is an aggregate of measured construction classes and is published within ABS Cat No 6427.0 (Tables 15 and 16). **Table 4-2** provides a summary of the *Producer Price Index – General Construction (41), Queensland* for the period March 2004 to June 2008.

Table 4-2 Producer Price Index – General Construction (41) Queensland

Period	Index Numbers (Series ID: A2333709J)	% Change	
		From Previous Period	*From Corresponding Quarter of Previous Year*
Mar-2004	123.0	2.1%	10.5%
Jun-2004	127.8	3.9%	11.9%
Sep-2004	129.5	1.3%	10.1%
Dec-2004	132.0	1.9%	9.5%
Mar-2005	136.0	3.0%	10.6%
Jun-2005	138.5	1.8%	8.4%
Sep-2005	141.1	1.9%	9.0%
Dec-2005	143.3	1.6%	8.6%
Mar-2006	145.4	1.5%	6.9%
Jun-2006	147.6	1.5%	6.6%
Sep-2006	149.9	1.6%	6.2%
Dec-2006	151.3	0.9%	5.6%
Mar-2007	154.0	1.8%	5.9%
Jun-2007	155.9	1.2%	5.6%
Sep-2007	158.2	1.5%	5.5%
Dec-2007	161.2	1.9%	6.5%
Mar-2008	163.6	1.5%	6.2%
Jun-2008	166.3	1.7%	6.7%

Source: Index Numbers taken from ABS Cat No 6427.0 (Tables 15 and 16)

4.2.2 Labour Price Index

The following discussion relates to the labour price index published by the ABS (Cat. No. 6345.0) (ABS, 2008c).

Basket of Goods

The ABS publishes four wage price indexes and four non-wage price indexes (covering leave, superannuation, payroll tax and workers compensation), which are then used in the production of two labour price indexes, that differ only in their treatment of bonuses. The ABS constructs its labour price indexes using a methodology that is similar to that used for other price indexes such as the CPI. Indexes utilise information collected from a representative sample of employee jobs across a sample of employing organisations.

Typical Applications

Indexes that include bonuses and commission are not considered to be pure price indexes as they can reflect changes in the quality of work performed. Indexes that exclude bonuses would therefore be better suited for use in the indexation of the labour component of water and wastewater infrastructure unit rates.

Labour price indexes would typically be adopted in applications where contracts need to incorporate changes in the labour price over time and a more general measure of price changes, such as CPI is considered to be inappropriate.

Publication Frequency

Wage Price Index figures are produced by the ABS for each quarter (months ending March, June, September and December) and are typically released within one month of the end of the quarter. Labour Price Indexes (including and excluding bonuses) are produced on a financial year basis, with the full data set updated annually in the September quarter *Labour Price Index, Australia* (cat. no. 6345.0).

Relevant Indexes

The ABS publishes a wide range of labour and wage price indexes at regular intervals (quarterly and annually). **Table 4-3** shows the quarterly wage price index for private and public employees in the Australian construction industry.

Data specific to Queensland labour costs is limited to a sector (i.e. private, public and an aggregate of these). Industry specific labour indexes are provided at the national level.

Table 4-3 Wage Price Index – Australian Construction Industry, Private & Public

Period	Index Numbers[1]	% Change	
		From Previous Period	*From Corresponding Quarter of Previous Year*
Mar-2004	100.3	1.2%	3.5%
Jun-2004	101.7	1.4%	4.4%
Sep-2004	103.2	1.5%	4.5%
Dec-2004	104.6	1.4%	5.5%
Mar-2005	105.9	1.2%	5.6%
Jun-2005	106.7	0.8%	4.9%
Sep-2005	108.1	1.3%	4.7%
Dec-2005	109.3	1.1%	4.5%
Mar-2006	111.2	1.7%	5.0%
Jun-2006	112.6	1.3%	5.5%
Sep-2006	113.5	0.8%	5.0%
Dec-2006	114.9	1.2%	5.1%
Mar-2007	116.2	1.1%	4.5%
Jun-2007	117.4	1.0%	4.3%
Sep-2007	119.0	1.4%	4.8%
Dec-2007	120.2	1.0%	4.6%
Mar-2008	121.1	0.7%	4.2%
Jun-2008	122.9	1.5%	4.7%

Source: Index Numbers taken from ABS Cat No 6345.0 (Table 5b)

Note 1 Total hourly rates of pay, excluding bonuses.

4.3 Matters to Consider

The ABS (2008a) provides advice in relation to general matters to consider when developing indexation clauses using a price index.

These are summarised in **Table 4-4**.

Table 4-4 Factors to Consider in Developing Indexation Clauses

Key Heading	Summary – Factors to Consider	Recommended Approach
Subject of Indexation	▪ Establish the base payment, selling or purchase price subject to indexation.	▪ Construction costs – water and sewage infrastructure. ▪ Base price to be set at June 2008 following adoption of unit rates presented in this report.

Key Heading	Summary – Factors to Consider	Recommended Approach
Index(es) Selection	▪ Index(es) selected will affect the price change recorded and should be chosen to best represent the item subject to indexation.	▪ Given the complex nature of the water and sewage assets under consideration, a construction index is considered most appropriate. ▪ *General Construction – Queensland* index produced by the ABS is endorsed by the Auditor-General as appropriate for work programmes of this nature. Base Index Value at June 2008: ▪ **166.3**
Source Citation	▪ Clearly identify the selected index and cite an appropriate source.	Producer Price Index – ABS Cat No 6427.0 ▪ Tables 15 & 16 – General Construction – Queensland Available at: http://www.abs.gov.au/ausstats/abs@.nsf/mf/6427.0
Frequency of Adjustment	▪ State the frequency of price adjustment.	▪ Producer Price Index – ABS Cat No 6427.0 is subject to quarterly revision.
Unforeseen Changes to Index	▪ Provide for renamed, varied or discontinued price indexes. ▪ Provide for potential revisions to the price index data.	
Changes to Base Period	▪ The reference base period of a price index may be changed from time to time. Indexation clauses should avoid locking in a particular base period.	
Define Price Adjustment Formula	▪ Define the formula for the price adjustment calculation.	$\%\Delta = \frac{(CurrentYr - BaseYr)}{BaseYr} \times 100$ ***Index Numbers ONLY*** The following indexation example has a reference base year of 1989-90 = 100.0, and illustrates the computation of percentage change: ▪ Index No. Current Year for the All Groups CPI for Sydney in 2003-04 = 144.1 less index number for the corresponding series in 2002-03 = 141.1 ▪ Change in index points = 3.0 ▪ Percentage change = 3.0/141.1 x 100 = 2.1%
Price Movement	▪ Allow for negative price movements.	

4.4 Conclusion

Use of a wage price index such as that presented in **Table 4-3** would require the disaggregation of the labour and non-labour components of the construction process and a re-evaluation of the most appropriate index for non-labour components. This approach would result in a significantly more complex process than the adoption and application of the Producer Price Index – General Construction (41), Queensland as discussed in **Section 4.2.1** above.

Until such time as the ABS commences collection and publication of data under the non-building construction n.e.c. (4122) class then the **General Construction (41) class** (**Table 4-2**) is considered the most appropriate for water and sewerage infrastructure construction works.

5 Data Analysis

The following section sets out the results of the data review and analysis, focussing on the data provided by GCW. Costs (where they are accompanied by an indication of the time period they represent) have been inflated to June $2008 using the Producer Price Index published by the ABS (i.e. General Construction (41) Queensland, ABS Cat No 6427.0) (**Table 4-2**).

5.1 Past Unit Rate Reports

Section 2.2 sets out the historical process through which GCW derived its current set of unit rates. This comprised preliminary reporting by Cardno MBK, then KBR, followed by peer review and revision stages and ultimately the adoption of KBR's amended report Water Supply and Sewerage Networks (13 September 2006).

Specifically this report provides unit rates against the following asset categories:

- Water and Sewerage Pipe
- Manholes
- Sewage Pump Station or emergency storage
- Water pump station
- Ground level and elevated (concrete and steel) reservoirs
- Adjustment factors – covering water and sewage pipelines and manholes

It is noted that the Tenix Alliance review of unit rates recommends some changes to the KBR rates that are not reflected in the amended KBR report. Rates identified as supplied by KBR in the Tenix Alliance report (March 2005) are the same as those presented in the revised KBR Report (September 2006). In consultation with GCW (Senior Planning Engineer pers comm. 27 August 2008) it has been assumed that the data presented in the KBR Report represent prices with a June 2004 base.

5.2 GCW Data

Rates presented in this section have been inflated to June $2008 (where appropriate) using the General Construction (41) Queensland table of the Producer Price Index (ABS Cat No 6427.0) published by the ABS.

*A copy of this index is provided as **Table 4-2**.*

The following section is a summary of the historical costs data provided by GCW from the sources summarised in **Table 5-1**. In addition to these spreadsheets, copies of various project sheets were provided for analysis. This data was collated and summarised and relevant data is presented below as part of the analysis of existing unit rates.

Table 5-1 Summary of Available Data

File Name (as provided by GCW)	General Comment on Data Review	Used Further
Akhtar Unit Cost Review.xls	Limited data.	**Section 5.2.1**
James – Unit Cost Review.xls	Limited data.	**Section 5.2.1**
WaterAndWastewaterPipes_0607_finYr_detail.xls	Insufficient Project definition.	No
BMP Unit Cost Review-akhtar (detailed).xls	Limited cost data provided.	No
GCW Infrastructure Assets with Bulk Adjust.xls		No
(Valued) Reservoirs.xls		No
(Valued) WTP.xls	Related to Treatment Plants – *Not considered further.*	
(Valued) STP.xls		
(Valued)SPS.xls	Good general data provided.	**Appendix A**
(Valued)WPS.xls		**Appendix A**

Issues identified with the data provided include:

- Limited to no context provided with spreadsheets (i.e. timing, purpose and/or methodology for unit cost reviews absent). Particularly problematic where projects are duplicated from one sheet to the next.
- Data often contains no clear reference to point in time when costs were incurred.
- Project definitions lack identification of pipeline type (e.g. sewage main v potable water) and frequently aggregate data to form a total project cost with no breakdown of component costs (e.g. a project comprising several pipeline lengths of different diameters as well as manholes presented with a single overall cost).
- Reference to unit rates other than those from the KBR Report (i.e. uncertainty surrounding unit rates adopted by GCW) (i.e. projects costed in 2007 utilising unit rates from 2002 with no apparent indexation).

A more rigorous project definition and data collection programme would be needed to facilitate meaningful statistical analysis of historical cost data.

5.2.1 Pipelines – Water & Sewage

In addition to the digital format data various hardcopy sheets were also provided containing potable water pipeline asset data. This data is presented in **Table 5-2**.

Table 5-2 Summary of Historical Cost Data – Potable Water Pipelines

Ø1 (mm)	TL1 (m)	Date	Lowest Bid (excl GST)	Unit Rates Real Costs *Inflated to $Jun08*
100	6	Sep-07	$5,800.00	$989.98
	7	Sep-07	$6,000.00	$877.82
	16.6	Sep-07	$5,305.00	$327.29
	40	Mar-05	$17,150.00	$475.88
	85	Sep-07	$20,682.00	$249.19
	92	Mar-05	$27,946.00	$337.15
	118	Sep-07	$28,670.00	$248.83
	172.5	Sep-07	$55,239.00	$327.95
	309	Mar-05	$62,030.00	$222.81
	311	Mar-05	$128,990.00	$460.35
	320	Dec-07	$173,986.95	$551.03
	379.5	Sep-07	$103,015.00	$278.00
	480	Mar-05	$79,581.00	$184.02
	513	Mar-05	$73,422.00	$158.85
	541	Mar-05	$104,872.00	$215.16
	880	Nov-04	$79,905.00	$102.43
150	16	Sep-07	$8,000.00	$512.06
	60.7	Sep-07	$25,609.00	$432.07
	90.6	Sep-07	$28,502.00	$322.18
	93.2	Sep-07	$29,324.00	$322.22
	100	Sep-07	$31,400.00	$321.57
	105.3	Sep-07	$38,450.00	$373.95
	127.9	Sep-07	$55,576.00	$445.01
	150	Nov-04	$38,005.00	$285.81
	158.4	Sep-07	$71,293.00	$460.94
	162.2	Sep-07	$71,447.00	$451.11
	165	Nov-04	$56,870.00	$388.81
	200	Sep-07	$63,328.00	$324.28
	210	Mar-05	$65,100.00	$344.08
	219.4	Sep-07	$98,712.00	$460.77
	225.7	Sep-07	$101,546.00	$460.77
	244.2	Sep-07	$109,904.00	$460.91
	246	Mar-05	$61,074.00	$275.56
	248	Mar-05	$70,146.00	$313.94
	316.3	Sep-07	$99,542.00	$322.30
	340.6	Sep-07	$107,182.00	$322.28
	342.9	Sep-07	$154,321.00	$460.90
	355	Sep-07	$92,721.00	$267.49
	362	Jun-06	$65,900.00	$193.00
	389.8	Sep-07	$101,810.00	$267.48
	405.3	Sep-07	$175,993.00	$444.70

Ø1 (mm)	TL1 (m)	Date	Lowest Bid (excl GST)	Unit Rates Real Costs *Inflated to $Jun08*
	445	Sep-07	$139,730.00	$321.57
	446.8	Sep-07	$194,023.00	$444.72
	462.2	Sep-07	$145,432.00	$322.24
	576.5	Sep-07	$250,326.00	$444.69
	675.2	Sep-07	$293,223.00	$444.75
	961.7	Sep-07	$417,605.00	$444.71
	1320	Oct-05	$293,817.75	$244.27
200	64.2	Sep-07	$36,807.00	$587.15
	344	Dec-05	$107,774.00	$341.10
	717	Sep-07	$243,140.00	$347.29
225	40	Sep-05	$70,954.00	$1,946.65
	66	Sep-04	$65,250.00	$1,115.25
	154	Feb-05	$110,900.00	$805.77
	182	Mar-05	$77,669.00	$473.66
	211	Mar-05	$103,680.00	$545.39
	233	Sep-04	$67,628.00	$327.42
	250	Nov-04	$54,613.00	$246.43
	385	Nov-04	$228,700.00	$670.10
	545	Nov-04	$83,858.00	$173.57
	742	Mar-05	$360,000.00	$538.51
	871	Aug-05	$252,500.00	$320.05
300	29	Nov-04	$49,430.00	$1,922.77
	558	Sep-07	$251,100.00	$460.85
	1045	Sep-05	$299,443.92	$314.46
	1200	Feb-08	$842,160.00	$711.25
450	250	Mar-07	$594,200.00	$2,491.13
			$1,516,013.00	$6,355.74
600	125	Apr-06	$477,025.00	$4,117.02
	1249	Feb-06	$1,433,914.00	$1,249.95
	2482	Mar-05	$1,873,611.00	$837.86
960	68	Jul-05	$98,260.00	$1,595.28
	197	Nov-07	$2,797,500.00	$14,543.01
	2002	Jul-07	$2,055,976.00	$1,061.58
	2300	Nov-07	$2,758,950.00	$1,228.47
	2339	Nov-06	$3,031,700.00	$1,362.81

5.2.2 Manholes

The data provided by GCW does not contain a breakdown of manhole projects suitable for comparison against incurred cost data (i.e. manholes were bundled with pipelines and only presented against total scheme costs). **Figure 5-1** demonstrates a significant difference in cost estimates between unit rates presented by Tenix Alliance and KBR. A similar pattern is observed for 1200 mm diameter manholes.

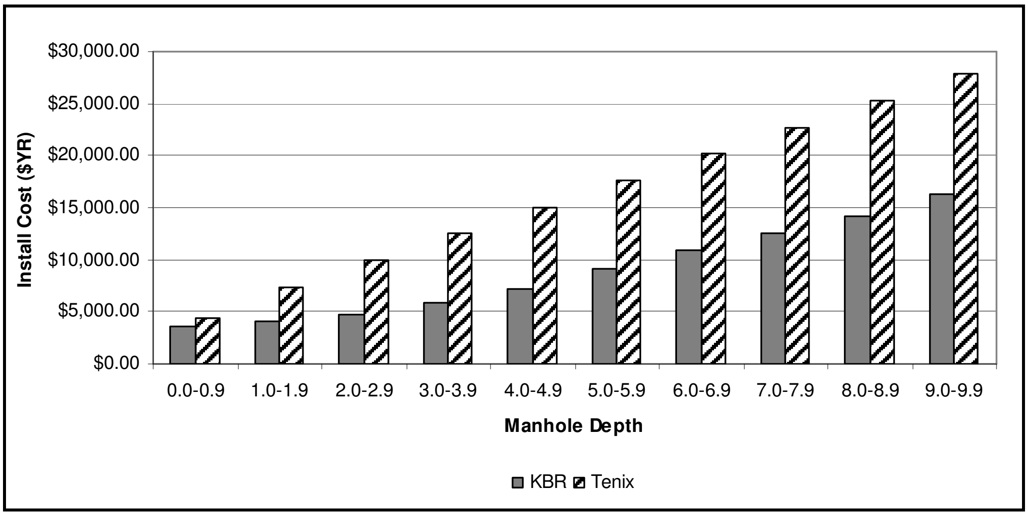

Figure 5-1 Unit Rates Against Depth (1,050mm Ø Manholes)

6 Derivation of First Principles Unit Rates

6.1 Methodology

A total of five independent civil construction contractors were approached and asked to provide prices for the cost of construction for the items included in this document. The costs/factors included in this report are averaged costs/factors from source data and reflect actual and estimated costs. Costs/factors are subject to the vagaries of procurement and various supply side influences and should therefore not be taken as absolute.

Data from major pipeline suppliers and civil construction contractors was utilised in the development of the unit rates provided in this report. **All data presented under the heading of "First Principles Unit Rates" represents June $2008 for ease of comparison with data provided by GCW.**

Figure 6-1 provides a schematic representation of the process that was adopted in the derivation of "First Principles Unit Rates".

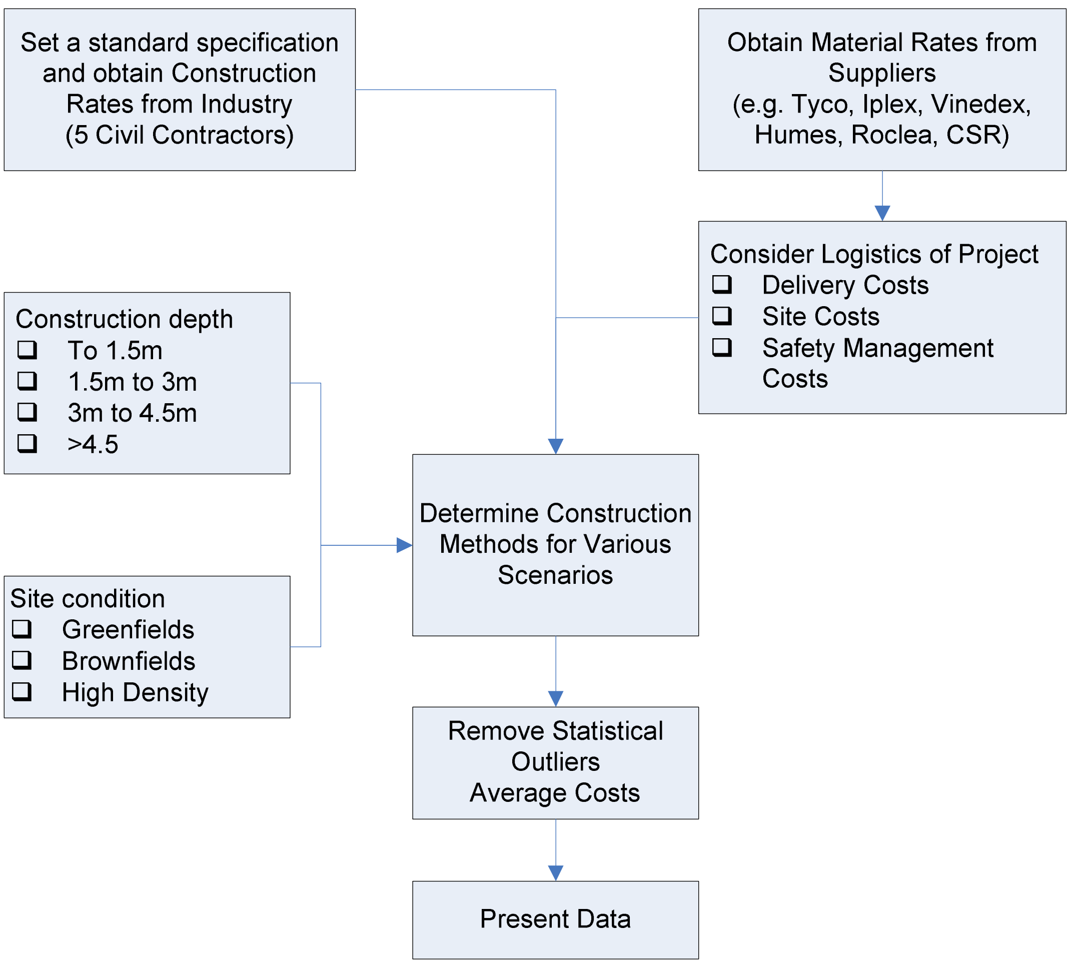

Figure 6-1 Process Map – Derivation of "First Principles Unit Rates"

6.1.1 Administration Costs

Administration costs are not incorporated within the unit rates estimates presented below.

These typically include items such as survey, planning, engineering design, construction supervision and contract administration. For cost planning purposes an allowance of 20% of construction costs would be appropriate, assuming a typical construct-to-design delivery model. This approach is consistent with that outlined in earlier consultancy reports (Tenix Alliance, 2005; KBR, 2004; and Cardno, 2006).

6.1.2 Risk Management – Contingency Allowance

A risk management or contingency allowance has not been incorporated within the unit rates estimates presented below.

Planning allowances should incorporate a degree of risk management through consideration of the level of available information and project definition. This is typically achieved through the adoption of contingency allowances. An approach such as that advocated by Tenix Alliance (2005) is considered reasonable for contingency estimates and is reproduced in **Table 6-1**.

Table 6-1 Risk Management – Contingency Allowance v Project Definition

Project Stage	Typical Level of Project Definition	Recommended Contingency
General/Preliminary Concept	▪ Size of infrastructure decided. ▪ Line drawn on a map but route not inspected. Some route of site risks.	40%
Concept Design	▪ Major elements identified. ▪ Routes generally confirmed by careful consideration of mapping and aerial photography, specific corridor constraints inspected. ▪ Specific sites known to be available.	30%
Preliminary Design	▪ Most elements of construction identified, quantities relatively well defined. ▪ Routes confirmed by field inspection and preliminary services searches. ▪ Sites inspected.	20%
Detail Survey & Design	▪ Elements of construction identified sufficient for tendering. ▪ Quantities clearly understood.	10%

6.1.3 Exclusions

The following potential cost categories have not been considered as part of this analysis as they are typically project specific and subject to a degree of variation that makes them unsuitable for inclusion in any derivation of unit rates. To the degree that such an approach is applied, the contingency allowances presented above would cover issues such as land acquisition and geotechnical issues.

Land Acquisition Land acquisition for reservoirs tends to be a difficult process with desirable reservoir sites often being desirable development sites. The costs and time frames for acquisition of land either by agreement with landowners or by compulsory acquisition have not been included in these estimates.

Geotechnical Issues Geotechnical conditions can significantly alter and add to overall design and construction costs. As the degree of variation in geotechnical costs is significant they have not been considered further here.

Early identification of potential geotechnical issues and detailed project scoping is recommended to minimise potential costs and time delays.

6.2 Pipelines

All pipeline asset unit rates are calculated to a base scenario which is a greenfield site at minimum depth (700 mm in trafficable area).

Pipeline material selection and standard manufacturer (supplier) pipeline diameter have a major influence on both construction cost and the supply of pipes. Standard pipeline diameters for pressure pipelines (water and sewer rising main) and gravity sewer main are presented in **Table 6-2**.

Following discussions with GCW officers (20 November 2008) unit rates for non-standard pipe sizes have been extrapolated from standard pipe rates for incorporation within this report. It is noted however that non-standard pipe diameters typically incur an additional 10% allowance reflecting costs incurred by manufacturers in terms of re-tooling and other set up costs.

A 10% allowance should therefore be added to the unit rates for non-standard pipe sizes presented in this section.

Construction prices were obtained from five civil contractors and averaged as a reasonable estimate of current market prices. These costs were then used to facilitate/verify the first principles example calculations, an example of which (showing daily construction rates) is presented in **Table 6-3**.

Table 6-2 Standard Pipe Diameters

Pipeline Ø (Ø < 960mm)	*Pressure Mains*	*Gravity Mains*	Pipeline Ø (Ø > 960mm)	*Pressure Mains*	*Gravity Mains*
32, 40, 50, 63, 90	×	×	960	✓	✓
100	✓	×	1000,1050	×	×
150	✓	✓	1085	✓	✓
200	✓	×	1200	×	×
225	✓	✓	1290	✓	✓
250	✓	×	1350	×	×
300	✓	✓	1500	✓	✓
375	✓	✓	1650	×	×
400	×	×	1800	✓	✓
450	✓	✓	1950,2100	×	×
500	✓	×	2159	✓	✓
525	×	✓			
600	✓	✓			
660,675,700	×	×			
750	✓	✓			
800,825,900	×	×			

Table 6-3 Water Mains Plant Rate – First Principles Example Calculation (Greenfield Scenario)

	Rate	Daily Cost					
Plant Rates	**$/hr**	**Use (hrs)**	**100-225 mm**	**Use (hrs)**	**375 mm**	**Use (hrs)**	**500 mm**
Backhoe	160	10	$1,600.00	10	$1,600.00		$1,600
Excavator	190	10	$1,900.00	20	$3,800.00	20	$3,800.00
Tip Truck	90	20	$1,800.00	20	$1,800.00	40	$3,600
Loader	160	10	$1,600.00	10	$1,600.00	10	$1,600
Tally Handler	160	10	$1,600.00	10	$1,600.00	10	$1,600
Front End Loader	160	-		-		10	$1,600
TOTALS			**$8,500.00**		**$10,400.00**		**$13,800.00**
Laying Rate		**m/day**	**300**	**m/day**	**250**	**m/day**	**200**
Unit Plant Rate		**$/m**	**28.33**	**$/m**	**41.60**	**$/m**	**69.00**

6.2.1 Key Assumptions

For each pipeline asset class (i.e. water mains, recycled water mains, rising sewer mains, gravity sewer mains) considered in the following analysis assumptions have been made that describe pipe material and class. A brief discussion of key assumptions and issues is presented below.

Fittings & Valves

Unit rates obtained from the market include air valves, stop valves and bends. For complex pipeline layouts the estimator should consider an additional sum for valves. ***These costs could reasonably be considered at 3% of the Greenfield construction costs.***

Diameter < 960 mm

Ductile iron cement lined (DICL) pipelines are available at the standard diameters indicated above. For the purposes of this assessment PN35, which is designed on the basis of an allowable operating pressure (AOP) of 3.5 MegaPascals (MPa), has been assumed. Another factor in this selection is the availability of PN35 across most of the "standard" pipeline diameters.

Supermain PVC-O pipes are manufactured in accordance with AS4441 (Int):2003 - Oriented PVC (PVC-O) pipes for pressure applications. These pipes are used widely across the water industry and are suited to most applications. For this assessment class 16 pipes were selected.

Diameter ≥ 960 mm

Pipeline projects with larger diameters (i.e. Ø≥960 mm) are assumed to utilise mild steel cement lined (MSCL) pipes for water mains and sewage rising mains, while PP SewerPro is the adopted material for sewage gravity mains.

Note also that cathodic protection is not included in the sewage main unit rates. ***An allowance of 3-5% for cathodic protection should be added to these pipelines.***

Project logistics introduce a significant multiplier for larger diameter pipeline works. For pipes toward the top end of the comparison range the transport of pipes is a significant cost component, where typically the size and weight of large diameter pipes allows for only one pipe per semi trailer.

6.2.2 Potable Water Mains

First principles unit rates are shown in **Table 6-4** and represent pipeline construction under the following conditions:

- greenfields environment;
- sandy/good soil conditions.

Table 6-4 Potable Water Mains – First Principles Unit Rates

Pipeline Ø (Ø < 960mm)	DICL ($/m)	PVC ($/m)	Pipeline Ø (Ø > 960mm)	MSCL ($/m)
100	$141	$104	960	$2,901
150	$233	$168	1000	$3,046
200	$306	$229	1050	$3,152
225	$362	$254	1085	$3,326
250	$418	$273	1200	$3,748
300	$461	$335	1290	$4,007
375	$654	$446	1350	$4,350
450	$777	$822	1500	$4,769
500	$946		1650	$5,316
600	$1,240		1800	$5,765
750	$1,759		1950	$6,324
			2159	$6,792

6.2.3 Recycled Water Mains

The construction of recycled water mains is largely governed by the same cost structure as potable water main construction. Cost differences arise as a result of additional risk management practices that are typically adopted such as signage and identification of recycled water mains. These additional costs during the as-constructed surveying make recycled water mains marginally more expensive than standard water mains.

For small diameter recycled water mains (typically Ø63 mm and Ø90 mm) dual trenching can be considered. This includes the excavation of a larger trench (800 mm) and laying water mains in parallel with the recycled water mains. Costs are presented in **Table 6-5**.

6.2.4 Sewage – Rising Mains

Best practice construction of rising mains includes the laying of mains to grade, which is designed to maximise network hydraulics and minimise pump operation requirements. As such rising mains are marginally more expensive to construct than water mains (where grades are less important). First principles unit rates estimates for rising mains are presented in **Table 6-6**.

Table 6-5 Recycled Water Mains – First Principles Unit Rates

Pipeline Ø (Ø < 960mm)	DICL ($/m)	PVC ($/m)	Pipeline Ø (Ø > 960mm)	MSCL ($/m)
63	$92		960	$2,936
90	$102		1000	$3,083
100	$142	$105	1050	$3,190
150	$235	$171	1085	$3,366
200	$310	$232	1200	$3,793
225	$366	$257	1290	$4,055
250	$423	$276	1350	$4,402
300	$467	$340	1500	$4,826
375	$662	$452	1650	$5,380
450	$787	$832	1800	$5,834
500	$958		1950	$6,400
600	$1,255		2159	$6,874
750	$1,780			

Table 6-6 Sewage Rising Mains – First Principles Unit Rates

Pipeline Ø (Ø < 960mm)	DICL ($/m)	PVC ($/m)	Pipeline Ø (Ø > 960mm)	MSCL ($/m)
100	$141	$121	960	$2,822
150	$245	$197	1000	$2,910
200	$334	$268	1050	$3,030
225	$402	$297	1085	$3,236
250	$473	$319	1200	$3,664
300	$520	$393	1290	$4,007
375	$731	$522	1350	$4,289
450	$868	$961	1500	$4,683
500	$1,053		1650	$5,180
600	$1,380		1800	$5,765
750	$1,958		1950	$6,260
			2159	$6,792

6.2.5 Sewage – Gravity Mains

Within the pipeline asset class, sewage mains have the greatest potential for cost variation. This is predominantly due to geotechnical issues arising from the need for construction at grade, at a depth typically greater than 1.5 m. Trenching and shoring safety management costs are also significant.

Adjustment factors for depth are shown in this table along with the adjusted unit rates. Further discussion of adjustment factors is provided in **Section 6.3**. Sewage pipe is supplied in specific manufacture sizes, with PP SewerPro available to 900 mm while pipes of diameter greater than 900 mm are vitreous clay. **Table 6-7** shows the derived rates for sewage mains.

Table 6-7 Sewage Gravity Mains at Various Depths – First Principles Unit Rates

Diameter (mm)		At Depth[1]	Unit Rates v Depth ($/m)					
			1.5m<d<3m		3m<d<4.5m		d>4.5m	
			AF	Rate	AF	Rate	AF	Rate
PVC	150	$225	1.19	*$268*	1.34	*$302*	1.47	*$331*
	225	$286	1.19	*$340*	1.34	*$383*	1.47	*$420*
	250	$303	1.19	*$361*	1.34	*$406*	1.47	*$445*
	300	$380	1.25	*$475*	1.40	*$532*	1.54	*$585*
	375	$528	1.25	*$660*	1.40	*$739*	1.54	*$813*
	450	$930	1.26	*$1,172*	1.41	*$1,311*	1.56	*$1,451*
	525	$1,133	1.26	*$1,428*	1.41	*$1,598*	1.56	*$1,767*
	600	$1,350	1.26	*$1,701*	1.41	*$1,904*	1.56	*$2,106*
	750	$1,787	1.35	*$2,412*	1.41	*$2,520*	1.67	*$2,984*
	900	$2,061	1.35	*$2,782*	1.45	*$2,988*	1.67	*$3,442*
Vitreous Clay	960	$2,613			1.45	*$3,789*	1.67	*$4,364*
	1000	$2,710			1.45	*$3,930*	1.67	*$4,526*
	1050	$2,830			1.45	*$4,104*	1.67	*$4,726*
	1085	$2,996			1.57	*$4,704*	1.80	*$5,394*
	1200	$3,370			1.57	*$5,291*	1.80	*$6,066*
	1290	$3,610			1.57	*$5,668*	1.80	*$6,498*
	1350	$4,020			1.83	*$7,357*	2.10	*$8,442*
	1500	$4,296			1.83	*$7,862*	2.10	*$9,022*
	1650	$4,760			1.83	*$8,711*	2.10	*$9,996*
	1800	$5,194			2.00	*$10,388*	2.30	*$11,946*
	1950	$5,670			2.00	*$11,340*	2.30	*$13,041*
	2159	$6,119			2.00	*$12,239*	2.30	*$14,075*

Note 1: "At depth" taken to be <1.5m and 1.5 m<d<3.0 m for pipe diameters <960 mm and >960 mm respectively. AF = Adjustment Factor

6.2.6 Reduced Inflow Gravity Sewers

Reduced Inflow Gravity Sewers (RIGS) are a modification of traditional sewer systems where manholes are replaced with PVC maintenance shafts and inspection openings and fittings are plastic sealed as opposed to concrete.

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Bends are also included in these systems reducing the requirement for manholes. As a consequence of reduced infiltration from these systems (i.e. less infiltration through plastic as opposed to concrete) pipe diameters can be reduced. The cost savings of RIGS maintenance shaft construction against traditional manhole construction can be significant, though in a total scheme has only a minor impact on construction costs. Cost savings are primarily then delivered through reduced pipe diameters across the network. The magnitude of any reduction is dependent upon the number of connections and local assumptions about infiltration.

Manhole construction cost differences are presented in **Section 6.4**. The actual savings associated with a total system are difficult to calculate as the majority of the benefits derived from the use of such systems centres around the ability to use a reduced pipe diameter. Pipeline costs are highlighted under **Section 6.2.4** and **Section 6.2.5**. The pipe diameter associated with the RIGS system is needed to estimate total system costs.

6.2.7 Vacuum Sewage Systems

Limited construction information and the high contingencies assigned to vacuum sewage projects (i.e. in the order of 40%) making unit rate pricing problematic. While the most appropriate approach to vacuum sewage main planning would be to calculate the construction costs on a scheme by scheme basis (i.e. complete design and costs for future schemes in advance and then incorporate in the infrastructure charges), it is recognised that GCW is seeking an allowance for planning purposes.

Table 6-8 contains indicative project costs for vacuum sewage systems of different capacities (i.e. based upon different numbers of equivalent persons). *Note that these figures incorporate a 40% contingency allowance and are intended for use in options analysis only.*

Table 6-8 Vacuum Sewage Systems

	COSTS ($'000's)					
EP	Pipelines	Pump Stations	Property Connections	Sub-Total	Contingency (40%)	TOTAL
500	$3,000	$700	$1,400.00	*$5,100*	$2,040	**$7,140**
1000	$5,600	$800	$2,500.00	*$8,900*	$3,560	**$12,460**
1500	$8,025	$900	$3,600.00	*$12,525*	$5,010	**$17,535**
2000	$9,600	$1,400	$4,600.00	*$15,600*	$6,240	**$21,840**
2500	$11,000	$1,500	$5,000.00	*$17,500*	$7,000	**$24,500**
3000	$12,600	$1,665	$5,700.00	*$19,965*	$7,986	**$27,951**
3500	$14,350	$1,837	$6,300.00	*$22,488*	$8,995	**$31,483**
4000	$16,000	$2,000	$6,800.00	*$24,800*	$9,920	**$34,720**
4500	$16,875	$2,093	$7,200.00	*$26,168*	$10,467	**$36,635**
5000	$18,000	$2,250	$7,500.00	*$27,750*	$11,100	**$38,850**

Source: Flovac Australia pers comm.. There is significant contingency (40%) built into these prices to reflect the highly variable nature of such projects.

6.3 Pipelines – Adjustment Factors/Additions

Factors that influence construction costs include:

- Material of Pipe;
- Diameter of Pipe (Magnified as "Non Standard" pipe sizes incur an additional 10% supply cost;
- Project Logistics (Weight of Load), i.e. one large Ø pipe per semi;
- Distance for Delivery;
- Site Condition;
- Depth of Construction;
- Variations in construction technique (magnified in larger diameter pipes);
- Dual trench construction techniques (e.g. small diameter recycled water mains and water mains in the same trench) – costs assumed to be 85% of the cost of two single trenches.

The two most significant factors influencing the total construction rates for pipelines are:

1. Site Condition – Green Fields, Brown Fields and High Density.
2. Depth of Construction (mostly impacts gravity sewer mains and large diameter pipelines).

Construction rates are also influenced by the depth of construction, which affects trenching and shoring requirements (i.e. greater focus on safety) and the volume of material to be excavated. The following sections highlight the influence of these factors on construction rates and costs.

These rates were obtained from a panel of civil contractors and averaged and then reviewed by experienced construction managers within Hyder for verification purposes.

Examples showing the application of adjustment factors to base unit rates are presented in **Appendix C.**

6.3.1 Marginal Laying Rates for Differing Site Conditions

There are a number of factors that affect the cost of completion of works in "Greenfields", "Brownfields" and "High density" environments. These include Traffic Management, Plant Access and Operation, Site Safety and Reinstatement Costs.

These factors are also variable depending on the nature of work, the geotechnical conditions of the site and the size of the excavation. This in turn is proportional to depth and pipe diameter. Following discussions with a number of contractors a cost per metre addition was adopted as the most appropriate method of considering these costs rather than a multiplier. These metre estimates were derived from industry research (five suppliers) and are provided in **Table 6-9**.

Hyder has not created a distinction between high density urban and CBD. The value in providing further breakdown is argued to be minimal as all adjustment factors represent estimates/aggregates covering a wide range of variables. In the absence of sufficient volumes of clear historical data for analysis aggregation of factors such as site conditions is preferable as it has the effect of smoothing variations.

Costs were allocated to various site parameters (as above these were averaged from contractor rates) and these were then calculated against the various pipe diameters. These daily average costs were calculated to metre rates.

6.3.2 Reinstatement Works

A significant factor influencing construction rates is the cost of reinstatement in brownfields and high density environments. Reinstatement rates varied substantially between contractors and a detailed assessment of these rates was conducted. The rates that were statistical outliers were removed from the data set. **Table 6-9** highlights these reinstatement costs and shows the total impact on cost of construction of all of the above influences. Construction cost factors include site safety (SS), traffic management (TM) and plant operation (PO).

6.3.3 Impacts of Depth on Construction Costs

The impacts of depth on construction vary according to factors such as geotechnical characteristics, site logistics and construction technique. The factors shown below represent the average cost multiplier (**Table 6-10**) (as supplied by major civil contractors). This data has been assessed and interpreted by Hyder to reflect the impacts of construction technique.

6.3.4 Pipe Jacking & Directional Drilling

Rates for pipe jacking and directional drilling are included in **Table 6-11** and **Table 6-12** below. Note that these rates are intended for use in high level options analysis only and do not represent competitive market rates. Directional drilling rates are based on soft rock and include butt-welded fittings, while pipe jacking rates are based on soft rock with steel pipes. Neither set of rates includes a contingency allowance.

Note that the rates presented in **Table 6-11** and **Table 6-12** assume soft rock. Soil condition multipliers are presented in **Section 6.3.6** for directional drilling. Pipe jacking rates are not materially affected by soil type as the existing pipe void is utilised as the pilot hole.

Note also that the entry/exit pit depth is highly variable and dependent upon site factors such as soil and topography. For this exercise a depth of 4 m has been assumed, with shoring/benching in accordance with trench safety requirements.

Table 6-9 Adjustment Rates for Various Construction Factors

Ø	Construction Cost Factors ($/day)				Greenfields		Brownfields				City (High Density)			
Ø	SS	TM	PO	TOTAL	Laying Rate	Unit Rates	Laying Rate	Marginal Cost Reinst.	Marginal Cost Const	Adj. Factor	Laying Rate	Marginal Cost Reinst.	Marginal Cost Const	Adj. Factor
(mm)	$/day				(m/day)	($/m)	(m/day)	($/m)			(m/day)	($/m)		
100	$1,500	$2,500	$1,000	$5,000	300	$141	180	$150	$28	2.26	120	$300	$42	3.43
150	$1,500	$2,500	$1,000	$5,000	300	$233	180	$150	$28	1.76	120	$300	$42	2.47
200	$1,500	$2,500	$1,000	$5,000	300	$306	180	$200	$28	1.74	120	$400	$42	2.44
225	$1,500	$2,500	$1,000	$5,000	300	$362	180	$200	$28	1.63	120	$400	$42	2.22
250	$1,700	$2,500	$1,000	$5,200	250	$418	150	$230	$35	1.63	100	$575	$52	2.50
300	$1,700	$2,500	$2,000	$6,200	250	$461	150	$230	$41	1.59	100	$575	$62	2.38
375	$1,700	$2,500	$2,000	$6,200	250	$654	150	$230	$41	1.41	100	$575	$62	1.97
450	$2,000	$2,500	$2,000	$6,500	200	$777	120	$230	$54	1.37	80	$575	$81	1.84
500	$2,000	$2,500	$2,000	$6,500	200	$946	120	$300	$54	1.37	80	$600	$81	1.72
600	$2,000	$2,500	$2,000	$6,500	200	$1,240	120	$300	$54	1.29	80	$600	$81	1.55
750	$2,200	$12,000	$3,000	$17,200	175	$1,759	105	$559	$164	1.41	70	$860	$246	1.63
960	$2,200	$12,000	$3,000	$17,200	175	$2,901	105	$559	$164	1.25	70	$860	$246	1.38
1000	$2,200	$12,000	$3,000	$17,200	175	$3,046	105	$585	$164	1.25	70	$900	$246	1.38
1050	$2,500	$12,000	$3,000	$17,500	175	$3,152	105	$585	$167	1.24	70	$900	$250	1.36
1085	$2,500	$12,000	$3,000	$17,500	175	$3,326	105	$650	$167	1.25	70	$1,000	$250	1.38
1200	$2,500	$12,000	$3,000	$17,500	175	$3,748	105	$650	$167	1.22	70	$1,000	$250	1.33
1290	$2,700	$12,000	$5,000	$19,700	150	$4,007	90	$825	$219	1.26	60	$1,100	$328	1.36
1350	$2,700	$12,000	$5,000	$19,700	150	$4,350	90	$825	$219	1.24	60	$1,100	$328	1.33
1500	$2,700	$12,000	$5,000	$19,700	150	$4,769	90	$825	$219	1.22	60	$1,100	$328	1.30
1650	$2,700	$12,000	$5,000	$19,700	150	$5,316	90	$825	$219	1.20	60	$1,100	$328	1.27
1800	$2,700	$15,000	$5,000	$22,700	150	$5,765	90	$900	$252	1.20	60	$1,200	$378	1.27
1950	$2,700	$15,000	$5,000	$22,700	150	$6,324	90	$900	$252	1.18	60	$1,200	$378	1.25
2159	$2,700	$15,000	$5,000	$22,700	150	$6,792	90	$900	$252	1.17	60	$1,200	$378	1.23

Table 6-10 Construction Factors (Multiplier) at Various Depths

Diameter (mm)	Multipliers vs Depth		
	1.5m<d<3m	3m<d<4.5m	d>4.5m
100; 150; 200; 225; 250	1.19	1.34	1.47
300; 375; 400	1.25	1.40	1.54
450; 500; 525; 600	1.26	1.41	1.56
750	1.35	1.41	1.67
900	1.35	1.45	1.67
960;1000;1050		1.45	1.67
1085; 1200; 1290		1.57	1.80
1350; 1500; 1650		1.83	2.10
1800; 1950; 2159		2.00	2.30

Table 6-11 Pipe Jacking – Indicative Unit Rates for Various Bore Diameters

Pipe Ø (mm)	Pipe Jacking ($/m)			Internal Pipe ($/m)
	Steel Enveloper	Drilling	TOTAL COST	TOTAL COST
150				$167
200				$243
300	$210	$750	$960	$397
350	$300	$775	$1,075	
375				$583
450				$714
500	$460	$800	$1,260	
600				$1,114
610	$590	$900	$1,490	
700	$870	$950	$1,820	
750				$1,.345
800	$1,200	$1,000	$2,200	
900				$1,701
1000	$1,500	$1,200	$2,700	
1050				$2,242
1500	$1,900	$1,500	$3,400	
Drill Pits/Excavations (x2)				$15,000

Source: Australasian Society of Trenchless technology pers comm. Material costs were provided by Vinidex for PE pressure pipe rated equivalent to PN16 (160m water pressure).

Rates include mob/demob of plant & equipment.

Table 6-12 **Directional Drilling – Indicative Unit Rates for Various Bore Diameters**

Bore Ø	Pipe Material	Fittings Allowance[1]		Total Materials	Drilling	TOTAL
(mm)	$/m	%	$/m	Subtotal	$/m	$/m
180	$77	15%	$11	$88	$675	$763
355	$174	15%	$26	$200	$750	$950
400	$295	10%	$29	$324	$775	$1,099
475	$358	9%	$32	$390	$800	$1,190
560	$462	9%	$42	$503	$900	$1,403
710	$858	6%	$51	$910	$950	$1,860
900	$1,459	5%	$73	$1,532	$1,000	$2,532
Drill Pits/Excavations (x2)						$10,000

Source: Australasian Society of Trenchless technology pers comm. Material costs were provided by Vinidex for PE pressure pipe rated equivalent to PN16 (160m water pressure).

Note 1 Fittings allowances as a percentage of pipe material were derived from communications with various contractors and past experience.

Rates include mob/demob of plant & equipment.

6.3.5 Pressure Reducing Valves

Table 6-13 presents first principles unit rates for pressure reducing valves assuming a typical depth of 2 m. Both contractor average and bottom-up first principles prices are presented and show a reasonable degree of correlation. Depth and soil multipliers should be applied to these rates.

Table 6-13 **Pressure Reducing Valves**

Diameter (mm)	Contractor Price Average	First Principles Estimates						
		F/meter	PRV	Pipes	Pits	Data Loggers	Plant/ Labour	TOTAL
100	$46,951	$2,200	$1,200	$4,875	$6,080	$7,800	$24,980	$47,135
150	$51,339	$2,230	$1,966	$6,070	$6,740	$7,800	$26,770	$51,576
200	$56,802	$2,700	$2,810	$8,450	$8,105	$7,800	$28,450	$58,315
250	$65,269	$3,050	$3,650	$10,020	$9,440	$7,800	$33,170	$67,130
300	$73,658	$3,150	$4,020	$13,790	$11,210	$7,800	$36,240	$75,210
375	$81,659	$3,360	$4,390	$14,470	$14,320	$7,800	$39,010	$83,350

The Contractor Price Average rates are recommended for adoption by GCW.

6.3.6 Soil Type

Table 6-14 presents adjustment factors to be applied for varying soil types, including areas containing acid sulphate soils. These adjustment factors are based upon discussions with pipe construction contractors and the extensive construction experience of key Hyder personnel.

Table 6-14 Adjustment Factors – Soil Type

Depth (m)	Soil Type	Pipe Ø (mm)				
		<150	150-300	300-600	600-900	900-2159
<1.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.1	1.2	1.3	1.8	2
	ASS areas	1.1	1.2	1.3	1.8	2
	Soft Rock	1.35	1.5	1.6	1.9	2.2
	Hard Rock	2	2.1	2.2	2.3	2.35
1.5m-3m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.2	1.3	1.4	1.5	1.6
	ASS areas	1.2	1.3	1.4	1.5	1.6
	Soft Rock	1.4	1.5	1.6	1.7	1.8
	Hard Rock	2.1	2.2	2.3	2.4	2.5
3.0m 4.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.2	1.3	1.4	1.5	1.6
	ASS areas	1.3	1.4	1.5	1.6	1.7
	Soft Rock	1.8	1.9	2	2.1	2.2
	Hard Rock	2.2	2.3	2.4	2.5	2.6
4.5m-6m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.5	1.6	1.7	1.8	1.9
	ASS areas	1.8	1.9	2	2.1	2.2
	Soft Rock	2	2.1	2.2	2.3	2.4
	Hard Rock	2.5	2.6	2.7	2.8	2.9
6.0m-7.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.6	1.7	1.8	1.9	2
	ASS areas	2	2.1	2.3	2.5	2.7
	Soft Rock	2.8	3	3.2	3.4	3.5
	Hard Rock	3	3.2	3.5	3.8	3.9
>7.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	2	2.1	2.3	2.5	2.7
	ASS areas	2	2.1	2.3	2.5	2.7
	Soft Rock	2.8	3	3.2	3.4	3.5
	Hard Rock	3	3.2	3.5	3.8	4
Directional Drilling	*Soft Rock*	1	1	1	1	1
	Poor Soil	1.7	1.6	1.6	1.6	1.5
	Hard Rock	1.7	1.6	1.6	1.6	1.5

Sand/Good Soil	good working conditions with high excavation rates
Poor Soil	areas with high water content where pumping of trenches will be required

	N.B. for directional drilling this includes sands and/or soils with the potential to collapse after drilling making pipe setting difficult
ASS Areas	areas containing potentially acid sulphate soils, requiring additional handling/management works
Soft/Hard Rock	areas where rock will impact on excavation rates

6.4 Manholes

Table 6-15 below has been compiled following the analysis of various construction rates as provided by civil contractors and suppliers. Manhole cost increments are presented against depth on **Figure 6-2**, highlighting the marginal difference between 1050 mm and 1200 mm diameter manholes.

The construction of these two manholes varies only in terms of the cost of material. The F-type rectangular manhole is shown to be less expensive at shallow depths (i.e. <3 m) becoming increasing cost prohibitive at greater depths (i.e. >3 m). This is attributed to the increase in concrete quantities required (i.e. greater wall thickness) compared to the circular alternatives.

Table 6-15 Manhole Installation – First Principles Unit Rates

Depth (m)	Manhole Diameter (mm)						
	1050	1200	1500	1800	2100[a]	Type F (900x900)	RIGS
0.0-0.9	$2,937	$3,160	$3,325	$3,725	$4,097	$2,208	$3,420
1.0-1.9	$4,791	$5,103	$5,235	$5,692	$6,261	$3,076	$3,420
2.0-2.9	$7,055	$7,499	$7,566	$8,093	$8,903	$4,091	$3,560
3.0-3.9	$9,805	$10,431	$10,399	$11,011	$12,112	$9,834	
4.0-4.9	$12,550	$13,349	$13,226	$13,923	$15,315	$15,999	
5.0-5.9	$17,205	$18,302	$18,021	$18,862	$20,748	$21,280	
6.0-6.9	$20,626	$21,961	$21,545	$22,491	$24,740	$29,752	
7.0-7.9	$25,127	$26,792	$26,180	$27,266	$29,992	$37,824	
8.0-8.9	$31,085	$33,127	$32,317	$33,587	$36,946	$48,199	
9.0-9.9	$35,597	$37,937	$36,965	$38,374	$42,211	$60,088	

Note a Price for 2100mm manholes estimated as 1800mm price plus 10% as size considered non-standard by contractors.

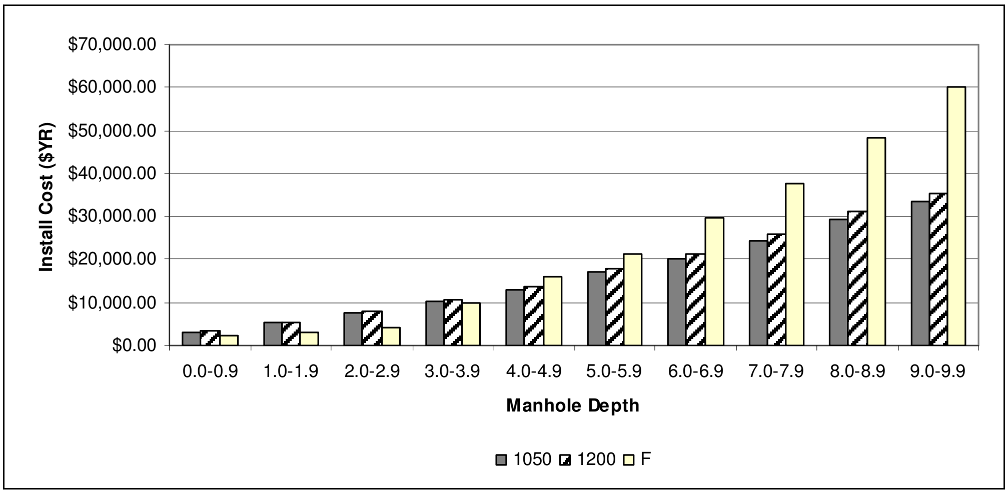

Figure 6-2 First Principles Unit Rates – Manholes

6.5 Pump Stations

6.5.1 Pump Station Specific Assumptions

Pump station (water and sewage) construction prices were obtained from five civil contractors and averaged as a reasonable estimate of current market prices. These costs were then used to facilitate/verify the first principles example calculations which are presented in **Appendix B**.

Additional assumptions adopted in the development of the unit rates presented in **Appendix B** include:

Wet Well/Dry well Larger pump stations are typically constructed with a wet well and a dry well with a building to house switchboards and heavy lifting gantries.

For the purposes of this analysis sewage pump stations with a wet well capacity of greater than 100 kL are assumed to include a wet and dry well. Allowances for these have therefore been included in the construction costs.

Generator & Emergency Power No provision has been made for the supply of automated generators.

6.5.2 Example First Principles Calculations – Pump Stations

As outlined above example first principle calculations for sewage and water pump stations are presented in **Appendix B**. **Figure 6-3**, **Figure 6-4** and **Figure 6-5** are produced below to show graphically the component construction costs, from first principles, for sewage and water pump stations respectively. The civil component costs of sewage pump stations are not necessarily dependent upon pump size and are therefore presented separately against storage volume. All other components are presented against pump size (power).

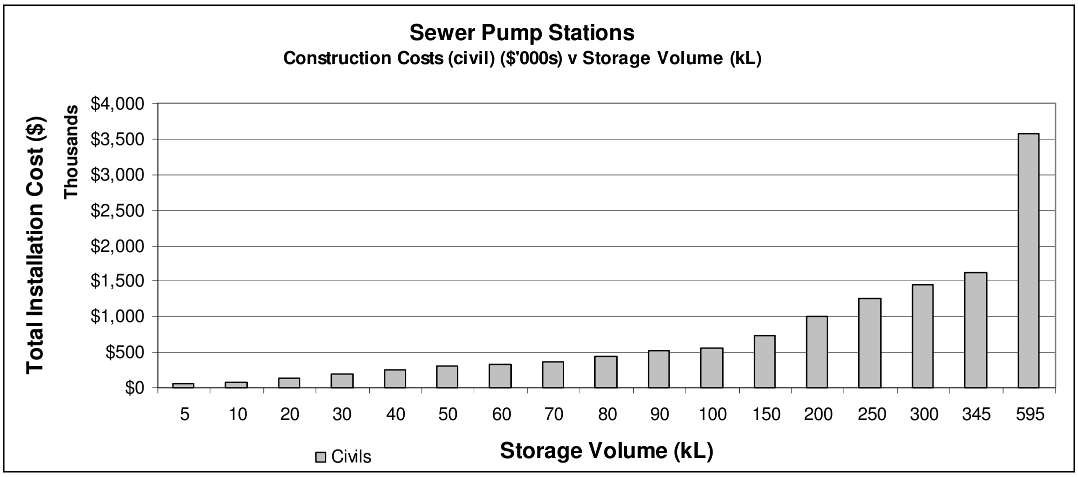

Figure 6-3 Sewage Pump Stations – Civil Component Construction Costs

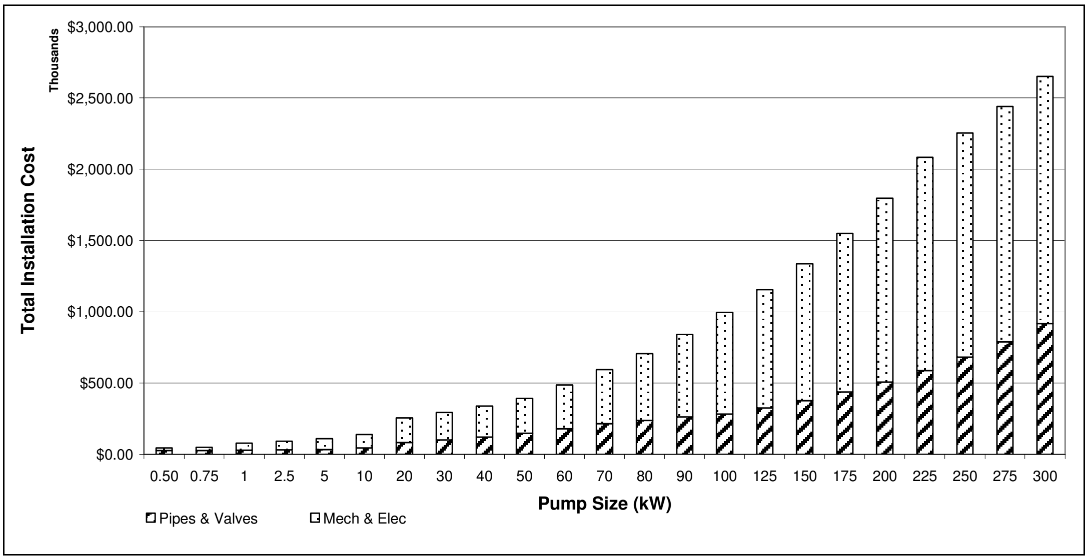

Figure 6-4 Sewage Pump Stations – Non-Civil Component Construction Costs

Water pump stations do not require storage and costs are typically related to pump rather than well size.

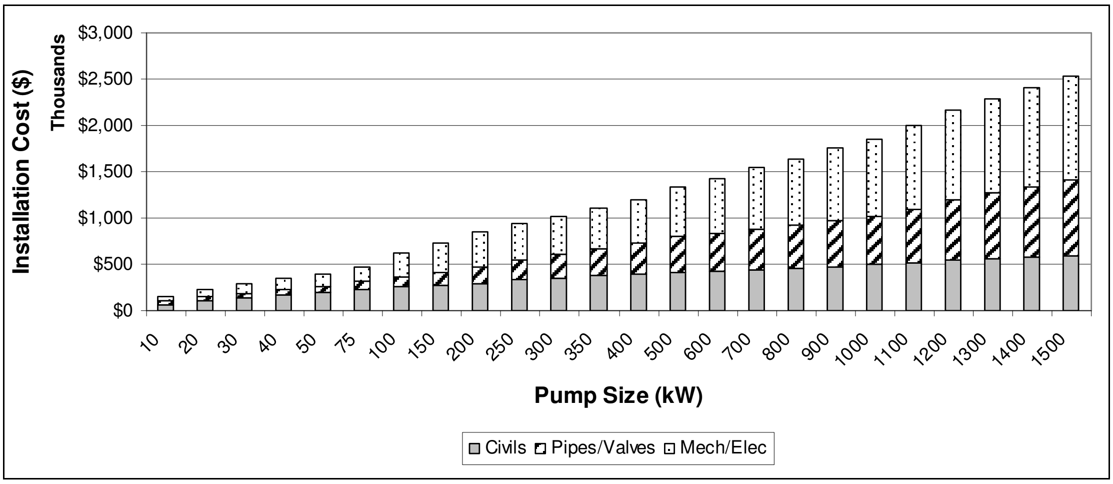

Figure 6-5 Component Construction Costs – Water Pump Stations

6.5.3 First Principles Unit Rates – Pump Stations

First principles unit rates for sewage and water pump stations are reproduced in **Table 6-16** and **Table 6-17** respectively. Total costs are broken into civil, pipework and equipment, mechanical, and electrical (including telemetry) components.

6.6 Reservoirs

Reservoir construction tends to be carried out by specialist contractors. Prices were sourced from experienced general civil contractors who typically construct storage assets through sub-contractor arrangements. It is apparent from these discussions that there is limited competition in this area, with sub-contractors effectively operating as monopoly or duopoly suppliers. An average cost method was adopted to produce the unit rates presented in **Table 6-18** and **Table 6-19**.

Table 6-16 Sewage Pump Stations – Component Cost Estimates – First Principles

Sewage Pump Stations – Component Cost Estimates($2008)				
Volume (kL)	Civils	Power (kW)	Pipes/Valves	Mech/Elec
5	$51,962	0.5	$25,474	$18,101
10	$79,228	0.75	$26,405	$21,554
15	$108,531	1	$27,336	$49,341
20	$130,840	2.5	$30,069	$61,677
25	$166,840	5	$33,076	$77,096
30	$193,245	10	$42,200	$96,370
40	$249,417	20	$82,800	$172,400
50	$304,004	30	$100,188	$193,709
60	$335,164	40	$121,227	$217,651
70	$369,519	50	$146,685	$244,553
80	$439,887	60	$177,489	$307,397

Sewage Pump Stations – Component Cost Estimates($2008)				
Volume (kL)	Civils	Power (kW)	Pipes/Valves	Mech/Elec
90	$529,510	70	$214,762	$379,502
100	$551,343	80	$236,775	$468,521
110	$574,077	90	$261,044	$578,421
120	$597,748	100	$280,600	$714,100
130	$622,394	110	$297,689	$757,589
140	$698,606	120	$315,818	$803,726
150	$741,151	130	$335,051	$852,673
160	$786,287	140	$355,456	$904,601
170	$834,172	150	$377,103	$959,691
180	$884,973	160	$400,069	$1,018,136
190	$938,868	170	$424,433	$1,080,140
200	$996,045	180	$450,281	$1,145,921
210	$1,058,059	190	$477,703	$1,215,707
220	$1,103,012	200	$506,795	$1,289,744
230	$1,147,066	210	$537,659	$1,368,289
240	$1,191,539	220	$570,402	$1,451,618
250	$1,249,321	230	$605,140	$1,510,118
260	$1,298,821	240	$641,993	$1,540,472
270	$1,338,658	250	$681,090	$1,571,435
280	$1,378,548	260	$722,568	$1,603,021
290	$1,418,496	270	$766,573	$1,635,242
300	$1,458,510	280	$813,257	$1,668,110
310	$1,498,596	290	$862,784	$1,701,639
320	$1,538,759	300	$915,328	$1,735,842
345	$1,623,679			
595	$3,572,095			

Note 1 Volume includes allowance for emergency storage

Table 6-17 Water Pump Stations – Component Cost Estimates – First Principles

Water Pump Stations – Component Cost Estimates ($2008)			
Pump Motor (kW)	**Civil**	**P&E**	**Mech/Elec**
10	$64,261	$35,701	$45,094
20	$105,440	$41,700	$75,600
30	$143,190	$45,965	$97,359
40	$173,772	$51,668	$116,021
50	$201,745	$60,725	$135,034
75	$232,979	$78,337	$163,619
100	$260,900	$96,936	$260,900
150	$276,000	$133,230	$322,050
200	$291,100	$171,030	$383,200

Water Pump Stations – Component Cost Estimates ($2008)			
Pump Motor (kW)	**Civil**	**P&E**	**Mech/Elec**
250	$329,054	$212,810	$392,721
300	$350,669	$257,115	$402,242
350	$372,626	$287,558	$440,391
400	$390,690	$332,971	$474,043
450	$400,567	$357,922	$516,704
500	$412,609	$383,732	$542,847
600	$421,579	$409,974	$592,458
700	$438,831	$436,396	$662,702
800	$457,617	$463,002	$722,917
900	$477,047	$489,801	$784,064
1000	$494,196	$516,800	$835,997
1050	$507,315	$541,580	$872,931
1100	$519,634	$566,576	$906,502
1150	$534,405	$591,798	$941,839
1200	$545,557	$648,008	$966,260
1250	$557,262	$674,959	$990,919
1300	$565,667	$702,163	$1,019,925
1350	$575,802	$729,631	$1,045,286
1400	$578,423	$757,373	$1,071,001
1450	$587,779	$785,400	$1,097,110
1500	$594,676	$813,724	$1,123,656

Table 6-18 Ground Level Reservoirs – First Principles Unit Rates

Volume (ML)	*Small Capacity* (Vol<8.0 ML)	Volume (ML)	*Large Capacity* (Vol≥8.0 ML))
0.3	$224,280	8	$3,196,585
0.35	$228,664	10	$3,541,512
0.4	$262,747	15	$4,505,410
0.45	$318,970	18	$5,332,897
0.5	$361,101	20	$5,520,326
1	$472,405	30	$6,826,569
2	$759,071	35	$7,746,964
2.5	$957,687	40	$8,353,750
3	$1,519,805	50	$9,587,682
4	$1,876,367	55	$10,623,784
5	$2,274,272	60	$11,306,909

Table 6-19 Elevated Reservoirs – First Principles Unit Rates

Volume (ML)	**Steel** *(Vol≤0.1 ML))*	**Volume** (ML)	**Concrete** *(Vol≥0.1 ML))*
0.01	$139,751	0.1	$317,882
0.02	$170,074	0.15	$409,256
0.03	$183,119	0.2	$426,219
0.04	$254,949	0.25	$626,260
0.05	$265,039	0.3	$712,435
0.06	$280,998	0.35	$1,062,785
0.07	$296,708	0.4	$1,219,901
0.08	$313,514	0.45	$1,776,787
0.09	$329,787	0.5	$2,010,620
0.1	$346,545		

The relatively infrequent nature of elevated reservoir construction and a corresponding reduction in confidence in available data suggests that elevated reservoirs should be subject to a separate costing on the basis of a preliminary design. This recommendation is endorsed by this report.

6.7 Treatment Plants

As a result of the scale and customised nature of treatment plants "first principles unit rates" are not considered suitable as a means for estimation of treatment plant costs. Modification to existing plants and development of new treatment capacity should be evaluated on the basis of a preliminary design.

It is recommended that planning budgets for treatment plants be based upon project specific design and cost forecasts taking into account the contingency allowances to manage design risk outlined in **Section 6.1.2**.

7 Comparative Analysis of Unit Rates

The following section provides a comparative analysis of the data considered in **Section 5** and the First Principles Unit Rates presented in **Section 6**. As a result of the typically non-standard nature of non-pipeline assets and the corresponding lack of detailed cost data (refer **Section 5**) this section focuses on pipeline asset data only. The unit rates presented in the following section represent the same time period (i.e. June $2008) and exclude on-costs. General assumptions, such as inclusion of valves, are considered to be sufficiently similar for use in this comparative analysis.

7.1 Pipelines – Water & Sewage

Figure 7-1 and **Figure 7-2** show a comparison of the First Principles Unit Rates developed in **Section 6** against the unit rates presented in previous consulting reports. These figures suggest that unit rates for smaller diameter pipes (i.e. Ø <960 mm) have been above the market rate, while for larger diameter pipes (i.e. Ø ≥960 mm) costs are well below the market rate and do not take into account additional costs associated with non-standard pipe diameters.

Market pricing was obtained by cost averaging construction prices for various asset classes, pipe types and pipe diameters from five civil contractors. In addition to the first principles unit rates (calculated according to the process outlined on **Figure 6-1**) a set of derived first principles unit rates has also been compiled (based on June 2008 plant hire and materials rates). These were developed from various plant and equipment costs that are utilised in the construction of an asset. This bottom-up assessment has been prepared for comparison purposes and tends to underestimate unit rates for assets (typically by 20-40% for pipeline diameters less than 600 mm) when compared to the market based approach outlined above.

A summary of costs is presented in **Table 7-1** for selected pipeline diameters (focussing on diameters 750 mm or less). This assessment was completed for water mains and similar patterns are observable for other asset classes.

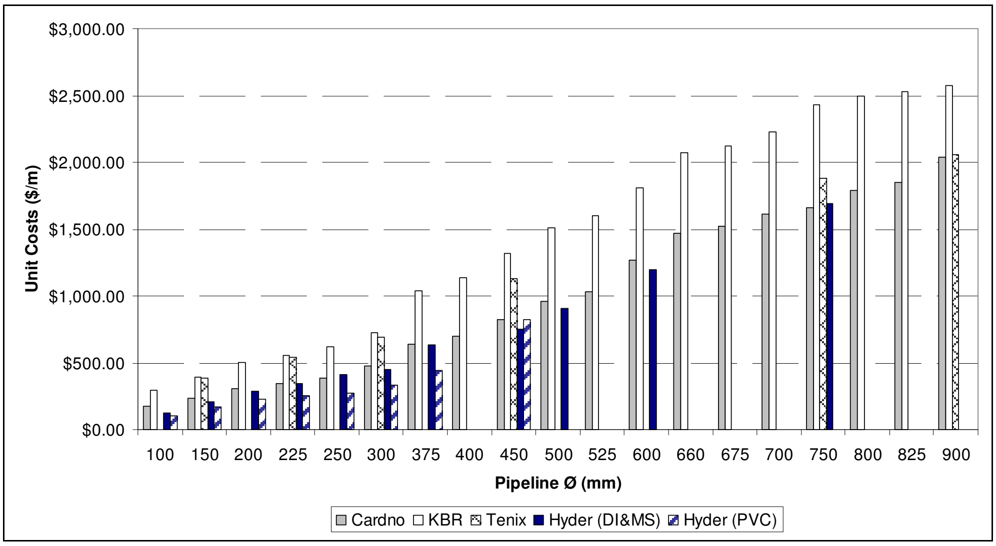

Figure 7-1 Water Pipelines (Ø<960 mm)

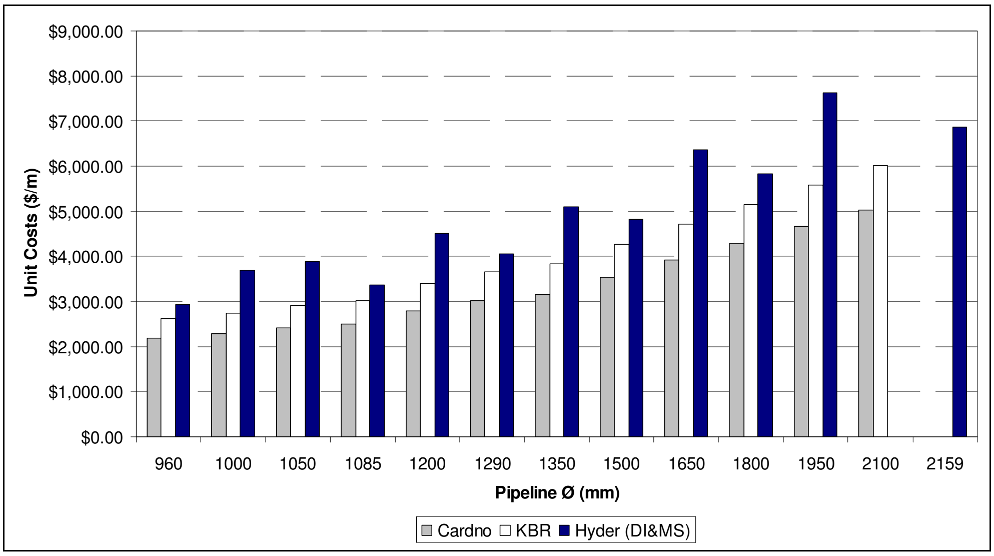

Figure 7-2 Water Pipelines (Ø≥960 mm)

Table 7-1 Comparison of First Principles Unit Rates Calculation Methods (Selected Pipes)

Pipe Ø (DICL only)	First Principles Unit Rates		Differential ($)
	(Market Avg)	(Derived Costs – Bottom Up)	
100	$141	$163	-$22
150	$233	$246	-$13
200	$306	$290	$16
225	$362	$318	$43
250	$418	$365	$53
300	$461	$423	$39
375	$654	$586	$68
450	$777	$705	$72
500	$946	$884	$62
600	$1,240	$1,088	$152
750	$1,759	$1,541	$219

Whilst initially the difference between the two unit rates presents a dilemma in that it increases significantly with pipe diameter it is important in that it represents the management of risks within a fixed price contract. For example the risks of reducing construction rates as a consequence of wet ground, rock or site stability are factored into market rate pricing. The allocation of risk is a reasonable contingency for civil contractors and in this case equates to between 20 and 40% of the cost on a per metre basis. Pipeline construction risks are proportional to depth and pipe diameter as the material to be excavated is also proportional.

This gap also poses some questions about procurement in that on a construction project where influences on construction rates such as rock are minimal then long term hourly rate contracts offer a significant opportunity for saving.

7.2 Pipelines – Short Pipe Lengths

Figure 7-3, Figure 7-4, and **Figure 7-5** provided below show the trend between unit rate ($/m) and installed length for 100 mm, 150 mm and 225 mm diameter potable water pipelines. Limited data (i.e. less than 10 projects) were available for additional pipe diameters and types and are therefore not considered further here. These figures are based upon the hardcopy data provided by GCW. A tabulated summary of the collated hardcopy data is presented as **Table 5-2** in **Section 5.2.1**.

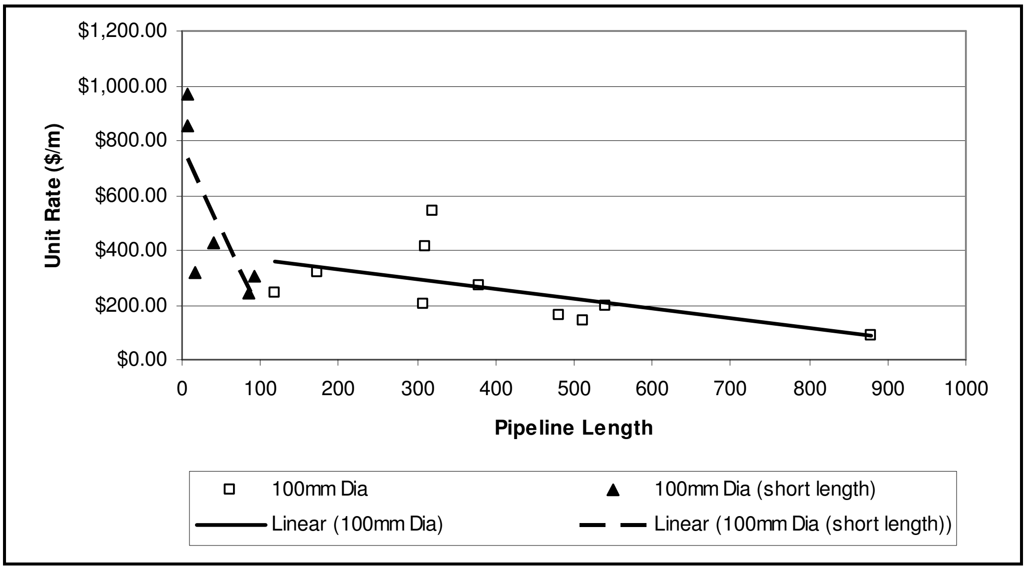

Figure 7-3 Relationship Between Unit Rate ($/m) & Project Size (100mm Ø Pipe)

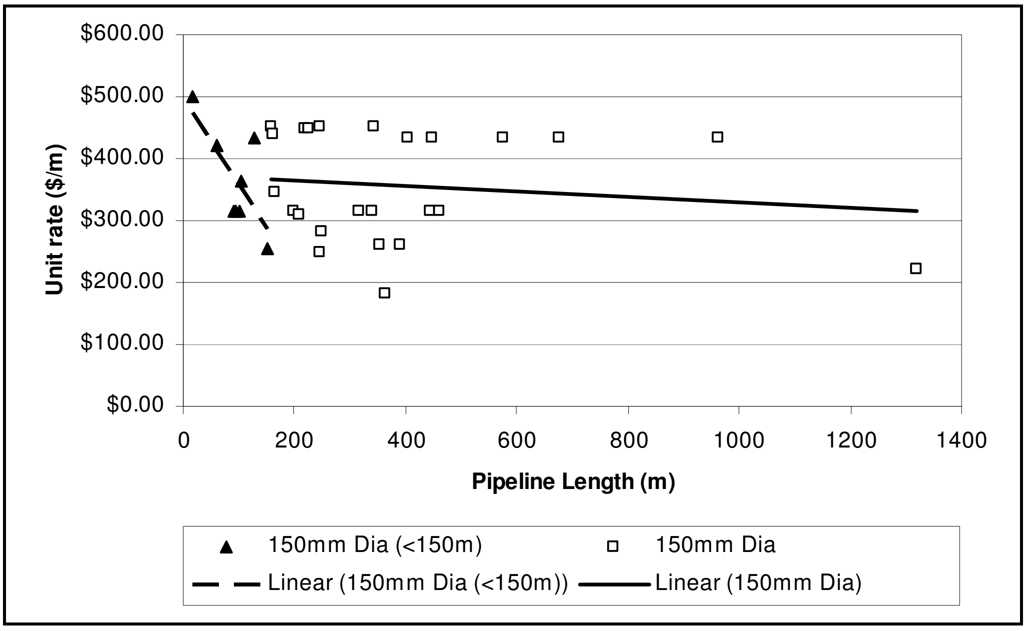

Figure 7-4 Relationship Between Unit Rate ($/m) & Project Size (150mm Ø Pipe)

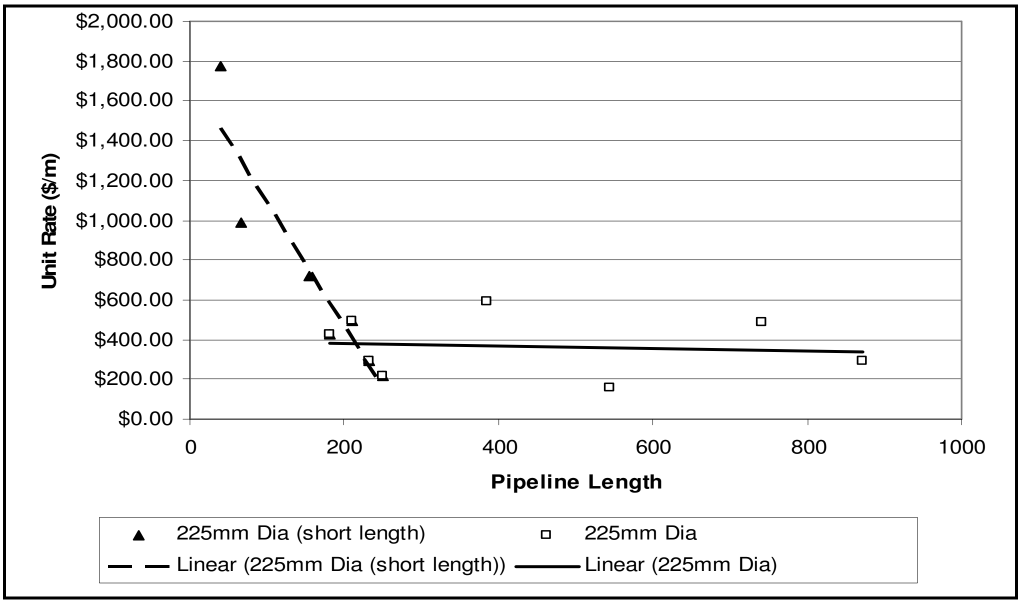

Figure 7-5 Relationship Between Unit Rate ($/m) & Project Size (225mm Ø Pipe)

Generally these figures demonstrate that there are economies of scale to be realised in the delivery of pipeline infrastructure, with the costs decreasing with increasing length, on a cost per unit basis. Alternatively this can be viewed as a cost premium for short lengths where fixed costs (e.g. plant mobilisation) comprise a significant component of the overall project cost.

Commercial factors are also likely to result in higher costs for short pipe lengths than longer runs. Pipe installation runs that typically take less than a full day to complete (i.e. in the order of up to 200 m) are likely to increase the likelihood that plant and/or personnel are idle (i.e. non chargeable) for part of the day. Longer pipe runs provide greater certainty in utilisation and therefore income. Contractors are likely to mitigate this risk through increased prices for short run pipes.

Based on the analysis of pipeline data presented above and the first principles unit rates presented in **Section 6.2** short length pipe allowances should be applied to all preliminary budget estimates as follows:

0-50 m	100%
51-100 m	70%
101-200 m	50%

*Using this approach a 25 m length of 500 mm diameter DICL potable water pipe, with a nominal unit rate of $900/m (**Section 6.2.2**) would be costed at $1,800/m.*

In order to minimise costs in the delivery of short run projects, consideration should be given to the adoption of procurement strategies that bundle projects of short length into packages of work. This would minimise the degree to which GCW pays a "utilisation allowance" by providing contractors with the ability to more efficiently schedule works and minimise idle time.

8 Recommendations

8.1 Unit Rates

Unit rates recommended for adoption are reproduced in **Appendix C** and reflect those presented in **Section 6**.

It is also recommended that the cost estimation methodology utilised by GCW be adapted to include estimates based on a preliminary design for complex and non-standard assets such as large elevated reservoirs, vacuum sewer systems and treatment plants.

8.2 Indexation

Based on the analysis presented in **Section 6.2**, and taking into account the ABS recommendations in relation to the development of an appropriate indexation methodology, the following approach is recommended for adoption by GCW:

- Adoption of the *Producer Price Index (ABS Cat No 6427.0) – General Construction Index – Queensland* for the indexation of unit rates for general construction of water and sewage assets.
- Indexation of rates at a minimum of every six months.
- Publication of the adopted methodology, including frequency of application of indexation to ensure transparency and confidence in the stated approach.

Until such time as the ABS commences collection and publication of data under the non-building construction n.e.c. (4122) class then the **General Construction (41) class** (**Table 4-2**) is considered the most appropriate for water and sewerage infrastructure construction works.

In support of this indexation approach, further works should be considered to refine GCW's cost estimation, measurement and control systems. The timely detection of discrepancies between estimated and incurred costs is crucial to the identification of areas where the base unit rates are in need of refinement or revision.

9 References

Kellogg Brown & Root Pty Ltd (2006) *Unit Costs Report – Water Supply & Sewerage Networks Revision D.* Prepared for Gold Coast Water. September 2006.

Tenix Alliance (2005) *ICP Unit Costs Peer Review Report.* Prepared for Gold Coast Water. March 2005.

Cardno (2006) *Water & Sewer Assets Valuation - Appendices.* Prepared for Gold Coast Water. September 2006.

Queensland Audit Office (2008) *Report to Parliament No. 4 for 2008 – Results of Audits at 31 May 2008.*

Australian Bureau of Statistics (1993) *Australian and New Zealand Standard Industrial Classification 1993.*

Australian Bureau of Statistics (2005) *Australian Consumer Price Index: Concepts, Sources and Methods 2005.*

Australian Bureau of Statistics (2008a) *Consumer Price Indexes, Australia, March Quarter 2008 – 6401.0.* www.abs.gov.au

Australian Bureau of Statistics (2008b) *Producer Price Indexes, Australia, June Quarter 2008 – 6427.0.* www.abs.gov.au

Australian Bureau of Statistics (2008c) *Labour Price Index, Australia, March Quarter 2008 – 6345.0.* www.abs.gov.au

Appendix A

Analysis of Fixed Asset Register Data

Potable Water Pipelines, Pump Stations & Reservoirs

Potable Water Mains

Table 9-1 has been derived from historical costs data provided by GCW and provides a measure of the relationship between pipeline length and unit rate for various projects. Data for pipe material (e.g. uPVC or DICL) was generally incomplete and has not been considered further in this analysis.

Table 9-1 Potable Water Mains – GCW Costing Data

Ø (mm)	Length (m)	Unit Rates ($Jun08)	Ø (mm)	Length (m)	Unit Rates ($Jun08)
150	15	$322.79	250	18	$1,330.75
	52	$322.79		28.5	$1,633.47
	54.5	$456.94		34	$509.94
	63.5	$626.92		72	$509.94
	72	$322.79		76	$1,119.26
	85	$374.58		88	$301.33
	88	$322.79		90.5	$1,544.19
	246	$322.79		134	$810.77
	258	$322.79	300	5	$3,162.30
	345	$322.79		6	$8,759.10
225	10	$2,380.93		35.5	$2,112.76
	10	$1,019.08		179.5	$98.22
	19	$2,380.93		179.5	$322.28
	19.25	$2,380.93		246	$597.21
	26.7	$217.65		258	$597.21
	28.45	$217.65		312	$1,403.60
	31	$1,342.94	600	26	$7,212.37
	51	$455.27		65	$1,477.26
	75.75	$663.49		102	$4,974.29
	90	$663.49		110	$1,477.26
				278	$1,477.26

Source: After GCW (2008) (Ahktar Unit Cost Review.xls and James – Unit Cost Review.xls)

Pump Stations

Analysis of pump station costs is centred upon the sewage pump station data presented in the spreadsheet *(valued)SPS.xls* provided by GCW. This data set contains a greater number of projects and is therefore more suited to further analysis than the water pump station data.

Sewage Pump Stations

Unit rates for sewage pump stations typically comprise civil works, which include well and building construction works, and non-civil works, which incorporate pipework and equipment, mechanical and electrical components. Costs for the well component of the civil works are dependent upon well volume, while the non-civil works components are more directly related to pump size (i.e. kW rating of pump motors).

The following section is included for descriptive purposes only. Costs were inflated to March $2008 prior to the release of the June 2008 index. In consultation with GCW these values have not been reworked and are presented below to demonstrate variations in costs across the pump station asset base.

Figure 9-1 to **Figure 9-5** show the distribution of costs, independent of pump sizing, for the non-civil components of projects. **Figure 9-6** is then presented to provide an indication of the number of pump station projects against standardised pump sizes.

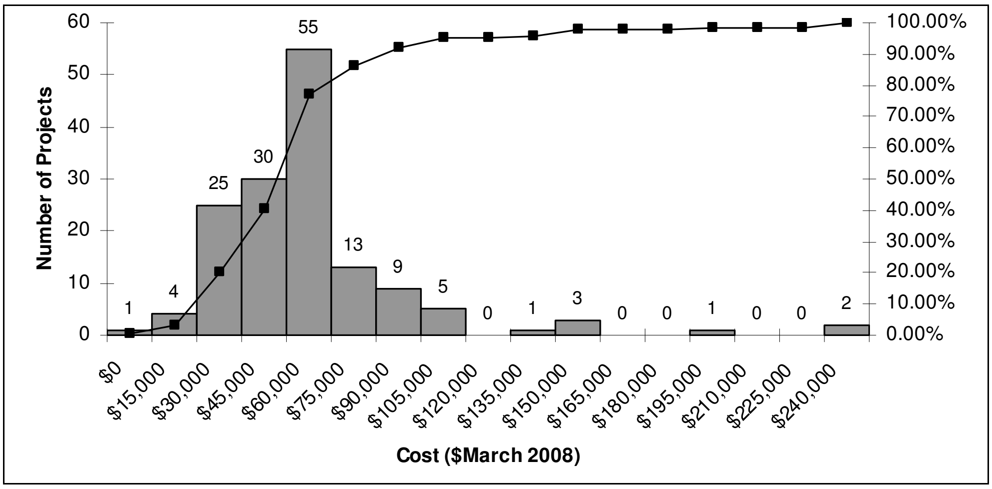

Figure 9-1 Frequency Distribution of Replacement Costs – Pipework

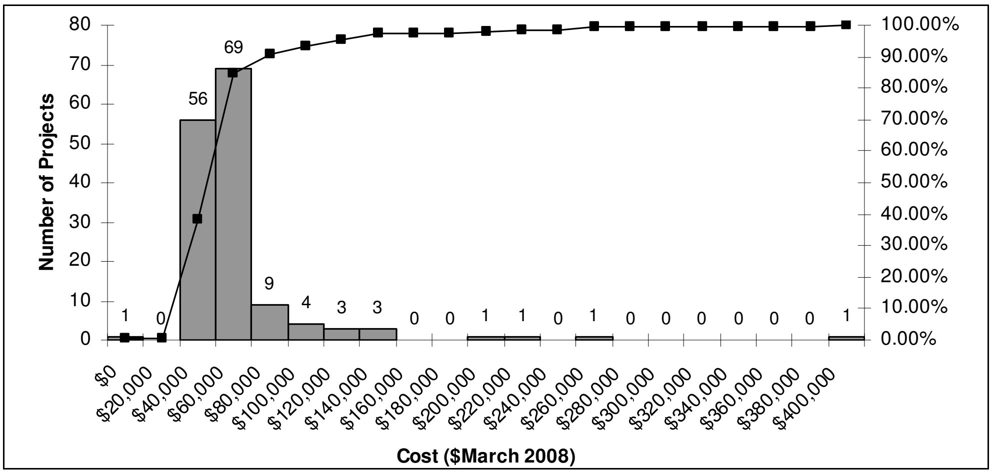

Figure 9-2 Frequency Distribution of Replacement Costs – Electrical

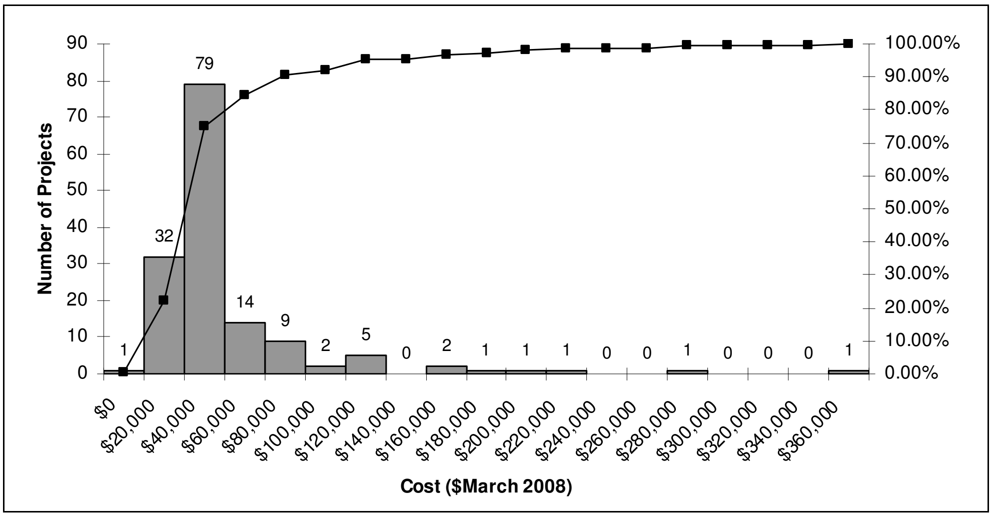

Figure 9-3 Frequency Distribution of Replacement Costs – Mechanical

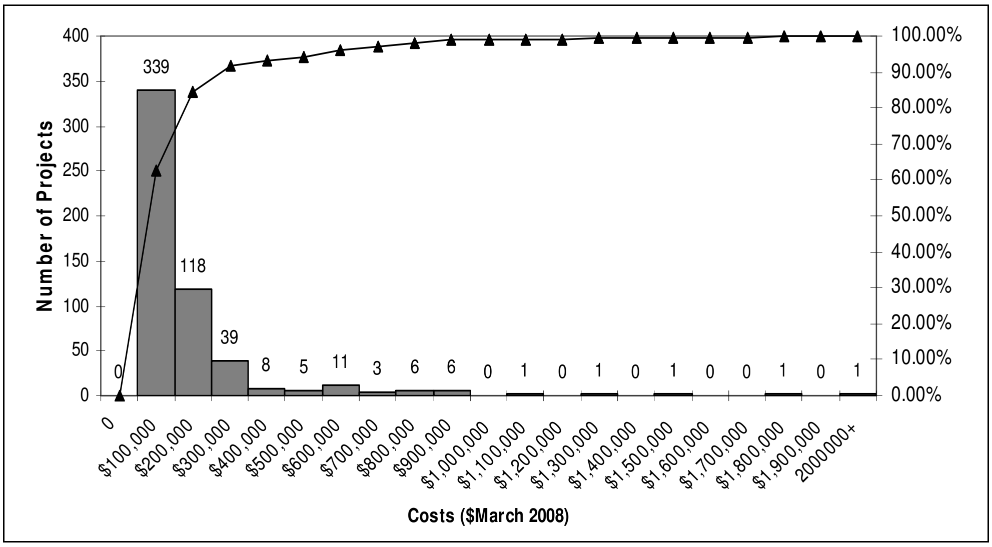

Figure 9-4 Replacement Costs – Civil Works (Wells)

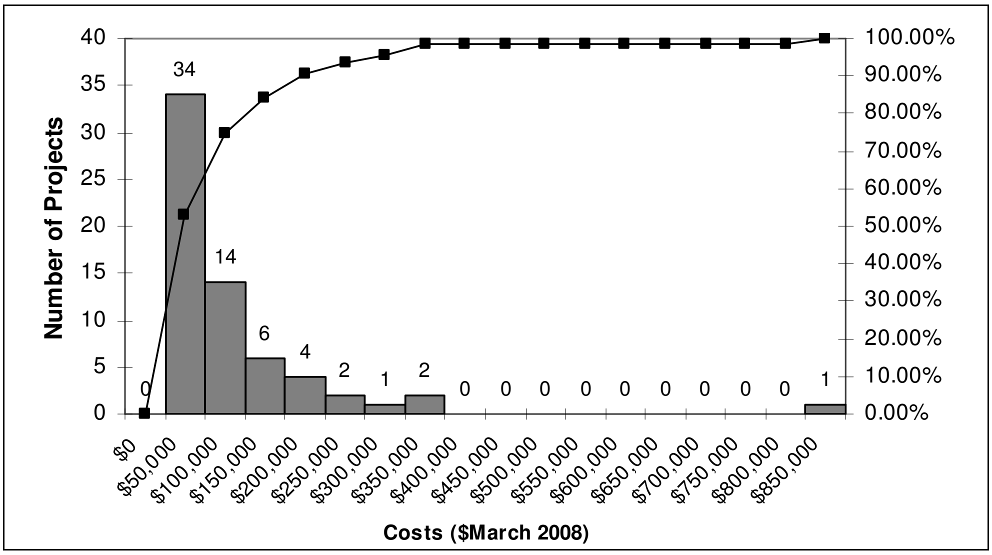

Figure 9-5 Replacement Costs – Civil Works (Buildings)

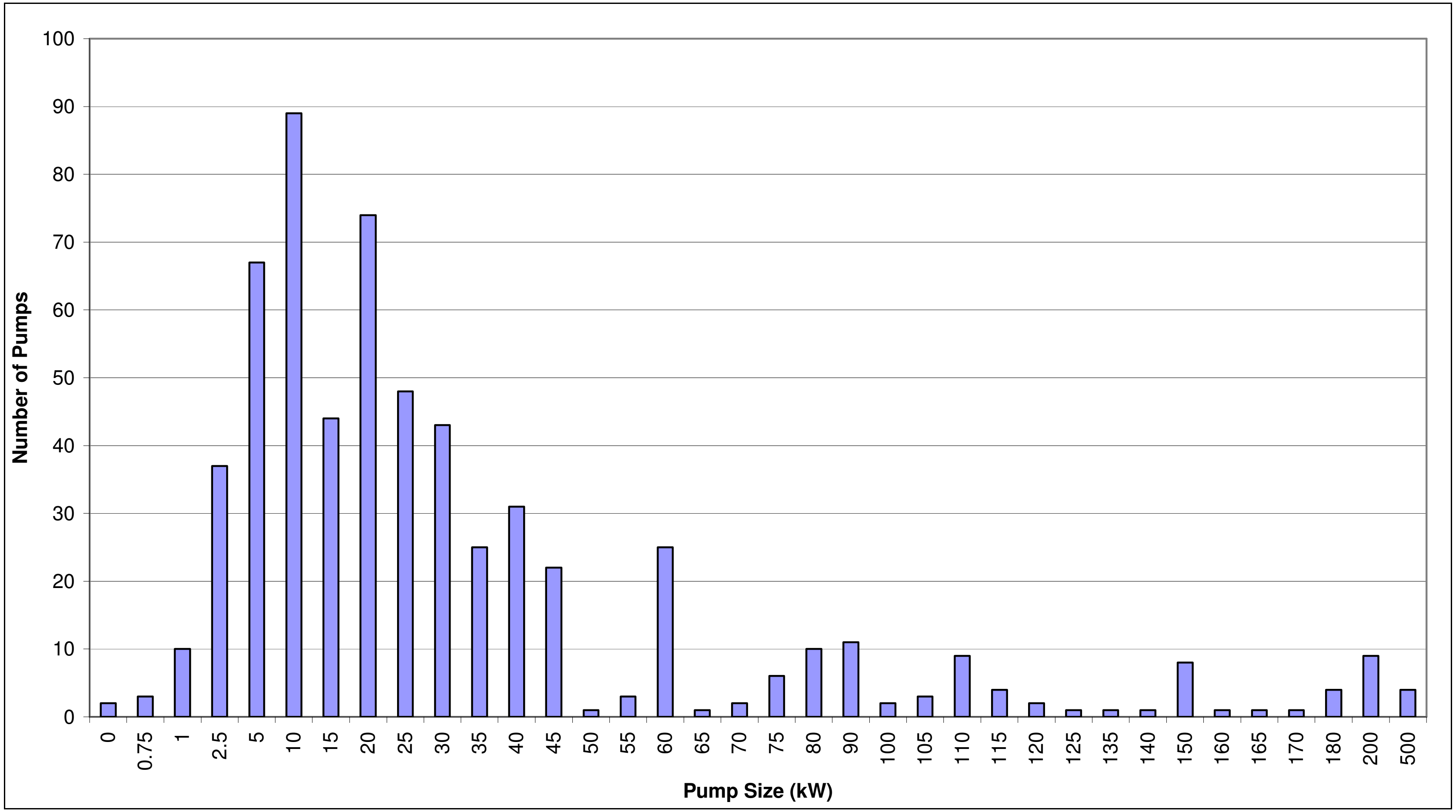

Figure 9-6 Frequency Distribution – No of Pumps v Pump Size

Key points conveyed by these figures (independent of pump size) include:

- pipework costs are between $15,000 and $105,000 for 90% of projects (**Figure 9-1**);
- electrical costs are between $20,000 and $100,000 for 90% of projects (**Figure 9-2**);
- mechanical costs are between $20,000 and $100,000 for 90% of projects (**Figure 9-3**);
- well construction costs are between $100,000 and $300,000 for 85% of projects (**Figure 9-4**);
- buildings typically (i.e. 90% of projects for which a building is installed) add between $50,000 and $250,000 to the total project cost (**Figure 9-5**); and
- approximately 85% of sewage pump station projects are less than 60 kW in size (**Figure 9-6**).

Pump size dependent data presented in **Figure 9-7**, **Figure 9-8**, **Figure 9-9** and **Figure 9-10** highlights the considerable variability apparent in replacement costs, as well as showing that the total value of non-civil costs increases with increasing pump size. These box and whisker plots highlight the median and inter-quartile ranges (i.e. 25^{th}, 50^{th} and 75^{th} percentiles) with the outer extremities representing minimum and maximum values. Key points conveyed by **Figure 9-7**, **Figure 9-8**, **Figure 9-9** and **Figure 9-10** include:

- Aggregated non-civil costs are skewed to the lower end of the cost spectrum, with high cost projects comprising a relatively low percentage of total projects for a given pump station size.
- Median values of non-civil costs increase as the pump size increases.
- The upper end of project costs is relatively independent of pump size (i.e. the maximum non-civil cost for a 10 kW pump station is shown to be in the order of $1 million, compared to a maximum in the order of $700,000 for a 60 kW pump station).

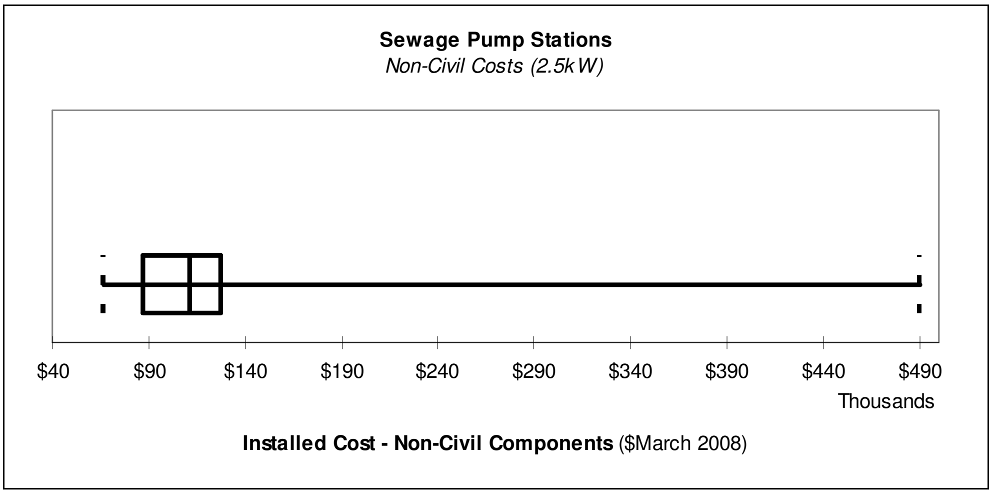

Figure 9-7 Box & Whisker Plot – Non-Civil Costs (2.5 kW Pump Station)

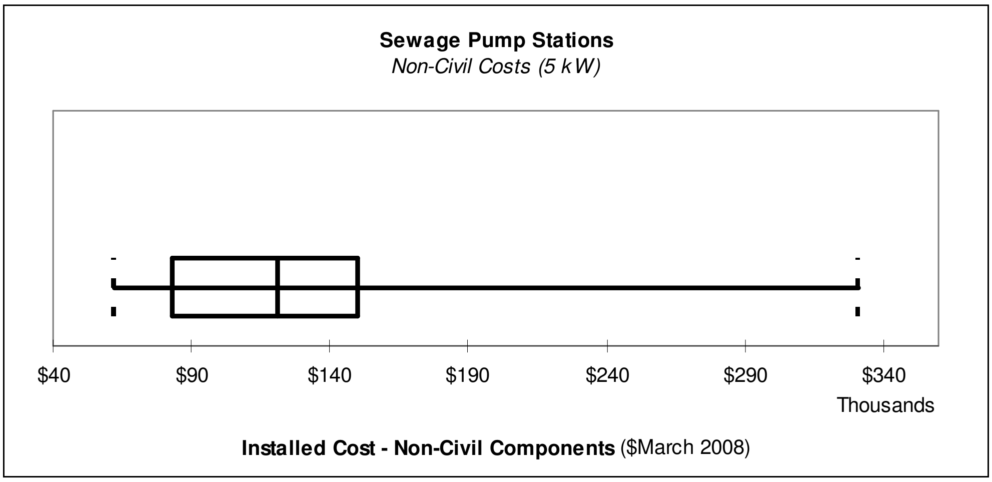

Figure 9-8 Box & Whisker Plot – Non-Civil Costs (5 kW Pump Station)

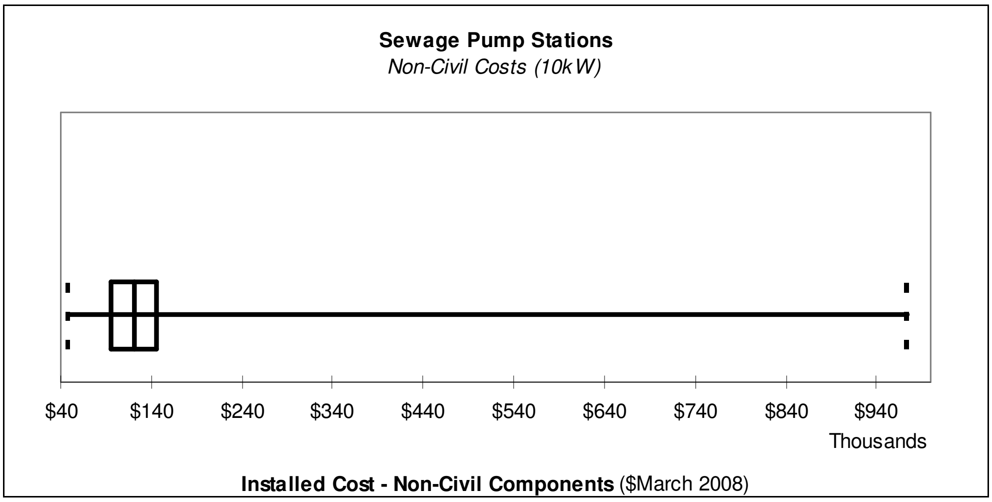

Figure 9-9 Box & Whisker Plot – Non-Civil Costs (10 kW Pump Station)

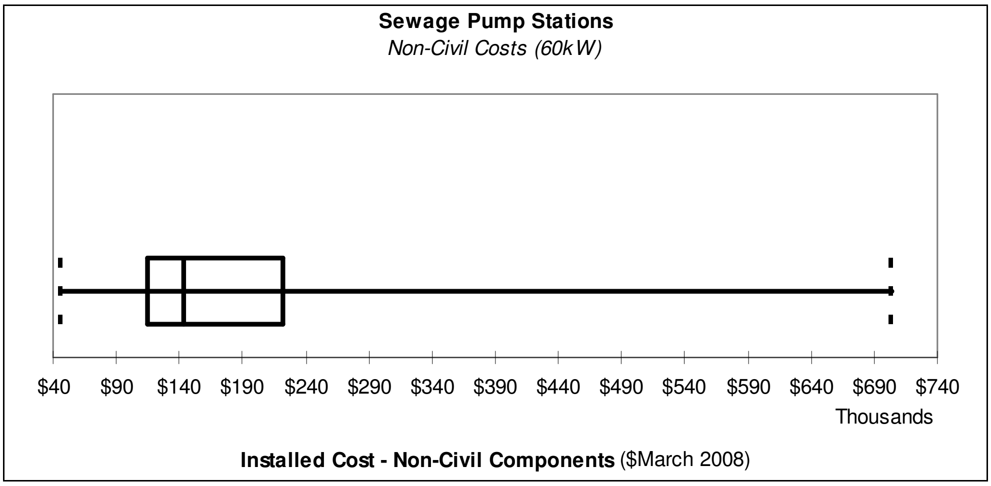

Figure 9-10 Box & Whisker Plot – Non-Civil Costs (60 kW Pump Station)

The analysis presented here generally shows total installation costs (both civil and non-civil) increasing with pump station size (for both civil and non-civil components). Analysis of the project data provided suggests that the civil component typically represents in the order of 42% of total sewage pump station replacement costs.

Reservoirs

Data provided by GCW (*(valued)Reservoirs.xls*) covers a total of 74 reservoirs covering a range of volumes. The current distribution of reservoir capacities within the Gold Coast region presented on **Figure 9-11** shows that the majority of these reservoirs (i.e. 65 of 74) are ground level reservoirs.

Figure 9-12 plots replacement costs on a total cost basis against reservoir volume using a logarithmic scale. Based on the ground level reservoir data provided total replacement costs (Y) vary with volume (X) according to the following relationship:

$$Y = 580918X^{0.608}$$

This relationship should be treated as indicative only and demonstrates that there are substantial returns to scale for increasing reservoir size.

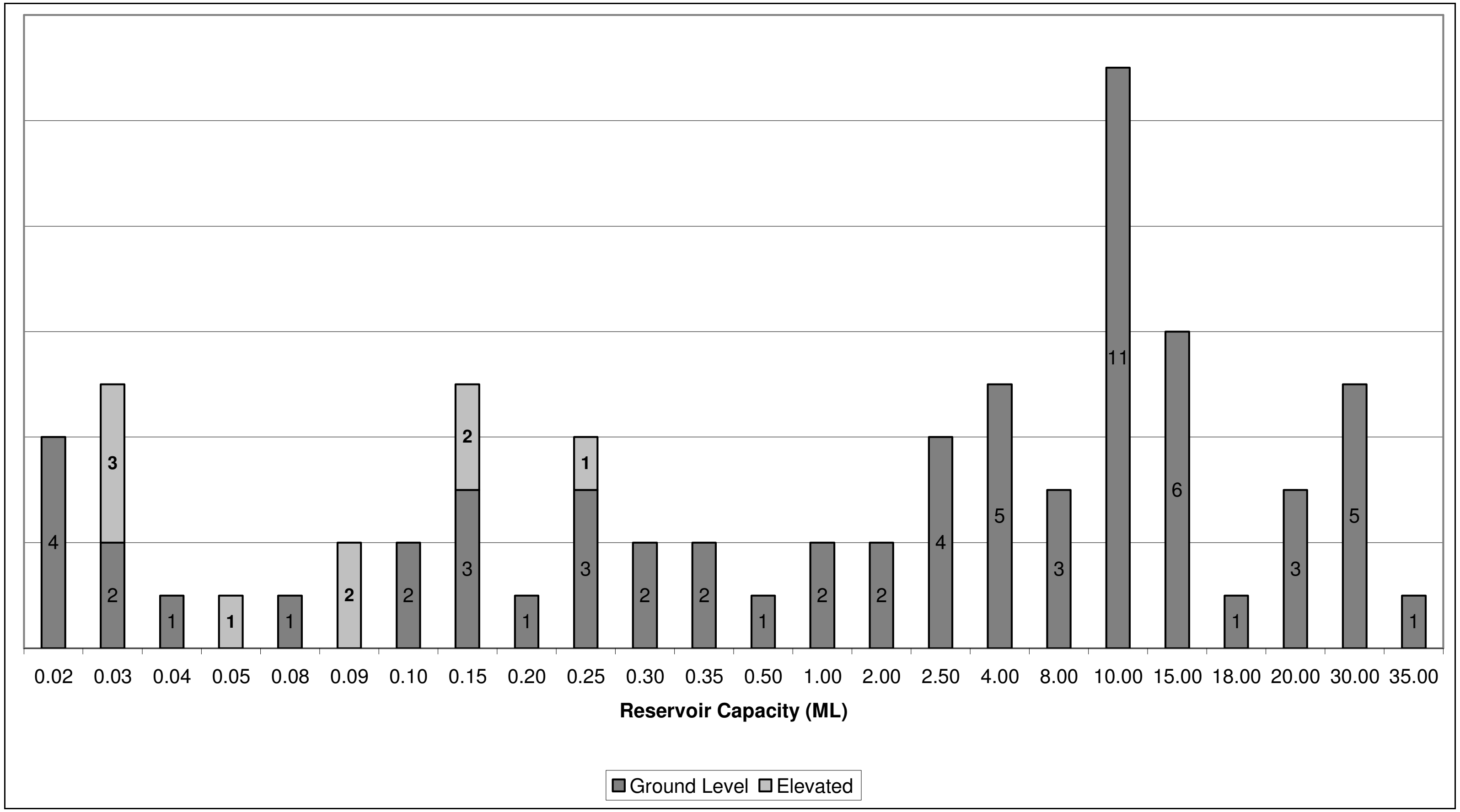

Figure 9-11 Frequency Distribution – Reservoir Capacity

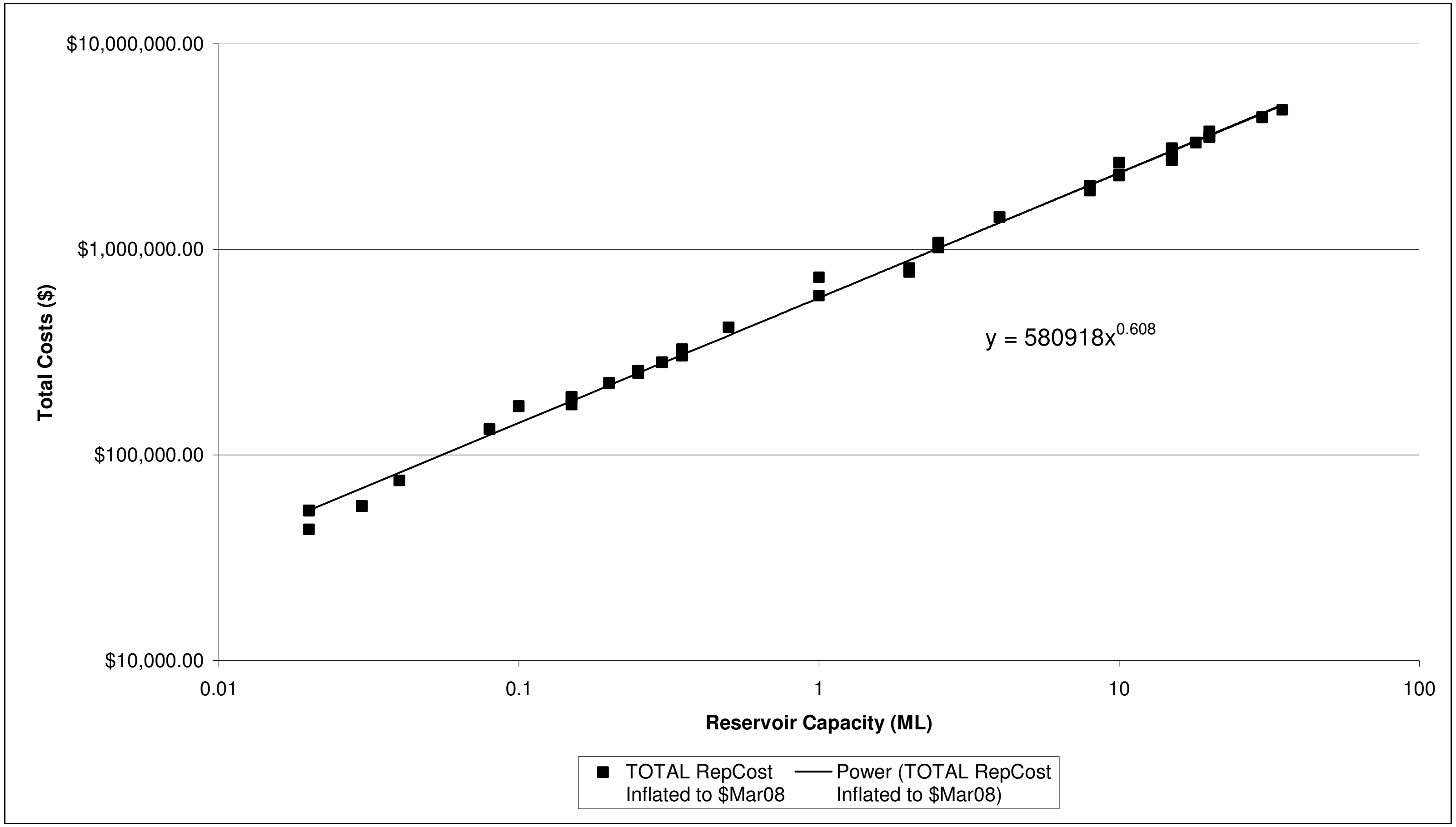

Figure 9-12 Ground Level Reservoirs – Relationship Between Replacement Cost & Capacity

Appendix B

First Principles – Example Calculations

Table B1 Sewage Pump Stations –First Principles Examples

Pump Size		(kW)	10			20			100		
Well Volume		(kL)	20			50			135		
Well Diameter		(m)	2.4			3.5			4.5		
Well Depth		(m)	4.5			5.2			8.5		
Pipe Diameter		(mm)	200			500			500		
Building Dimension		(m)	N/A			6 m x 8 m			12 m x 8 m		
		Unit	**No.**	**$/unit**	**Cost**	**No.**	**$/unit**	**Cost**	**No.**	**$/unit**	**Cost**
Civils											
Well	Well (ex Slab)	m	4.5	$3,600	$16,200	5.2	$6,200	$32,240	8.5	$12,000	$102,000
	Base Slab	No.	1	$4,700	$4,700	1	$5,800	$5,800	1	$7,600	$7,600
	Ventstack	item	1	$24,000	$24,000	1	$24,000	$24,000	1	$62,000	$62,000
	Lids	item	4	$1,100	$4,400	4	$1,300	$5,200	4	$2,700	$10,800
	Rd Access	m	65	$500	$32,500	65	$500	$32,500	75	$500	$37,500
Excavation	Excavator	hr	24	$190	$4,560	36	$190	$6,840	120	$190	$22,800
	Tipper	hr	24	$120	$2,880	36	$120	$4,320	120	$120	$14,400
	Backhoe	hr	24	$150	$3,600	36	$150	$5,400	120	$150	$18,000
	Geotech (drill)	item	1	$12,000	$12,000	1	$12,000	$12,000	1	$35,000	$35,000
	Geotech Anal	item	1	$6,000	$6,000	1	$6,000	$6,000	1	$12,000	$12,000
	Survey	item	1	$20,000	$20,000	1	$20,000	$20,000	1	$32,000	$32,000
Building	Base Slab	m^2	0	$0	$0	48	$300	$14,400	96	$300	$28,800
	Building	m^2	0	$0	$0	48	$1,400	$67,200	96	$1,400	$134,400
	Access	item	0	$0	$0	1	$15,105	$15,105	1	$15,105	$15,105
	Lighting	item	0	$0	$0	1	$10,000	$10,000	1	$27,000	$27,000
	Fencing	m	0	$0	$0	140	$150	$21,000	200	$150	$30,000
	Gantry	item	0	$0	$0	1	$22,000	$22,000	1	$45,690	$45,690
	Subtotal				***$130,840***			***$304,005***			***$635,095***
Valves/Pipework											
Non Return Valve		No.	2	$3,200	$6,400	4	$5,400	$21,600	6	$15,200	$91,200
Gate Valves		No.	4	$2,900	$11,600	6	$3,600	$21,600	8	$9,500	$76,000
DI Pipe		m	55	$400	$22,000	55	$600	$33,000	105	$900	$94,500
Pipework Fittings		%		10%	$2,200		20%	$6,600		20%	$18,900
	Subtotal				***$42,200***			***$82,800***			***$280,600***
Mech/Elec											
Level Control		No.	1	$3,700	$3,700	2	$3,700	$7,400	2	$3,700	$7,400
VFD/Soft Starters		No.	0	$15,300	$0	0	$15,300	$0	3	$15,300	$45,900
Switchboard		No.	1	$35,000	$35,000	1	$72,000	$72,000	1	$168,000	$168,000
Float Switch		No.	1	$1,200	$1,200	1	$1,200	$1,200	2	$1,200	$2,400
Well Washer		No.	1	$2,600	$2,600	2	$2,600	$5,200	4	$2,600	$10,400
Pumps		No.	2	$14,500	$29,000	2	$25,000	$50,000	3	$94,000	$282,000
Mg flowmeter		No.	1	$6,670	$6,670	1	$12,000	$12,000	1	$73,000	$73,000
Pump Controller		No.	1	$5,600	$5,600	1	$5,600	$5,600	1	$16,000	$16,000
RTU		No.	1	$7,000	$7,000	1	$7,000	$7,000	2	$7,000	$14,000
Odour Control		No.	1	$5,600	$5,600	1	$12,000	$12,000	1	$95,000	$95,000
	Subtotal				***$96,370***			***$172,400***			***$714,100***
TOTAL					**$269,410**			**$559,205**			**$1,629,795**

Table B2 Water Pump Station – First Principles Examples

Pump Size	(kW)	20			100			200		
Flow Rate	(L/s)	23			110			220		
Pipe Diameter	(mm)	200			375			500		
No. of Pumps (Duty S/by)		2			3			3		
Slab Depth	(mm)	300			300			300		
Item	**Unit**	**No.**	**Rate ($/unit)**	**Cost**	**No.**	**Rate ($/unit)**	**Cost**	**No.**	**Rate ($/unit)**	**Cost**
Valves/Pipework										
Non Return Valve	No.	2	$3,000	$6,000	3	$7,000	$21,000	3	$13,660	$40,980
Gate Valves	No.	4	$2,175	$8,700	6	$4,406	$26,436	6	$9,300	$55,800
DI Pipe	m	45	$400	$18,000	55	$600	$33,000	55	$900	$49,500
Pipework Fittings	%		50%	$9,000		50%	$16,500		50%	$24,750
Subtotal				***$41,700***			***$96,936***			***$171,030***
Civils										
Excavation – Rd Access	m	24	$500	$12,000	65	$500	$32,500	65	$500	$32,500
Excavation – Excavator	hr	24	$190	$4,560	40	$190	$7,600	40	$190	$7,600
Excavation – Tipper	hr	24	$120	$2,880	40	$120	$4,800	40	$120	$4,800
Excavation – Backhoe	hr	24	$150	$3,600	40	$150	$6,000	40	$150	$6,000
Excavation – Geotech drilling	item	1	$16,000	$16,000	1	$16,000	$16,000	1	$16,000	$16,000
Excavation – Geotech Analysis	item	1	$6,800	$6,800	1	$6,800	$6,800	1	$6,800	$6,800
Excavation – Survey	item	1	$10,000	$10,000	1	$20,000	$20,000	1	$20,000	$20,000
Building – Base Slab	m	24	$300	$7,200	48	$300	$14,400	56	$300	$16,800
Building – Building	m	24	$1,100	$26,400	48	$1,600	$76,800	56	$1,600	$89,600
Building – Stairs and Access	item	0	$15,000	$0	1	$15,000	$15,000	1	$15,000	$15,000
Building – Lighting	item	1	$10,000	$10,000	1	$10,000	$10,000	1	$10,000	$10,000
Building – Security Fencing	m	40	$150	$6,000	140	$150	$21,000	140	$150	$21,000
Building – Gantry	item	0	$30,000	$0	1	$30,000	$30,000	1	$45,000	$45,000
Subtotal				***$105,440***			***$260,900***			***$291,100***
Mech/Elec										
Switchboard	No.	1	$24,000	$24,000	1	$83,700	$83,700	1	$116,000	$116,000
Pressure Sensors		2	$1,200	$2,400	3	$1,200	$3,600	3	$1,200	$3,600
Pumps (kW)	pump	2	$8,900	$17,800	3	$33,000	$99,000	3	$57,000	$171,000
Variable Speed Drive	No.	2	$6,850	$13,700	3	$15,000	$45,000	3	$21,000	$63,000
Mg flowmeter	No.	1	$4,000	$4,000	1	$15,900	$15,900	1	$15,900	$15,900
Pump Controller	No.	1	$6,700	$6,700	1	$6,700	$6,700	1	$6,700	$6,700
RTU	No.	1	$7,000	$7,000	1	$7,000	$7,000	1	$7,000	$7,000
Subtotal				***$75,600***			***$260,900***			***$383,200***
TOTAL				**$222,740**			**$618,736**			**$845,330**

Table B3 Reservoirs – First Principles Examples

Storage Volume	(ML)		1		3		20	
Pipework Diameter	**(mm)**		**250**		**300**		**500**	
	Unit	**Rate**	**No.**	**Cost**	**No.**	**Cost**	**No.**	**Cost**
		($/unit)		**($)**		**($)**		**($)**
Valves/Pipework								
Non Return Valve (250-300mm)	No.	$6,500	2	$13,000	4	$26,000	0	$0
(500mm)	No.	$25,455	0	$0	0	$0	3	$76,365
Altitude Valve (250-300mm)	No.	$12,600	1	$12,600	2	$25,200	0	$0
(500mm)	No.	$35,000	0	$0	0	$0	2	$70,000
Gate Valves (250-300mm)	No.	$3,200	2	$6,400	4	$12,800	0	$0
(500mm)	No.	$9,500	0	$0	0	$0	4	$38,000
Pipe (dia = 250mm)[1]	m	$350	10	$3,500	0	$0	0	$0
Pipe (dia = 300mm)[1]	m	$450		$0	10	$4,500	0	$0
Pipe (dia = 500mm)[1]	m	$900		$0		$0	10	$9,000
Fittings (% P/work)	%	50%	%	$1,750	%	$2,250	%	$4,500
Subtotal				**$37,250**		**$70,750**		**$197,865**
Civils								
Structure	Height x Thick		4m x 0.3m		5m x 0.3m		6m x 0.4m	
Concrete (excl base)	m^3	$300	101.6	$30,480	175	$52,500	210	$63,000
Structural Steel	Item		0	$25,000	0	$400,000		$1,100,000
Base	Item		1	$35,000	1	$174,000		$1,026,300
Roof @.762 wide	m^2	$15	500	$7,500	800	$12,000	4000	$60,000
Roof Beams								
Avg 20m @ 3m	m	$305	108	$32,940	0			
Avg 30m @ 3m	m	$600	0	$0	600	$360,000	900	$540,000
Rd Access	m	$500	50	$25,000	100	$50,000	100	$50,000
Stairs and Access	item	item	1	$25,000		$55,000		$135,000
Lighting	item	item	1	$5,000		$54,000		$108,000
Security Fencing	m	$150	200	$30,000	400	$60,000	1200	$180,000
Excavation								
Excavator	hr	$190	80	$15,200	180	$34,200	280	$53,200
Tipper	hr	$120	80	$9,600	180	$21,600	280	$33,600
Backhoe	hr	$150	40	$6,000	180	$27,000	280	$42,000
Sand/Gravel	m^3	$220	160	$35,200	200	$44,000	1000	$220,000
Geotech drilling	item			$20,000		$20,000		$20,000
Geotech Analysis	item			$12,000		$12,000		$12,000
Survey	item			$15,000		$15,000		$20,000
Site Rectification	item			$35,000		$35,000		$55,000
Subtotal				**$363,920**		**$1,426,300**		**$3,718,100**
Mech/Elec								
Level Control Probes	No.	$6,500	1	$6,500	2	$13,000	2	$13,000
Telemetry Control	item	item	1	$30,000	1	$160,000	1	$160,000
Mg flowmeter	No.	item	1	$8,500	1	$40,000	2	$146,000
RTU	No.	$7,000	1	$7,000	2	$14,000	2	$14,000
Subtotal				**$52,000**		**$227,000**		**$333,000**
TOTAL				**$453,170**		**$1,724,050**		**$4,248,965**

Note 1 A nominal 10m allowance for pipework is included for each example provided.

Appendix C

Recommended Unit Rates

NOTE:

All unit rates presented in Appendix C represent June $2008.

Allowances & Exclusions

Administration costs are not incorporated within the unit rates estimates presented below.

These typically include items such as survey, planning, engineering design construction supervision and contract administration. For cost planning purposes an allowance of 20% of construction costs would be appropriate, assuming a typical construct-to-design delivery model.

A risk management or contingency allowance has not been incorporated within the unit rates estimates presented below.

Planning allowances should incorporate a degree of risk management through consideration of the level of available information and project definition. This is typically achieved through the adoption of contingency allowances.

Table C-1 Risk Management – Contingency Allowance v Project Definition

Project Stage	Typical Level of Project Definition	Recommended Contingency
General/Preliminary Concept	▪ Size of infrastructure decided. ▪ Line drawn on a map but route not inspected. Some route of site risks.	40%
Concept Design	▪ Major elements identified. ▪ Routes generally confirmed by careful consideration of mapping and aerial photography, specific corridor constraints inspected. ▪ Specific sites known to be available.	30%
Preliminary Design	▪ Most elements of construction identified, quantities relatively well defined. ▪ Routes confirmed by field inspection and preliminary services searches. ▪ Sites inspected.	20%
Detail Survey & Design	▪ Elements of Construction identified sufficient for tendering. ▪ Quantities clearly understood.	10%

The following potential cost categories have not been considered as part of this analysis as they are typically project specific and subject to a degree of variation that makes them unsuitable for inclusion in any derivation of unit rates. To the degree that such an approach is applied, the contingency allowances presented above would cover issues such as land acquisition and geotechnical issues.

Land Acquisition Land acquisition for reservoirs tends to be a difficult process with desirable reservoir sites often being desirable development sites. The costs and time frames for acquisition of land either by agreement with landowners or by compulsory acquisition have not been included in these estimates.

Geotechnical Issues Geotechnical conditions can significantly alter and add to overall design and construction costs. As the degree of variation in geotechnical costs is significant they have not been considered further here.

Early identification of potential geotechnical issues and detailed project scoping is recommended to minimise potential costs and time delays.

Application of Adjustment Factors - Examples

The following describes the application of the various multipliers to establish a unit rate for various asset classes.

Steps	**Calculation**
Single Adjustment Factor	B x F = Unit Rate
Two Adjustment Factors	B x F + B x (S – 1) = Unit Rate
Three Adjustment Factors	B x F + B x (S – 1) + B x (T – 1) = Unit Rate

Where:

B = Base Rate	F = First Multiplier
S = Second Multiplier	T = Third Multiplier

Single Adjustment Factors

Where a single variable is applicable the applied to the base rates established then the adjustment factor is multiplied against the established base rate.

Using as an example a 250 mm µPVC water main in a brownfields environment requires application of a brownfield adjustment factor of 1.63 to a base rate (greenfields, minimum cover, good soil) of $273/m.

B = $273/m	Adjusted Unit Rate = B x F	
F = 1.63	Adjusted Rate	= $273 x 1.63
		= $444.99/m

Multiple adjustment factors

Where there are multiple adjustment factors the calculation becomes more complex. It is important to ensure that the adjustment factors are not compounded.

Taking the same example as above and including a second adjustment factor for poor soil (adjustment factor of 1.2).

B = \$273/m	B x F + B x (S –1) = Unit Rate	
F = 1.63 S = 1.2	Adjusted Rate	= \$273 x 1.63 + \$273 x (1.2 - 1) = \$444.99 + \$54.6 = \$499.54/m

Potable Water Mains

Table C-2 Potable Water Mains – Recommended Unit Rates

Pipeline Ø (Ø < 960mm)	DICL (\$/m)	PVC (\$/m)	Pipeline Ø (Ø > 960mm)	MSCL (\$/m)
100	\$141	\$104	960	\$2,901
150	\$233	\$168	1000	\$3,046
200	\$306	\$229	1050	\$3,152
225	\$362	\$254	1085	\$3,326
250	\$418	\$273	1200	\$3,748
300	\$461	\$335	1290	\$4,007
375	\$654	\$446	1350	\$4,350
450	\$777	\$822	1500	\$4,769
500	\$946		1650	\$5,316
600	\$1,240		1800	\$5,765
750	\$1,759		1950	\$6,324
			2159	\$6,792

Recycled Water Mains

Table C-3 Recycled Water Mains – Recommended Unit Rates

Pipeline Ø (Ø < 960mm)	DICL ($/m)	PVC ($/m)	Pipeline Ø (Ø > 960mm)	MSCL ($/m)
63	$92		960	$2,936
90	$102		1000	$3,083
100	$142	$105	1050	$3,190
150	$235	$171	1085	$3,366
200	$310	$232	1200	$3,793
225	$366	$257	1290	$4,055
250	$423	$276	1350	$4,402
300	$467	$340	1500	$4,826
375	$662	$452	1650	$5,380
450	$787	$832	1800	$5,834
500	$958		1950	$6,400
600	$1,255		2159	$6,874
750	$1,780			

Sewage Rising Mains

Table C-4 Sewage Rising Mains – Recommended Unit Rates

Pipeline Ø (Ø < 960mm)	DICL ($/m)	PVC ($/m)	Pipeline Ø (Ø > 960mm)	MSCL ($/m)
100	$141	$121	960	$2,822
150	$245	$197	1000	$2,910
200	$334	$268	1050	$3,030
225	$402	$297	1085	$3,236
250	$473	$319	1200	$3,664
300	$520	$393	1290	$4,007
375	$731	$522	1350	$4,289
450	$868	$961	1500	$4,683
500	$1,053		1650	$5,180
600	$1,380		1800	$5,765
750	$1,958		1950	$6,260
			2159	$6,792

Sewage Gravity Mains

Table C-5 Sewage Gravity Mains at Various Depths – Recommended Unit Rates

	Diameter (mm)	Unit Rates v Depth ($/m)						
		At Depth[1]	1.5m<d<3m		3m<d<4.5m		d>4.5m	
			AF	Rate	AF	Rate	AF	Rate
PVC	150	$225	1.19	*$268*	1.34	*$302*	1.47	*$331*
PVC	225	$286	1.19	*$340*	1.34	*$383*	1.47	*$420*
PVC	250	$303	1.19	*$361*	1.34	*$406*	1.47	*$445*
PVC	300	$380	1.25	*$475*	1.40	*$532*	1.54	*$585*
PVC	375	$528	1.25	*$660*	1.40	*$739*	1.54	*$813*
PVC	450	$930	1.26	*$1,172*	1.41	*$1,311*	1.56	*$1,451*
PVC	525	$1,133	1.26	*$1,428*	1.41	*$1,598*	1.56	*$1,767*
PVC	600	$1,350	1.26	*$1,701*	1.41	*$1,904*	1.56	*$2,106*
PVC	750	$1,787	1.35	*$2,412*	1.41	*$2,520*	1.67	*$2,984*
PVC	900	$2,061	1.35	*$2,782*	1.45	*$2,988*	1.67	*$3,442*
Vitreous Clay	960	$2,613			1.45	*$3,789*	1.67	*$4,364*
Vitreous Clay	1000	$2,710			1.45	*$3,930*	1.67	*$4,526*
Vitreous Clay	1050	$2,830			1.45	*$4,104*	1.67	*$4,726*
Vitreous Clay	1085	$2,996			1.57	*$4,704*	1.80	*$5,394*
Vitreous Clay	1200	$3,370			1.57	*$5,291*	1.80	*$6,066*
Vitreous Clay	1290	$3,610			1.57	*$5,668*	1.80	*$6,498*
Vitreous Clay	1350	$4,020			1.83	*$7,357*	2.10	*$8,442*
Vitreous Clay	1500	$4,296			1.83	*$7,862*	2.10	*$9,022*
Vitreous Clay	1650	$4,760			1.83	*$8,711*	2.10	*$9,996*
Vitreous Clay	1800	$5,194			2.00	*$10,388*	2.30	*$11,946*
Vitreous Clay	1950	$5,670			2.00	*$11,340*	2.30	*$13,041*
Vitreous Clay	2159	$6,119			2.00	*$12,239*	2.30	*$14,075*

Note 1: "At depth" taken to be <1.5m and 1.5 m<d<3.0 m for pipe diameters <960 mm and >960 mm respectively.

Vacuum Sewer Systems – Options Analysis Only

Table C-6 Vacuum Sewage Systems

	COSTS ($'000's)					
EP	**Pipelines**	**Pump Stations**	**Property Connections**	**Sub-Total**	**Contingency (40%)**	**TOTAL**
500	$3,000	$700	$1,400.00	*$5,100*	$2,040	**$7,140**
1000	$5,600	$800	$2,500.00	*$8,900*	$3,560	**$12,460**
1500	$8,025	$900	$3,600.00	*$12,525*	$5,010	**$17,535**
2000	$9,600	$1,400	$4,600.00	*$15,600*	$6,240	**$21,840**
2500	$11,000	$1,500	$5,000.00	*$17,500*	$7,000	**$24,500**
3000	$12,600	$1,665	$5,700.00	*$19,965*	$7,986	**$27,951**
3500	$14,350	$1,837	$6,300.00	*$22,488*	$8,995	**$31,483**
4000	$16,000	$2,000	$6,800.00	*$24,800*	$9,920	**$34,720**
4500	$16,875	$2,093	$7,200.00	*$26,168*	$10,467	**$36,635**
5000	$18,000	$2,250	$7,500.00	*$27,750*	$11,100	**$38,850**

Source: Flovac Australia pers comm.. There is significant contingency (40%) built into these prices to reflect the highly variable nature of such projects.

Adjustment Rates for Pipeline Construction – General

Table C-7 Adjustment Rates for Various Construction Factors

Pipeline Ø	**Adjustment Factor** *(i.e. Greenfields unit rate x adjustment factor)*	
(mm)	Brownfields	City (High Density)
100	2.26	3.43
150	1.76	2.47
200	1.74	2.44
225	1.63	2.22
250	1.63	2.50
300	1.59	2.38
375	1.41	1.97
450	1.37	1.84
500	1.37	1.72
600	1.29	1.55
750	1.41	1.63
960	1.25	1.38
1000	1.25	1.38
1050	1.24	1.36
1085	1.25	1.38
1200	1.22	1.33
1290	1.26	1.36
1350	1.24	1.33
1500	1.22	1.30
1650	1.20	1.27
1800	1.20	1.27
1950	1.18	1.25
2159	1.17	1.23

Hyder

Adjustment Rates for Pipeline Construction – Depth Allowance

Table C-8 Construction Factors (Multiplier) at Various Depths

Diameter (mm)	Multipliers vs Depth		
	1.5m<d<3m	3m<d<4.5m	d>4.5m
100; 150; 200; 225; 250	1.19	1.34	1.47
300; 375; 400	1.25	1.40	1.54
450; 500; 525; 600	1.26	1.41	1.56
750	1.35	1.41	1.67
900	1.35	1.45	1.67
960;1000;1050		1.45	1.67
1085; 1200; 1290		1.57	1.80
1350; 1500; 1650		1.83	2.10
1800; 1950; 2159		2.00	2.30

Pipe Jacking & Directional Drilling

Table C-9 Pipe Jacking – Indicative Unit Rates for Various Bore Diameters

Pipe Ø (mm)	Pipe Jacking ($/m)			Internal Pipe ($/m)
	Steel Enveloper	Drilling	TOTAL COST	TOTAL COST
150				$167
200				$243
300	$210	$750	$960	$397
350	$300	$775	$1,075	
375				$583
450				$714
500	$460	$800	$1,260	
600				$1,114
610	$590	$900	$1,490	
700	$870	$950	$1,820	
750				$1,.345
800	$1,200	$1,000	$2,200	
900				$1,701
1000	$1,500	$1,200	$2,700	
1050				$2,242
1500	$1,900	$1,500	$3,400	
Drill Pits/Excavations (x2)				$15,000

Source: Australasian Society of Trenchless technology pers comm. Material costs were provided by Vinidex for PE pressure pipe rated equivalent to PN16 (160m water pressure).

Rates include mob/demob of plant & equipment.

Table C-10 Directional Drilling – Indicative Unit Rates for Various Bore Diameters

Bore Ø	Pipe Material	Fittings Allowance[1]		Total Materials	Drilling	TOTAL
(mm)	$/m	%	$/m	Subtotal	$/m	$/m
180	$77	15%	$11	$88	$675	$763
355	$174	15%	$26	$200	$750	$950
400	$295	10%	$29	$324	$775	$1,099
475	$358	9%	$32	$390	$800	$1,190
560	$462	9%	$42	$503	$900	$1,403
710	$858	6%	$51	$910	$950	$1,860
900	$1,459	5%	$73	$1,532	$1,000	$2,532
Drill Pits/Excavations (x2)						$10,000

Source: Australasian Society of Trenchless technology pers comm. Material costs were provided by Vinidex for PE pressure pipe rated equivalent to PN16 (160m water pressure).

Note 1 Fittings allowances as a percentage of pipe material were derived from communications with various contractors and past experience.

Rates include mob/demob of plant & equipment.

Pressure Reducing Valves

Table C-11 Pressure Reducing Valves

Ø (mm)	Contractor Price Average	First Principles Estimates						
		F/meter	PRV	Pipes	Pits	Data Loggers	Plant/ Labour	TOTAL
100	$46,951	$2,200	$1,200	$4,875	$6,080	$7,800	$24,980	$47,135
150	$51,339	$2,230	$1,966	$6,070	$6,740	$7,800	$26,770	$51,576
200	$56,802	$2,700	$2,810	$8,450	$8,105	$7,800	$28,450	$58,315
250	$65,269	$3,050	$3,650	$10,020	$9,440	$7,800	$33,170	$67,130
300	$73,658	$3,150	$4,020	$13,790	$11,210	$7,800	$36,240	$75,210
375	$81,659	$3,360	$4,390	$14,470	$14,320	$7,800	$39,010	$83,350

Soil Type

Table C-12 Adjustment Factors – Soil Type

Depth (m)	Soil Type	Pipe Ø (mm)				
		<150	150-300	300-600	600-900	900-2159
<1.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.1	1.2	1.3	1.8	2
	ASS areas	1.1	1.2	1.3	1.8	2
	Soft Rock	1.35	1.5	1.6	1.9	2.2
	Hard Rock	2	2.1	2.2	2.3	2.35
1.5m-3m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.2	1.3	1.4	1.5	1.6
	ASS areas	1.2	1.3	1.4	1.5	1.6
	Soft Rock	1.4	1.5	1.6	1.7	1.8
	Hard Rock	2.1	2.2	2.3	2.4	2.5
3.0m 4.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.2	1.3	1.4	1.5	1.6
	ASS areas	1.3	1.4	1.5	1.6	1.7
	Soft Rock	1.8	1.9	2	2.1	2.2
	Hard Rock	2.2	2.3	2.4	2.5	2.6
4.5m-6m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.5	1.6	1.7	1.8	1.9
	ASS areas	1.8	1.9	2	2.1	2.2
	Soft Rock	2	2.1	2.2	2.3	2.4
	Hard Rock	2.5	2.6	2.7	2.8	2.9
6.0m-7.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	1.6	1.7	1.8	1.9	2
	ASS areas	2	2.1	2.3	2.5	2.7
	Soft Rock	2.8	3	3.2	3.4	3.5
	Hard Rock	3	3.2	3.5	3.8	3.9
>7.5m	*Sand/Good Soil*	1	1	1	1	1
	Poor Soil	2	2.1	2.3	2.5	2.7
	ASS areas	2	2.1	2.3	2.5	2.7
	Soft Rock	2.8	3	3.2	3.4	3.5
	Hard Rock	3	3.2	3.5	3.8	4
Directional Drilling	*Soft Rock*	1	1	1	1	1
	Poor Soil	1.7	1.6	1.6	1.6	1.5
	Hard Rock	1.7	1.6	1.6	1.6	1.5

Sand/Good Soil	good working conditions with high excavation rates
Poor Soil	areas with high water content where pumping of trenches will be required N.B. for directional drilling this includes sands and/or soils with the potential to collapse after drilling making pipe setting difficult
ASS Areas	areas containing potentially acid sulphate soils, requiring additional handling/management works
Soft/Hard Rock	areas where rock will impact on excavation rates

Manholes

Table C-13 Manhole Installation – Recommended Unit Rates

Depth (m)	Manhole Diameter (mm)						
	1050	1200	1500	1800	2100[a]	Type F (900x900)	RIGS
0.0-0.9	$2,937	$3,160	$3,325	$3,725	$4,097	$2,208	$3,420
1.0-1.9	$4,791	$5,103	$5,235	$5,692	$6,261	$3,076	$3,420
2.0-2.9	$7,055	$7,499	$7,566	$8,093	$8,903	$4,091	$3,560
3.0-3.9	$9,805	$10,431	$10,399	$11,011	$12,112	$9,834	
4.0-4.9	$12,550	$13,349	$13,226	$13,923	$15,315	$15,999	
5.0-5.9	$17,205	$18,302	$18,021	$18,862	$20,748	$21,280	
6.0-6.9	$20,626	$21,961	$21,545	$22,491	$24,740	$29,752	
7.0-7.9	$25,127	$26,792	$26,180	$27,266	$29,992	$37,824	
8.0-8.9	$31,085	$33,127	$32,317	$33,587	$36,946	$48,199	
9.0-9.9	$35,597	$37,937	$36,965	$38,374	$42,211	$60,088	

Note a Price for 2100mm manholes estimated as 1800mm price plus 10% as size considered non-standard by contractors.

Sewage Pump Stations

Table C-14 Sewage Pump Stations – Recommended Component Cost Estimates

Sewage Pump Stations – Component Cost Estimates($2008)				
Volume (kL)	Civils	Power (kW)	Pipes/Valves	Mech/Elec
5	$51,962	0.5	$25,474	$18,101
10	$79,228	0.75	$26,405	$21,554
15	$108,531	1	$27,336	$49,341
20	$130,840	2.5	$30,069	$61,677
25	$166,840	5	$33,076	$77,096
30	$193,245	10	$42,200	$96,370
40	$249,417	20	$82,800	$172,400
50	$304,004	30	$100,188	$193,709
60	$335,164	40	$121,227	$217,651
70	$369,519	50	$146,685	$244,553
80	$439,887	60	$177,489	$307,397
90	$529,510	70	$214,762	$379,502
100	$551,343	80	$236,775	$468,521
110	$574,077	90	$261,044	$578,421
120	$597,748	100	$280,600	$714,100
130	$622,394	110	$297,689	$757,589
140	$698,606	120	$315,818	$803,726
150	$741,151	130	$335,051	$852,673

Sewage Pump Stations – Component Cost Estimates($2008)				
Volume (kL)	Civils	Power (kW)	Pipes/Valves	Mech/Elec
160	$786,287	140	$355,456	$904,601
170	$834,172	150	$377,103	$959,691
180	$884,973	160	$400,069	$1,018,136
190	$938,868	170	$424,433	$1,080,140
200	$996,045	180	$450,281	$1,145,921
210	$1,058,059	190	$477,703	$1,215,707
220	$1,103,012	200	$506,795	$1,289,744
230	$1,147,066	210	$537,659	$1,368,289
240	$1,191,539	220	$570,402	$1,451,618
250	$1,249,321	230	$605,140	$1,510,118
260	$1,298,821	240	$641,993	$1,540,472
270	$1,338,658	250	$681,090	$1,571,435
280	$1,378,548	260	$722,568	$1,603,021
290	$1,418,496	270	$766,573	$1,635,242
300	$1,458,510	280	$813,257	$1,668,110
310	$1,498,596	290	$862,784	$1,701,639
320	$1,538,759	300	$915,328	$1,735,842
345	$1,623,679			
595	$3,572,095			

Note 1 Volume includes allowance for emergency storage

Water Pump Stations

Table C-15 Water Pump Stations – Recommended Component Cost Estimates

Water Pump Stations – Component Cost Estimates ($2008)			
Pump Motor (kW)	**Civil**	**P&E**	**Mech/Elec**
10	$64,261	$35,701	$45,094
20	$105,440	$41,700	$75,600
30	$143,190	$45,965	$97,359
40	$173,772	$51,668	$116,021
50	$201,745	$60,725	$135,034
75	$232,979	$78,337	$163,619
100	$260,900	$96,936	$260,900
150	$276,000	$133,230	$322,050
200	$291,100	$171,030	$383,200
250	$329,054	$212,810	$392,721
300	$350,669	$257,115	$402,242
350	$372,626	$287,558	$440,391
400	$390,690	$332,971	$474,043
450	$400,567	$357,922	$516,704
500	$412,609	$383,732	$542,847
600	$421,579	$409,974	$592,458

700	$438,831	$436,396	$662,702
800	$457,617	$463,002	$722,917
900	$477,047	$489,801	$784,064
1000	$494,196	$516,800	$835,997
1050	$507,315	$541,580	$872,931
1100	$519,634	$566,576	$906,502
1150	$534,405	$591,798	$941,839
1200	$545,557	$648,008	$966,260
1250	$557,262	$674,959	$990,919
1300	$565,667	$702,163	$1,019,925
1350	$575,802	$729,631	$1,045,286
1400	$578,423	$757,373	$1,071,001
1450	$587,779	$785,400	$1,097,110
1500	$594,676	$813,724	$1,123,656

Reservoirs

Table C-16 Ground Level Reservoirs – Recommended Unit Rates

Volume (ML)	***Small Capacity*** *(Vol<8.0 ML)*	**Volume (ML)**	***Large Capacity*** *(Vol≥8.0 ML))*
0.3	$224,280	8	$3,196,585
0.35	$228,664	10	$3,541,512
0.4	$262,747	15	$4,505,410
0.45	$318,970	18	$5,332,897
0.5	$361,101	20	$5,520,326
1	$472,405	30	$6,826,569
2	$759,071	35	$7,746,964
2.5	$957,687	40	$8,353,750
3	$1,519,805	50	$9,587,682
4	$1,876,367	55	$10,623,784
5	$2,274,272	60	$11,306,909

Table C-17 Elevated Reservoirs – Recommended Unit Rates

Volume (ML)	**Steel** *(Vol≤0.1 ML))*	**Volume** (ML)	**Concrete** *(Vol≥0.1 ML))*
0.01	$139,751	0.1	$317,882
0.02	$170,074	0.15	$409,256
0.03	$183,119	0.2	$426,219
0.04	$254,949	0.25	$626,260
0.05	$265,039	0.3	$712,435
0.06	$280,998	0.35	$1,062,785
0.07	$296,708	0.4	$1,219,901
0.08	$313,514	0.45	$1,776,787
0.09	$329,787	0.5	$2,010,620
0.1	$346,545		