PREPARING A CONSULTANT BRIEF FOR A LARGE WASTEWATER INFRASTRUCTURE PLANNING PROJECT – A CASE STUDY OF PROJECT STORM 2.

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ABSTRACT

In 1996, Watercare Services commissioned its first dynamic computer model of its trunk wastewater collection network. Known as Project Storm, it was the largest water utility modelling project in New Zealand at the time. The construction of the model required interrogation, rationalisation and data cleansing of approximately 6,000 network components from both corporate asset management and GIS systems. The calibration of the model made use of 180 rain and flow gauges over its 400 square kilometre catchment area.

Project Storm was completed in 1999 and an international review panel concluded that the Project Storm model produced predictions that were as accurate as could realistically be achieved. Moreover, the panel noted that the project was well thought out and was delivered to a high standard of practice, and completed in accordance with recognised best practices. This fact was also recognised locally when Project Storm received an ACENZ Award.

Watercare has a programme in which its wastewater collection model is updated on a 10-yearly cycle, timed to coincide with the national census. The updates include the capture of latest rainfall and flow information to facilitate a full recalibration of the model and to reflect changes within sub-catchments. These changes include land development, population changes, and operational changes within the network itself. The update also provides an opportunity to utilise advances in modelling software technology and computer processing power. The 2006 update of the Watercare wastewater collection model was known as Project Storm 2.

In 2005, Watercare began work to prepare the project brief for Project Storm 2. A key focus in the development of the brief was an underlying objective that the Project Storm 2 model would be better than the original Project Storm model. Fundamental to this was to encourage the tendering consultants to bring innovation into the project and not to provide "regular old modelling".

Project Storm 2 was completed in 2008 on budget. A peer review determined that the project was innovative, applied sound engineering judgement as well as an appropriate quality assurance procedure. The peer review also concluded that the Project Storm 2 model was a substantial improvement on the previous Project Storm model.

This paper comments on the challenges in preparing the Consultants' Brief for Project Storm 2. It also provides discussion on the lessons learnt through the process, and ideas that may be useful for the planning and preparation of modelling briefs by client organisations in the future.

KEYWORDS

Modelling, flow survey, project management, sustainable pricing

1 INTRODUCTION

Effective scoping and management is fundamental to the organisations that are responsible for the planning, funding and delivery of publicly funded projects. This is even more important today given the economic climate and the dissatisfaction with recent council rate increases.

Modelling projects are no different in their requirement for scoping and management. Possibly more so given our industry's general lack of understanding of modelling projects and their perceived ability to absorb money for what appears to be little value.

Many client organisations are trying to get "more for less", which is encouraging lower quality outcomes and unsustainably low-priced tenders. This paper proposes that these organisations should instead be looking to get "what's right for what's paid".

It is widely recognised that managing these often complex, skill-intensive modelling projects can be challenging and at times appear impossible. This is not helped by the fact that modelling in New Zealand is still a relatively "young" engineering discipline and, as such, not well understood by the wider engineering community. Given this, it is most often a mistake to categorise modelling as a commodity service in the way that some of the more established engineering disciplines have been.

This wider lack of understanding of the modelling discipline is probably the primary reason that correct scoping of modelling projects in New Zealand has been so notoriously difficult. The consequence of incorrectly scoping the project manifests itself in the setting of unrealistic budgets. Unrealistic budgets lead to unsustainable tender prices, moving quickly onto the downward spiral of dissatisfaction with engineering (both as a professional body and as a career). This downward spiral is discussed later in this paper.

In this paper we are not suggesting that we inflate what modelling, or engineers in general, are doing in terms of value, quality, or price. We are instead seeking to initiate a better, more consistent approach to scoping, and ultimately the delivery of modelling projects and the engineering value they can bring. Better for the client organisation, who is ultimately responsible to the rate payer and better for the modellers and the reputation of the engineering profession in general.

We are proposing the development of a system by where client organisations are better supported in understanding and scoping their modelling engineering requirements. This will improve project budgeting and funding, and facilitate the engineering profession, providing value to the community and not a misunderstood commodity service. Under this approach, engineers will be able to remain passionate about their chosen profession, and yet remain challenged to meet the client's requirements and commercial realities. This is an achievable goal, as the example of Project Storm 2 will demonstrate.

2 MODELLING 101

2.1 OWNERSHIP OF MODELLING COMMISSIONS

In general, computer modelling projects in New Zealand have not always had the best success in delivering on their originally defined objectives. They are often considered to be late, over budget and the deliverables, particularly reports lack a degree of thoroughness; not always answering the question the client has asked. In a previous paper presented at a Water New Zealand conference, it was argued that this lack of success falls very much on the shoulders of the client[1].

It was postulated that it is the client who identifies the need for a modelling project; they scope it, set the budget, write the brief, tender it, evaluate proposals, and make recommendations for appointments. Moreover, they are responsible for providing project datasets, and are the only party with a direct (commercial) influence over the project for its duration.

As a public water utility, you are responsible for spending public provided money. As a chief executive of a public water utility once stated on this, you need to be able to look your neighbour, your mother, or whoever in the eye, and say, "yes I have spent your money wisely". Which of course doesn't necessarily mean getting the cheapest job, it means ensuring the best, most appropriate job is done, meeting the community's requirements.

2.2 THE 'PROBLEM' WITH MODELLING

In short, computer modelling is a relatively unevenly understood discipline of the engineering profession. As some put it, it is a necessary evil that precursors the real engineering of design and construction. Others see it as the project itself, the "be all and end all". The fact is computer modelling is a highly specialised engineering discipline. Decisions for operational changes which affect network performance and capital investments are often based on the predictions and interpretations of model outputs. As the focus on making better investment decisions increases, greater emphasis on confidence of the information and analysis that supports those investment decisions will occur. As such it's important to get the computer modelling right; the key to this is effective management of all aspects of computer modelling projects.

2.3 MODELLING, 'ENGINEERING OR ART'?

Modelling engineering is an art. The development of a model is more closely aligned to sculpture than traditional mechanistic engineering disciplines.

Sculpture takes time. It requires the artist to study and understand the stone from which the final form will be developed, and any flaws it may have that will affect the final quality of the form. Similar to assessment of asset data in modelling.

In shaping the sculpture, the artist uses different tools to transform the stone into its new form; the quality of these tools, combined with the experience of the artist, affect the final form. Similar to data processing tools, spreadsheets and level of experience in modelling.

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[1] *Project Management – The Key To Successfully Delivering Your Next Modelling* Project Myles Lind, Watercare Services Ltd; Matt Thomson, Opus International Consultants Ltd

The finishing of the final form of the sculpture requires a sound understanding of what tools and techniques are required to achieve the best finish. Similar to a model calibration process with the adjusting and refining of the various model parameters.

With sculpture, the artist sets the price for the final piece of work. Not similar to modelling. The price is agreed ahead of the work. Consequently, we have two directly opposing forces – quality of outcome versus commercial boundaries.

With modelling, these two opposing forces are able to be balanced if both the client and the consultant understand what the outcomes required are in terms of quality and limitations. However, all too often with modelling, one or both parties fail to adequately understand the projects attributes, making the balancing of quality and commercial forces impossible. Nobody truly wins this battle as it results in unsustainable engineering – both in terms of engineering solutions and in terms of the profession itself.

2.4 THE DOWNWARD SPIRAL

We have today a dichotomy on our hands: we wish to raise the profile of the Modeller and the value that modelling brings to our profession and our communities/society versus the desire to stay in business in hard economic times. This latter point can manifest itself in a "death by a thousand cuts" pricing war, in which no one will see the entirety of until it is too late.

This is obviously a negative, if not dire situation for the industry and our collective professional health.

The classical downward spiral as it pertains to modelling in New Zealand is illustrated in **Figure 1** below. The main aspects of this downward spiral are characterised by:

- Poor client understanding / scoping leading to:
  - Underestimate budget,
- Competitive tendering process leading to:
  - Acceptance of lowest price
- Consultants use this as a means to secure workload leading to:
  - Consultant margins low / limited on job training potential / project losses
  - Lower quality outcomes / low overall project satisfaction
- Consultant is unable to invest appropriately in staff / resources leading to:
  - Dissatisfaction by staff in profession
- Clients "sheltered" from consultants / industry dissatisfaction leading to:
  - No improvement in client understanding / scoping
  - Repeating of previous client mistakes / budget underestimates
- Competitive tendering process again leading to:
- Accepting lowest price which may now be at an unsustainable price level, leading to:
  - People leaving the profession. . .
  - Skills / resourcing shortages . . .
  - Projects / industry stops?

Best Estimated Price

Un-Sustainable Low Price

Figure 1

3 PROJECT STORM 2

Watercare's Asset Management Plan includes a rolling 10-yearly programme by where its wastewater collection model is upgraded. Project Storm 2 was the 2006 planned upgrade of Watercare's wastewater network model. Given the past issues with rationalising various city and regional population projections, Watercare made the decision to coincide the flow survey for Project Storm 2 with the national census.

The 10-yearly upgrade includes the capture of latest rainfall and flow information to facilitate a full recalibration of the model to reflect changes within its sub-catchments. These changes included land development, population changes, and operational changes within the network itself. The upgrade also provides an opportunity to utilise advances in modelling software technology and computer processing power.

A year out from the national census, Watercare began work to scope Project Storm 2 and prepare the consultants brief. The underlying goal of Project Storm 2 was to produce a better model than was produced during the original Project Storm. Fundamental to this was to encourage and enable the tendering parties to bring innovation to the project and not to provide "regular old modelling".

Project Storm 2 was completed in 2008 on budget, even though the programme had slipped by a couple of months. A peer review determined that Project Storm 2 was innovative, applied sound engineering judgement and an appropriate quality assurance procedure. The peer review also concluded that the Project Storm 2 model was a substantial improvement on the previous Project Storm model.

3.1 THE PROJECT STORM 2 APPROACH

The biggest challenge in developing the Consultant's Brief for Project Storm 2 was in scoping the project. In particular; what is in scope, what is out of scope and what are the deliverables. Underpinning this was the question around how do you prepare a brief that gives certainty of outcomes, without constraining innovation?

It was through attempting to balance these items that it was identified that stating the project objective clearly, combined with setting (and publishing) the budget for the project would ultimately guide the project in terms of scope, outcomes and innovation. The challenge was in ensuring the budget was realistic.

A key part of the scoping work for Project Storm 2 was to take a look back to what was learnt during the original Project Storm some ten years earlier. All of Watercare's staff who were involved in the original Project Storm had left the company. Watercare's solution to this lack of in-house knowledge was to facilitate a workshop that was attended by a number of key staff involved in the original project. This was undertaken by tracking down the authors of the various technical reports completed during the project. Watercare then arranged for people to be brought to Auckland at Watercare's expense for the workshop. An important part of this workshop was looking at what Watercare could have done better during the original project. Some of the key suggestions that came out of this workshop are summarised below:

- Watercare should make time available before the project commences to collate and date stamp key data sets. Additional information on the quality (Watercare's confidence) in the accuracy of the data should also be collected from both the planning and operations teams;
- A large amount of knowledge was gained on the quality of sites for flow and rainfall gauging during the original project, this information needs to be

recalled from company archives and made available for planning the surveys for Project Storm 2.

- Additional funding should be made available for increasing rain gauging density as Auckland exhibits a large spatial variation in rainfall across the Auckland region, due to the catchment size and topography (e.g. the Waitakere Mountains and numerous Volcano cones).
- Provide additional funding to facilitate on-the–job training. Provide allowance for engineers to visit key sites, undertake sketches, surveys and take photographs of key network structures and understand what flows and other 'field data' look like.

Clients are not always the best at setting clear objectives for a modelling project. There are times when a consultant will be asked to build a model, calibrate it, verify it, and run some options. The objectives of the project are lost in the client specifying the methodology, not actually specifying what they need as an outcome. All too often clients try to be the engineer, instead of letting the consultants be the engineer. The client should focus on clearly stating what they believe the modelling project objectives to be and, when possible, provide indicatively how much they have budgeted (time and funding) to achieve those objectives. From Auckland experience, and this is likely to be different for other clients, spending time, and effort specifying methodology and software is a wasted effort. It's the consultant's responsibility to be up to date with latest techniques, software technologies, sizes of hard drives, processing speeds and alike. As such it's the consultants who should be informing the client of the best methodology for achieving the project objectives within the planned budget.

Sometimes the clients' needs can be met without the development of a model. It's important that the client focuses on getting the right tool for the job and in particular focuses on achieving the projects objectives. We've all heard of the term "modelling for modelling's sake".

When scoping projects, clients could also give more consideration to scoping the project (and its deliverables) in manageable sized pieces. Experience has shown that modelling projects than span over a year generally don't stay 'on course' as well as modelling projects which are less than a year in duration. A recent example of this was a modelling project in which the staff changes over the 18 month period of the project resulted in only one member of the original client/consultant team being there to see the project completed – there was a complete change out of all the staff involved with the technical and management aspects of the job. It was only the project director from the consultant's side who remained – and as might be expected of such a role had very little to do with the project day to day anyway.

3.2 WHAT DID PROJECT STORM DO WELL?

On the client side of Project Storm 2, a number of things were done well. The first of these was to set and articulate a clear project objective and publish the project budget. This provides very clearly to the tendering parties the boundaries to the project and strong guidance for where efforts are best focused.

All of the tendering parties were provided with a working copy of the previous Watercare wastewater network model ahead of the tendering process. This enabled all of the tendering teams to understand model set up, assumptions, and time durations for completing simulations. All of which helped produce better, more accurate tenders.

Watercare's project manager spoke in black and white. There was never any "grey areas" in communications – which was an effective two-way process due to the experience in the consultant's modelling team. The Watercare project manager understood the difference between what is a nice to have and what was important to the project. As a result, key decisions which could affect project timelines and budgets were made fast and were final.

Watercare appointed a peer reviewer who was not in direct competition with the appointed consultant, namely Dr Achela Fernando from Unitec for Project Storm 2. Previous experience with Dr Fernando on an earlier Watercare project showed the lead consultant was more open to discussing their work and assumptions. This was due to the consultant understanding that the peer reviewer had a very strong focus on the technical aspects of the project and was not going to undermine their work and try to take future stages of work off them.

This approach was used for Project Storm 2 as historically, Watercare's experience with peer review consultant and lead consultants in direct competition has resulted in:

- Lack of trust between parties;
- Peer reviewer ignores budget and time constraints on project;
- Peer reviewer may attempt to 'show up' lead consultant;
- Peer reviewer may ignore data quality issues and their effect on project outcomes; and
- Peer reviewer requires additional detail, explanation, plots, tables figures to show results, not always of benefit.

Overall in Watercare's experience, lead consultants and peer review consultants who are in direct competition with each other will result in sub-prime outcomes. This approach places undue tension on the lead consultant; after all, you appointed them as the preferred consultant for the project.

From the consultant's side, strong well-proven project and technical management procedures were implemented and adhered to. There was also a healthy respect for the client and the client's ability and knowledge of modelling commissions.

Scope was constantly monitored and through regular and effective communications with the client's project manager, scope was properly understood. This meant that expectations were understood and scope creep was properly managed.

Figure 2 illustrates what can be achieved when both client and consultant understand the project scope and expectations.

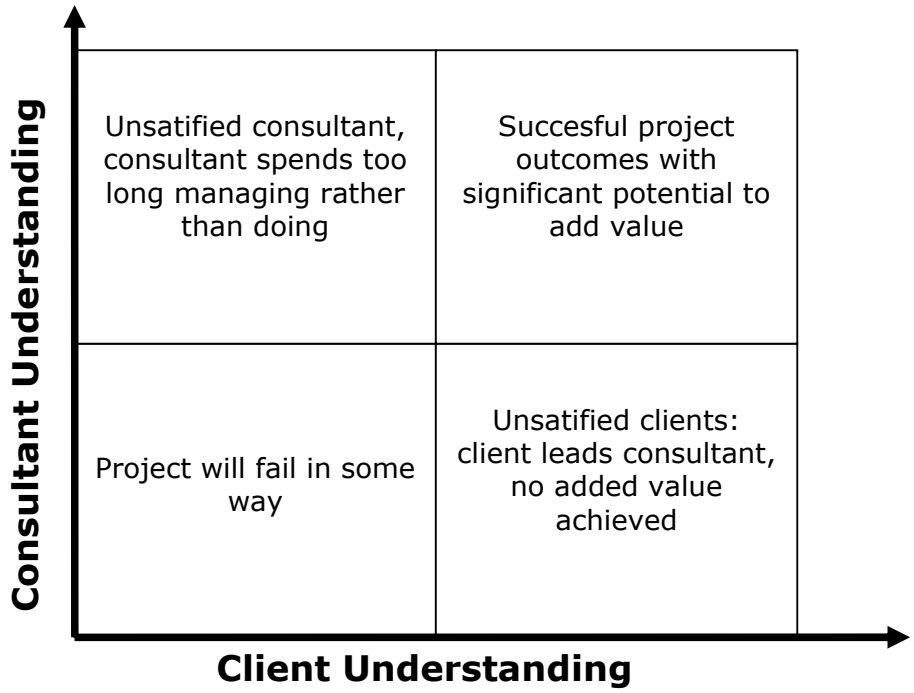


Figure 2

Another key aspect of the success of Project Storm 2 was the management and control of data, particularly flow survey data. This was reviewed weekly, that way we knew that we had good quality and coverage of data for calibration. It also meant we knew how many extra weeks of survey weren't needed, flow gauges were therefore on time and no delays to project or additional costs were incurred as a result.

4 APPLYING LESSONS LEARNT

What Project Storm 2 has shown us is that modelling commissions can be successful. Consequently, we will now identify key learnings that can be further developed to assist all those involved in modelling projects, clients and consultants alike, for the greater good of the New Zealand water industry.

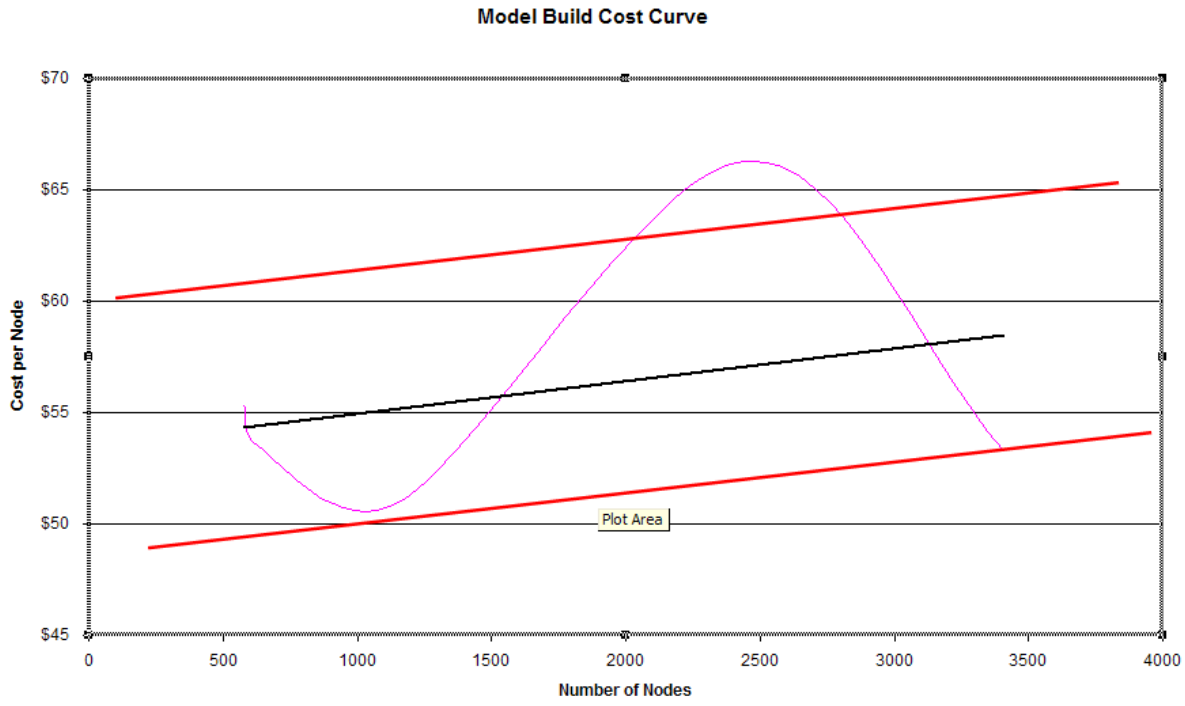
4.1 SETTING THE BUDGET

The underlying issues with sewer modelling are 1) getting good asset data and 2) getting good flow survey data. As many of you will point out this is not new, it's not rocket science, but it has been an issue now for as long as modelling has been in New Zealand. This paper proposes a new way of thinking to address these underlying issues. In short - set realistic budgets and let tendering parties know the budget. The budget for Project Storm 2 was developed in conjunction with Peter Kinley, who at the time was managing a citywide modelling programme for Auckland City. Peter was able to provide the most recent costing data on large scale flow surveys and help refine the estimates on the model development and calibration allowances. Through consultations with other water company modelling staff. As a result, when Watercare went to the market for consultants to lead Project Storm 2, tenders were published budget and tenders assessed on non-price attributes only.

4.2 MODELLING PROJECT COST CURVES

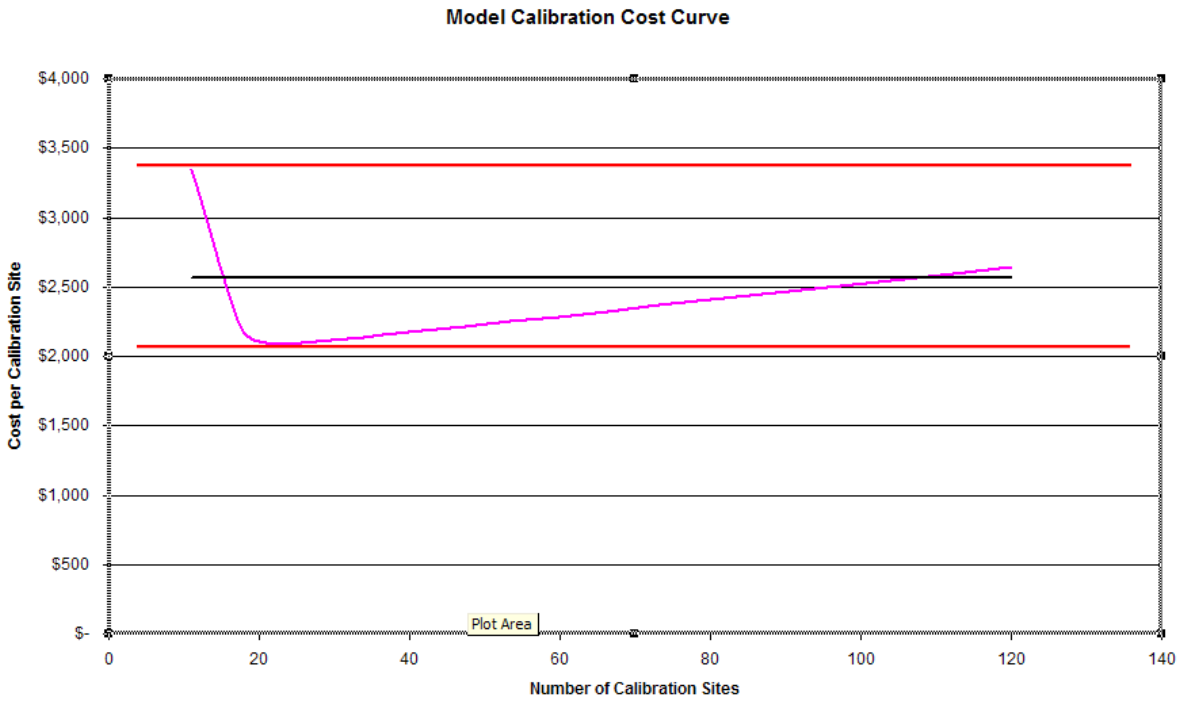
To help with setting realistic budgets this paper proposes the development of modelling cost curves. This is a concept which has already been implemented by IPENZ/ACENZ for other engineering disciplines[2]. The following are an initial attempt to develop similar curves for modelling projects. The curves provide a (red line) upper and lower bound that clients can use to estimate budgets for modelling projects – taken from real modelling projects from the Auckland area. The lower band represents simple or second generation modelling projects by where a model has already been developed and is suitable to be updated. The upper limit is where a more complex model is being developed. It should be noted that these curves are purely provided as an indicative budgeting envelope/estimation tool and are based on a limited number of modelling projects from Auckland .Going forward they will need further development, quality controls, and regular updating with new project cost data and adjusted as appropriate with national cost indices. Other disciplines of engineering have already share the same concerns as modelling engineers and have recently confirmed their commitment to addressing the issue of balance in regard to professional services procurement. IPENZ/ACENZ have already developed cost curves to assist in the setting of budgets for engineering project. Better project outcomes are achievable through quality-based selection which provides a reasonable budget for assessment of alternatives. Unsustainable tenders are those significantly below the clients estimate.

These modelling project cost curves provided below are a start. As a client, they will give you a general guide as to how much you should be budgeting for a particular modelling project.

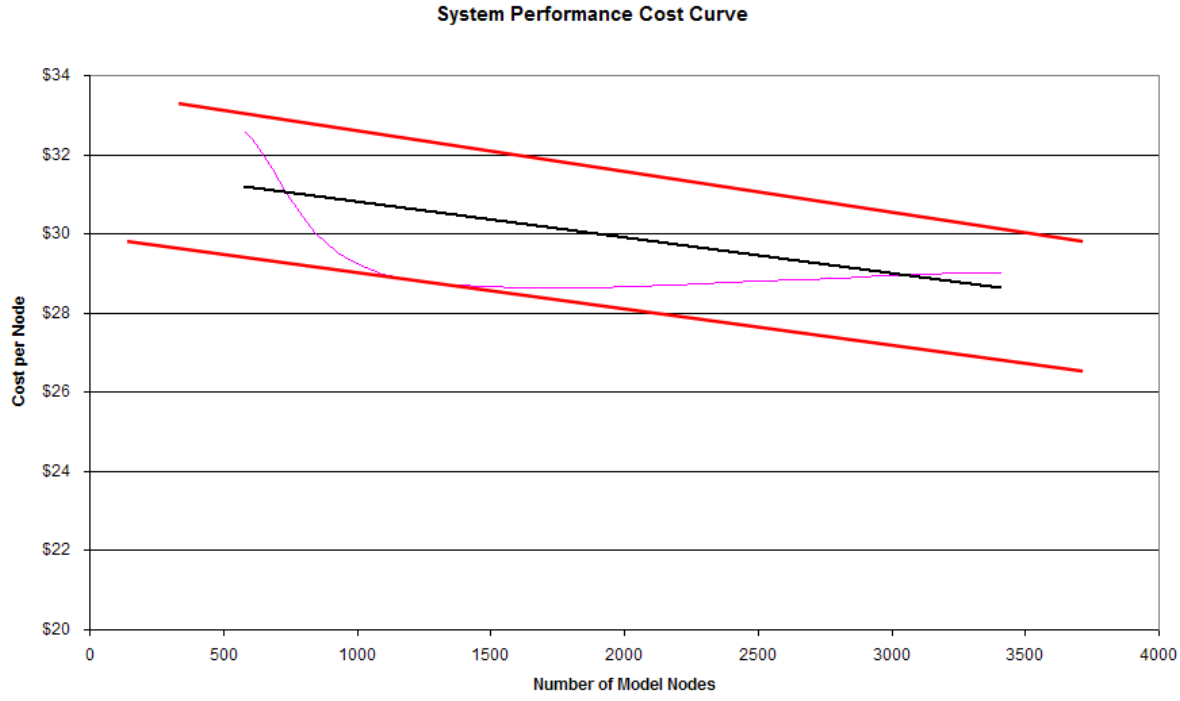


Source – Watercare 2008/2009

[2] IPENZ/ACENZ Fee Guidelines for Consulting Engineering Services January 2004 – 1st edition



Source – Watercare 2008/2009



Source – Watercare 2008/2009

4.3 FLOW SURVEYS

As a guide for a three month survey, flow survey costs are provided on a per site per month basis in the below table. Note – consultant led project management of a flow survey can incur a 10% to 40% premium on the below rates, depending on the frequency and level of auditing required on the data as it is collected.

	Easy Access	**Average** (Level 1 Traffic Management)	**Difficult Access** (Level 2 Traffic Management)
Flow Gauge	$900 / Site	$1,600 / Site	$2,200 / Site
Rain Gauge	$200 / Site	$225 / Site	$250 / Site

Source – Watercare 2008/2009

It's important to understand that both flow gauge and rain gauge sites need calibration and data collection. When the prices for gauging start to fall below the lower limits outlined above, it is likely that either the site visits are being reduced in frequency or shortcuts are being taken on the site calibrations. Either way, the quality of your data will likely be lower, ultimately resulting in a lower quality model, and poorer decision making capability based on that model. In short – you get what you pay for with flow surveys.

4.4 ASSESSING PRICED ATTRIBUTES

Modelling project tenders are normally assessed on weighted qualitative and price attributes. For the price attributes the highest grading is normally given to the lowest tender price – irrespective of how reasonable that price may be. The gradings are then reduced as the tender price increases.

Modelling is not alone with its accepting of low prices for projects. The challenge is ensuring that the tender price accepted is not unsustainably low, and hence has a negative impact over the short term (on the project) and over the longer term (on the engineering profession).

The challenge we face as a profession is that we acknowledge and accept that methods of procurement for professional services need to demonstrate a consideration of market competition. The challenge is balancing this against ensuring the engineering services are fit for purpose, value for money and are a true reflection of the market conditions.

As a profession, we have a responsibility to avoid unsustainable pricing. Unsustainable pricing of professional services contracts drive both new and experienced resources away from our profession. Moreover, it affects the quality of our services, increasing reputation risk.

Ensuring robust and realistic fee estimates are prepared and published in the briefing documents is important. The project budget, prepared by the client, should be published along with the project objectives as this gives the clear direction on the client's expectations of the project and its outcomes. Modelling project tenders have historically shown a significant, potentially irreconcilable, tender price range will occur when an estimate of the project budget is not published, up to 100% variations in some cases.

Methods have been developed around the world to discourage unsustainably low tender prices. In Australia, a method which uses both weighted qualitative attributes

with weighted the price attributes. The price attributes are graded highest on the median tender price. Gradings then decrease as the tender price moves further (both greater than and less than) the median tender price.

As an interim step, this could be a good process to be used in New Zealand for modelling projects. Once sufficient modelling projects have been completed based on a such a process, additional emphasis should be placed on the client organisations to provide published budgets and assess tenders on a 'limited – lowest price' approach. This approach would remove unsustainably low priced tenders from consideration, but not penalise tenders for innovation leading to price reductions or previous or expert experience which could also lead to cost savings on a project.

This latter approach provides opportunity for our profession to remain innovative and responsive to advancements in computing power and modelling tools – a key component of modelling engineering projects. This approach also acknowledges that innovation can provide cost savings and allow for a lower tender price. Obviously, reasonable limits need to be placed on the level of savings that innovation and experience can provide. To that end, as a starting point, it is proposed that innovation and experience cost savings be limited to not more than 10% of the clients budget estimate. Thus all tenders which are received that are less than 90% of the estimated project fee by the client should not be considered further in the evaluation.

An alternative to this would be for the client to undertake risk-adjusted costing to normalise the priced tenders, taking into account the risks to the project of utilising too much, or an untested innovation or method-short-cut. But this is a whole other debate.

4.5 CLIENT SUPPORT

The currently available forums for knowledge sharing are failing client organisations who undertake modelling projects. All too often these forums are led by consulting firms, with limited client organisation involvement. Up until recently the Water New Zealand Modelling Group only had one client organisation representative in its twelve party make up. Today there are two.

One solution to this is that client organisations could benefit from a client to client (C2C) forum or some other mechanism by where they can share their experiences and provide guidance to other clients. The challenge with setting up this type of forums is the distances between clients, and often they don't travel between cities very often for work as consultants often do.

This would tend to lend itself to a forum that meet during conferences, or a more regular session through social networking tools such as online chat-rooms, conference calls or possibly even through the Facebook website.

The forum could cover all manner of issues from, identifying business needs to scoping and budget reviews, to procurement and management of modelling services, all the way through to peer reviews. The forum could be structured or ad-hoc to meet the requirements of the client organisations.

It will be important that any guidance that is provided is done so by another client organisation who has sound experience in modelling projects, and has done the 'hard yards'. Perhaps a list of client organisation representatives should be published with their contact details. The primary aim of this forum would be to share good client knowledge between client organisations and ultimately have both the clients and the consultants (and our engineering profession) reap the benefits.

Resourcing the set up and maintenance of this forum will need to be worked through as part of a project plan for setting up the scheme. The scheme would also need to be agreed to in principal by an appropriate supporting body such as ACENZ, IPENZ and/or Water New Zealand.

SUMMARY

One of the key challenges facing modelling engineering is delivering on its potential benefits to the engineering profession and being commercial. As computing power increases, computer based engineering analysis, such as modelling, will become more and more mainstream. Modelling is still relatively new to New Zealand engineering firms, and as such it is still a bit of an unknown, a 'gimmick' until proven useful. Poor scoping and unsustainable budgets will not help modelling deliver its benefits to the engineering profession or the community at large.

This paper has attempted to show there is a way forward and a way to stop the downwards spiral. It also proposes industry standard project scoping tools to help clients get the scope and ensure project budgets are realistic right from the outset. From there all you need to focus on is:

- Clearly understanding the objectives and constraints of the modelling project;
- Manage expectations by ensuring both parties are realistic about what the modelling project will deliver;
- A client to client (C2C) support forum;
- The use and further development of project cost estimation curves; and
- Re-think lowest price tender assessments with either "median tender price" or "limited lowest price" evaluations.

5 ACKNOWLEDGEMENTS

We wish to acknowledge the comments and thoughts of our colleagues in the modelling profession who have helped in preparing this paper, in particular Peter Kinley for sharing with us his experiences in managing large modelling projects.

6 DISCLAIMER

This paper contains the opinions and points of view from the authors' perspective only. It does not necessarily represent the opinions or beliefs of Watercare Services Limited or Aurecon Consultants.

7 REFERENCES

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