DEVELOPMENT OF THE NATIONAL STORMWATER MODELLING GUIDE

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ABSTRACT

The purpose of this project was to develop a national stormwater modelling guide. The guide covers urban stormwater flood modelling, including urban streams and watercourses, but excludes major rivers except as they impact as boundary conditions on urban networks. The scope of the guide is to provide a nationally consistent and robust urban stormwater modelling process to aid in understanding flood risk and management. It will help address differences, inconsistencies and gaps in flood risk information including modelling, flood hazard maps and variations between council approaches, design standards and policies related to flooding. Having a holistic and consistent approach and understanding of the flood hazard in different areas provides certainty for planners, developers and engineers about the best ways to manage risk.

The national stormwater modelling guide provides a consistent framework for model planning, delivery and use for application by a diverse range of stakeholders. This paper will provide valuable insights to those who want to know more about the development process and the background thinking that informed the final guide.

Guide development was started by volunteers from the Water New Zealand Modelling Special Interest Group in 2019. The initiative was then allocated funding by the Department of Internal Affairs in late 2022 with Water New Zealand appointed as project managers and consultants engaged to complete the guide in early 2023. The process of reviewing current practices (local and international) began in March 2023 with a range of industry workshops and surveys delivered throughout the rest of 2023. A literature review, gap analysis and initial guide structure was published in October 2023. A final draft was completed in December 2023 and circulated to ~180 industry volunteers for feedback. The first edition of the guide is planned to be published in April 2024 for industry-wide use.

The work is being supported by an Advisory Group of volunteers from industry. Members include consultants, developers, local government staff, and representatives from the Ministry for the Environment and NIWA. The role of the Advisory Group is to provide feedback on work as the project progresses and ensure that the final guide is accessible, practical and cohesive for ongoing use in the wider industry.

This paper will provide an overview of the first edition guide and a discussion of:

- How workshops were used to understand industry needs, 'test' key content and influence the final document.
- The importance of model planning – why this ended up being the longest and most complex section of the guide.
- Lessons learned in developing a system to describe stormwater model types that linked clearly with purpose and end use of results.
- The challenge of creating an accessible guide (and not a detailed specification).

KEYWORDS

Stormwater, Modelling, Guide

INTRODUCTION

The purpose of the guide is to offer approaches and recommend resources for addressing inconsistencies and gaps in advice relating to computer modelling of urban stormwater systems and flood hazard mapping. It is intended to support and encourage holistic and consistent understanding of flood hazard, which lead to informed decisions about the best ways to manage risk. Councils, land developers and communities may use the guide to understand the simulation of flood risk and the use of model outputs to support a common understanding of urban flood risks and associated impacts.

The following items were in the scope of this project:

- Provide a nationally consistent and robust urban stormwater flood hazard modelling process to aid in understanding flood risk and management.
- Provide guidance and define best practice approaches for urban stormwater modelling.

The following topics were outside the scope of this document:

- Water quality, including sediment transport, and erosion and scour assessment. It is recognised that stormwater models may be used in these applications.
- Provide a detailed model build specification. Specification level guidance should be based on local conditions and provided by the organisation leading or procuring modelling work.
- Providing national rainfall-runoff guidance. A summary of common methods used in Aotearoa New Zealand is provided within the guide.

BACKGROUND

Guide development was started by Water New Zealand Modelling Special Interest Group volunteers in 2019. The initiative was then allocated funding by the Department of Internal Affairs in late 2022, Water New Zealand appointed as project managers and consultants engaged to complete the guide in early 2023. The process of reviewing current practices (local and international) began in March 2023 with a range of industry workshops and surveys delivered throughout the rest of 2023. A literature review, gap analysis and initial guide structure was published in October 2023. This initial work phase confirmed the need and scope for guide development.

A draft guide was completed in December 2023 and circulated to ~180 industry volunteers for feedback. The first edition of the guide is planned to be published in April 2024 for industry-wide use.

GUIDE OVERVIEW

This guide should be used as a reference by those procuring, building and using urban stormwater models as a set of best practice recommendations. The document aligns with the main processes of planning, building, using, sharing and maintaining urban stormwater models. The guide is structured around several key modelling processes. Figure 1 shows these processes, along with conceptual interactions between the processes that might occur.

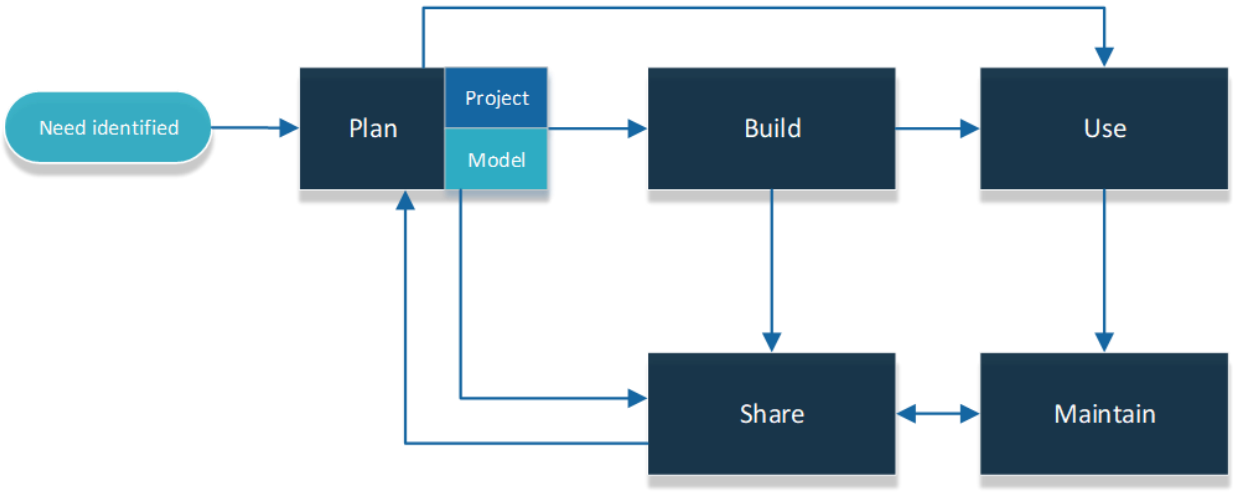

Figure 1: Key Modelling Processes

The premises behind these processes are that the project and then the model needs to be planned, a base model established, which is then used for the simulation of scenarios of interest. Once the simulations are complete, the models should be archived, the base model maintained, and model versions and/or metadata shared. Table 1 provides a summary of key content within each section of the guide.

Table 1: Guide Summary

No.	Section	Content Summary
1	Introduction	Purpose, guiding principles and user guide
2	Plan - Project	Define model purpose, engage with stakeholders, review background information and plan quality assurance
3	Plan - Model	Define success criteria, identify phenomena, confirm approach and methodology, select software, set model management practices and commence data collection
4	Build	Prepare hydrological inputs, build hydraulic model, set boundary conditions, complete quality assurance, define limitations and assumptions, assess model confidence and prepare reporting
5	Use	Test and compare current and future scenarios by varying model boundary conditions, hydrology and hydraulics (including blockage assessment)
6	Maintain	Approaches for archiving and updating model assets
7	Share	Managing intellectual property rights, metadata and data formats
8	Glossary	Definitions of technical terms
9	References	References used to create this guide and links to good practice examples

DISCUSSION

The following sections provide a discussion on lessons learned and challenges encountered during the development of the guide.

WORKSHOPS – AN EFFECTIVE TOOL FOR TESTING CONTENT AND GAINING BUY-IN

The structure and content of the guide was informed by a series of industry workshops. These were held at the following Water New Zealand events:

- Modelling Symposium Workshop – March 2023
- Online Workshop – April 2023
- Stormwater Conference Workshop – May 2023
- Conference and Expo - Workshop – October 2023
- Online Workshop – October 2023

These workshops provided opportunities for the project team to confirm the scope of the guide, collate background information, test draft content and obtain feedback from the industry. This proved to be valuable as it allowed key concepts around model planning and categorisation to be tested early on and revised before significant work was completed. Table 2 provides a summary of key questions asked at each of the workshop phases and outcomes realised.

Table 2: Workshop Summary

Phase	Key Questions	Outcomes
Early Project	• What is needed in the guide? • What is available now? • What works well / not so well?	• Confirmation of key content for the guide • Comprehensive list of existing literature to review • Wide range of opinions from experienced industry practitioners on which existing guidance is most effective
Mid Project	• Have we missed anything important? • What are the key gaps in current guidance? • Does the draft structure look OK? • What format should the guide be delivered in?	• Confirm that initial guide structure covers key requirements • Identification of any remaining gaps that the new guide needed to cover • Industry input on the best way to publish the guide
Late Project	• Do these key concepts / content make sense? • What are the barriers to achieving these things?	• Ensure that model planning fundamentals are appropriate and suitable for application in a range of contexts • Improved understanding of why other similar guidance documents / standards are not extensively adopted and how this project can do better

THE IMPORTANCE OF MODEL PLANNING

The authors found this section the most challenging to write out of the entire guide. It was found that most existing literature did not cover this stage of a stormwater modelling project in much detail – despite it being fundamental to the success of the project. The initial approach to the model planning section of this guide combined model 'confidence' concepts developed by the Department of Food, Environment and Rural Affairs (Defra) in the UK with components relating to input data reliability and method suitability. This approach was the subject of a workshop in the middle of the project. Feedback clearly showed that the confidence aspect was not appropriate in the context that it was applied. The approach was revised and is summarised in Figure 2. Subsequent workshops and feedback demonstrated the revised approach was well received. Some workshop participants also suggested applying the approach across all types of modelling projects (such as wastewater or water supply) as the concepts were robust and easily transferable.

As a result of workshops and industry feedback, the authors split the 'Plan' section into two. This allowed clear separation of content appropriate for those planning or procuring a modelling project at a high level and those involved in detailed model planning. This was a clear need for the industry based on the feedback received and workshop discussion.

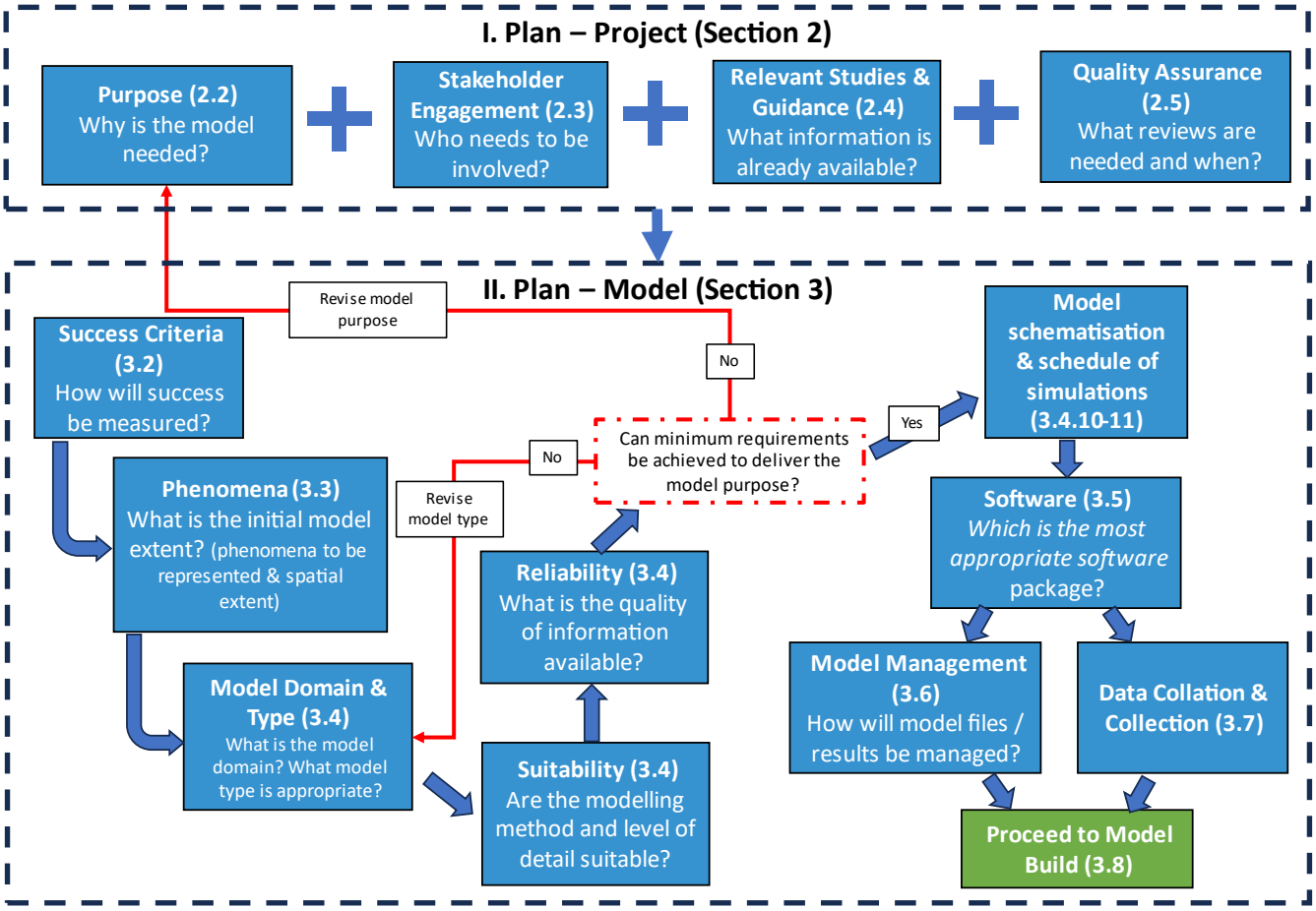

Figure 2: Model Planning Process

MODEL TYPES AND LINKS WITH PURPOSE

The fundamental concept applied in model planning was a clear link between modelling approach and purpose. The author's experience was that many modelling projects failed due to poor linkages between the overall purpose of building the model and the model approach selected. It is essential that that the work *begins with the end in mind.* The guide provides two concepts to guide selection of a modelling approach and the underlying components – *suitability* and *reliability*:

- A *suitable* approach can achieve the objectives defined by the model purpose.
- All model types or approaches can be *reliable* depending on the quality of the implementation and the data used. Some approaches require less comprehensive or sophisticated datasets to achieve acceptable reliability, but if data quality is poor then reliability will be low.
- No matter how *reliable* an approach may be, if it is not *suitable*, then it will not achieve the model objectives or project purpose.
- Quality of implementation is crucial for *reliability* and must be confirmed through quality assurance.
- A decrease in *reliability* is not the same as increased uncertainty. The latter is a result of selecting a lower or higher complexity modelling approach. Broader ranges of uncertainty should be accounted for when using a simpler approach through sensitivity analysis.

Figures 3 to 5 show how these concepts were integrated with the model planning process, provide further information on how they were defined and how they link with the model purpose.

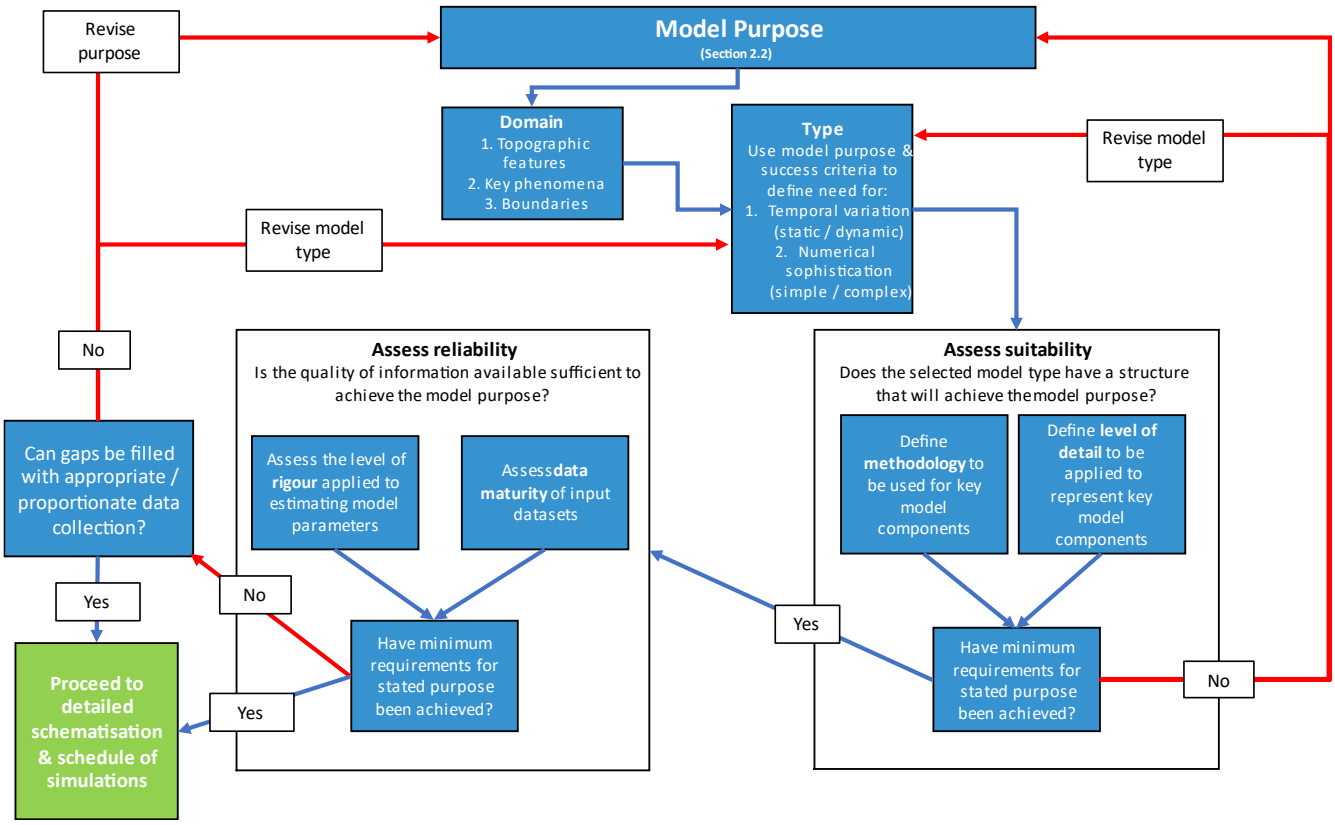

Figure 3: Detailed model planning process

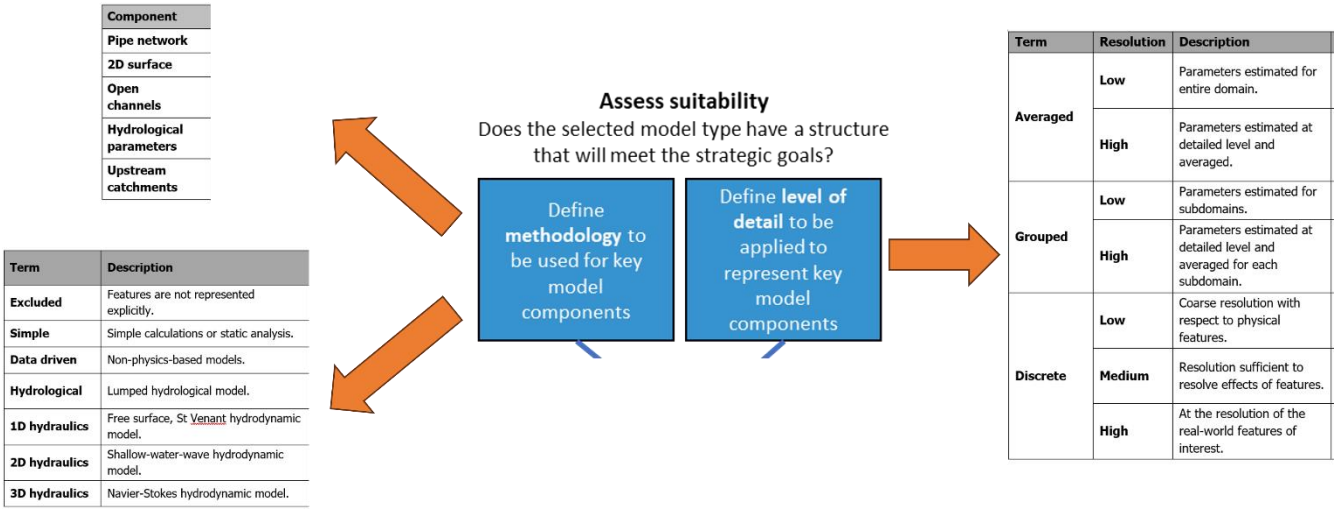

Figure 4: Assessment of Model Approach Suitability

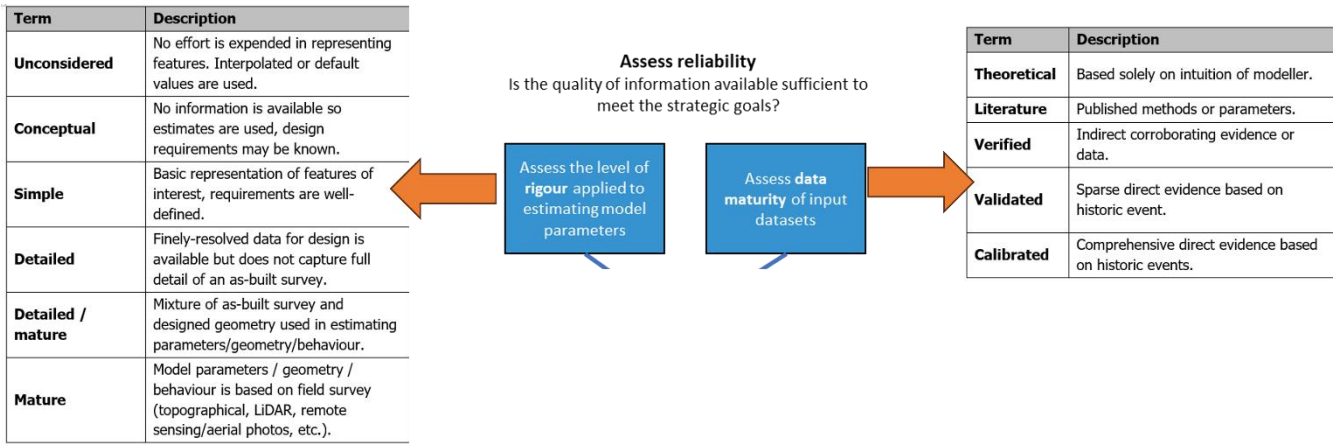

Figure 5: Assessment of Model Approach Reliability

ACCESSIBILITY - GUIDE OR SPECIFICATION

Workshops completed early in the development process showed that the guide needed to:

- Be accessible to a range of audiences
- Be applicable at a national level
- Not be a specification (as this was more appropriately applied at a local or regional level based on local conditions)

This presented a significant challenge to the authors as the level of detail needed to be enough to be useful to expert & non-expert audiences, but not become so detailed that it could not be applied nationally. This challenge was addressed through varying the level of detail through the document based on the intended end user of each section. Examples of this include:

- Providing a user guide in the Introduction to link readers with content relevant to them.

- Splitting the 'Plan' section into Plan – Project and Plan – Model to reflect the different needs of users applying the guide in a procurement context or for detailed model planning.
- Writing the 'Build' section in way that allows readers to clearly identify the sections they need and read them in isolation (without having to read the section linearly from start to finish).

The guide publication format was also discussed in the workshop sessions. Feedback received suggested that publication of the guide in website and PDF format would meet the needs of most users. This allows users to quickly search, access and apply individual sections (website format) or print & annotate (PDF format) based on their personal preferences. This publication method also allows for:

- Clear version control and change management
- Ease of update in the future
- Enabling innovation and adaption of the guide to meet end user needs

NEXT STEPS

The feedback collected through workshops and industry surveys along with input from the authors and Advisory Group was consolidated into a potential future work programme as summarised below. It should be noted that the items described below are currently unfunded and are provided as recommendations for future direction only.

- Develop a standard national methodology for rainfall-runoff estimation.
- Address issues around inconsistent language and poor understanding of common technical terms associated with extreme rainfall, flooding and flood mapping.
- Determine the need, scope and support for developing national water quality modelling guidance.
- Develop a framework for training and recognising professionals involved with stormwater modelling.
- Definition and interpretation of flood hazard based on recent flooding experiences in Auckland and the Hawkes Bay leading to government funded property buy-outs.

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