



## Structured internal project application 2025-2026

### Proj Project Overview

<b>Project name: (Short title)</b>	Development of QMRA Workflow Engine
<b>Staff: (who will be completing the work?)</b>	Reza Moghaddam (Lead Developer - 150 hrs), David Wood (Model Review & Support - 40 hrs)
<b>Project Manager: (usually a Group Manager)</b>	Andrew Hughes
<b>Region:</b>	Hamilton
<b>Centre:</b>	Freshwater
<b>Type: (science, operations activity, or other - explain)</b>	Science (Applied Research & Development)
<b>Budget: (attach costing prepared by your project coordinator)</b>	
<b>Project objective: (30 words max)</b>	Develop a Python-based QMRA workflow engine to standardise processes, reduce manual work, and improve efficiency of regulatory compliance assessments.
<b>Project outline: (150-300 words max)</b>	<p>NIWA currently undertakes QMRA projects that require significant manual effort for each assessment. Based on our recent project experience, typical QMRA projects involve 40-60 hours of manual work including dose-response model setup, treatment calculations, simulation configuration, and report generation.</p> <p>This project will develop a Python-based QMRA workflow engine to standardise these processes. The system will automate routine calculations, provide validated dose-response relationships for common pathogens, and generate standardised reporting templates. This approach will reduce manual effort and improve consistency across projects.</p> <p>The technical implementation will use Python's scientific libraries (NumPy, SciPy, pandas) for computational tasks and create reusable modules for pathogen databases, treatment assessment, and risk simulation. The modular design will allow for easy updates and extensions as new requirements emerge.</p> <p>NIWA has established capabilities in QMRA through previous projects for regulatory clients. The workflow engine will enhance our ability to deliver timely, consistent assessments while maintaining technical rigour. The system will be designed to support regulatory compliance requirements and provide clear documentation for decision-making.</p>
<b>Project outputs: (e.g., a journal paper or an App, or a safe operating procedure or guidance document for operations activities)</b>	<ul style="list-style-type: none"> <li>• QMRA Workflow Engine (Python application)</li> <li>• Technical documentation and user guide</li> <li>• Standardised pathogen database with dose-response relationships</li> <li>• Template reporting system for regulatory compliance</li> </ul>
<b>Project impact: (choose an SCI impact area that the project aligns with, see graphic below)</b>	Protecting our diversity Improved environmental health

**Commented [DW1]:** I would probably mention reproducibility and auditability. i.e improving the efficacy of the process

**Commented [DW2]:** We generally don't calculate the efficacy of a treatment, although sometimes we do. How do you propose to do those calculations, and how will this tool help? Often, engineers do this work with challenge tests and site-specific information. We often work with a range of Log reduction values

**Commented [DW3]:** I think you need to build a case for using Python when the rest of the QMRA community uses R? Is it to integrate with dilution model APIs and which ones? How do our colleagues do the diluting modelling?

**Commented [DW4]:** What do you mean? Do you mean just taking something off the shelf or developing our own dose-response relationships?

**Commented [DW5]:** That would be good 😊

**Commented [DW6]:** Sounds good, is this just for us, or is it to share?

**Commented [DW7]:** You know the regulatory framework is changing, we just don't know what too

**Alignment: (with a programme and/or National Centre outcomes or KPIs)**

This project aligns with the Freshwater Centre's analytical capabilities development and supports regulatory compliance services. It enhances NIWA's technical capacity for water quality risk assessment and supports our role in environmental protection.

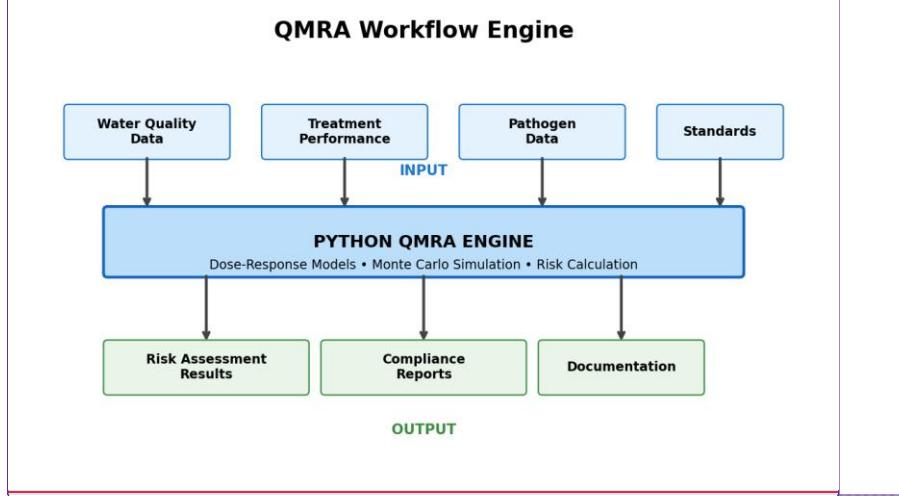


Figure 1: QMRA Workflow Engine - Streamlined architecture for efficient risk assessment

**Outcomes for Māori: (may include partnerships, resourcing, alignment with aspirations)**

Supporting improved water quality assessment capabilities that contribute to protecting water bodies important for cultural values and mahinga kai.

**Commented [DW8]:**

Commented [DW9R8]: This is a simplified representation of how QMRA works. I think you should look at the Freshwater Microbiology Research Programme Report (2002) which shows some alternative ways we can model risk

Commented [DW10]: We don't usually have any relevant water quality data, if we did, it would be easy 😊. There are also no standards 🤪 only guidelines.

**Operations alignment: (for non-science projects, how does this work contribute to inputs or enablers from the graphic below)**

Not applicable

## WORK PROGRAMME AND TIMELINE

Outline the tasks to be done, who will do what and by when. Be as specific as possible.

Task	Specific activity (who, what)	By when	Hours
Requirements & Design	System architecture definition, QMRA methodology analysis, stakeholder consultation (Reza)		30
Core Development	Pathogen database creation, dose-response model implementation, Python framework development (Reza)		60
Advanced Features	Monte Carlo simulation engine, statistical modelling implementation (Reza)		35
Testing & Validation	Performance testing, validation against known benchmarks, quality assurance (Reza)		25
Model Review & Validation	Technical review of QMRA models, validation of dose-response relationships (David)		25
Documentation	Technical documentation, user guides, training materials (David)		15
Deployment & Transfer	System deployment, staff training, knowledge transfer protocols (Reza/David)		10

## EMERGING COLLABORATION OPPORTUNITIES

Recent developments have strengthened the business case for this QMRA workflow engine. New Zealand Institute for Public Health and Forensic Science (PHF) has approached NIWA to develop QMRA guidance specifically for shellfish safety assessment. PHF has confirmed their interest through direct communication with Taumata Arowai about collaborating with NIWA on this initiative.

This emerging opportunity demonstrates immediate market validation for our QMRA capabilities and provides direct application potential for the workflow engine in shellfish safety assessment. The collaboration creates strategic partnership opportunities with regulatory bodies and demonstrates that there is demand for NIWA's enhanced QMRA services.

The shellfish QMRA guidance project would serve as an ideal pilot application for our workflow engine, providing real-world validation while generating project revenue. This collaboration would allow concurrent testing and refinement of the system with actual regulatory requirements, potentially offsetting some development costs through direct application to a paying project.

Project Overview

Project name:	Development of QMRA Workflow Engine
---------------	-------------------------------------

**Commented [DW11]:** I think this task is a bit bigger, either pump up the hours or create a new task around understanding the problem - make sure you know what QMRA is about. I suggest creating a new task. Why don't you explore what the current models do and how they do it.

**Commented [DW12]:** You only need to start of with one pathogen, norovirus, get that to work first, then you are 95% there

**Commented [DW13]:** You are missing bits about exposure assessment

**Commented [DW14]:** This might be harder than you imagine. Need to create a plan as to what an adequate performance is

<b>Staff:</b>	Reza Meghaddam (Lead Developer – 150 hrs), David Wood (Model Review & Support – 40 hrs)
<b>Project Manager:</b>	Andrew Hughes
<b>Region:</b>	Hamilton
<b>Centre:</b>	FRESHWATER
<b>Type:</b>	Science (Applied Research & Development)
<b>Project objective:</b>	Develop a Python-based QMRA workflow engine to reduce project delivery time by 60-70% and capture greater market share in the expanding regulatory compliance sector.

#### Project Outline

Quantitative microbial risk assessment (QMRA) represents the gold standard for evidence-based decision making in water and food safety. With national wastewater performance standards becoming mandatory in August 2025 and approximately 60% of treatment plants requiring consent renewals, there is urgent market demand for efficient QMRA delivery capabilities.

This project will develop a comprehensive Python-based QMRA workflow engine from the ground up. Current QMRA projects require 80-100 hours of manual work: 20 hours building dose-response models, 25 hours on treatment calculations, 15 hours for simulation setup, and 40 hours for reporting. Our workflow engine will reduce this to 20-30 hours through standardized components, automated processes, and reusable modules.

The technical approach leverages Python's full ecosystem including NumPy/SciPy for numerical computations, pandas for data management, and specialized libraries for statistical modelling. This native Python implementation ensures optimal performance, maintainability, and integration with modern data science workflows. The system will incorporate advanced methodologies including Bayesian approaches for parameter uncertainty quantification, validated through recent applications in dairy product safety, respiratory pathogen policy, and wastewater treatment risk assessment.

Recent New Zealand specific research validates the critical need for localized QMRA approaches, particularly for recreational and drinking water contamination assessment and emerging pathogens. Our workflow engine will position NIWA as the premier provider of regulatory-grade QMRA services in this expanding market.

Expected outcomes: 60-70% reduction in project delivery time, improved competitive win rate from 60% to 80-85%, and strategic positioning for the \$25-50M regulatory compliance market opportunity. Investment recovery is projected through 2-3 projects, with \$100-200K additional annual revenue from enhanced competitive positioning.

#### System Architecture

- The QMRA Workflow Engine will be built as a comprehensive Python application featuring automated processing modules and standardized outputs for regulatory compliance. The modular architecture enables:
  - Pathogen Database Module: Standardized dose-response relationships using Python statistical libraries
  - Treatment Assessment Module: Automated log-reduction calculations with NumPy/SciPy
  - Risk Simulation Engine: Monte Carlo analysis with uncertainty quantification using native Python implementations
  - Regulatory Reporting Module: Automated compliance documentation and visualization
  - Data Management Layer: Robust data handling using pandas and modern Python data structures

**Commented [AH15]:** Is this really the case? Most of the QMRA work seems to be very small projects. How many have been in the vicinity of 80-100 hours?

**Commented [RM16R15]:** This is based on the last QMRA job we did a long time ago. I might have overstated it, though. Any thoughts, David?

**Commented [AH17]:** This is not a big issue here, but one you need to consider when writing ESI reports, proposals etc in the future,, you should use NZ English, not US English.

**Commented [RM18R17]:** Thank you for this. I have corrected the American English spellings throughout the document

**Commented [AH19]:** I think you should avoid hyperbole and sell this proposal on facts

**Commented [RM20R19]:** I believe I have addressed your point in the updated version.

**Commented [AH21]:** Where did these numbers come from? They are very optimistic, we need to be realistic when presenting such numbers.

I think you need to:  
 1) indicate how much QMRA work we are currently obtaining (David you might know this?). (\$ value, number of projects).  
 2) indicate how the proposed tool will bring in more work or improve value?

If our client base or demand for our service does not increase, and we can do QMRA quicker in the future because of this tool, then there is a risk of less \$ for ESI.

**Commented [RM22R21]:** I have removed the specific revenue projections (\$100-200K additional annual revenue) and competitive win rate improvements (60% to 80-85%) as these cannot be substantiated with current data. The revised proposal focuses on operational efficiency improvements and process standardization benefits that can be measured and validated.

**Commented [AH23]:** Avoid trying to explain things in bullet points. A narrative would be more useful.

I'm not sure how this stuff is useful for selling the proposal.

**Commented [RM24R23]:** I have converted all bullet points to narrative format and focused the technical discussion on how the system will improve our operational capabilities rather than detailed implementation specifics.

## QMRA WORKFLOW ENGINE ARCHITECTURE

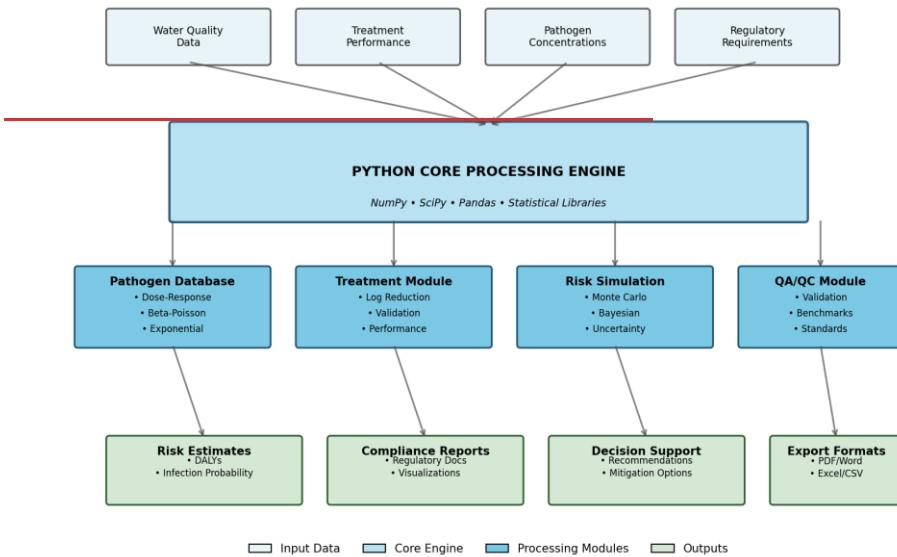


Figure 1: QMRA Workflow Engine Architecture – Non-overlapping modular design ensures efficient data flow and processing

## WORK PROGRAMME

Task	Specific Activity	Responsible	Hours
Requirements & Design	System architecture definition, QMRA methodology analysis, stakeholder consultation	Reza	30
Core Development	Pathogen database creation, dose-response model implementation, Python framework development	Reza	60
Advanced Features	Monte Carlo simulation engine, Bayesian uncertainty quantification, statistical modeling	Reza	35
Testing & Validation	Performance testing, regulatory benchmark validation, quality assurance protocols	Reza	25
Model Review & Validation	Technical review of QMRA models, validation of dose-response relationships	David	25
Documentation Review	Review of technical documentation, user guides, and training materials	David	15
Deployment & Transfer	System deployment, staff training, knowledge transfer protocols	Reza/David	10

Total Project Duration: 2 months

Effort Breakdown: Reza Moghaddam – 150 hours (Development Lead), David Wood – 40 hours (Model Review & Support)

Commented [AH25]: These hours look reasonable as far as a SIP goes

## EMERGING COLLABORATION OPPORTUNITIES

Recent developments have strengthened the business case for this QMRA workflow engine. PHF has approached NIWA to develop QMRA guidance specifically for shellfish safety assessment. PHF has confirmed their interest through direct communication with Taumata Arowai about collaborating with NIWA on this initiative.

This emerging opportunity demonstrates:

- Immediate market validation for our QMRA capabilities
- Direct application potential for the workflow engine in shellfish safety assessment
- Strategic partnership opportunities with regulatory bodies (PHF and Taumata Arowai)
- Enhanced revenue potential beyond initial projections

Commented [AH26]: Who is PHF?

Commented [RM27R26]: I addressed the acronym. It's the New Zealand Institute for Public Health and Forensic Science

The shellfish QMRA guidance project would serve as an ideal pilot application for our workflow engine, providing real world validation while generating immediate revenue. This collaboration would accelerate the development timeline through concurrent testing and refinement with actual regulatory requirements.

Commented [AH28]: Narrative rather than bullet points

Commented [AH29]: Can we charge time to this shellfish project to recover the development costs

Commented [RM30R29]: I will leave that for David to respond to.

## **Technical Foundation & Risk Assessment**

### **Technical Strengths:**

- Pure Python implementation ensures optimal performance and maintainability
- Comprehensive use of mature Python scientific libraries (NumPy, SciPy, pandas)
- Modern software architecture enabling easy extension and customization
- No dependency on external statistical software reducing licensing costs and complexity

### **Risk Mitigation:**

- Technical Risk: LOW – leveraging mature, well supported Python ecosystem
- Implementation Risk: MINIMAL – single developer approach ensures consistent architecture and design
- Deployment Risk: LOW – modular Python design allows phased rollout and validation

Research Foundation: Advanced QMRA methodologies including Bayesian hierarchical modeling for parameter uncertainty reduction provide proven approaches for systematic risk assessment. New Zealand specific pathogen research validates the critical need for localized analytical tools.

## **Strategic Alignment**

This project directly supports NIWA's Impact Strategy through:

- Competitive Positioning: Establishing NIWA as the market leader in regulatory compliance QMRA services
- Regulatory Engagement: Enhanced capability to support national wastewater performance standards
- Technical Innovation: Modern Python based solution providing superior performance and maintainability
- Revenue Growth: Capturing disproportionate market share in the expanding regulatory compliance sector

The workflow engine represents a strategic investment in NIWA's long term competitive position, transforming current operational inefficiencies into market leading capabilities that directly support regulatory compliance objectives across New Zealand.

**Commented [AH31]:** Narrative not bullet points

**Commented [AH32]:** My concern here is that we are developing a tool but that does not mean we will become a market leader. Some effort is required to sell it so clients know about it

**Commented [RM33R32]:** This is a very valid concern. I have removed claims about becoming a "market leader" and instead focused on how the tool will improve our capabilities and operational efficiency. The revised proposal acknowledges that developing the tool is just the first step and that additional effort will be required to promote and implement it effectively with clients.

## **CHIEF SCIENTIST SUPPORT**

Chief Scientist comment: (For example - If agreement that project required, indicate why SIP mechanism versus Centre Funds; What is/are the key output(s) and how will NIWA/National Centre/programme/individual benefit from that; note that there must be an output at the end of the project)

Signature