Structured internal project application 2025-2026

Project Overview

Project name:	Development of QMRA Workflow Engine
Staff:	Reza Moghaddam (Lead Developer - 150 hrs), David Wood (Model Review & Support - 40 hrs)
Project Manager:	Andrew Hughes
Region:	Hamilton
Centre:	FRESHWATER
Type:	Science (Applied Research & Development)
Project objective:	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 standardiszed 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.

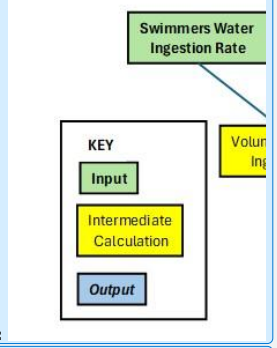
Expected outcomes: 60-70% reduction in project delivery time, improved competitive win rate from 60% to 80-85%, and strategic positioning for the $25-50M regulatory compliance market opportunity. Investment recovery is projected through 2-3 projects, with $100-200K additional annual revenue from enhanced 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 [DW1]: I would probably mention reproducibili
Commented [RM2R1]: absolutely correct. Reproducibility a
Commented [DW3]: We generally don't calculate the efficac
Commented [RM4R3]: You're right that treatment efficacy
Commented [DW5]: I think you need to build a case for usin
Commented [RM6R5]: WELL, Python was chosen for
Commented [DW7R5]: That's a good answer - internal
Commented [DW8]: What do you mean? Do you mean just
Commented [RM9R8]: I needed to be much clearer - definit
Commented [DW10]: That would be good
Commented [DW11]: Sounds good, is this just for us, or is it
Commented [RM12R11]: Scope focuses on internal
Commented [DW13]: You know the regulatory framework i
Commented [RM14R13]: - Emphasized competitive



Commented [DW15]:
Commented [DW16R15]: This a a simplified representation
Commented [RM17R15]: - Expanded scope to understand
Commented [DW18]: We don't usually have any relevant
Commented [RM19R18]: Modified architecture for scenari
Commented [DW20]: I think this task is a bit bigger, either
Commented [RM21R20]: New dedicated task addresses yo
Commented [DW22]: You only need to start of with one
Commented [RM23R22]: "focus initially on norovirus as a
Commented [DW24]: You are missing bits about exposure
Commented [RM25R24]: New task: "Implementation of
Commented [DW26]: This might be harder than you imagin
Commented [RM27R26]: Tasks now include: "performanc
Commented [AH28]: Is this really the case? Most of the QM
Commented [RM29R28]: This is based on the last QMRA jo
Commented [AH30]: This is not a big issue here, but one yo
Commented [RM31R30]: Thank you for this. I have correct
Commented [AH32]: I think you should avoid hyperbole and
Commented [RM33R32]: I believe I have addressed your
Commented [AH34]: Where did these number come from?
Commented [RM35R34]: I have removed the specific rever
Commented [AH36]: Avoid tying to explain things in bullet
Commented [RM37R36]: I have converted all bullet points

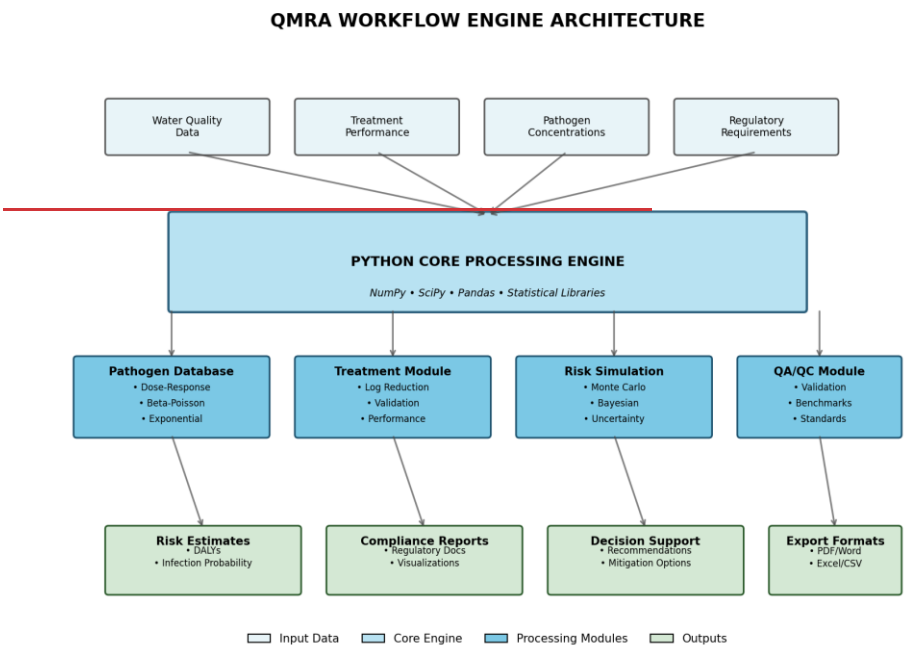


Figure 1: QMRA Workflow Engine Architecture - Non-overlapping modular design ensures efficient data flow and processing

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)

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

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 [AH38]: These hours look reasonable as far as a SIP goes

Commented [AH39]: Who is PHF?

Commented [RM40R39]: I addressed the acronym. It's the New Zealand Institute for Public Health and Forensic Science

Commented [AH41]: Narrative rather than bullet points

Commented [AH42]: Can we charge time to this shellfish project to recover the development costs

Commented [RM43R42]: 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~~

Commented [AH44]: Narrative not bullet points

~~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~~

Commented [AH45]: 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 [RM46R45]: 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.

~~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.~~

Project Overview	
Project name: (Short title)	Development of QMRA Assessment Toolkit
Staff: (who will be completing the work?)	Reza Moghaddam (Lead Developer - 170 hrs), David Wood (Model Review & Support - 40 hrs)
Project Manager: (usually a Group Manager)	Andrew Hughes
Region:	Hamilton
Centre:	Freshwater
Type: (science, operations activity, or other - explain)	Science (Applied Research & Development)
Budget: (attach costing prepared by your project coordinator)	
Project objective: (30 words max)	Develop a Python-based QMRA assessment toolkit to standardise processes, improve reproducibility and auditability, and reduce manual work for regulatory compliance assessments.
Project outline: (150-300 words max)	Earth Sciences New Zealand currently undertakes QMRA projects using @Risk Excel add-in, which has proven problematic and costly. Recent projects have lost up to 80 hours due to security system conflicts, requiring client extensions and budget overruns. Based on our project experience, typical QMRA projects involve 40-60 hours of work including dose-response model setup, exposure assessment, dilution modelling integration, simulation configuration, and report generation using @Risk. This project will develop a Python-based QMRA assessment toolkit

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Commented [RW47]: Define acronym

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Commented [RW48]: Where in the system - NIWA firewall? Microsoft? We don't need lots of detail but greater clarity would be useful

Commented [RW49]: I think this is commercial, licensed software - it's worth adding this detail here

	following a Minimum Viable Product (MVP) approach, focusing specifically on norovirus exposure scenarios for primary contact and shellfish consumption. The toolkit will replace @Risk dependency, incorporate Earth Sciences New Zealand's dilution modelling capabilities (our key differentiator), and work with engineer-provided log reduction values rather than attempting complex treatment calculations. This focused approach avoids the 'do everything' trap while delivering immediate value. The Python implementation will upskill Reza's technical capabilities in the QMRA methodology while maintaining our competitive position in the QMRA market. The toolkit will integrate dilution modelling inputs, automate routine calculations, and generate standardised outputs. While Charlotte Jones-Todd has developed an R package, this Python approach provides greater integration with Earth Sciences New Zealand systems and builds internal technical depth essential for our $40-70K QMRA projects that generate additional consenting work opportunities.
Project outputs: (e.g., a journal paper or an App, or a safe operating procedure or guidance document for operations activities)	• QMRA Assessment Toolkit (Python MVP replacing @Risk dependency) • Norovirus exposure models for primary contact and shellfish consumption • Dilution modelling integration module (NIWA's key differentiator) • Validated dose-response database with engineer-provided LRV inputs • Standardised reporting templates for regulatory compliance
Project impact: (choose an SCI impact area that the project aligns with, see graphic below)	Protecting our diversity Improved environmental health
Alignment: (with a programme and/or National Centre outcomes or KPIs)	This project aligns with Earth Sciences New Zealand's analytical capabilities development and supports regulatory compliance services. It enhances our technical capacity for water quality risk assessment and supports our role in environmental protection. The improved reproducibility and auditability will strengthen our credibility with regulatory bodies.
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. The enhanced QMRA capabilities will support decision-making that considers cultural significance of water resources and traditional food gathering practices.
Operations alignment: (for non-science projects, how does this work contribute to inputs or enablers from the graphic below)	Not applicable

Commented [RW50]: Enhancing?

Commented [RW51]: Move this to the first paragraph, to provide context to the typical QMRA projects?

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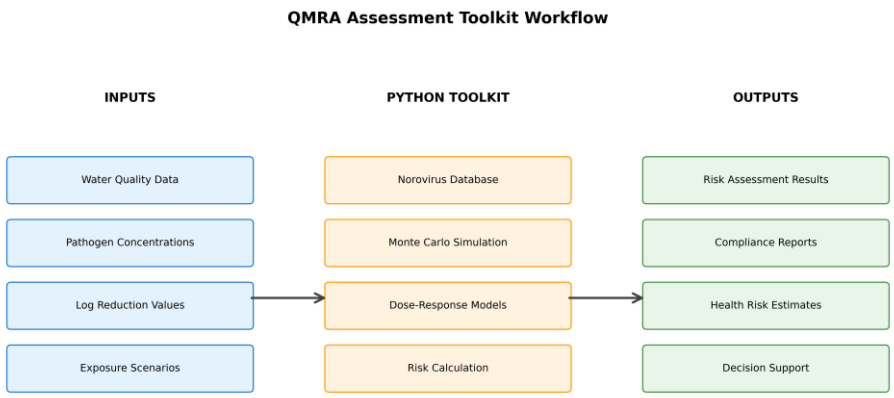

Figure 1: QMRA Assessment Toolkit - System Architecture & Workflow

The QMRA Assessment Toolkit processes multiple data inputs through a modular Python-based system. Input data includes water quality measurements, pathogen concentrations, user-defined log reduction values, population demographics, and exposure scenarios. The core processing engine integrates a norovirus pathogen database as the initial proof-of-concept, applies Monte Carlo simulation for uncertainty analysis, and implements validated dose-response models. The system generates comprehensive outputs including risk assessment results, regulatory compliance reports, health risk estimates, and decision support documentation for environmental health protection, while integrating Earth Sciences New Zealand's dilution modelling capabilities.

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
QMRA Literature Review & Charlotte's R Package Assessment	Review Charlotte Jones-Todd's R package, assess existing QMRA tools, analyse current models and methodologies to avoid reinventing wheel (Reza)		25
MVP Requirements & Design	Define minimum viable product scope (norovirus primary contact + shellfish), system architecture, @Risk replacement strategy (Reza)		35
Core Development (Norovirus MVP)	Develop norovirus exposure models for primary contact and shellfish consumption, Python framework replacing @Risk (Reza)		45
Dilution Modelling Integration	Implement Earth Sciences New Zealand's dilution modelling capabilities integration, our key differentiator in NZ QMRA market (Reza)		25
Monte Carlo & Uncertainty Analysis	Implement Monte Carlo simulation replacing @Risk functionality, uncertainty quantification for decision support (Reza)		20
Testing & Validation	Validate against known benchmarks, test @Risk replacement functionality, ensure regulatory compliance outputs (Reza)		20
QMRA Model Review & Validation	Technical review of implemented models, validation of dose-response		25

Commented [RW52]: Can more explicit detail be added on when the reviews will take place - I recommend after each step above?

	relationships and dilution integration (David)		
Documentation & Training	Technical documentation, user guides, training materials for @Risk transition, regulatory templates (David)		15
Deployment & @Risk Transition	System deployment, staff training on new toolkit, transition away from @Risk dependency (Reza/David)		10

Table 1: Work Programme and Timeline for QMRA Assessment Toolkit Development (Total: 210 hours)

EMERGING COLLABORATION OPPORTUNITIES

Earth Sciences New Zealand has completed seven QMRA projects over the past three years, with individual project values of $40-70K. The real business value extends beyond the QMRA work itself, as these projects provide entry into the consenting process and generate additional consulting opportunities, as demonstrated by the Beachlands QMRA follow-on work.

The New Zealand Institute for Public Health and Forensic Science (PHF) has approached Earth Sciences New Zealand to develop QMRA guidance specifically for shellfish safety assessment, providing immediate application for the norovirus shellfish consumption models planned in this toolkit. This collaboration demonstrates market demand and offers real-world validation opportunities.

The @Risk replacement toolkit addresses a critical operational issue. Recent projects have lost up to 80 hours due to @Risk security conflicts, requiring client extensions and budget overruns. Moving to our own Python-based solution eliminates this dependency while building internal technical capability essential for maintaining competitive advantage in the changing regulatory environment.

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