NIWA
Taihoro Nukurangi

Scoping Document

Waimakariri Irrigation Ltd. Storage Ponds Control System Scoping Document

Prepared for Rooney Earthmoving Ltd

Draft 2 - February 2012

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NIWA Proposal No:
NIWA Project:

Contents

Figures

Reviewed by ..... Approved for release by .....

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1 Introduction

Waimakariri Irrigation Ltd (WIL) operates an irrigation scheme drawing water from the Waimakariri River, North Canterbury, distributing this water through a network of races between that river and the Ashley River. The scheme has operated for several years and is managed on behalf of shareholders by Waimakariri Irrigation Ltd.

WIL is "a run of the river scheme" where water delivery to shareholders is based on a rostered usage and ordering system, which is subject to restrictions under resource consent conditions. To increase the reliability of supply to its shareholders, WIL are looking to contract Rooney Earthmoving Ltd to construct storage ponds at the top of the scheme, so that excess water can be collected and stored during time of plenty for supply during restriction periods.

As potential prime design and build contractors for the WIL Storage Ponds project, Rooney Earthmoving are working with Damwatch to determine pond design. As preferred contractors to Rooney Earthmoving, NIWA have been asked to assist in the preparation of a scoping document for the monitoring and control of the storage pond system.

The objective of this scoping document is to outline the basic requirements for an automated monitoring and control system for the WIL Storage Ponds. The specification covers physical requirements such as electrical interfaces, operational requirements, and requirements relating to the integration of the control system within the existing WIL monitoring and control infrastructure provided by NIWA.

This document is provided on the primary assumption that NIWA are the preferred Control System Contractor.

2 Project Methodology and Scope

2.1 Control System Contractor Scope

The Control System Contractor (NIWA) will be responsible for carrying out the supply, configuration, installation, commissioning and on-going support of the equipment and services outlined in Sections 5 and 6 later in this document. The general scope of the control system contract can be described as follows:

1) Detailed Design phase, including:
   a) A more detailed description of equipment and configuration than is provided in this document
   b) A detailed description of proposed operation
   c) Electrical drawings for supplied equipment and interfaces to other systems
   d) Confirmed pricing for the delivery phase based on the design
2) Following the Detailed Design Phase, the Delivery Phase consisting of:
   a) Supply of level/flow monitoring equipment, including:
      i) Level/flow monitoring equipment.
      ii) Logger / controllers.
      iii) Instrument enclosures.
      iv) Networking equipment:
         (1) Fibre optic option: Interfaces to fibre optic cables to be installed by others
         (2) WiFi option: WiFi networking hardware supply, installation, and configuration
      v) Other instruments as may be included within the design.
   b) Supply of gate monitoring and control equipment:
      i) Supply of hardware to provide automated gate control, providing control and monitoring functionality on top of manual gate control systems to be provided by the gate supplier.
   c) Supply of data collection and delivery services:
      i) Communication hardware and software required to interface loggers and controllers to the existing WIL data collection and control system.

ii) Management of pond monitoring and control nodes through the NIWA Neon Server system.

iii) Overall system setpoint control software, to implement specific WIL Storage Ponds control rules and strategies, and to manage the distribution of flow setpoints out to control points within the WIL system.

2.2 Items Supplied By Others

NIWA is not expected to be responsible for:

a) Permits, consents or permissions that are required for system construction and operation, beyond any licensing requirements for equipment supplied.

b) Physical installation of some equipment, including:

i) Provision of 230VAC mains power to the gate control structures.

ii) Installation of instrumentation cable in conduit between structures. NIWA will provide instrumentation cable free issue, for installation within conduit, and instructions for installation.

iii) Installation of fibre optic cables, to termination points within each of the Gate Control Huts – should the fibre optic network option be selected.

iv) Installation of gate and stilling well structures. NIWA will provide the stilling well enclosures, for installation on towers provided by others. Note – care must be taken with the installation of stilling wells to ensure that depth and location are suitable.

c) Provision of the electric or hydraulic actuation systems for the gates, including:

i) Manual control systems, with connection points for control of the gates when on automatic

ii) Electronic gate position feedback, for use by the control system

iii) Standard flow regulators for hydraulic pumps, and pressure limit switches to prevent motor overload.

iv) Weatherproof enclosures required to house the electrical and/or hydraulic control systems for the new gate structures.

d) Provision of auto mode start/stop command interfaces to pump electrical systems, where the pump electrical systems are to be provided by the pump supplier.

2.3 General Scope of Work Assumptions

The following assumptions will apply to the general scope of work for the control systems contract:

1) Rooney Earthmoving Ltd and Damwatch are responsible for civil and mechanical design aspects of this project, and will provide guidance on its required control strategies and fail-safe conditions. NIWA will implement these strategies as described in Section 3 of this document.

2) Some integration with existing WIL control and monitoring sites may be required for operation of the pond system. Design of the Pond Control System will need to account for this interaction.

3) Expectations for per-site installation and commissioning of Control System Contractor supplied equipment is noted in sub-sections under Sections 5 and 6 of this document.

4) There will be on-going running costs for the system, for wireless data, server management, and other related services, and these will be identified in the pricing summary. Ideally these costs will be rolled into a wider service agreement that NIWA already has in place with WIL for their existing systems.

3 System Overview and Control Strategy

3.1 WIL Storage Ponds Control System Overview

Figure 1 provides a simple system schematic, identifying key components from a control system perspective.

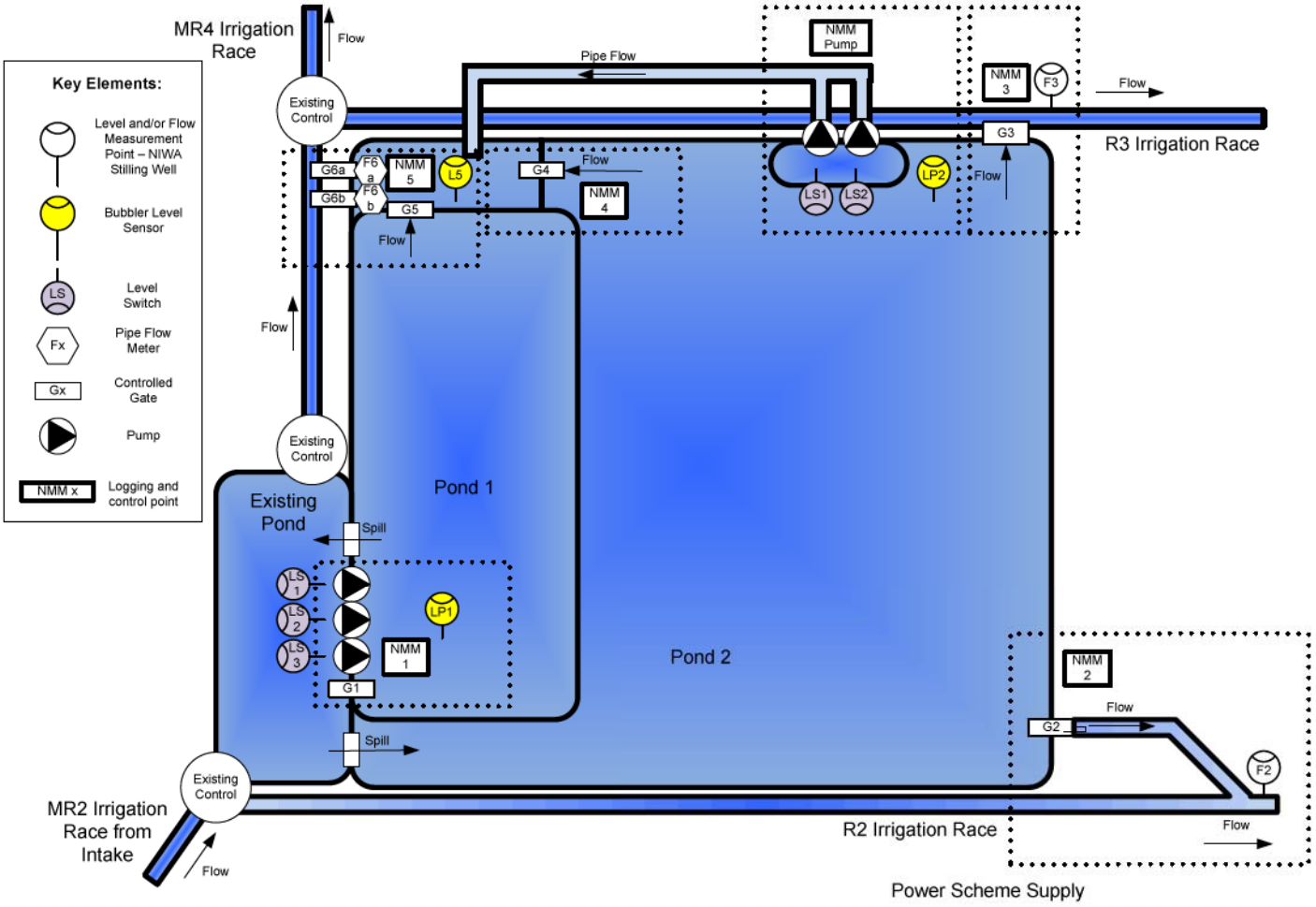

Figure 1 – WIL Storage Ponds System Overview

There will be monitoring and control nodes at six points in the system:

NMM1: The Pond 1 Intake Gate and Pump control

NMM2: Pond 2 Outlet to R2

NMM3: Pond 2 Outlet to R3

NMM4: Pond 2 Outlet to "the Tub"

NMM5: Pond 1 Outlet to "the Tub" and "the Tub" Outlet to MR4

NMM Pump: Control of Pumps running from Pond 2 to "the Tub"

Each of the 6 monitoring and control points will contain a Neon data logger / controller unit that will regularly report data back to the Neon Server, which will form the interface point with the wider WIL monitoring and control system. The Neon Server will also be used to distribute information between each of the logger/controller sites, which will be used to enable level information from Ponds 1, 2, and the Tub to be used to control the gates and pumps to maintain setpoint levels and flows. The Neon Server will be hosted by NIWA within a secure infrastructure, with an optional local PC terminal within one of the Pond gate control huts.

3.2 Existing WIL Control and Monitoring Infrastructure Overview

The WIL monitoring and control system has been incrementally developed by NIWA over a period of more than 10 years. As such it contains a mixture of old and new technologies, which requires consideration when further extending the system. An overview of the current infrastructure can be seen in Figure 2 below.

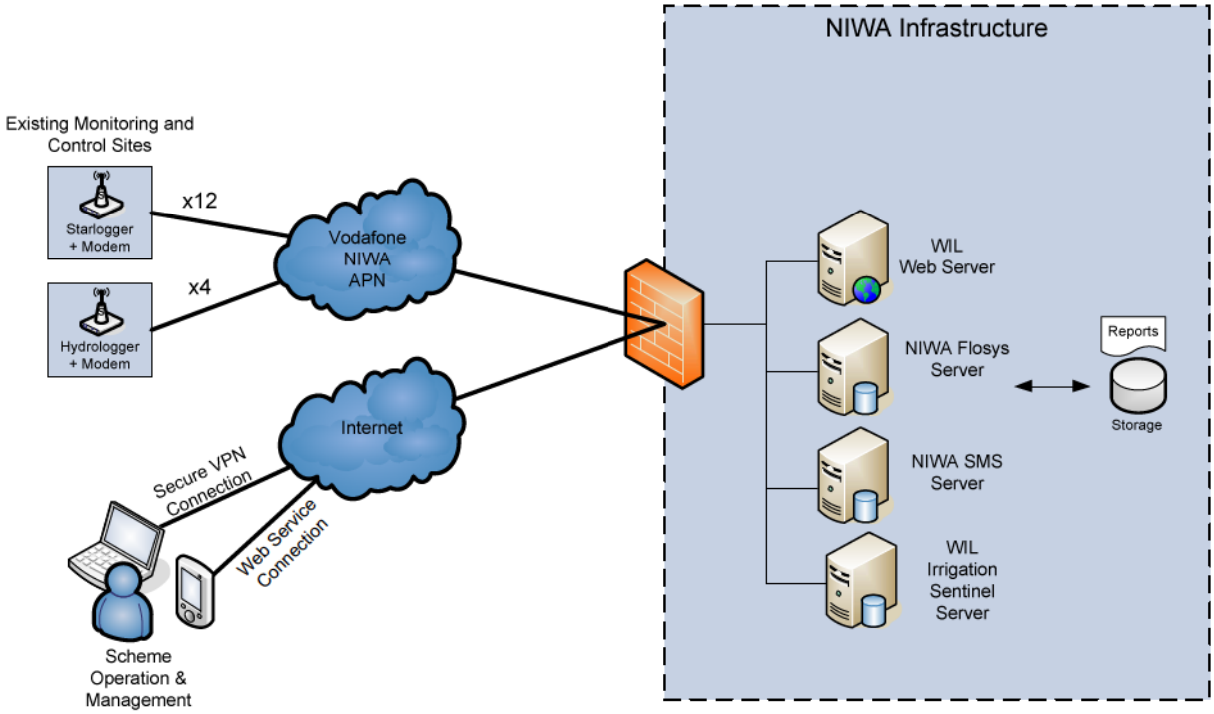

Figure 2 – WIL Monitoring and Control Infrastructure Overview

Key features of this system are:

1) 16 monitoring and/or control sites consisting of Unidata Starlogger and Hydrologger loggers and GPRS cellular modem connections to NIWA via NIWA's private Vodafone access point

2) Remote scheme management by NIWA Irrigation Sentinel software:

   a) Server component extracting data directly from loggers through their cellular connections

   b) Client component running on a laptop and connecting to NIWA via secure VPN connection

   c) Client component running on an Android cellphone and connecting to NIWA via internet and web service connection

3) Logger data collected by a NIWA hosted Flosys server for long term storage and reporting

4) NIWA hosted WIL website

3.3 WIL Infrastructure Extension For Pond Control

Figure 3, below, shows how the WIL monitoring and control system will be extended to include the new Pond Control System.

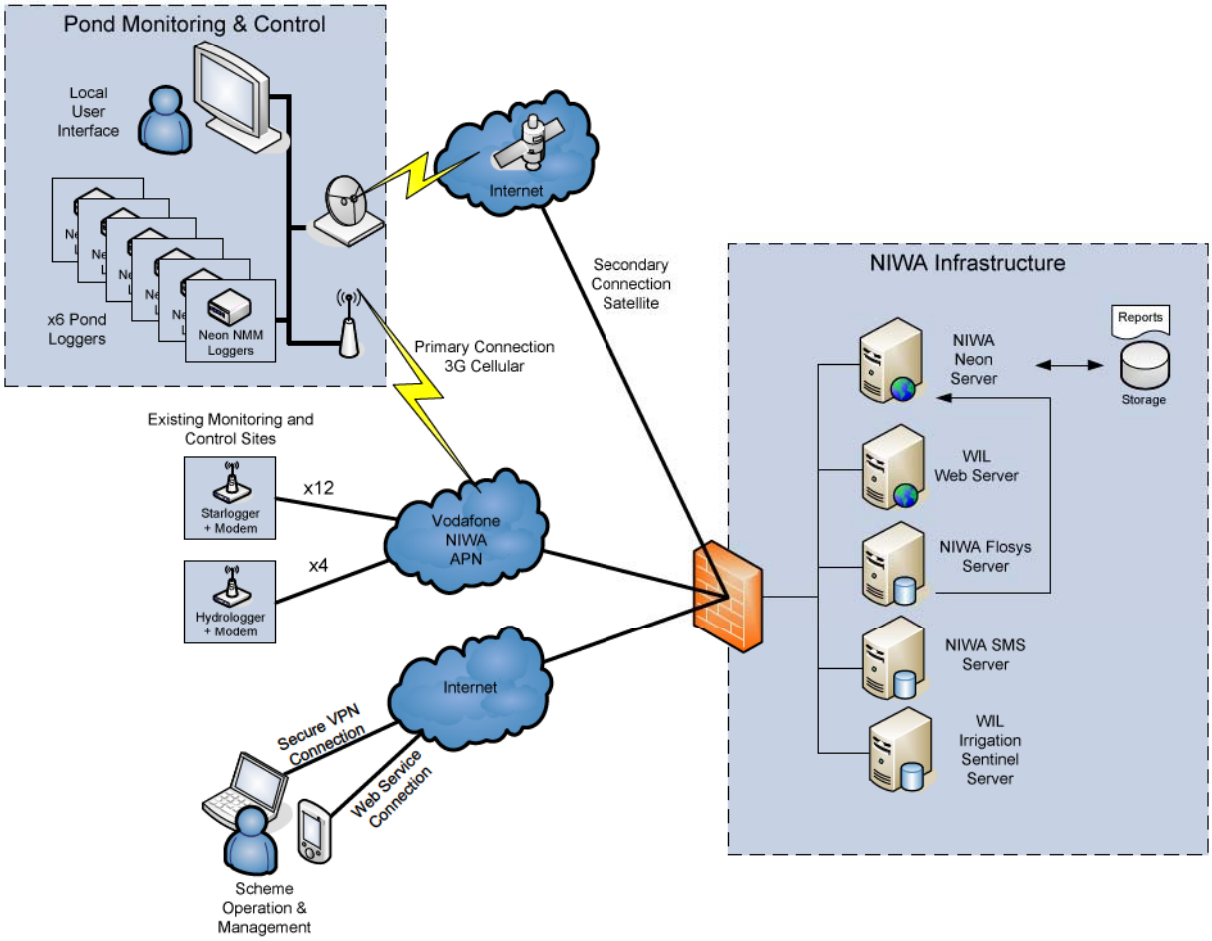

Figure 3 – WIL Infrastructure Extension for Pond Control

Key extensions and modifications to the existing system are:

1) Addition of 6 Neon based loggers for Pond monitoring and control. These will be locally networked, with data exchanged with the NIWA hosted Neon server primarily through a 3G cellular connection, and a secondary satellite connection as a backup route.

2) Addition of a Neon Server to the NIWA hosted infrastructure. This will provide a web based interface for observation of pond data. WIL may also opt to engage NIWA to port Flosys data from existing loggers into Neon, to provide a complete scheme view and reporting platform. This will also provide a platform for WIL to add Neon nodes to their scheme and/or migrate the older Starlogger and Hydrologger logger sites to the newer Neon platform.

3) An optional panel mounted touch screen PC at the ponds to enable easy local access to Irrigation Sentinel and Neon.

4) Extension of the WIL Irrigation Sentinel application to include pond control functionality.

3.4 Storage Pond Monitoring and Control Nodes

The following descriptions of operation are brief and simplistic, and are to be more fully documented as part of detailed design.

3.4.1 NMM1 – Pond 1 Inlet

There will be one hydraulically actuated control gate, and three on/off pumps controlled from the NMM1 site.

Where possible, the gate will be used to control flow from the existing pond into Pond 1 when Pond 1 is lower than the pond feeding it, otherwise the gate will be closed and the pumps run to pump additional water up into Pond 1 as may be required.

NMM 1 will include 3 level switches in the existing pond, which will be used to control the operation of the 3 pumps that feed from that pond into Pond 1. The pumps will be started incrementally – first one, then the next, then the last, as the availability of water in the feed pond and the availability of storage capacity in Pond 1 dictates.

NMM1 will also include a bubbler level instrument for measurement of Pond 1 level.

NMM1 will need to receive the existing buffer pond level from the existing monitoring equipment on that pond in order to correctly operate the gate into Pond 1. A simple means of achieving this will be to upgrade the existing pond level encoder to have a 4-20mA analog output, so that this can be wired directly to the NMM1 logger.

It is expected that the Pond Intake control node will alert the system operator of the following conditions, and take these prescribed actions:

1) On detection of loss of 230VAC power at the gate control site for more than a preset number of minutes an alarm will be raised. If the inlet gate is open it will be left open and water will continue to flow into Pond 1 until the level reaches equilibrium with the existing buffer pond. If the inlet gate is closed it will remain closed. If the pumps were running they will stop, as by inference their power supply has also been lost.

2) On loss of contact with the Neon Server or Pond 1 level logger for more than a preset number of minutes, an alarm will be raised.

3) Operator alarms will also be generated if:

   a) The Pond 1 "full" level setpoint is exceeded, indicating that overfilling is occurring and that the spill level is about to be reached.

   b) Any of the 3 feed pumps are detected to be running when the lowest feed pond level switch is no longer submerged.

   c) The gate is not observed to move when it is commanded to do so.

3.4.2 NMM2 – Pond 2 Outlet to R2

There will be one hydraulically actuated control gate allowing water to flow from Pond 2 into race R2. There may also be a second hydraulically actuated gate allowing water to flow from Pond two into a race or pipe feeding a hydroelectric power scheme, however control and monitoring equipment for this is not included in the initial scope of work covered by this document.

The outlet at this site will have an associated downstream flow monitoring site – a stilling well in the R2 race.

The Pond 2 gate will be controlled in the following manner:

1) Gate to control to maintain a flow setpoint in R2 as measured downstream of the confluence of the R2 and the outlet from Pond 2. This may require coordination with the existing control system feeding water to R2 upstream of the Ponds.

2) The gate will hold steady at the current position and generate an alarm for the operator under the following circumstances:

   a) Loss of 230VAC power at the pond controller for more than a preset number of minutes

   b) The gate is not observed to move when it is commanded to do so.

c) The gate control is unable to achieve the flow setpoint in R3

3.4.3 NMM3 – Pond 2 Outlet to R3

There will be one hydraulically actuated control gate allowing water to flow from Pond 2 into race R3.

The outlet at this site will have an associated downstream flow monitoring site in the form of a stilling well.

The pond gate will be controlled in the following manner:

1) Gate to control to maintain a flow setpoint in R3 as measured downstream of the confluence of the R3 and the outlet from Pond 2. This may require coordination with the existing control system feeding water to R3 upstream of the Ponds.

2) The gate will hold steady at the current position and generate an alarm for the operator under the following circumstances:

   a) Loss of 230VAC power at the pond controller for more than a preset number of minutes

   b) The gate is not observed to move when it is commanded to do so.

   c) The gate control is unable to achieve the flow setpoint in R3

3.4.4 NMM4 – Pond 2 Outlet to the Tub

There will be one hydraulically actuated control gate allowing water to flow from Pond 2 into the Tub.

The gate will hold steady at the current position and generate an alarm for the operator under the following circumstances:

a) Loss of 230VAC power at the pond controller for more than a preset number of minutes

b) The gate is not observed to move when it is commanded to do so.

This site will require knowledge of Tub level from NMM5 and Pond 2 level from NMM Pump.

3.4.5 NMM5 – Pond 1 Outlet to the Tub and Tub Outlet to MR4

There will be one hydraulically actuated control gate allowing water to flow from Pond 1 into the Tub, and two hydraulically actuated gates controlling the flow of water from the Tub into MR4.

The outlets to MR4 will have associated flowmeters, although the overall gate control flow value will come from the existing control site on MR4, as some water is diverted to R3 after the feed from the Tub and before the existing MR4 flow monitoring site.

This site will require knowledge of the Pond 1 level from NMM1.

It is expected that the NMM 5 Tub control node will alert the system operator of the following conditions, and take these prescribed actions:

1) On detection of loss of 230VAC power at the gate control site for more than a preset number of minutes an alarm will be raised. The three control gates will remain at their current position until commanded to do otherwise.

2) On loss of contact with the Neon Server or NMM 5 logger for more than a preset number of minutes, an alarm will be raised.

3) Operator alarms will also be generated if:

   a) The Tub "full" level setpoint is exceeded, indicating that overfilling is occurring and that the spill level is about to be reached.

   b) Any gate is not observed to move when it is commanded to do so.

3.4.6 NMM Pump

There will be two on/off pumps controlled to provide water from Pond 2 to the Tub under conditions where water will not naturally flow in that direction.

There will be two level switches associated with pump control – one set for low level to disable the pumps, and the other set as a secondary low level failsafe and alarm point.

The NMM Pump site will also include a pond level bubbler for measurement of Pond 2 level.

Alerts will be generated for the operator under the following circumstances:

1) Loss of 230VAC power at the pond controller for more than a preset number of minutes

2) The Pond 2 "full" level setpoint is exceeded, indicating that overfilling is occurring and that the spill level is about to be reached.

3) Either of the 2 pumps are detected to be running when the lowest Pond 2 level switch is no longer submerged.

4 Risks and Mitigations

The proposed control system consists of many electronic, mechanical, and software components – some to be provided by NIWA, and others to be provided to the project by other parties. Failure of any one of these elements is possible, and the consequences of such failures should to be considered in system design, mitigation, and risk management strategies.

While the system will be largely under automatic control, it must be noted that human supervision and availability to intervene has been assumed in the design, and will be a requirement for safe and compliant operation of the system.

Potential failure scenarios, detection mechanisms, consequences, and proposed actions will be explored and documented as part of the Detailed Design stage of the project.

5 Schedule of Control System Contractor Services – Detailed Design Phase

This Specification provides a high level view of the form and function of the required monitoring and control system for the WIL Storage Ponds. As the system is potentially complex, and requires interaction and synchronisation of scope of work between several suppliers, a Detailed Design Phase will be required to:

1) Confirm the overall scope of supply for NIWA, and interface points with other suppliers

2) Provide electrical drawings for the control and monitoring system components

3) Refine the detailed description of operation for the system monitoring and control system including:

    a) Operation of each monitoring and control node, including interpretation of how the system operating requirements will apply to that node, dependence on other nodes, and exception and alarm conditions

    b) Logging regimes

    c) System alarms

    d) Control system user interface – a brief description of the form and functionality of the user interface.

    e) Failure scenarios, their detection, and their management

4) Confirm required computer server components and connectivity

5) Confirm fibre optic or WiFi communications network design for the pond control system

6) Confirm pricing for the delivery of the proposed design

7) Develop a delivery schedule for NIWA components of the Delivery phase of the project, with listed dependencies where tasks are contingent on others.

6 Schedule of Control System Contractor Goods and Services – Delivery Phase

Following confirmation of scope, costs, and formalisation of a contact for the delivery of the proposed system, it is expected that NIWA will provide the following goods and services:

6.1 Pond Logger Sites

6.1.1 NMM1 – Pond 1 Inlet

There will be one hydraulically actuated control gate, and three on/off pumps controlled from the NMM1 site. NMM1 will also include a level bubbler instrument for measurement of Pond 1 level.

An overview of the configuration of this site is shown in Figure 4 below.

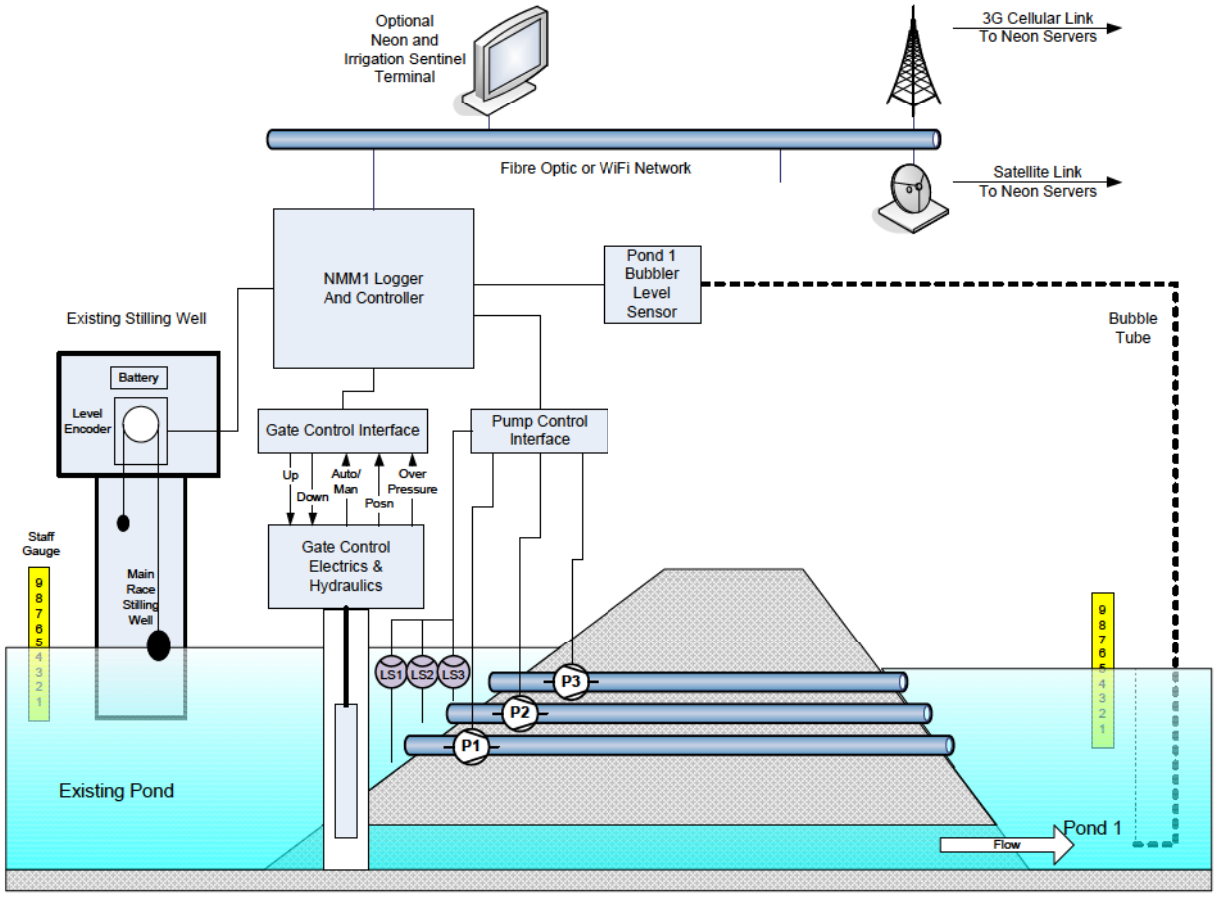

Figure 4 – NMM1 Pond Inlet Schematic

Control System Contractor supply for this site will include:

1) The following equipment to be installed in the NMM1 Control Hut provided by others:

   a) A Controller / Logger with sufficient inputs and outputs to handle the instrumentation and interfaces for the site. The Controller/Logger will be capable of autonomous operation in the event of loss of communications with the Neon Server system. If communications with the Neon Server are lost the Controller/Logger will maintain a local record of historical data, which will automatically upload to the Neon Server on resumption of communications.

   b) One Gate Controller Interface, in an enclosure suitable for mounting in the Gate Control hut which is to be provided by others. The Gate Controller Interfaces will have inputs, outputs and pass-through connections for:

      i) Gate hydraulic pressure switch (expects normally closed clean contact)

      ii) Gate raise command – clean contact output to gate controls

      iii) Gate lower command – clean contact output to gate controls

      iv) Gate position input – nominally 0-2.5VDC or 4-20mA

      v) Gate Auto/Manual switch and Up/Down manual push buttons

   c) 1 x Bubbler water level sensor and up to 50m of bubbler tubing. The Bubbler instrument will be installed in the control hut, and the bubble tube will be run to a suitable location at the lowest point of the pond. Staff gauge plates for visual reference of level at the pond will be provided for visual reference of pond level if a suitable method for mounting them can be established.

   d) Pump control interface, providing:

      i) Clean contact on/off outputs signals to the 3 pumps to be provided by others

      ii) Clean contact on/off inputs signals from for each of the 3 pumps, to provide pump running indication

   e) Local 230VAC to 12VDC power supply and battery

   f) A panel mounted touch screen PC running the following software:

      i) Web access to Neon, providing a view of system information – including information from WIL loggers beyond the Pond Control System

      ii) Remote access to NIWA Irrigation Sentinel software, configured to manage the calculation and distribution of level and flow setpoints to pond control nodes.

g) Fibre Optic and Wired Network equipment (Fibre Optic option only):

   i) 24 Port Managed Switch

   ii) Media converter, required to transform fibre optic signals to wired Ethernet format for connection to the managed switch

   iii) Fibre Optic terminations within the hut

h) WiFi Network equipment (WiFi option only):

   i) 24 Port Managed Switch

   ii) WiFi Bridge/Access Point

   iii) Single antenna

i) 3G Cellular broadband connection, used for primary communications with the Neon Server and other systems

j) Satellite broadband connection, used for secondary communications with the Neon Server and other systems

2) Three level switches, to be installed at the pump inlets. These will provide failsafe normally open clean contacts for the pump control logic.

3) Installation and commissioning services for supplied equipment, excluding cable burial and conduits.

   a) Termination of instruments, Gate Controller Interface and other connections to the Gate Controller / Logger.

   b) Termination of sensor and interface connections at the Gate Controller

   c) Set-up of the Bubbler

   d) Testing and commissioning of the monitoring and control system

The gate supplier will provide:

4) The physical gate, drive hydraulics and electrical actuation controls

5) Gate position feedback to the Gate Controller Interface

6) Hydraulic line pressure switch

The pump supplier will provide:

7) Motor starters and associated electrical supplies and controls for 3 pumps, complete with clean contact connections for remote control of pumps from the NIWA Neon logger.

6.1.2 NMM2 – Pond 2 Outlet to R2

There will be one hydraulically actuated control gate allowing water to flow from Pond 2 into race R2.

The outlet at this site will have an associated downstream flow monitoring site in the form of a stilling well in the R2 race.

An overview of the configuration of this site is shown in Figure 5 below.

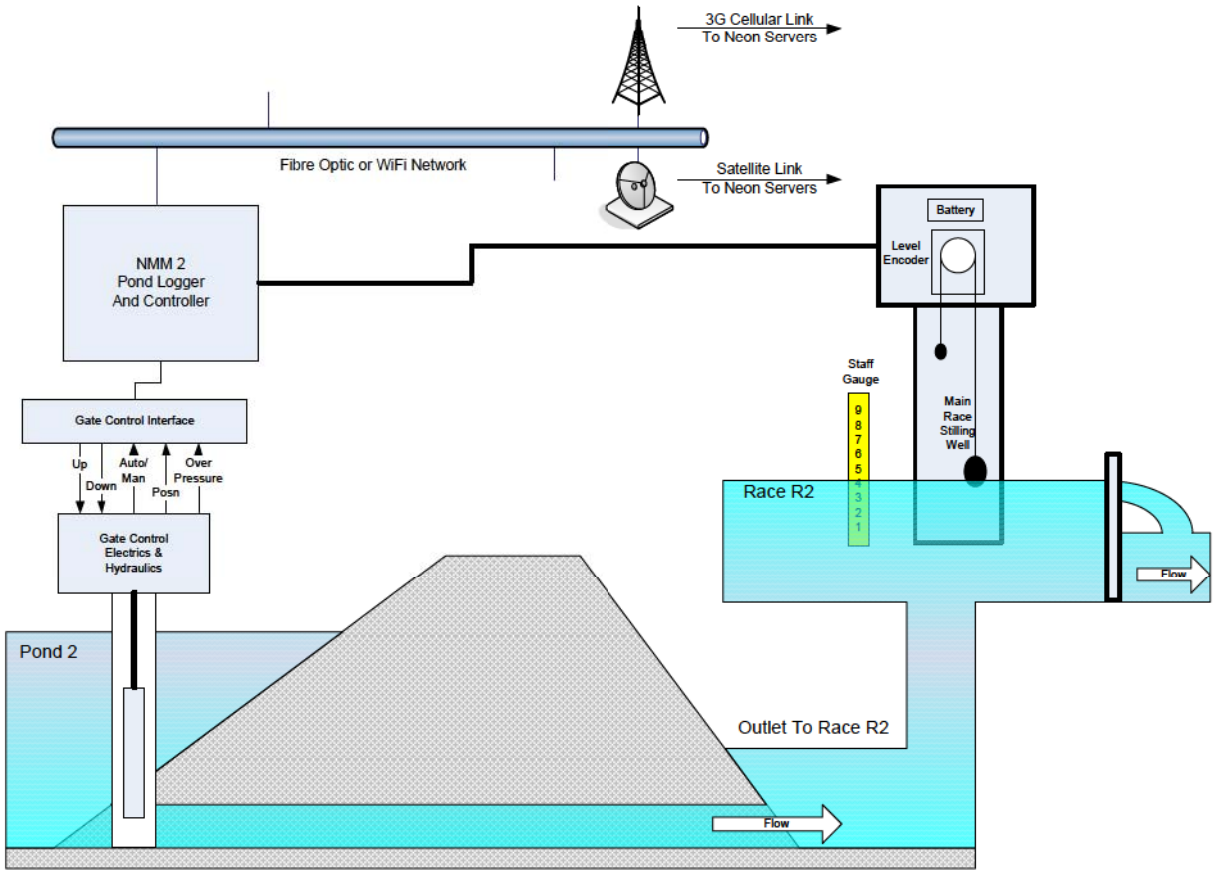

Figure 5 – NMM2 Pond 2 Outlet to R2 Schematic

Control System Contractor supply for this site will include:

1) The following equipment to be installed in the NMM2 Control Hut provided by others:

   a) A Controller / Logger with sufficient inputs and outputs to handle the instrumentation and interfaces for the site. The Controller/Logger will be capable of autonomous operation in the event of loss of communications with the Neon Server system. If communications with the Neon Server are lost the Controller/Logger will maintain a local record of historical data, which will automatically upload to the Neon Server on resumption of communications.

   b) One Gate Controller Interface, in an enclosure suitable for mounting in the Gate Control hut which is to be provided by others. The Gate Controller Interface will have inputs, outputs and pass-through connections for:

      i) Gate hydraulic pressure switch (expects normally closed clean contact)

      ii) Gate raise command – clean contact output to gate controls

      iii) Gate lower command – clean contact output to gate controls

      iv) Gate position input – nominally 0-2.5VDC or 4-20mA

      v) Gate Auto/Manual switch and Up/Down manual push buttons

   c) Local 230VAC to 12VDC power supply and battery

   d) Fibre Optic and Wired Network equipment (Fibre Optic option only):

      i) Media converter, required to transform fibre optic signals to wired Ethernet format for connection to the managed switch

      ii) Fibre Optic terminations within the hut

   e) WiFi Network equipment (WiFi option only):

      i) WiFi Bridge/Access Point

      ii) Single directional antenna

2) One Stilling Well with water level instrumentation, to be installed downstream of the Pond 2 outlet. The stilling well instrumentation will include:

   a) A lockable aluminium stilling well enclosure

   b) Encoder, float, counterweight, and beaded floatline

c) Electric plumb bob

d) A 7Ahr local storage battery

e) Staff gauge plates for visual reference of level at the stilling well site – provided free issue to the stilling well tower installer for installation by them.

f) Wired link to the NMM2 Gate Control Hut logger.

3) Installation and commissioning services for supplied equipment, excluding cable burial and conduits.

a) Termination of instruments, Gate Controller Interface and other connections to the Gate Controller / Logger.

b) Termination of sensor and interface connections at the Gate Controller

c) Installation of instrumentation into the Stilling Well towers (towers to be installed by others)

d) Testing and commissioning of the monitoring and control system

The gate supplier will provide:

4) The physical gate, drive hydraulics and electric actuation controls

5) Gate position feedback to the Gate Controller Interface

6) Hydraulic line pressure switch

6.1.3 NMM3 – Pond 2 Outlet to R3

One hydraulic gate and stilling well as per NMM2 above.

6.1.4 NMM4 – Pond 2 Outlet to the Tub

There will be one hydraulically actuated control gate allowing water to flow from Pond 2 into the Tub.

An overview of the configuration of this site is shown in

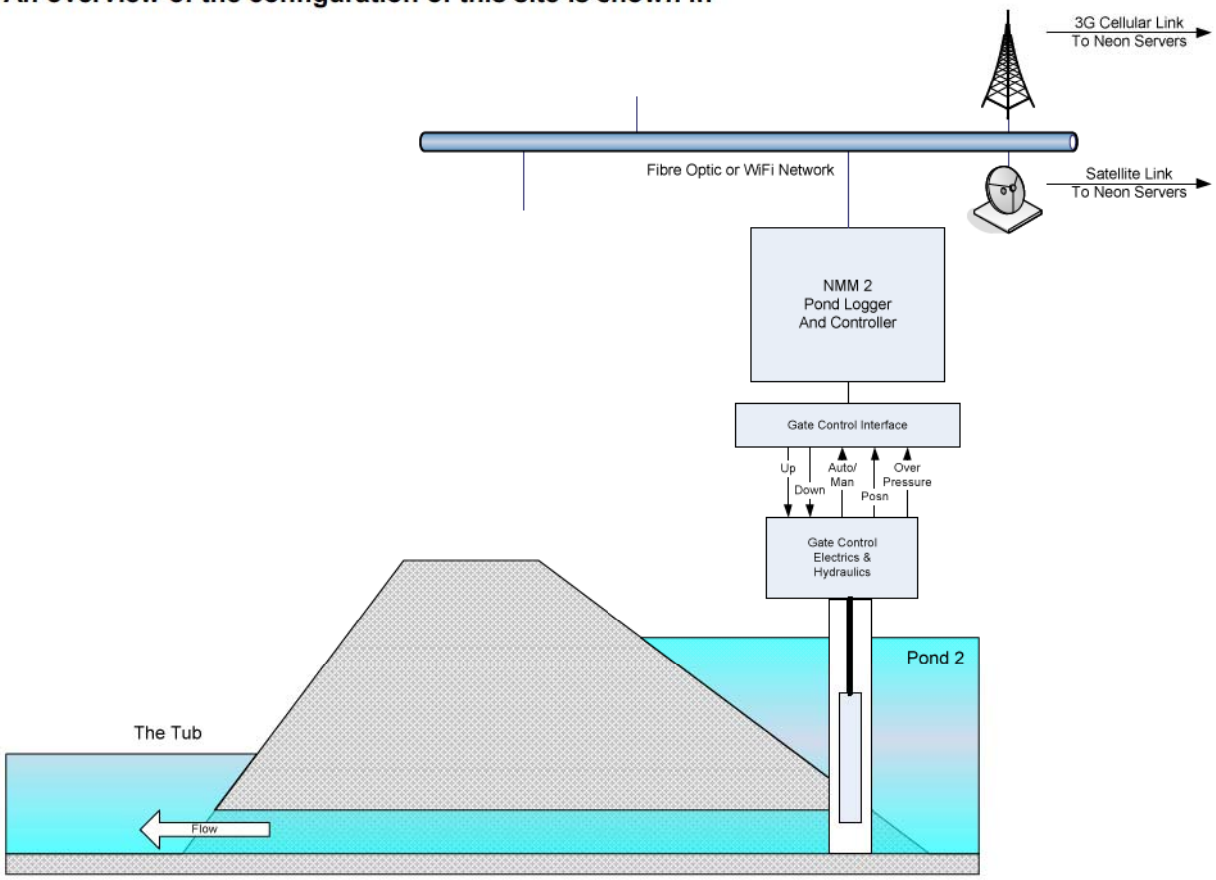

Figure 6 below.

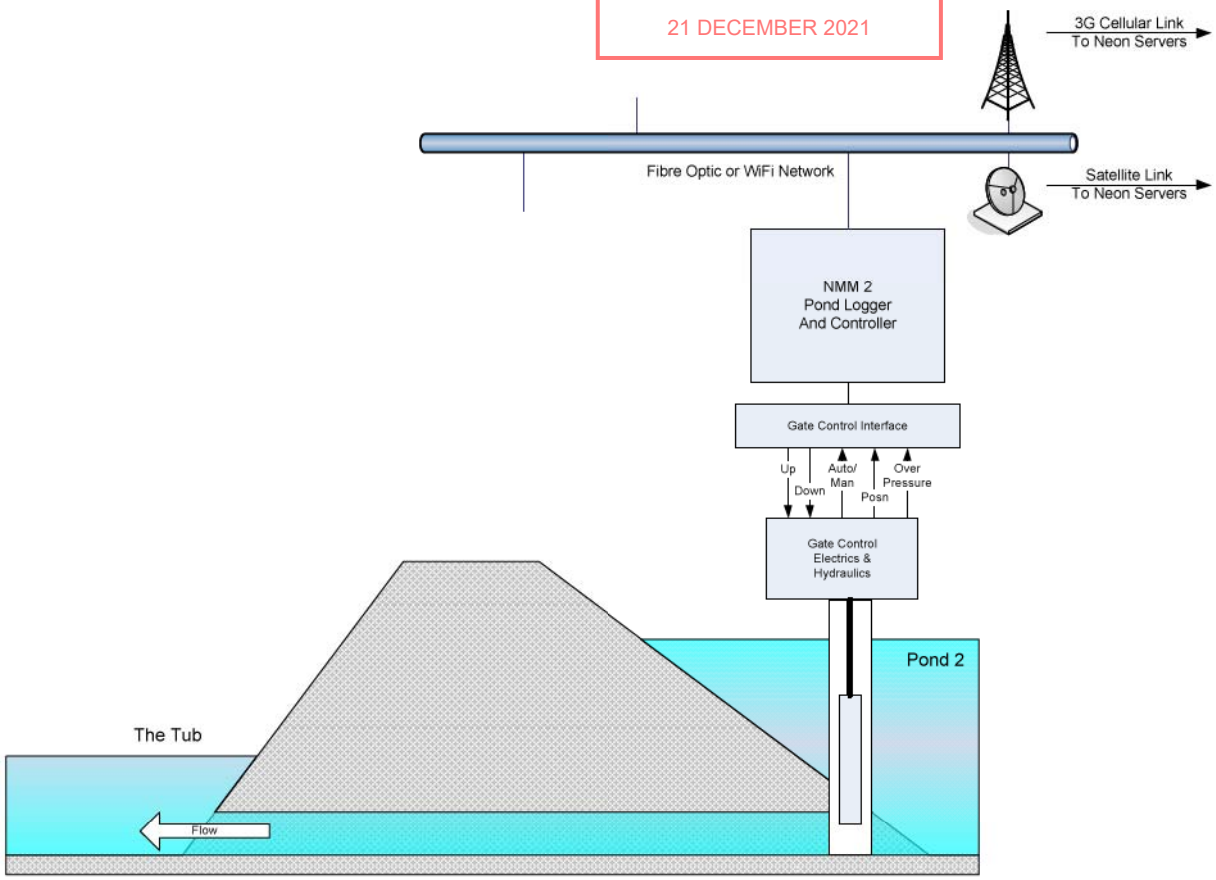

Figure 6 – NMM4 Pond 2 Outlet to the Tub Schematic

Control System Contractor supply for this site will include:

1) The following equipment to be installed in the NMM4 Control Hut provided by others:

   a) A Controller / Logger with sufficient inputs and outputs to handle the instrumentation and interfaces for the site. The Controller/Logger will be capable of autonomous operation in the event of loss of communications with the Neon Server system. If communications with the Neon Server are lost the Controller/Logger will maintain a local record of historical data, which will automatically upload to the Neon Server on resumption of communications.

   b) One Gate Controller Interface, in an enclosure suitable for mounting in the Gate Control hut which is to be provided by others. The Gate Controller Interface will have inputs, outputs and pass-through connections for:

      i) Gate hydraulic pressure switch (expects normally closed clean contact)

      ii) Gate raise command – clean contact output to gate controls

      iii) Gate lower command – clean contact output to gate controls

iv) Gate position input – nominally 0-2.5VDC or 4-20mA

v) Gate Auto/Manual switch and Up/Down manual push buttons

c) Local 230VAC to 12VDC power supply and battery

d) Fibre Optic and Wired Network equipment (Fibre Optic option only):

i) Media converter, required to transform fibre optic signals to wired Ethernet format for connection to the managed switch

ii) Fibre Optic terminations within the hut

e) WiFi Network equipment (WiFi option only):

i) WiFi Bridge/Access Point

ii) Single directional antenna

2) Installation and commissioning services for supplied equipment, excluding cable burial and conduits.

a) Termination of instruments, Gate Controller Interface and other connections to the Gate Controller / Logger.

b) Termination of sensor and interface connections at the Gate Controller

c) Testing and commissioning of the monitoring and control system

The gate supplier will provide:

3) The physical gate, drive hydraulics and electric actuation controls

4) Gate position feedback to the Gate Controller Interface

5) Hydraulic line pressure switch

6.1.5 NMM5 – Pond 1 Outlet to the Tub and Tub Outlet to MR4

There will be one hydraulically actuated control gate allowing water to flow from Pond 1 into the Tub, and two hydraulically actuated gates controlling the flow of water from the Tub into MR4.

The outlets to MR4 will have associated flowmeters, although the overall gate control flow value will come from the existing control site on MR4, as some water is diverted to R3 after the feed from the Tub and before the existing MR4 flow monitoring site.

An overview of the configuration of this site is shown in Figure 7 below.

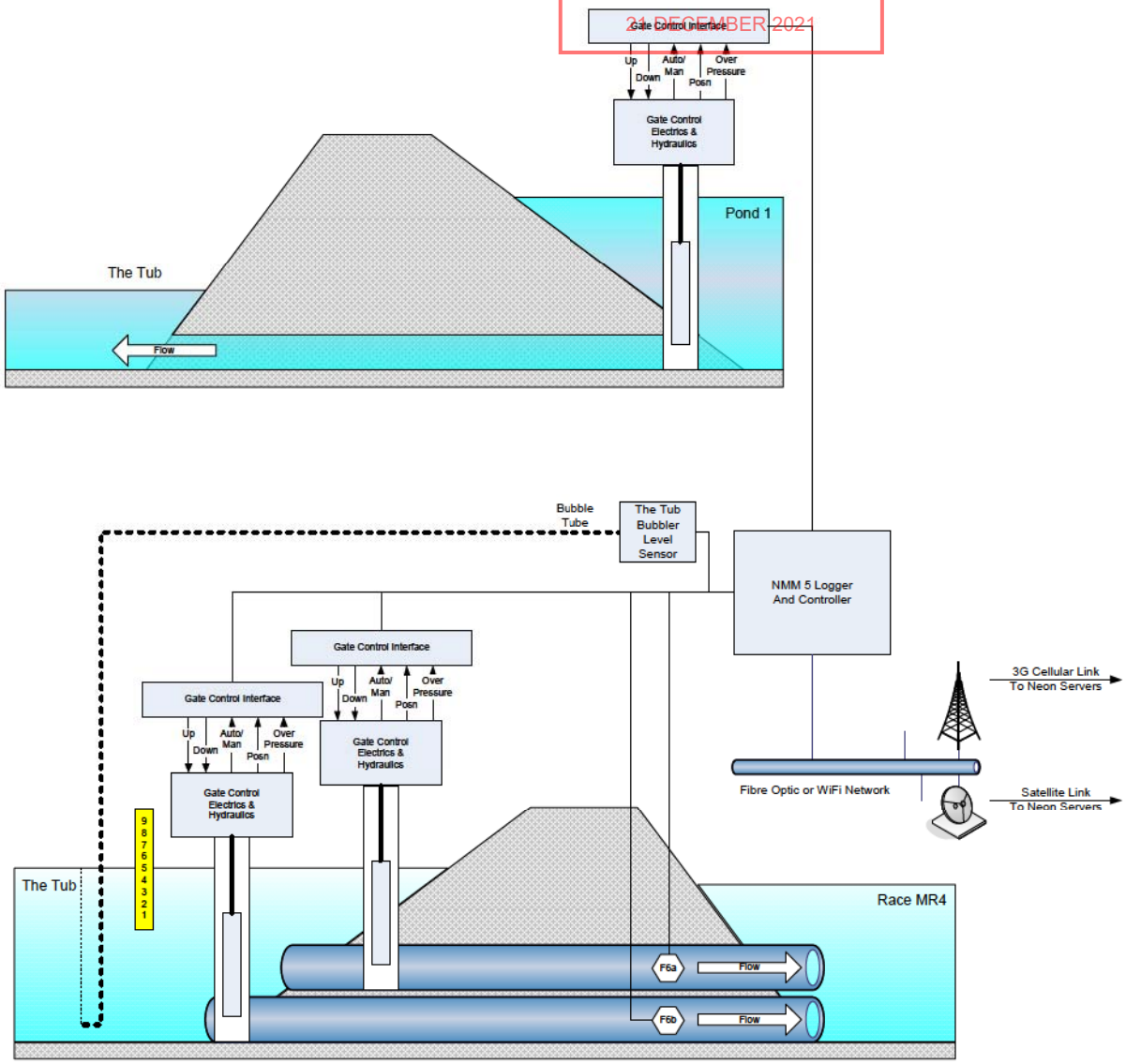

Figure 7 – NMM5 Pond 1 Outlet to the Tub and Tub Outlet to MR4 Schematic

Control System Contractor supply for this site will include:

1) The following equipment to be installed in the NMM5 Control Hut provided by others:

   a) A Controller / Logger with sufficient inputs and outputs to handle the instrumentation and interfaces for the site. The Controller/Logger will be capable of autonomous operation in the event of loss of communications with the Neon Server system. If communications with the Neon Server are lost the Controller/Logger will maintain a local record of historical data, which will automatically upload to the Neon Server on resumption of communications.

   b) 1 x Bubbler water level sensor and up to 50m of bubbler tubing. The Bubbler instrument will be installed in the control hut, and the bubble tube will be run to a suitable location at the lowest point of the pond. Staff gauge plates for visual

reference of level at the pond will be provided for visual reference of pond level if a suitable method for mounting them can be established.

c) Three Gate Controller Interfaces, in enclosures suitable for mounting in the Gate Control hut which is to be provided by others. The Gate Controller Interfaces will have inputs, outputs and pass-through connections for:

   i) Gate hydraulic pressure switch (expects normally closed clean contact)

   ii) Gate raise command – clean contact output to gate controls

   iii) Gate lower command – clean contact output to gate controls

   iv) Gate position input – nominally 0-2.5VDC or 4-20mA

   v) Gate Auto/Manual switch and Up/Down manual push buttons

d) Local 230VAC to 12VDC power supply and battery

e) Fibre Optic and Wired Network equipment (Fibre Optic option only):

   i) Media converter, required to transform fibre optic signals to wired Ethernet format for connection to the managed switch

   ii) Fibre Optic terminations within the hut

f) WiFi Network equipment (WiFi option only):

   i) WiFi Bridge/Access Point

   ii) Single directional antenna

2) Installation and commissioning services for supplied equipment, excluding cable burial and conduits.

   a) Termination of instruments, Gate Controller Interface and other connections to the Gate Controller / Logger.

   b) Termination of sensor and interface connections at the Gate Controller

   c) Installation of instrumentation into the Stilling Well towers (towers to be installed by others)

   d) Testing and commissioning of the monitoring and control system

The gate supplier will provide:

3) The physical gate, drive hydraulics and electric actuation controls

4) Gate position feedback to the Gate Controller Interface

5) Hydraulic line pressure switch

Others will provide:

6) Pipe flowmeters suitable for measuring flow from the Tub into MR4. The flowmeters will ideally have a pulsed digital output for volumetric flow and may optionally also have an analog output of current flowrate.

6.1.6 NMM Pump – Pond 2 to Tub

There will be two on/off pumps controlled from the NMM Pump site. NMM Pump will also include a level bubbler instrument for measurement of Pond 2 level.

An overview of the configuration of this site is shown in

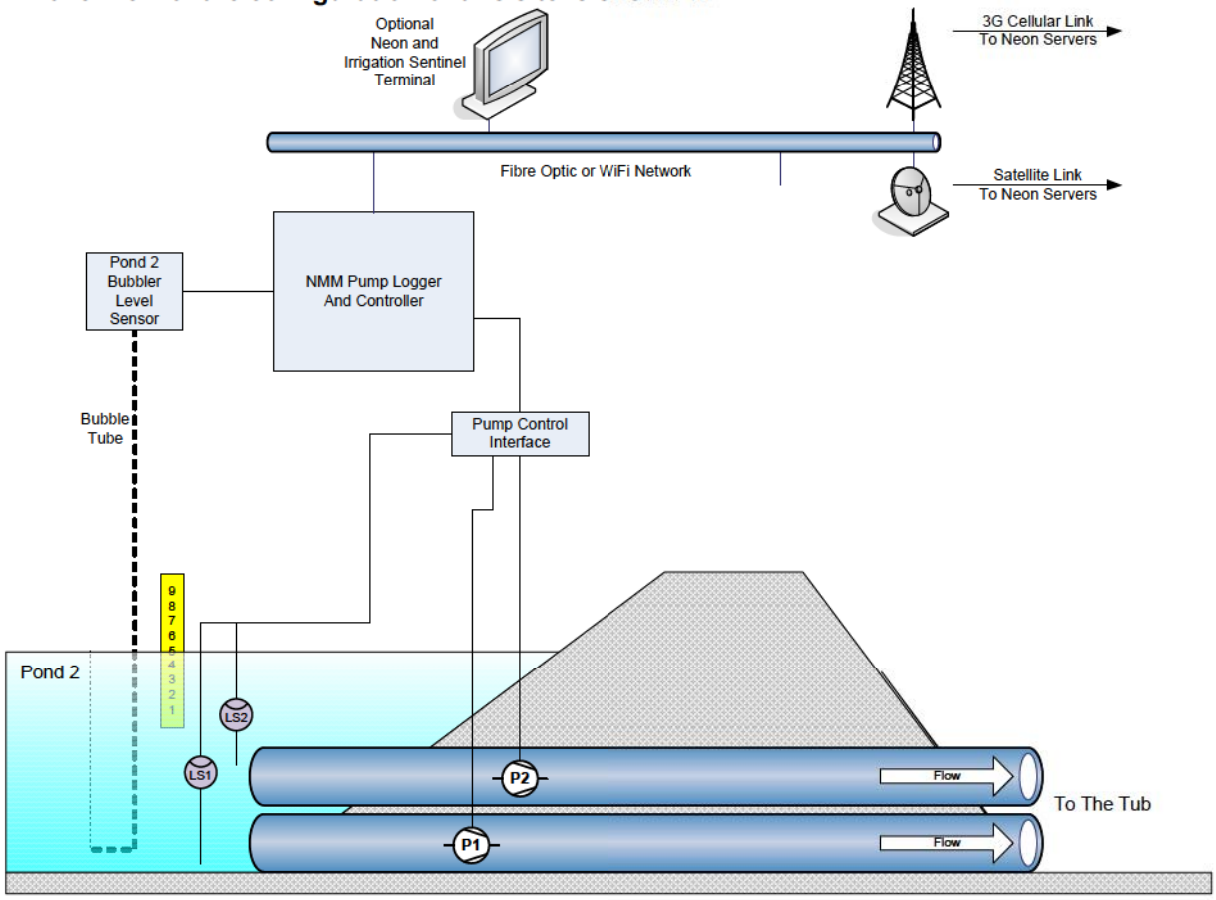

Figure 8 below.

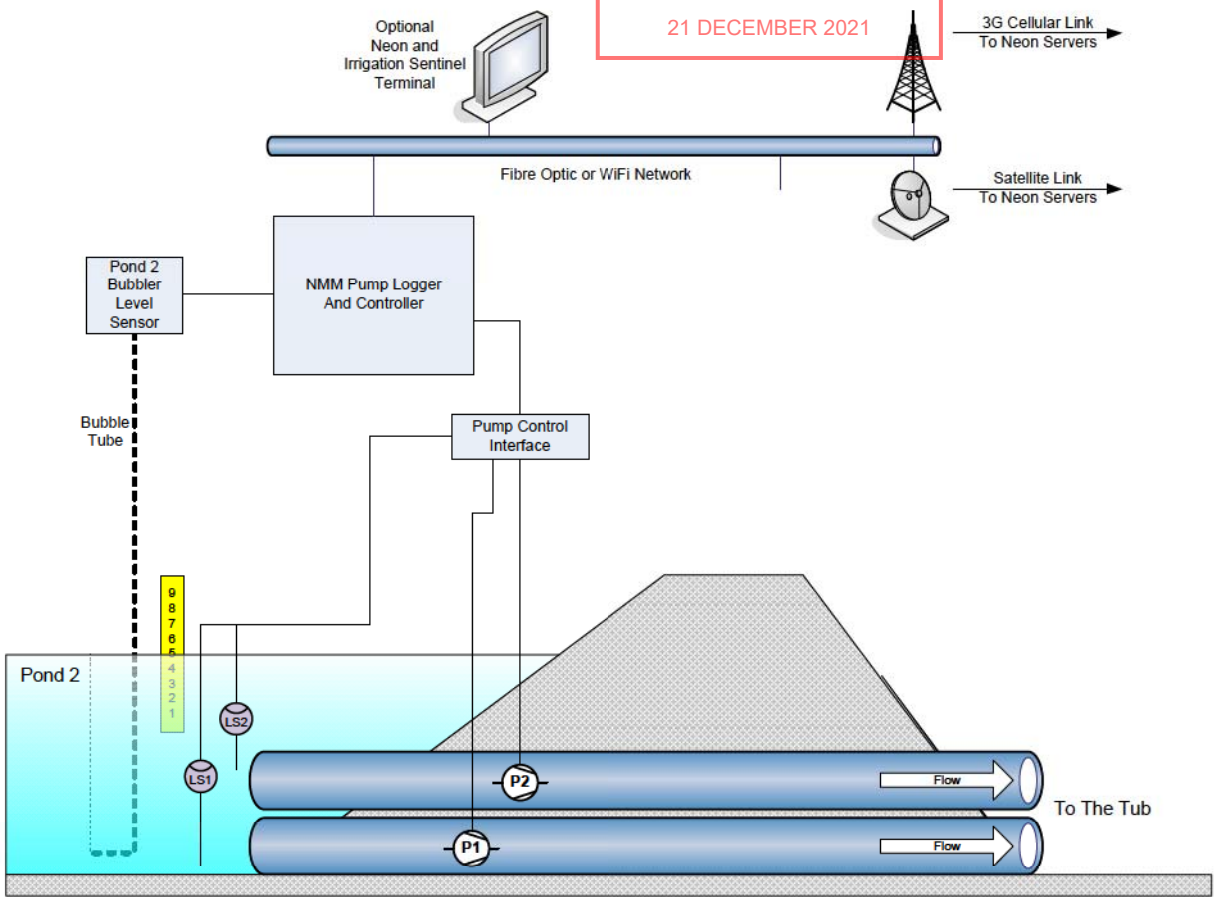

Figure 8 – NMM Pump System Schematic

Control System Contractor supply for this site will include:

1) The following equipment to be installed in the NMM Pump Control Hut provided by others:

   a) A Controller / Logger with sufficient inputs and outputs to handle the instrumentation and interfaces for the site. The Controller/Logger will be capable of autonomous operation in the event of loss of communications with the Neon Server system. If communications with the Neon Server are lost the Controller/Logger will maintain a local record of historical data, which will automatically upload to the Neon Server on resumption of communications.

   b) 1 x Bubbler water level sensor and up to 50m of bubbler tubing. The Bubbler instrument will be installed in the control hut, and the bubble tube will be run to a suitable location at the lowest point of the pond. Staff gauge plates for visual reference of level at the pond will be provided for visual reference of pond level if a suitable method for mounting them can be established.

   c) Pump control interface, providing:

i) Clean contact on/off outputs signals to the 2 pumps to be provided by others

ii) Clean contact on/off inputs signals from for each of the 2 pumps, to provide pump running indication

d) Allowance for inputs from two low level switches to be installed above the pump inlets

e) Local 230VAC to 12VDC power supply and battery

f) Fibre Optic and Wired Network equipment (Fibre Optic option only):

i) Media converter, required to transform fibre optic signals to wired Ethernet format for connection to the managed switch

ii) Fibre Optic terminations within the hut

g) WiFi Network equipment (WiFi option only):

i) WiFi Bridge/Access Point

ii) Single directional antenna

2) Two low level switches, to be installed above the pump inlets. These will provide failsafe normally open clean contacts for the pump control logic. Low level activation (open circuit) of either of these switches will disable logger control of the pumps.

3) Installation and commissioning services for supplied equipment, excluding cable burial and conduits.

a) Termination of instruments, and other connections to the Logger.

b) Set-up of the low level switches

c) Set-up of the Bubbler

d) Testing and commissioning of the monitoring and control system

4) The pump supplier will provide:

a) Motor starters and associated electrical supplies and controls for 2 pumps, complete with clean contact connections for remote control of pumps from the NIWA Neon logger.

6.2 Monitoring / Control Software

Several options exist for the configuration and distribution of server components required to support the WIL system. Key factors in the design of the system are:

a) Need to support a significant number of existing WIL pre-Neon loggers

b) Potential future expansion to include on-farm Neon loggers for water metering, leading to potential heavy use of the Neon web interface

c) Need to reduce the full scheme reliance on communications to the Pond site

For the above reasons the proposed design is that all logging and control nodes within the WIL Storage Ponds system will communicate back to NIWA infrastructure and servers.

The following diagram summarises the proposed components, some of which exist within the current WIL system:

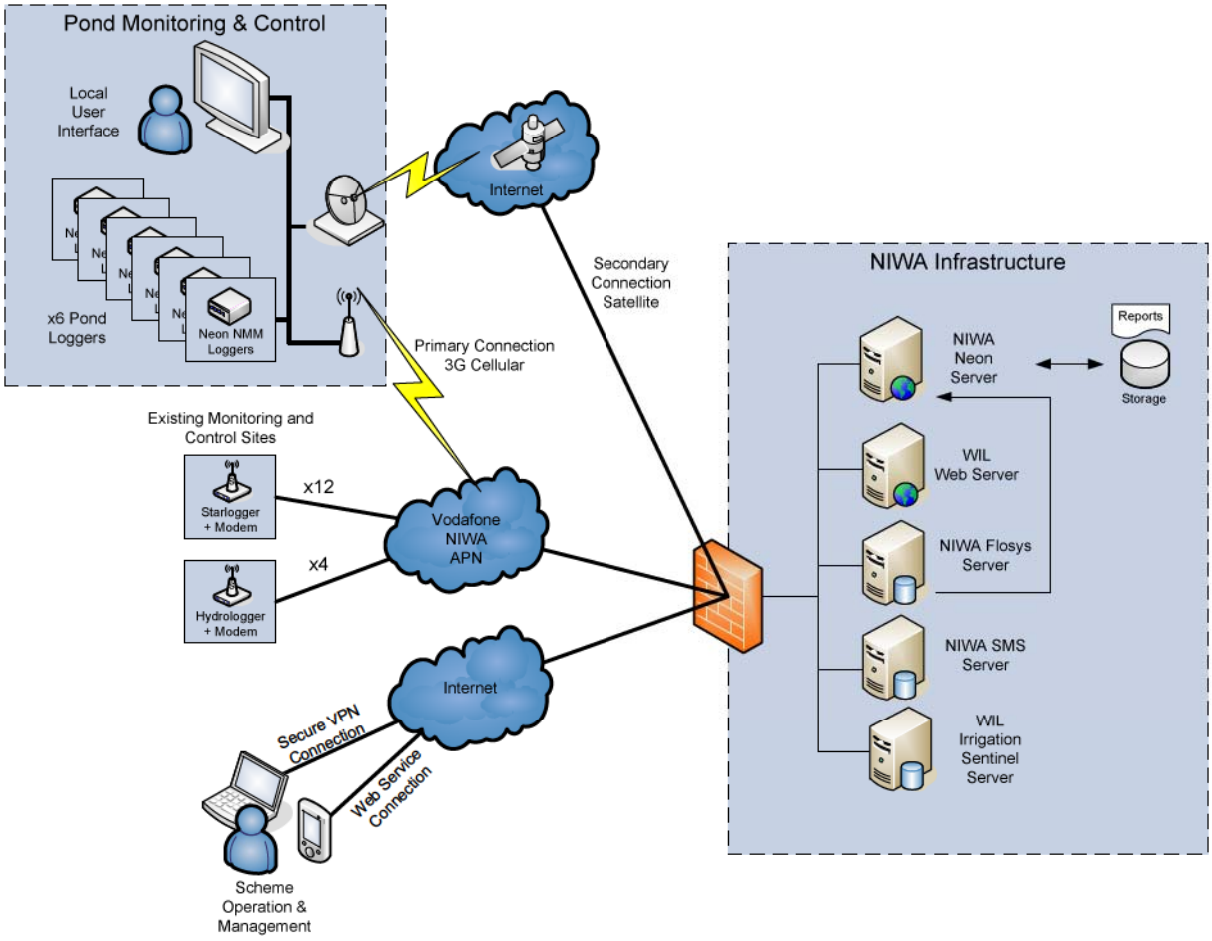

Figure 9 – WIL Storage Ponds Control System Overview

The WIL control and monitoring system will be realised as follows:

1) **Legacy logger data collection:** Will continue to through Flosys, although WIL will be provided the option for NIWA to pipe this data through to Neon so that Neon becomes the single point of access to all WIL data.

2) **Pond Neon data collection:** Pond Neon loggers will report their data to the NIWA Neon server via the collective 3G cellular or satellite connection.

3) **NIWA SMS Interface for status requests and alerts**: Will be provided via the NIWA hosted Neon Server and SMS Server application via an internet link to the site.

4) **Neon web interface:** Will be hosted on a NIWA server and available on-site at the Ponds through an optional Panel PC installed at NMM1. Elsewhere, access to Neon will be available through any standard internet connection.

5) **Irrigation Sentinel System Setpoint Management:** Will reside on a NIWA hosted Server and will coordinate transfer of information and setpoints between Neon loggers within the Pond Control System. The existing WIL Irrigation Sentinel application will be extended to include pond control functionality.

6) **WIL Web Server:** WIL are currently considering re-building and moving this website to a commercial web hoster. In the meantime it will remain as-is where-is.

6.3 Race Gauging and Rating Services

As the current provider of gauging and rating service to WIL, NIWA expect to be involved in the rating and maintenance of new flow monitoring sites. Site flow gauging services will be provided to establish a level/flow rating curve for each flow monitoring stilling wells. Ideally the initial rating will be performed at a range of low to high flows.

Once the system is in operation, periodic gaugings should be done to confirm that the rating is still accurate, or whether changes in the system have modified the flow behaviour. Such services be included within our on-going service contract with WIL.

6.4 General Services

General services provided by NIWA as part of this project will include:

1) Electrical drawings for the monitoring and control system component of each site
2) Supply of network hardware relating to the fibre optic / WiFi and wired Ethernet network
3) Liaison with other suppliers to ensure that NIWA scope is compatible with theirs. Differences in scope will be resolved where possible, and escalated to the Client if there are potential cost implications.
4) Project Management for Control System Contractor provided components of the project

6.5 Subcontracted Services

NIWA will subcontract the following services to specialist providers:

6.5.1 Fibre Optic Network Terminations and Testing (Fibre Optic Option)

NIWA propose to subcontract the following items to a specialist fibre optic network provider:

1) Testing of fibre optic cable prior to installation by others
2) Termination of the fibre optic cable at each of the four NMM Control Huts. This will include:
    a) Provision of an enclosure to contain cable splicing and terminations
    b) Termination of fibre cores in SC connectors where these are required at the site
    c) Splicing of “in” cable cores to associated “out” cable cores for all cores not required at a given site
3) Testing of the fibre optic network installation once completed

6.6 Maintenance and Support Services

It is anticipated that NIWA will include on-going support and maintenance of the Storage Pond Control System within our existing WIL service contract. This is an annually renewed contract, running July to June.

7 Control System Realisation

7.1 General Control System Requirements

Basic requirements for the control of the WIL Storage Ponds include:

1) Compatibility with the existing WIL logger, data collection, reporting and control systems.

2) It must be robust and reliable, and each node must be capable of operation in isolation if need be.

3) It must support text message alerting

4) It must be locally supportable.

5) Additional requirements include:

    a) Ability to support future extension – more measured or controlled parameters, video cameras, etc.

7.2 Control System Overview

As outlined in sections 3.3 and 6.2, the proposed solution consists of local Neon loggers communicating with NIWA hosted server components. The server components provide a platform for data collection, storage, presentation, scheme management, and coordination of scheme information back to the local loggers.

Most of the server components exist as part of the current WIL monitoring and control system, and will be modified or extended to incorporate the Pond monitoring and control system. The exact final configuration and location of these servers has yet to be determined, as some rationalisation may be possible, but such work would be performed outside the scope of this contract.

7.3 Local Logger Network

There are three options the connection of local Pond loggers to the servers within the NIWA infrastructure.

7.3.1 Local Logger Communications

Given good and reliable on-site cellular communications, it is possible to configure the system so that each Neon logger communicated directly back to the Neon server system through its own cellular network connection. This remains an option for consideration, and the pros and cons include:

Advantages:

1) A simple topology

2) Cheapest to implement

Disadvantages:

3) Failure of the cellular network will result in loss of visibility of the ponds

4) Running costs of 6 data accounts potentially higher than a consolidated connection.

5) The need for information sharing between nodes is such that communication failure from one critical node could effectively disable the pond control system. Better to spend the money on a pair of redundant consolidated connections?

7.3.2 Fibre Optic Network Option

NIWA propose a fibre optic network configuration as shown in the following diagram, subject to review by fibre optic specialist:

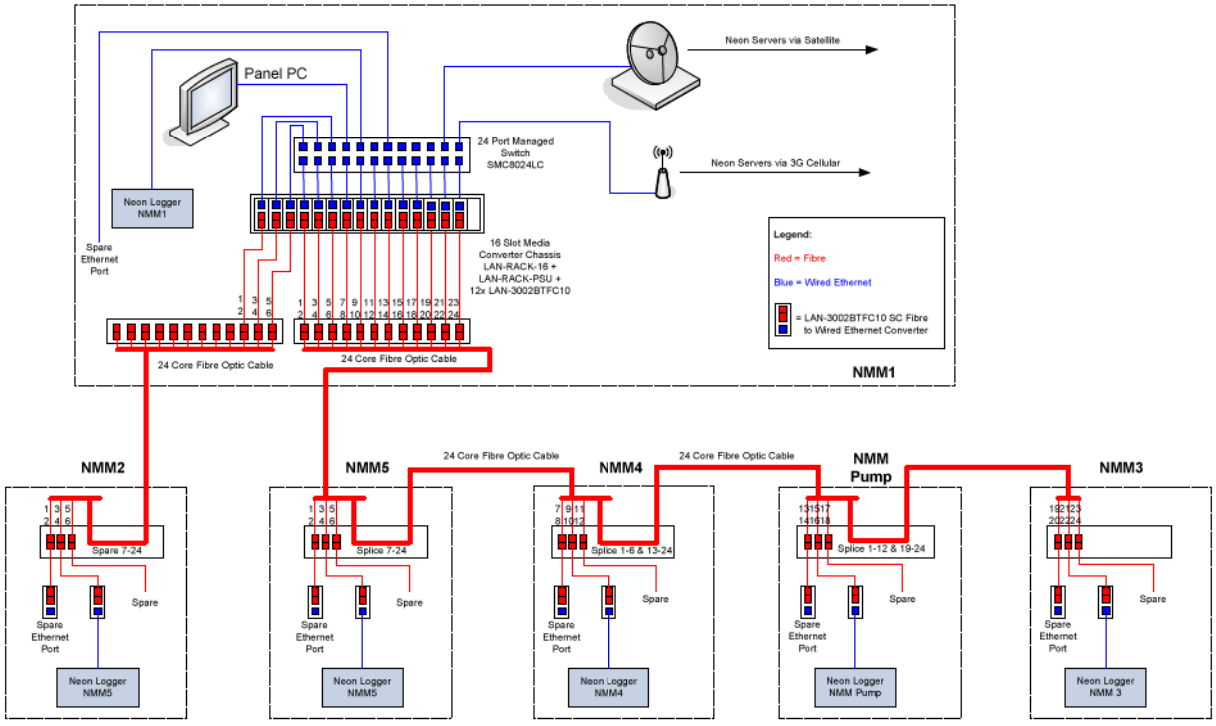

Figure 10 – Fibre Optic Network Schematic

Features of this design are:

1) NMM1 equipment:

   a) 24 Port Managed Ethernet Switch, providing connection between each of the fibre nodes, connection to devices at NMM1, and 5 spare ports connected to a spare fibre to each site.

   b) 16 slot Media Converter rack with redundant power supply, complete with 15 Media Converters and 1 spare slot. Each of the Media Converters provides an interface between a pair of optical fibres and a wired Ethernet channel

   c) 2 x 24 core fibre optic cable termination points

   d) Wired Ethernet connections between the NMM1 logger and the communications network

2) NMM2-5 and NMM Pump (x5):

   a) Termination box for incoming and outgoing fibre optic cables. Fibres required for local use will be terminated with SC connectors, and other fibres will be spliced for continuation to other sites.

   b) 2x Media Converters – one each to provide wired Ethernet connections for:

      i) Neon logger Neon communications
      ii) Spare

Benefits of a fibre optic network include:

1) Secure – the network is closed and effectively invisible

2) Not susceptible to electrical interference

Disadvantages of a fibre optic network include:

3) Susceptible to cable breaks – mitigated by allowing for spare cores in the cable, but fatal if the entire cable is severed

4) More expensive than other options

7.3.3 WiFi Network Option

A more cost effective solution for the link between Neon logger nodes and the Neon Server is the installation of a generic 802.11b/g/n WiFi network between the NMM nodes. The topology of the system (effectively a square with control nodes at each corner) will require that the hub of the network is non-directional, and it would have to be secured to minimise the likelihood of access by unauthorised parties.

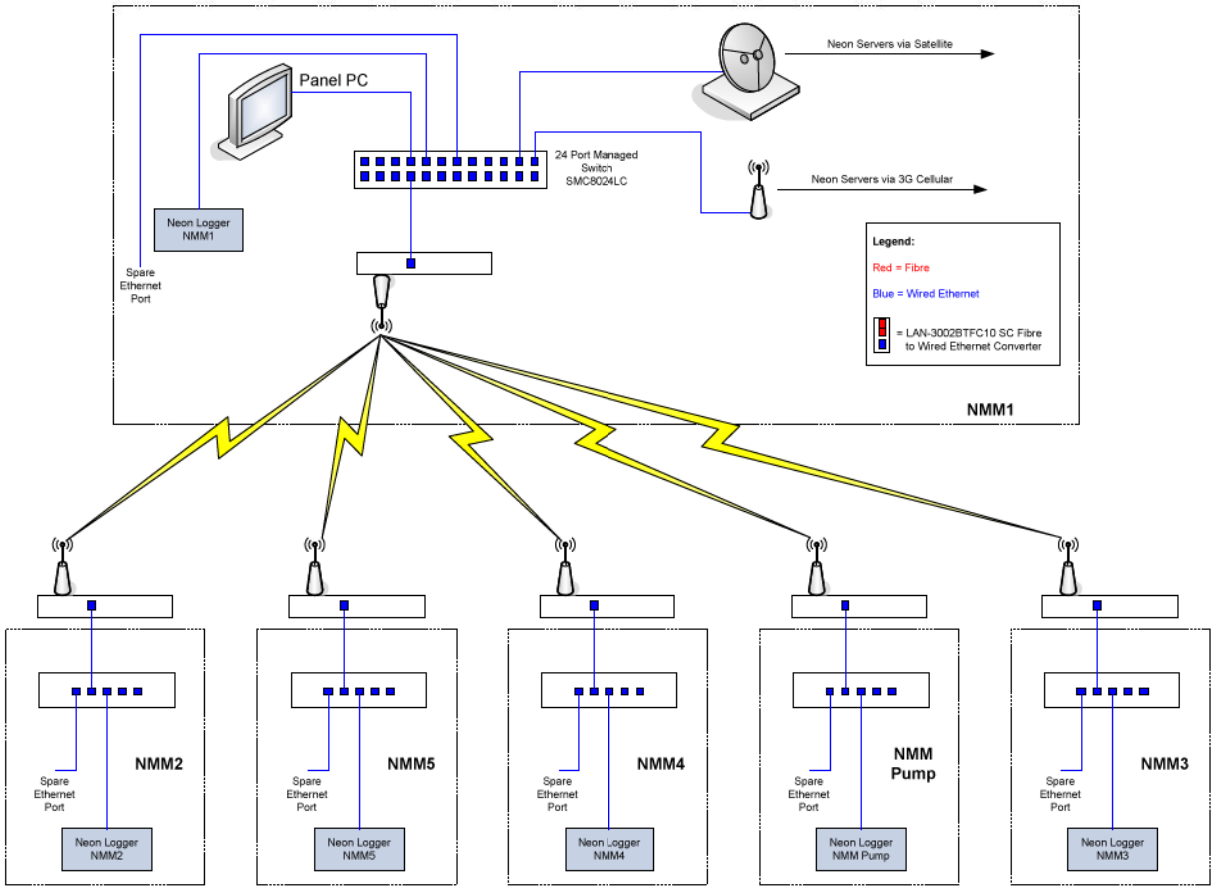

Figure 11 – WiFi Network Schematic

Features of this design are:

1) NMM1 equipment:

   a) 24 Port Managed Ethernet Switch, providing connection between the local WiFi Access Point, the Neon Server, the local Neon logger, and any other Ethernet devices that may be added at this point.

   b) A WiFi Bridge / Access Point, with a wide beam antenna aimed at the diagonally opposite NMM3 site, but with coverage of other NMM sites as well.

2) NMM2-5 and NMM Pump equipment (x5):

   a) A WiFi Bridge / Access Point, with an antenna aimed at the NMM1 site.

   b) A 4 port Ethernet switch, allowing connection of the local Neon logger and other equipment into the WiFi Ethernet network.

Benefits of a WiFi network include:

i) Considerably cheaper than the fibre optic option

ii) Not susceptible to cable damage

Disadvantages of a WiFi network include:

iii) Susceptible to electrical interference, although use of directional antennae will mitigate this

iv) Less secure, although this will be mitigated by employing directional antennae where possible, several layers of security, and setting the network to be invisible to general discovery inquiries.

7.4 Internet Access Options

Internet access to the site will be required for both the Fibre Optic and WiFi communications options, to provide a path for the Neon loggers to communicate with the NIWA hosted servers. The basic requirement is an "always on" Internet connection with a static IP address and "reasonable" transmission and reception bandwidth.

Given the importance of good visibility of data around and from the site, the proposed solution includes a primary and secondary internet connection, providing redundancy that will mitigate the failure of one or other of the networks.

7.4.1 Cellular Network Options

Given adequate coverage, 3G cellular phone networks provide options for the connection between the Neon and the outside world. These include:

1) Vodafone 3G connection, using NIWA's private Access Point, providing a simple and secure connection to NIWA systems and the Internet. The Vodafone coverage map suggests that extended 3G functionality will be available on site, and this can be improved through the use of a directional and high gain Yagi antenna aimed at the closed local cell site. Using the NIWA APN will also allow the site to be assigned a static IP address, which will be of advantage for ease of connection to the site.

2) Telecom XT 3G data connection, using a public network connection. Use of a Telecom XT connection may require subscription to an external service to provide a fixed IP or DNS address for the site, to enable remote connection.

Benefits of direct cellular connections:

i) Will be cheaper than a satellite connection.

Trade-offs in using direct cellular connections:

ii) Potentially less secure

NIWA already have loggers at the existing pond sites communicating on the Vodafone network, so this is a viable option.

7.4.2 Satellite Communication Options

An option for communications between the Neon system and the outside world is a satellite communications link to the Internet. There are at least two options for achieving this:

1) BGAN (Broadband Global Area Network) – an industrial strength satellite communications network utilising the geostationary Inmarsat satellite network. BGAN is commonly used by the oil & gas, utilities, and mining industries. NIWA have access to BGAN equipment and competitive network access pricing through our 80% ownership of Unidata, the manufacturers of Neon data loggers.

2) Farmside satellite data connection – Farmside is a rural Internet service provider, and offers a cost effective and proven option for satellite broadband data connections.

8 Associated Costs

Pricing will be provided in three parts, being an initial price for system design, an estimated price for the delivery of the system based on the current understanding of scope, and an estimate of on-going running cost and support options, again based on the current understanding of scope. A fixed price shall be provided for the Delivery and Support phases of the project once the scope is agreed as part of the Design Phase of the project.

9 Schedule

To be confirmed following Detailed Design.

10 Intellectual Property

All intellectual property originating from either party prior to the commencement of the contract, including that which is used for the purposes of providing the services, remains the exclusive property of the party introducing that intellectual property.

11 Open and Unresolved Items

The following items remain in question – to be resolved during the detailed design phase:

1) Neon logger to server communications – which of the options in section 7.3 do we use? Local comms from each logger will be cheapest to implement but potentially least robust.

2)