MWWTP Technical Memorandum.

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Quality statement

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02	30.05.23	Incorporated comments	Colby Putnam	Louis Ortenzio	Dugall Wilson	Niall Chapman

1 Introduction

The Martinborough wastewater treatment plant (WWTP) is owned by South Wairarapa District Council (SWDC). The assets and operations for the WWTP are managed by Wellington Water (WWL). WWL have engaged Stantec and Lutra to plan, design, and oversee the implementation of a compliance upgrades programme for the treatment to improve compliance, resilience, accommodate future growth, and improve aspects of health and safety.
The Martinborough WWTP (MWWTP) is an oxidation pond-based treatment system with maturation ponds and tertiary treatment (UV disinfection). Treated water is currently discharged to the Ruamahanga River and/or to land, with staged increases planned for land irrigation to minimise river discharge as outlined in the discharge resource consent (No. WAR120258).
In August 2022, Greater Wellington Regional Council (GWRC) issued SWDC with an abatement notice for MWWTP's resource consent non-compliances pertaining to hydraulic load constraints when discharging to land and river, and exceedances in E. coli and nutrient limits when discharging to river (Johnston, 2022). GWRC have requested a plan of corrective actions to address these issues by 31st May 2023.
In response, the compliance upgrade programme has been slightly adjusted to address the abatement notice in the short term (Gardiner, 2022).

1.1 Objectives

The objectives of this memo include the following:

- Outline a scope for the investigations and works proposed to be undertaken over the 23/24 financial year at the MWWTP to address the concerns raised in the abatement notice;
- Provide a level 1 cost estimate to allow for allocation of funds to enable the execution of the scope of work.

1.1.1 Additional Considerations

SWDC and WWL will be undertaking a growth projection plan during the 2023/24 financial year, in parallel with the scope of work outlined in this memorandum. The growth projection plan is not within this project's scope of work; however, the outcomes of this plan will be relied upon for design and planning purposes for the compliance upgrades programme of works.

1.1.2 Assumptions

Several assumptions were made with regards to sludge dewatering. See Section 3.1.1 for more information.

2 Compliance Upgrades Programme

The compliance upgrades programme scope for Martinborough WWTP is extensive and includes a wide range of improvements to improve treatment performance and accommodate future growth. Most of these upgrades are long term as they require background investigations to produce design envelopes, evaluate risk, estimate cost, etc. Work to address the abatement notice immediately and to build a foundation for the long-term upgrades is presented in Table 1. Long-term upgrades are included at a high level in Table 2. The preliminary scope for the long-term upgrades will form part of the larger project management plan for the future plant upgrades. The list of long-term upgrades is not exhaustive.

Table 1 - Scope of work planned for the 23/24 financial year to address the abatement notice.

Upgrade	Benefits	Requirements to enable works/design
Desludging of the facultative and maturation ponds	Restores oxidation treatment plant capacity to assist in meeting resource consent compliance by improving ammonia and E. coli. Reduction prior to the treated effluent reaching the UV reactor.	▪ Enabling works ▪ Resource consents
Influent flow and quality measurement	Verifies current plant performance by understanding current loads and flows (e.g., I&I issues) and is the basis for a design envelope which helps inform future treatment upgrades.	None
UV system investigation and optimisation	Restores UV system treatment capacity in line with design specifications and increases E.coli reduction efficiency prior to discharge.	None

Table 2 – Preliminary scope of future upgrades for Martinborough WWTP

Upgrade	Benefits	Requirements to enable works/design
Installation of a new pond inlet screen	Removal of rags and debris that can cause premature wear and/or failure of equipment; removal of inorganic material that can contribute to build up on the pond floors	▪ Future growth projections for wastewater reticulation network ▪ Basis of design for raw influent flow for process sizing ▪ Hydraulic profile for integration into plant headworks
Floating wetland removal	Reduces debris/materials entering UV systems	None
Pond aerator renewal	Provides oxygenation of pond to allow for effective treatment at current and future pollutant loadings	▪ Future growth projections of wastewater reticulation network ▪ Basis of design for raw influent pollutant loads for process sizing
New maturation pond outlet pump station with screen	Access to current screen and pump wetwell presents H&S risks	▪ Future growth projections of wastewater reticulation network

Upgrade	Benefits	Requirements to enable works/design
New UV treatment system	Provides disinfection treatment at future flows and predicted water qualities	▪ Future growth projections of wastewater reticulation network ▪ Water quality design envelope
Stage 2A irrigation including new rising main to transfer pumps at Pain Farm irrigation and the irrigation system at Pain Farm itself.	Provides site for long term wastewater disposal via land application	▪ Future growth projections of wastewater reticulation network
Provision to connect to the future winter storage – Stage 2B	Provides resilience for long term wastewater disposal via land application	▪ Future growth projections of wastewater reticulation network
Security fencing	Reduces H&S and security risks to site	▪ Upgraded plant design to understand future site layout requirements
Electrical and control improvements	Provides upgraded control system, surge protection, remote access to facilitate continuous operations	▪ Upgraded plant design and ancillary system requirements
Power supply upgrade	Larger power supply system to support new and larger treatment systems at upgraded WWTP	▪ Future growth projections for wastewater reticulation network ▪ Full load power requirements for upgraded WWTP
General site works	Improves overall plant functionality and operability	▪ Upgraded plant design and ancillary system requirements
Existing building improvements and modifications	Provides suitable facilities for long term, sustainable operations	▪ Upgraded plant design and ancillary system requirements

3 Proposed Works for 2023/24

To expediently address the non-compliances set out in GWRC Abatement Notice A1020 and to begin preparing a design envelope for the compliance upgrade programme, a scope of work is outlined in the following sections for the 23/24 financial year. The scope of works includes the following activities:

- Oxidation pond and maturation ponds desludging to restore treatment capacity.
- Raw influent flow monitoring and quality characterisation to establish a design envelope for sizing of treatment processes for the upgraded plant. This effort will also require the growth projections for the wastewater reticulation network in Martinborough.
- Investigation and optimisation of the existing UV disinfection unit. While not part of the upgrades programme, the intention is to gain treatment improvements on the existing assets to provide better effluent quality as it pertains to resource consent compliance.

The following sections provide detail into these planned activities/investigations.

3.1 Oxidation Pond and Maturation Ponds Desludging

During the operation of oxidation ponds, solids settle at the bottom in a layer of microorganisms and inert solids referred to as the sludge blanket. Throughout the life of an oxidation pond based WWTP, the depth of the blanket increases to a point where the following issues arise (Cameron & Clark, 2017):

- Reduced effective treatment capacity of the plant due to decreased retention time due to voided volume in the oxidation pond;
- Increased compliance risk due to increased decay of biomass resulting in higher rate of ammonia release back into wastewater solution;
- Increased odour nuisance due to increased anaerobic decomposition. Additionally, less anaerobic decomposition products (e.g. methane, H_2S) are oxidised due to the reduced aerobic water layer above the sludge blanket;
- Increased risk of sludge suspension and carry over as the top of the sludge blanket is more susceptible to disturbance from currents generated by wind and wave action.

The Martinborough WWTP was constructed in 1975. Since its inception, the oxidation pond and maturation ponds have not been desludged. A sludge survey was conducted in 2021 to quantify the volume and mass of sludge. Refer to Figure 1 and Table 3 for information from the sludge survey.

Table 3 – Martinborough Sludge Survey Results (Mayes, 2021).

Parameter	Unit	Facultative Pond 1	Maturation Pond 1
Area	Ha	1.6	0.05
Assumed Total Depth	m	1.5	1.5
Average Free Water Depth	m	1.045	1.43
Average Sludge Depth	mm	455	70
Volume of Sludge	m^3	7,285	35
Assumed Solids Content	% DS	3.0	3.0
Mass of Sludge	T-DS	220	1

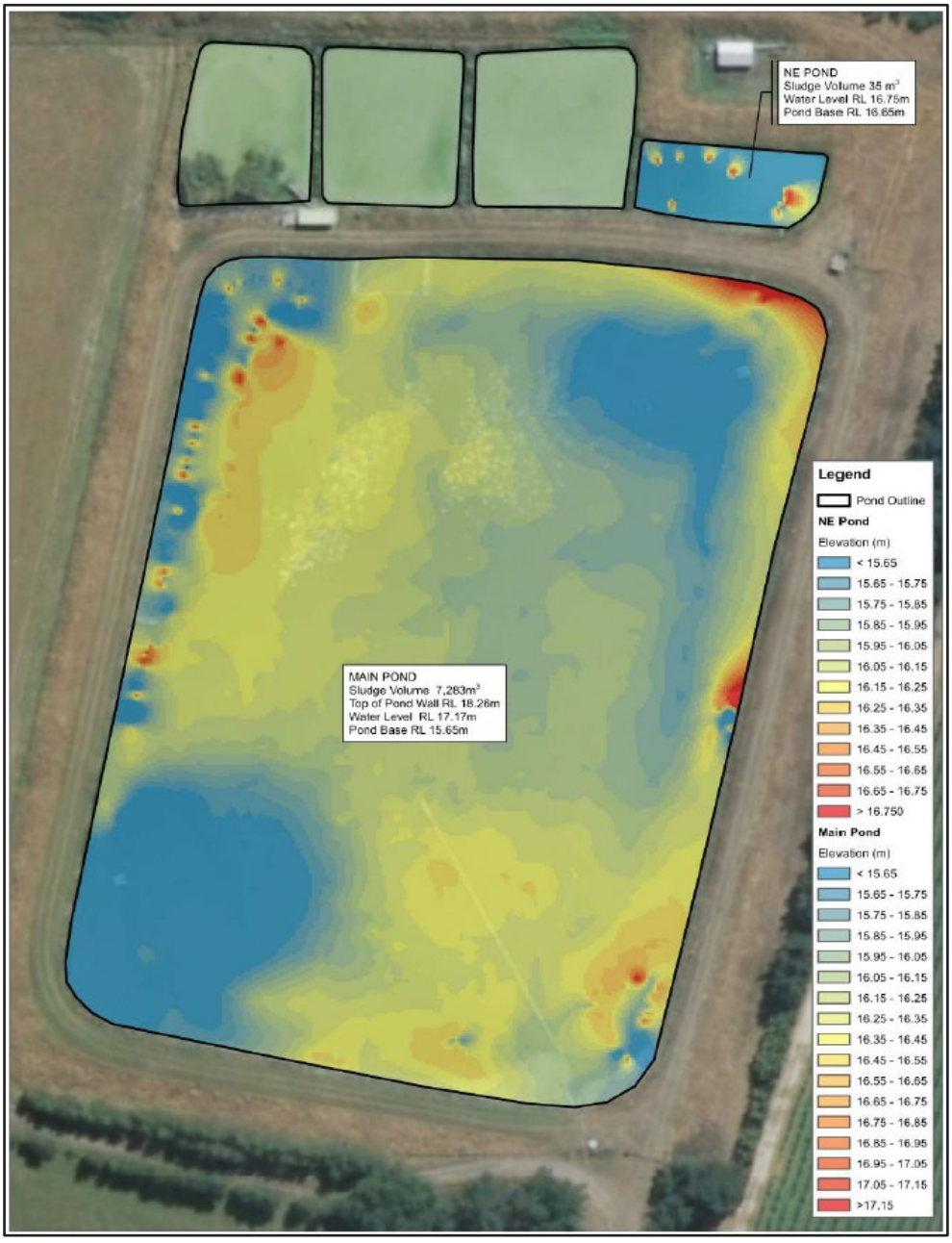

Figure 1 – Martinborough WWTP Pond Sludge Survey (Mayes, 2021).

Site visits were conducted by Hydracare and Conhur, contractors specialising in the desludging of oxidation ponds, on 8th May 2023 and 9th May 2023. The objective of these site visits included the following:

- Develop a scope of work with the contractor including access requirements, potential Geobag laydown areas, and location to existing plant operations;
- Develop an understanding of any potential operational or treatment disruptions that may be incurred during the desludging process;
- Obtain an accurate cost estimate for the scope of work.

The contractors provided the following information:

- There was discussion around the costs and benefits of immediate dewatering onsite via centrifuge vs storage and dewatering onsite via geobag. These costs and benefits are detailed in Table 4.

- One contractor indicated that three geobags (30 m x 15 m) would be required giving a total bunded area of approximately 2,500 m^2. The other contractor indicated 6 geobags with a bunded area footprint of 4,400 m^2.
- The validity of the sludge blanket solids concentration assumption at 3% was questioned. The contractor's experience is that this can potentially be 5-6%, meaning the volume of dry solids to be dewatered is potentially double what is stated in the 2021 sludge survey report. Contractors recommended a detailed sludge survey.
- One contractor stated that moving the desludging dredge would cost $8,000 every time the dredge is lifted into a new position. This implicates the value in desludging of the first maturation pond, therefore the volume of sludge in this pond should first be confirmed.

As the dry solids concentration has a significant impact on the dewatering process and required investment, a sludge survey including total solids, total suspended solids, and volatile suspended solids concentration samples will be commissioned to accurately quantify the total mass of sludge required for removal and dewatering.

A service road for truck access encompasses the oxidation pond and links to the adjacent irrigation field, where a potential geobag laydown area has been proposed. The proposed location for geobag laydown (in red) and the service road are presented in Figure 2.

Figure 2 – Aerial photographs of the potential geobag laydown area (left) and site access roads (right).

Based on upfront capital costs, expected dry solids content and the ability to defer disposal costs, it is expected that geobag dewatering will be the preferred option and a decision around desludging method will be evaluated shortly after this memo is issued. Further considerations for these options are presented in Table 4. It should be noted that while the range of dry solids concentrations for geobags can be as low as 17% in adverse or sub-optimal conditions, it is more common and therefore expected for the dry solids concentration to be 30 - 40%. A discussion of the resource consenting process triggered by the dewatering operation is detailed in the following section.

Table 4 - Cost-benefit summary of sludge dewatering via geobag or centrifuge.

Approach	Benefit	Cost
Geobag – Delayed Disposal	▪ Delayed disposal costs ▪ Higher achievable dewatered sludge dry solids concentration (17-40%) ▪ Anticipated dry solids percentage is in the 30-40% range at MTBWWTP.	Extensive enabling works including additional resource consents for: ▪ Pad construction (potentially) ▪ Disposal of contaminated land (potentially) ▪ Leachate discharge to land/water (potentially) ▪ Odour discharge to air
Centrifuge – Immediate Disposal	▪ Temporary installation avoids extensive enabling works and multiple additional resource consents	▪ Immediate disposal costs ▪ Enabling works to support temporary location and operation of dewatering centrifuge ▪ Lower achievable dewatered sludge dry solids concentration (15-19%)

3.1.1 Resource Consenting for Desludging

Initial investigations and considerations have been carried out to understand the potential resource consent application processes that will be triggered by both potential dewatering options. Stantec's principal planner was engaged to provide initial guidance during this process. The following assumptions were made in these investigations:

- If a concrete pad is to be constructed for the geobag laydown area, the area will be classified as a Hazardous Activities and Industries List (HAIL) site (MfE, 2021);
- The applications will be non-notifiable;
- Three months preparation for supporting technical reports;
- One month for preparation of the three consent applications;
- Two months total for consent application processing (i.e. assumes doubling of the standard non-notified consent processing times).

An overview of the consent processes is presented in Table 5.

Table 5 - Overview of the resource consent applications for both sludge dewatering options.

Dewatering Option	Resource Consent	Responsible Authority	Comment	Application Requirements
▪ Geobag	Land-use Consent: Disturbing soil in a HAIL site.[1]	SWDC	Earthworks in a HAIL site is a permitted activity if it satisfies the conditions set out in clause 8 of the NESCS[2]	▪ Assessment of environmental effects report
▪ Geobag	Discharge Permit: Wastewater to land	GWRC	Dependent on the risk of seepage or other discharges in desludging operation	▪ Assessment of environmental effects report ▪ Desludging management plan
▪ Geobag ▪ Centrifuge	Discharge Permit: Odour to air	GWRC	Required due to SWDC's original application where they specified odour discharges, not including desludging activity odour	▪ Assessment of environmental effects report ▪ Update existing odour management plan

[1] An outline plan may also need to be submitted to SWDC, which describes all new works to be undertaken within the WWTP designation boundary. It is assumed that this will be straightforward task (if required at all) and would be included within the documentation for the land use consent application.
[2] National environmental standard for assessing and managing contaminants in soil to protect human health. The WWTP designation may also over-ride the NES. This will need discussion with SWDC consents team.

3.2 WWTP Influent Flow and Quality Measurement

Several treatment plant upgrades are required to satisfy conditions of the MWWTP resource consent and to accommodate potential growth. To adequately design these systems and accommodate growth, a design envelope based on plant influent flowrates, pollutant concentrations, and growth projections must be developed through flow monitoring and water quality sampling and analysis. Historically, flow and quality data has been proven to be ambiguous or inconsistent. This investigation will require the analysis of raw influent flowrates into the treatment plant and a sampling programme utilising equipment presented in Figure 3 below.

Figure 3 - MWWTP influent flowmeter (left) and typical portable composite sampler (right).

The following methodology for developing the plant design envelope is proposed:

- Review the existing SCADA flow data and sampling data;
- Inspect, calibrate, and correct deficiencies for the influent flowmeter as required;
- Develop a raw influent sampling programme;
- Engage third party lab for sample collection and analysis;
- Execute sampling/monitoring over the course of 12 months
- Perform statistical analysis of data to develop plant design envelope for flows and pollutant loads.

3.3 UV Disinfection Investigation and Optimisation

UV disinfection is the final treatment process at the MWWTP prior to discharge (either to land or river). The UV disinfection unit is responsible for the destruction of pathogenic material, most notably *E. coli* as it pertains to the MWWTP discharge resource consent. The UV disinfection system is not currently achieving consent requirements. Refer to Table 6 for an overview of UV treatment performance at MWWTP with respect to the resource consent (Kuranchie, 2022)

Table 6 - MWWTP UV Treatment Performance (1st July 2021 – 30th June 2022).

Consent Condition	River Discharge Flow Range	Limit	Allowable Exceedances (consecutive samples)	Actual Exceedances (consecutive samples)
Schedule 2: Condition 6(a)	≤3,000 m^3/day	100 CFU/100mL	5/10	7/12
Schedule 2: Condition 6(a)	≤3,000 m^3/day	1,400 CFU/100mL	2/10	3/12
Schedule 2: Condition 6(b)	≤3,000 m^3/day	All discharges must be UV treated	0/10	0/12

The UV disinfection system at MWWTP consists of a feed pump wetwell located in Maturation Pond 4, feed pumps, flow metering, automated valves and one (1) duty Berson UV disinfection unit. The piping, flow monitoring, valves and UV disinfection unit are installed as a containerised system. The container includes the UV unit control panel, which communicates to the plant PLC located in the irrigation pump building. Refer to Figure 4 for photos.

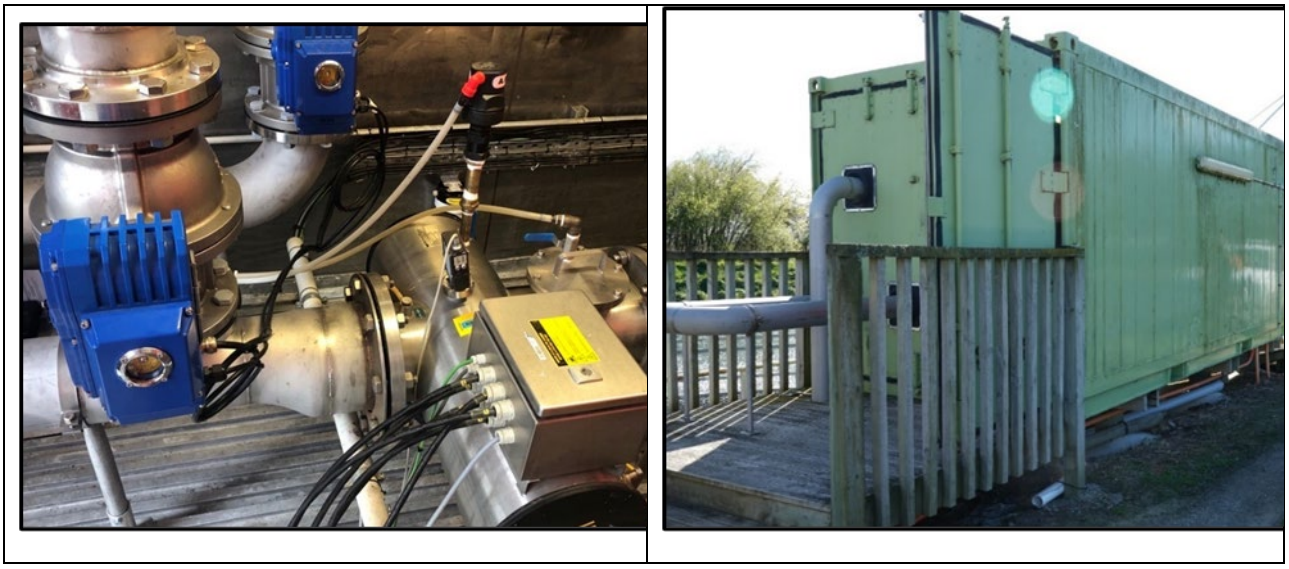

Figure 4 - MWWTP Berson UV Disinfection Unit (left) and UV Container (right).

The project team recommend investigating the UV system to understand why it is not meeting the required performance standard and follow up with corrective actions. The following methodology is proposed:

- Inspect and calibrate system components and correct any system deficiencies as required;
- Renew system components as required;
- Collect and analyse water quality samples (e.g. UV transmittance) into the UV reactor;
- Download and review the UV PLC programme and identify any potential improvements;
- Investigate any bolt on equipment which may improve disinfection effectiveness (e.g. automated strainers);
- Implement and commission any recommended changes;

It should be noted that the removal of the floating wetland outlined in Table 2 is expected to improve UV performance. While it is not within this scope of works, it is recommended that WWL and SWDC pursue this activity.

4 Cost Estimates

A level 1 cost estimate has been prepared for each package of work to allow for appropriate funding requests.
The quotes received from Hydracare and Conhur for pond desludging and dewatering were relatively similar with a few different assumptions that impacted pricing. Assumptions around the enabling works of a geobag dewatering area was the primary driver for price differences in this instance.

For the purposes of this memo, a midpoint was used for the cost of geobag dewatering area preparation. Sludge disposal costs for geobag dewatering are still required but have been deferred until after the 23/24 financial year and have not been included in the cost estimate.
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An NPV analysis has not been carried out to determine which dewatering option is cheaper long-term. In the future, disposal costs will require reassessment, taking into account the fluctuating prices of sludge solids disposal, as well as the confirmation of the volume of sludge to be disposed of.

An estimate comparing two options for sludge dewatering is presented in Table 7. Estimates for influent flow and quality measurement and UV investigation and optimisation are presented in Table 8. A summary of total costs is presented in Table 9 .Complete cost estimates are presented in Appendix B .

It should be noted that funding risk has not been included as part of this cost estimate.

Table 7 - Level 1 cost estimate for pond desludging (assumes 40% contingency).

Item	Option 1: Geobag Dewatering			Option 2: Centrifugal Dewatering		
	Base Estimate	Contingency $	Total $	Base Estimate	Contingency $	Total $
Pond Desludging & Dewatering	$528,150	$211,260	$739,410	$926,750	$370,700	$1,297,450

Table 8 - Level 1 cost estimate for influent flow and quality measurement, UV investigation and optimisation (assumed 40% contingency.)

Item	Base Estimate	Contingency $	Total $
Influent Flow & Quality Measurement	$80,000	$32,000	$112,000
UV Investigation & Optimisation	$22,000	$8,800	$30,800

Table 9 - Level 1 cost estimate for total works (assumes 40% contingency.)

Estimate Component	Cost Item	Option 1: Geobag	Option 2: Centrifuge
Total Base Estimate	Base Estimate	$630,150	$1,028,750
	Contingency	$252,060	$411,500
	Expected Estimate	$882,210	$1,440,250

5 Programme - Timeline

The timeline for the scope of works for 2023/24 is presented in Table 10. It is assumed that very little progress is made during December and January due to summer holidays.

Table 10 - MWWTP programme for proposed works during the 2023/24 financial year.

Activity	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24
Desludging: General												
Site Investigations - Embankment Geotechnical												
Sludge Survey and Sampling												
Desludging Option 1: Geobag Dewatering[1]												
Enabling Works Investigation/Design												
RC Application Impact Assessment Reports (3)												
Regional Council Consent Processing												
Carry Out Enabling Works												
Contractor Desludging												
Desludging Option 2: Centrifugal Dewatering												
RC Application Impact Assessment Reports (1)												
Regional Council Consent Processing												
Contractor Desludging & Sludge Disposal												
Influent Flow & Quality Measurement												
Flowmeter Inspection, Calibration and Correction												
Sampling Plan Development and Implementation												
Data Analysis and Design Envelope Development												
UV Investigation & Optimisation												
System Inspection, Calibration and Correction												
UV PLC Programme Analysis and Improvement												
UV Sampling												
Improvement Investigation and Implementation												

Note 1: Anticipated to be the preferred sludge dewatering option.

6 Conclusions and Recommendations

Martinborough WWTP is currently not achieving consent requirements related to hydraulic load constraints when discharging to land and river, and E.coli and nutrient limits when discharging to river. As a result, GWRC have issued SWDC with an abatement notice and require SWDC to have a plan of corrective actions to address these issues.

An existing, long-term programme of works planned for Martinborough WWTP has been adjusted for immediate response to the abatement notice and to enable future design works. This memo outlines a scope of work to set Martinborough WWTP on the path to compliance in the 23/24 financial year and includes the following activities:

- Dewater and desludge the ponds at the WWTP to restore treatment capacity;
- Carry out influent flow and quality measurement to set a baseline for current plant performance, establish the extent of I&I the treatment plant receives, and to define an influent design envelope to inform future treatment plant upgrades and;
- Investigate and optimise the UV disinfection system to meet the required performance standard.

The following actions are recommended to get the above scope of works underway:

- Allocate funding to support this programme of works;
- Carry out a sludge sampling survey to confirm the quantity and quality of sludge in the treatment ponds;
- Evaluate and decide which dewatering option is most suitable for SWDC;
- Prepare contract documentation for the dewatering service;
- Start the required resource consent applications once a dewatering option has been decided;
- Inspect and refurbish (if necessary) the influent flowmeter;
- Develop a raw influent sampling programme;
- Engage ELS for their laboratory services and implement the sampling programme;
- Analyse the flow and quality data and develop a design envelope;
- Inspect and refurbish (if necessary) the UV system;
- Implement UV sampling;
- Download UV PLC programming;
- Analyse all UV data, investigate and implement improvements.

7 References

Cameron, S., & Clark, S. (2017). *Good Practice Guide for Waste Stabilisation Ponds: Design and Operation.* Wellington: Water NZ.

Gardiner, A. S. (2022). *MEMO – MARTINBOROUGH WWTP ABATEMENT NOTICE RESPONSE.* Wellington: WWL.

Johnston, A. (2022). *WAR120258.* Masterton: GWRC.

Kuranchie, A. (2022). *Martinborough Wastewater Treatment Plant Annual Resource Consents Report 2021/2022.* Wellington: WWL.

Mayes, J. (2021). *SWDC Sludge Survey Results.* Lower Hutt: Cardno.

MfE. (2021). *Hazardous Activities and Industries List (HAIL).* Wellington: Ministry for the Environment.

Wright, S. (2019). *Cost Estimation Manual.* Wellington: WWL.

Appendix A Project Risk Register

Threat or Opportunity	RID	Risk Title	Description/ Cause/ Consequence	Risk Owner	Risk Owning Org	Date Raised (xx/xx/xxxx)	Risk Status	Phase	Conseq	Likelihood	Pre-mitigation Risk Score	Mitigation and Treatment Plans	Conseq	Likelihood	Residual Risk Score	P5 - Best case (Value)	Most Likely (Value	P95 - Worst Case (Value)	Risk Value	P5 - Best case	Most Likely	P95 - Worst Case	
T	1	Site access/control	**Description**: Number/frequency of site visits place workload on WWL Ops team lead to co-ordinate and wider WWL Ops team to allow access/induct visitors **Cause**: Site visits required for the project **Consequence**: Burden on WWL Ops, impacts to Project Delivery timeframe	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Medium	15	Issuing of site key and designation of a site engineer and main contact to organise site visits	Medium	Low	11	5,000	15,000	50,000	20,000	Minimal impact on WWL Ops staff	Additional time spent to manage WWL Ops to ensure their workloads are not increased	Additional cost to account for WWL Ops time and impact to relationship and project delivery	Threat
T	2	Site access/physical	**Description**: Site access is limited to single vehicle width in many areas. This limits working area/access for project and access for WWL Ops BAU **Cause**: Existing site constraints **Consequence**: Site access restricted/impacted affecting WWL Ops and Project team/contractors	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Medium	15	Project areas demarked from the rest of the site Complete stakeholder comms Explore use of the river stop bank Trenched temporary services, use of suitably rigid conduit/sleeve if crossing pond perimeter track	Medium	Low	11	1,000	25,000	60,000	27,200	Minimal impact on WWL Ops staff	Additional time spent on demarking project area from the rest of the site. A secondary temporary acccess may need to be installed.	Additional cost to account for WWL Ops time and impact to relationship and project delivery	Threat
T	3	Excavations	**Description**: Potential risk to integrity of pond embankment **Cause**: Construction excavations **Consequence**: Spill, unauthorized discharge to land. Asset damage, environmental impacts, reputational damage	Contractor	TBC	19/05/2023	Draft	Implementation	High	Medium	19	Geotech investigations Shoring of excavations	High	Low	16	10,000	20,000	75,000	29,000	Geotech investigations are completed and no ground stablisation is required other than minimum shoring requirements	Geotech investigations are completed and some ground stablisation is required other than minimum shoring requirements	Geotech investigations are completed and significant ground stablisation is required	Threat
T	4	Desludging power supply	**Description**: Limited provision of power supply on site, it is unknown whether the capacity of the currently supply is sufficient for additional project loading **Cause**: Additional power supply required from desludging **Consequence**: Power supply interruptions to site (trips), increase in project costs if additional power supply is required to be installed	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	High	High	21	Investigate site power supply capacity	High	Medium	19	15,000	50,000	150,000	63,000	Investigation into the power supply on-site reveals that there is sufficient supply for the additional loads	Investigation into the power supply on-site reveals that that there may be insufficient supply for the additional loads but this could be addressed by load shedding	Investigation into the power supply on-site reveals that there is in insufficient supply for the additional loads and a new transformer and conduits are required	Threat
T	5	Scope creep	**Description**: Additional work added, queries not directly related to the project **Cause**: Wider programme of works required at the treatment plant which may not be directly related to the current project scope **Consequence**: Time and cost, negative impacts to client/stakeholder relationships	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	High	17	Set clear deliverables and refer to plan	Medium	Medium	15	5,000	10,000	70,000	21,000	Scope creep does not occur and can be managed by project management	Some scope creep occurs but expectations are managed with the client through project management	Significant scope creep occurs resulting in significant budget increase	Threat
T	6	Budget	**Description**: Constrained budget and additional funds are unlikely **Cause**: Lack of funding **Consequence**: Overspend and negative impacts to project deliverables	Consultant	Stantec	19/05/2023	Live - Treat	Project	High	Medium	19	Strict cost/scope controls	High	Low	16				-	Sufficient funding available to complete scope of work	Only enough funding available to address certain elements in the scope of work	Not enough funding available to progress with project	Threat
T	7	WWL Ops resourcing	**Description**: Site is not manned fulltime. WWL Ops team covers 8 individual sites and may not have any additional headroom for site management **Cause**: Site is not manned fulltime. **Consequence**: Impacts project delivery timeframe	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	High	Medium	19	Project team to define what resourcing requirements from WWL are and advise	High	Low	16	5,000	15,000	50,000	20,000	WWL Ops are able to work around resourcing requirements	WWL Ops are able to work around resourcing requirements but require some support from the project team	WWL Ops are unable to work around resourcing requirements and there are project delays	Threat
T	8	Odour	**Description**: Geo-bags used for desludging may generate offensive odour due to anaerobic sludge **Cause**: Geo-bags used for desludging are in open air **Consequence**: Complaints from stakeholders and neighbouring properties	Consultant	Stantec	19/05/2023	Draft	Pre Implementation	High	Medium	19	WWL odour management plan, desludging contractor query - has this been an issue in the past and how was it mitigated? Resource Consent application to ensure efective management plan is generated and implemented.	High	Low	16	5,000	15,000	50,000	20,000	Odour is not offensive	Odour is slightly offensive but can be managed through an odour management plan	Odour is significantly offensive and will require treatment	Threat
T	9	Information	**Description**: Information required may not be available to the project team or may not exist **Cause**: Lack of historical information **Consequence**: Service strikes and operational impacts	Consultant	Stantec	19/05/2023	Live - Treat	Project	High	Medium	19	Obtain Woogle site access Complete site walkovers Complete service locations and markouts	High	Low	16	5,000	15,000	30,000	16,000	All historical information is present in Woogle and can be obtained	Most historical information is present in Woogle and the remainder of the information can be gathered through operator documentation, discussions and service locations.	Little to no historical information is present in Woogle requiring significant effort to gather the information	Threat
T	10	Infectious materials	**Description**: Site receives raw sewage and has an irrigator which generates aerosol **Cause**: Raw sewage treatment on-site **Consequence**: Health impacts, project delays	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Low	11	Always wear appropriate PPE when visiting site Vaccination of contractors Avoid the irrigator spray drift Stop work when wind direction blows aerosols to worksite at excessive speeds.	Medium	Very Low	4					Adhere to PPE requirements when working around raw sewage, aerosols not impacting the work site.	Adhere to PPE requirements when working around raw sewage, set up work site in such a way that aerosols will not impact site, be mindful of wind speeds and direction during irrigation	No PPE to adhere to requirements when working around raw sewage, work stopped due to excessive aerosols in project area.	Threat
T	11	Hygiene	**Description**: Site does not have a potable water supply **Cause**: Unavailability of potable water supply **Consequence**: There is risk of gastro illness	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Low	11	Always maintain good personal hygiene and have hand sanitiser/wet wipes ready in vehicles Water containers/tanks to be available to wash hands	Medium	Very Low	4				-	Water containers for washing to be available		No water available on site for washing purposes	Threat
T	12	Covid-19	**Description**: Covid-19 results in sickness within the project team **Cause**: Covid-19 pandemic **Consequence**: Health impacts to project team and WWL Ops. Delays to project	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Medium	15	Ensure team are vaccinated Usage of facemasks when in close proximity to others Redundancy in team to ensure project can progress even if a team member gets sick	Medium	Low	11	5,000	10,000	25,000	12,000	There are no impacts from Covid-19	There are some impacts from Covid-19 but these are manageable	There are significant impacts from Covid-19 resulting in project delays	Threat
T	13	Weather	**Description**: Unfavourable extreme weather conditions may result in impacts to project tasks, timelines and delivery dates **Cause**: Extreme weather conditions **Consequence**: Impact to project tasks, timelines and delivery dates	Consultant	Stantec	19/05/2023	Live - Treat	Implementation	Medium	Medium	15	Early identification of tasks vulnerable to weather impacts and plan around suitable weather Identify wet weather contingency to contract period for programming and communications	Medium	Low	11	5,000	15,000	50,000	20,000	Unfavourable weather conditions are not encountered	Some unfavourable weather conditions are encountered but early identification of tasks vulnerable to weather impacts have provided appropriate mitigation measures	Significant adverse weather conditions are encountered and early identification of tasks vulnerable to weather impacts are insufficient resulting in cost and time implications	Threat
T	14	Supply Chain	**Description**: Supply chain issues and contractor availability may impact timelines and delivery **Cause**: Supply chain constraints **Consequence**: Impact on timelines and delivery, project delays	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Medium	15	Identify supply chain requirements and engage contractors early on in the project life cycle	Medium	Low	11	5,000	7,500	50,000	15,500	There is minimal supply chain issues and no further mitigation actions are required	There is some supply chain issues but these can be addressed through early contractor engagement or early procurement and programming	There are significant supply chain issues resulting in project delays	Threat
T	15	Timeline for delivery	**Description**: Proposed works need to fit within required timeframes, some work may need to be undertaken in a season **Cause**: Strict timeframes to be adhered to **Consequence**: Tight timeframes to work towards, project delays	Consultant	Stantec	19/05/2023	Live - Treat	Project	Medium	Medium	15	Investigate task timelines and identify risks to project delivery	Medium	Low	11	2,500	5,000	10,000	5,500	There are no significant risks identified to project delivery	There are some risks identified to project delivery but these can be mitigated	There are significant risks identified to project delivery and significant effort is required to mitigate them	Threat
T	16	Regulatory - Consent breaches	**Description:** Consent breaches during the desludging process **Cause**: **Consequence**: Consent breaches	Consultant	Stantec	19/05/2023	Live - Treat	Implementation	High	Medium	19	Assess risk of task and potential impacts to site consents, project consents and plan accordingly	High	Low	16	5,000	15,000	75,000	25,000	Consenting checks completed reveal no further planning assessments are required and there is minimal risk to site consents	Consenting checks completed reveal some further planning assessments are required and some planning is required to manage risk to site consents	Consenting checks completed reveal significant further planning assessments are required and significant planning is required to manage risk to site consents	Threat
T	17	Operations	**Description**: Project tasks impact site operability **Cause**: De-sludging process results in negative impact **Consequence**: Operational impacts, breakdowns or failures caused by the de-sludging process, project delays	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	High	Low	16	Assess risks of tasks and potential impacts and required controls	High	Very Low	8	5,000	25,000	75,000	31,000	Minimal impact on operations	Additional time spent on planning to ensure that site operability is not impacted	Additional time spent on planning to ensure that site operability is not impacted but unforeseen circumstances occur resulting in negative impacts	Threat
T	18	Desludging equipment	**Description**: Breakdown/equipment failures **Cause**: Failure of equipment **Consequence**: Failure of equipment resulting in stoppage of work/task impacting delivery timeframes	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	Medium	Low	11	Identify vulnerable equipment/single points of failure, plan/procure redundancies	Medium	Very Low	4	5,000	25,000	75,000	31,000	Time spent identifying vulnerable equipment/single points of failure reveals no causes for concern	Time spent identifying vulnerable equipment/single points of failure reveals some planing required for redundancy	Time spent identifying vulnerable equipment/single points of failure reveals significant issues requiring resolution	Threat
T	19	Poor construction and installation of desludging equipment	**Description**: Poorly installed desludging equipment **Cause**: Unsuitably qualified contractor **Consequence**: Environmental incident or injury/death to workers	Consultant	Stantec	19/05/2023	Live - Treat	Implementation	High	Low	16	Select appropriate contractor with good track record QA checks and auditing to be completed through construction monitoring process	High	Very Low	8	5,000	15,000	30,000	16,000	A suitably qualified contractor is hired and minimal QA checks and auditing are required to be carried out	A suitably qualified contractor is hired and moderate QA checks and auditing are required to be completed	A suitably qualified contractor is hired but significant QA checks and auditing are required to be carried out	Threat
T	20	Contaminated land	**Description**: Encountering contaminated soil may result in environmental harm, project delays and increases in cost **Cause**: Possibility of encountering contaminated land **Consequence**: Environmental harm, project delays in increases in project cost	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	Medium	Medium	15	Check SLUR site designation of site Complete soil testing if required	Medium	Very Low	4	1,000	25,000	100,000	35,200	Minimal contaminated land is encountered and there are little disruptions to the project	Some contaminated land is encountered and the contractor will have to allow for some disposal of contaminated land	Contaminated land is encountered throughout the site area and large amounts of soil disposal is required. There are no suitable landfills available for disposal of large quantities of contaminated material.	Threat

Threat or Opportunity	RID	Risk Title	Description/ Cause/ Consequence	Risk Owner	Risk Owning Org	Date Raised (xx/xx/xxxx)	Risk Status	Phase	Conseq	Likelihood	Pre-mitigation Risk Score	Mitigation and Treatment Plans	Conseq	Likelihood	Residual Risk Score	P5 - Best case (Value)	Most Likely (Value	P95 - Worst Case (Value)	Risk Value	P5 - Best case	Most Likely	P95 - Worst Case	
T	21	Archaelogical discovery	**Description**: Archaelogical discovery during construction. The site is within an existing field so is considered to be low risk. **Cause**: Archaelogical artifacts found during construction **Consequence**: Construction is halted	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	Medium	Low	11	Complete archaelogical check	Medium	Very Low	4	2,000	5,000	15,000	6,400	Arch Check is completed and the the team can proceed on an accidental discovery protocol	Arch Check is completed and the the team can proceed on an accidental discovery protocol	Arch Check is completed and an Archaeological Authority is required to be obtained	Threat
T	23	Unknown geotechnical conditions	**Description**: Unknown geotech conditions **Cause**: No existing information available on geotech conditions **Consequence**: Changes required to construction methodology, increase in cost relating to certain geotech conditions	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	Medium	Medium	15	Complete geotechnical investigations	Medium	Low	11	10,000	20,000	65,000	28,000	Extra over ground investigations to determine soil stability for open excavation	Extra over ground investigations to determine soil stability for open excavation reveals that the soil conditions are not as favourable and some soil stabilisation measures are required	Extra over ground investigations to determine soil stability for open excavation reveals that the area is unstable and additional comprehensive soil stabilisation measures are required	Threat
T	24	Underground services	**Description**: Risk of underground services impacting on construction **Cause**: Uncertainty of service locations **Consequence**: Service strikes, potential delays to project, cost implications	Consultant	Stantec	19/05/2023	Live - Treat	Pre Implementation	High	Medium	19	Complete B4UDig early and service markouts prior to any physical works	High	Very Low	8	15,000	25,000	75,000	28,000	Extra over physical investigations to confirm service locations - no design or programme changes incurred.	Extra over physical investigations to confirm service locations - minor design or programme changes incurred.	Extra over physical investigations to confirm service locations - major design or programme changes incurred.	Threat
T			**Description**: **Cause**: **Consequence**:								0				0				-				Threat

Appendix B Cost Estimate

Complete cost estimates for each activity and total works are presented in the tables below.

Table 11 - Level 1 cost estimate for pond desludging (assumes 40% contingency).

Item	Description	Option 1: Geobag Dewatering			Option 2: Centrifugal Dewatering		
		Base Estimate	Contingency $	Total $	Base Estimate	Contingency $	Total $
Pond Desludging & Dewatering	Site Investigations - Embankment Geotechnical Investigations	$25,000	$10,000	$35,000	$25,000	$10,000	$35,000
	Sludge Survey and Sampling (ponds 1-5)	$15,000	$6,000	$21,000	$15,000	$6,000	$21,000
	Optional metals, TCLP and PFAS analysis	$5,000	$2,000	$7,000	$5,000	$2,000	$7,000
	Resource Consent Application Impact Assessment Reports (3)	$45,000	$18,000	$63,000	$10,000	$4,000	$14,000
	Application Fees	$15,000	$6,000	$21,000	$5,000	$2,000	$7,000
	Regional Council Processing Fees	$15,000	$6,000	$21,000	$5,000	$2,000	$7,000
	Mobilisation	$54,000	$21,600	$75,600	$60,000	$24,000	$84,000
	Carry Out Enabling Works – Dewatering Area[1]	$151,250	$60,500	$211,750	n/a	n/a	n/a
	Carry Out Enabling Works – Sump Pump	$20,000	$8,000	$28,000	n/a	n/a	n/a
	Contractor Desludging & Dewatering (Oxidation Pond)[2]	$137,500	$55,000	$192,500	$273,750	$109,500	$383,250
	Contractor Desludging (First Maturation Pond)[2]	$10,500	$4,200	$14,700	$11,500	$4,600	$16,100
	Demobilisation	$34,900	$13,960	$48,860	$39,000	$15,600	$54,600
	Sludge Disposal[2]	n/a	n/a	n/a	$477,500	$191,000	$668,500
	Subtotal	$528,150	$211,260	$739,410	$926,750	$370,700	$1,297,450

Note 1: A midpoint price from both contractor quotes was used for the geobag dewatering area construction.
Note 2: Desludging, dewatering and disposal costs have been normalised to 250 tonnes of dry solids and 1,250 tonnes of sludge removed (assuming centrifugal dewatering on site) as contractors made different assumptions for sludge blanket dry solids concentration.

Table 12 - Level 1 cost estimate for influent flow and quality measurement, UV investigation and optimisation (assumed 40% contingency.)

Item	Description	Base Estimate	Contingency $	Total $
Influent Flow & Quality Measurement	Flowmeter inspection, calibration and correction (incl. parts renewal)	$5,000	$2,000	$7,000
	Sampling Programme Development and Implementation	$15,000	$6,000	$21,000
	Laboratory Costs (two sample collections per week, 52 weeks)	$40,000	$16,000	$56,000
	Data Analysis and Design Envelope Development	$20,000	$8,000	$28,000
	Subtotal	$80,000	$32,000	$112,000
UV Investigation & Optimisation	System inspection, calibration and correction (excl. parts renewal)	$5,000	$2,000	$7,000
	UV PLC Programme Analysis and Improvement	$5,000	$2,000	$7,000
	UV Sampling	$2,000	$800	$2,800
	Improvement Investigation and Implementation	$10,000	$4,000	$14,000
	Subtotal	$22,000	$8,800	$30,800

Table 13 - Level 1 cost estimate for total works (assumes 40% contingency.)

Estimate Component	Cost Item	Option 1: Geobag	Option 2: Centrifuge	Factor
Total Base Estimate	Base Estimate	$630,150	$1,028,750	
	Contingency	$252,060	$411,500	@ 40%
	Expected Estimate	$882,210	$1,440,250	