26 August 2016

Nelson City Council
C/- Francis Lojkine
MWH NZ Ltd
PO Box 13249
CHRISTCHURCH 8141

Dear Francis,

Resource Consent Applications RM165114, RM165115 and RM165116 – Accidental and overflow discharges
Nelson Regional Sewerage Business Unit (NRSBU)

This letter provides the further information sought in your request for further information (RFI) requests of 3 May and 24 May 2016. The numbers used below correspond with the numbering used in the RFI letter.

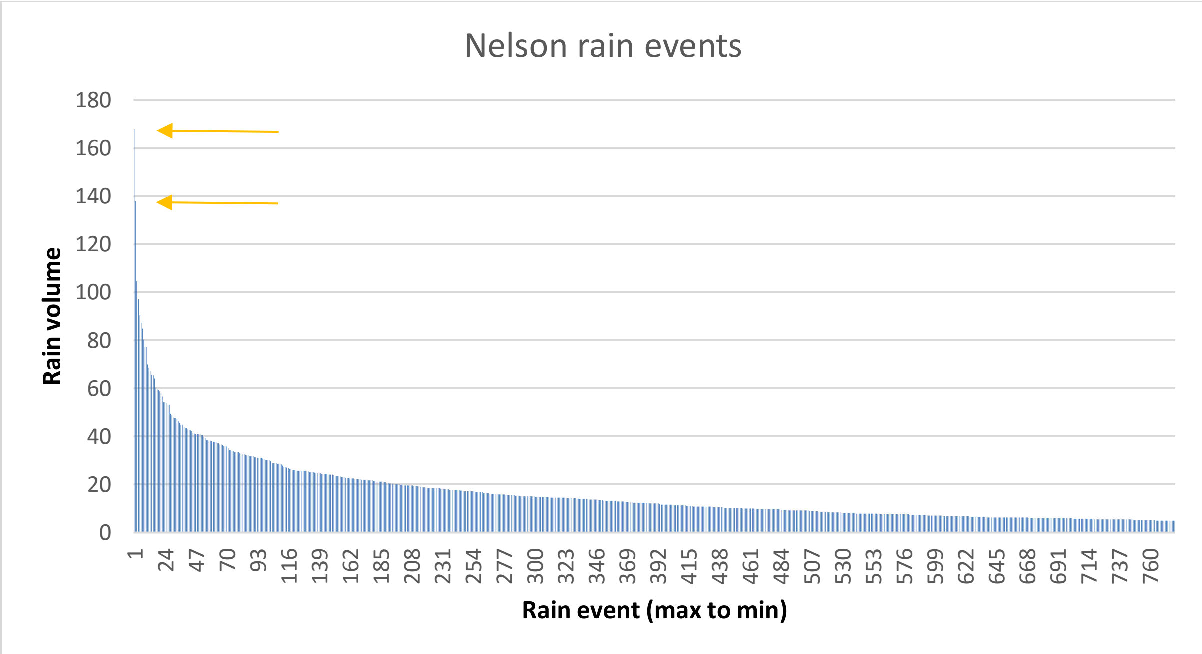
<u>Attachments</u>
NB. The numbering of attachments follows on from that used in application.

K	Updated Figures 5 and 6
L	NMDHB Procedure HPO 014 – "*Recreational Water Exceedances (for Bacteria & Cyanobacteria) & Sewage Spill Notification"*
M	"*Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas*." MfE and MoH; June 2003
N	Bathing water results vs overflows vs rainfall: spreadsheet and graphs
O	Proposed Sampling Locations Plan
P	Cawthron Letter 1636
Q	Disposal of Trade Waste Agreement
R	NRSBU 2015/16 Business Plan
S	NRSBU 2016/17 Business Plan
T	NRSBU Wastewater Asset Management Plan

1. Records of discharge following infrastructure upgrades

Updated graphs are provided as **Attachment K**, along with annotations to cross reference between volumes/durations with pump stations to address the matter raised in the engineering report (and RFI letter dated 24 May 2016).

NB. The overflows that occurred on 24 March 2016 coincided with the second highest daily rainfall event recorded in Nelson since 1 December 2000. The overflows that occurred on 14 December 2011 coincided with the highest rainfall event recorded in Nelson over the same period. The two maximum rain events can be seen on the left hand side of the graph below.



2. Saxton pump station

The applicant has reconsidered the functioning and demands of the Saxton Pump Station. It is now intended (and is volunteered) that the applicant will install first flush chambers at all pump stations. Design and implementation will be within two years. Sizing will be determined during this design phase and will depend on, for example, capital availability, flow volumes, and site constraints.

These first flush chambers will incorporate a 10mm screen at Saxton where one is not currently in place.

The chambers will be of particular value as an extra contingency measure to capture small dry weather overflows that would otherwise discharge to the inlet.

3. Contact recreation and public health risks

To inform our further information response in regard to contact recreation and public health risks we have undertaken further conversations and meetings with representatives of the NMDHB; principally Mr Geoff Cameron.

Mr Cameron has provided us with a procedural document entitled "Procedure HPO 014 – *Recreational Water Exceedances (for Bacteria & Cyanobacteria) & Sewage Spill Notification*". This document (**Attachment L**) has been useful for a number of purposes in better understanding the public health response to spill events, and is provided as part of this further information response.

On page 5 of the *Procedure HPO 014* document there is a reference to the "Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas. MfE and MoH; June 2003". This document is the most applicable guidelines for managing water quality in relation to public contact and human health. These guidelines are provided as **Attachment M**.

Public Health Risk

Table G1 on page G2 of the guidelines provides a list of the illnesses, symptoms and pathogens that can result from contact with contaminated recreational water. This table is reproduced as Figure 1.

Table G1: Bathing-related illnesses, symptoms and pathogens, with relevant references

Illness/symptoms	Pathogen	Reference
Campylobacteriosis – acute diarrhoea with risk of dehydration lasting about five days, but may be longer. Usually with fever, headaches and nausea in the first stages. Abdominal pain can be sufficiently severe for patients to be hospitalised with suspected appendicitis.	*Campylobacter jejuni*	Koenraad et al 1997
Cryptosporidiosis – acute diarrhoea. Symptoms may wax and wane but duration in healthy persons is usually less than 20 days with spontaneous complete recovery. May be fatal in immunocompromised patients.	*Cryptosporidium parvum*	Sorvillo et al 1992
Ear infection – otitis externa, skin infection of the outer ear and otitis media, inner ear infection with exudate and earache.	Not identified (usually *Pseudomonas aeruginosa*, *Streptococcus*, and *Staphylococcus*)	Robson & Leung 1990
Enterovirus-like illness – vomiting, diarrhoea, and abdominal pain.	Enteroviruses (type not identified)	D'Alessio et al 1981
Hepatitis A – long incubation with symptoms developing gradually. Symptoms include loss of appetite, malaise, fever and vomiting followed by jaundice.	Hepatitis A virus	Bryan et al 1974
Norwalk gastrointestinal illness – usually sudden onset with vomiting, diarrhoea and abdominal pain. Vomiting frequently appears without warning and may be projectile and uncontrollable, while diarrhoea may be explosive.	Small round structured viruses (SRSVs), including Norwalk virus	Barron et al 1982
Respiratory illness – cold and flu-like symptoms. May be associated with fever.	Adenovirus and others not identified	McBride, Salmond et al 1998; Corbett et al 1993; Fattal et al 1986
Shigellosis – diarrhoea that may vary from relatively mild to violent, with abdominal pains and fevers.	*Shigella sonnei*	Rosenberg et al 1976
Swimmer's ear – otitis externa, infection of the outer ear.	Not identified (usually *Pseudemonas aeruginosa*)	Calderon and Mood 1982
Typhoid and Paratyphoid (enteric) – fever	*Salmonella typhi* and *Salmonella paratyphi*	PHLS 1959

Figure 1: Table G1 from MfE and MoH Microbial Water Quality Guidelines

One of the key concerns raised by Mr Cameron for illness from contact recreation around Nelson is the outbreak of Norovirus. Norovirus is also known as Norwalk virus and is listed in Figure 1.

Sampling Results

In terms of sampling and analysis for enterococci, there is currently no comprehensive and systematic sampling and testing that is directly tailored toward gauging the effects of accidental sewage spills from the applicant's pump stations. Reference in the application was to routine bathing water sampling and analysis that is carried out at (relevantly) Monaco Beach and Tahunanui Beach.

Enclosed is a spreadsheet of bathing water quality sampling results (**Attachment N**). Exceedances of the amber alert (>140) and red alert (>280) enterococci concentrations from the Microbioloigical Water Quality Guidelines (**Attachment M**) have been highlighted in the data.

The applicant has annotated these records with recorded pump station spill events, and other events such as heavy rain. Because the sampling and testing are not specifically for the purpose of picking up the viral signature of an overflow, it is difficult to draw definitive conclusions about the effect that spills have on bathing water quality.

However, the applicant has attempted to line up spill events with contamination and no consistent pattern can be detected. It should also be acknowledged that in the event of heavy rain (the conditions that are also most likely to result in a sewage overflow) there can be considerable viral and bacterial contamination of marine water resulting from runoff of contaminants from the urban area. This is borne out in some of the results provided.

It is acknowledged that there is a shortage of reliable testing data that would be useful in informing authorities about the public health risk. A volunteered testing regime is described later in this section.

Public Health Response and Risk Management

The RFI letter asks for specific information about particular steps (e.g. warning signs and locations) that are taken. The applicant advises that it is simply not possible to be so prescriptive in setting out the exact response that will be taken. This is because of the vast array of circumstances that will inform response decisions. Instead the emphasis is placed on setting up an appropriate management and decision making structure to effective manage each spill.

The Procedure HPO 014 document attached provides the best guide to how the public health risks of a spill are managed. The document provides the purpose as being:

> *"The purpose of this procedure is to ensure that [Health Protection Officers] respond to seasonal recreational water exceedances and sewage spills in a uniform manner across the district"*

The document then outlines a comprehensive procedure (commencing page 3) that, for every sewage spill, all relevant parties are advised and a dedicated Sewage Spill Team is established.

The Team is made up of:

- NRSBU and Council representative(s),
- Contractor representative(s),
- The Medical Officer of Health or his/her delegate, and
- Health Protection Officer(s).

As identified in the document, that team is responsible for undertaking the initial risk assessment including all of the matters identified on page 4. It is from this risk assessment that decisions are made about whether an "advisory" is put in place, any public health messaging is undertaken, and what warning signs are to be erected by the TLA.

For example, the Sewage Spill Team's response will (appropriately) vary significantly depending on the circumstances of the spill. A 5 cubic metre spill of heavily diluted sewage during a rain event will demand a considerably different response to a larger spill during dry weather. Seasonal considerations will also come into play with extensive contact recreation occurring in the summer months, whereas there is much less contact recreation during winter. The Sewage Spill Team will continue to function until the end of the response.

The RFI also seeks information on when it is determined that a health risk has passed. This is determined by the collective assessment of the experienced people who make up the Sewage Spill Team who have extensive knowledge of contact recreation hazards based on many years of collective experience in managing bathing water quality at the key recreational locations.

However, through the course of holding discussions to address the RFI it has become apparent that there would be value in building a body of information about the effects and behaviour of spill events. Therefore the applicant has devised a sampling plan which is described below. This sampling plan has had the input and support of both Mr Cameron for the NMDHB and Stephen Lawrence for Environmental Inspections Ltd (EIL) which is contracted by NCC to undertake compliance monitoring of resource consents.

Volunteered Sampling Programme

Determining an appropriate sampling regime is complex as a spill can occur at any stage of the tide and at any stage of the day or night. It has been necessary to work out a sampling regime that is able to detect pollution at key locations, whilst also being practicable to implement. It is considered that an important part of the sampling programme is to build a consistent record of results.

As stated above the applicant has had the input of experienced professionals who are responsible for the protection of public health, bathing water monitoring and resource consent enforcement.

It is proposed and volunteered that following every spill (regardless of volume and circumstances) samples will be taken and analysed for enterococci concentrations.

Samples will be taken from each of the sampling sites (see below) at the following times:

(1) 4 hours after the spill, regardless of the time or stage of the tide;

(2) 2 hours after the first high tide following the spill; and

(3) 2 hours after the second high tide following the spill.

The sampling sites are as shown on the attached plan (**Attachment O**) and are identified as follows:

(a) Monaco boat-ramp;

(b) Parkers cove; and

(c) Tahunanui beach.

These three locations are the key contact recreation areas that could be affected by a spill at any one of the pump station discharge locations. They also have the advantage of having water available for sampling regardless of the state of the tide. (4 hours after a spill event may correspond with a low tide.)

Having the first sample taken 4 hours after a spill removes the variability of the tidal cycles. While the tide is clearly important, relying on a certain stage of the tide to trigger samples may cause a discharge plume to be missed. Therefore it is necessary to obtain a sample a certain period of time after a discharge. Based on the team's experience of inlet circulation and the time to detect pollution after rain events, four hours is considered appropriate.

Following the first initial sample, subsequent samples will be taken two hours after then subsequent high tides. Again, this is the stage of the tide when pollution is most likely to be detected as it is mobilised from within the inlet and taken past the monitoring sites.

Consideration was given to attempting to tailor the monitoring locations to spill locations, or alternatively to vary the requirement to monitor based on wet versus dry weather spill events. However, it is considered that there remains considerable value in collecting a body of consistent sampling records that applies consistently. The need for simplicity to avoid mistakes is also apparent.

It should also be noted that there is a turn-around time of approximately 48 hours to obtain results from sampling. Clearly with tidal flushing occurring every tidal exchange (~12 hours) it is considered that the sampling has as much, if not more, value in providing a body of data about how spills behave to inform future decision-making.

Conclusion

Decision making in relation to sewage spills from the applicant's pump-stations is undertaken on a case-by-case basis, guided by the Council's Emergency Response Document and by the NMDHB's protocol document. A team is put together that involves expertise and extensive experienced. It is this team that makes the decisions around the protection of public health.

It is considered that this is a more responsive, flexible and appropriate structure than attempting to put in place rigid parameters and requirements through a resource consent document that will not be able to be responsive to the wide range of circumstances that can apply.

Having said that, it is recognised and acknowledged that a systematic sampling regime is not currently in place and there would be benefits in doing so. Therefore, the applicant has volunteered a simple but effective sampling plan that will be implemented in the event of any overflow discharge from an NRSBU pump-station. This will provide quantitative data about spill events on both an individual and cumulative basis.

4. Appropriateness of limits and guidelines

The relevance of the Bell Island coastal permit and discharge have been addressed in the Cawthron Letter (Letter 1636) attached.

Exceedances of the Trade Waste Bylaw standards have been addressed in the Cawthron Letter (Letter 1636) attached (**Attachment P**).

The Trade Waste Bylaw is useful to provide some comparison and context for the concentrations of sewage determinands. The Bylaw applies to a large number of industries that contribute wastewater and trade waste into the Nelson City Council's reticulation system.

However, the five contributors – NCC, TDC, NPI, Alliance and Enza – are managed through a separate agreement(s) between the contributors and the NRSBU. This agreement is entitled the Disposal of Trade Waste Agreement and an example is provided as **Attachment Q**. The agreement clearly sets the parameters of supplying trade waste to the NRSBU system, including concentrations of determinands. The Trade Waste Bylaw is only applicable where the Agreement is not specific. Therefore it is not necessary or appropriate that applicant use the limits of the Trade Waste Bylaw as a target for its five contributors.

5. Assessment of ecological effects

All points raised in this section of the RFI are addressed in the Cawthron Letter in **Attachment P**.

6. Reasonable mixing zone and dilution factors

All points raised in this section of the RFI are addressed in the Cawthron Letter in **Attachment P**.

Under the second to last bullet point of Item 6, the RFI requests a recommendation for spatial and temporal monitoring. The Cawthron scientists have provided recommendations in this regard and these are provided below.

The applicant restates that it is of the opinion that specific monitoring is required in relation to ecological outcomes. The work undertaken by Cawthron has identified that the effects are temporary, minor and highly localised around the discharge locations. The two territorial authorities undertake ongoing routine SOE reporting which includes the Waimea Inlet.

The applicant considers that the discharges are rare and unpredictable, they can also occur in different locations making targeting baseline monitoring difficult. As such there would seem to be no purpose in attempting to undertake a systematic ecological monitoring regime and to do so would be a disproportionate response to the application.

It is noted that the resource consents that authorise essentially the same activity from the Nelson City Council reticulation system into similar habitats such as the Nelson Haven (RM105388V1 and RM105388AV1), are not subject to conditions that require any sort of ecological monitoring.

However, notwithstanding the above assessment and comments, Appendix A provides a potential sampling methodology as requested in the RFI.

7. Effects of climate change

Cawthron scientists have addressed the current guidance on planning for climate change and some potential effects. See Cawthron letter 1636.

The applicant remains of its opinion that it is impossible to predict with any useful level of accuracy or precision what the future risk of overflows may be due to the high number of variables. The fundamental flaw in attempting to predict the frequency and magnitude of further overflow events is that to do so is to ignore the asset management process which is the fundamental driver of the capacity of the reticulation system.

The applicant (NRSBU) is a joint committee of the Tasman District and Nelson City Councils. The NRSBU reticulation and treatment system is subject to an ongoing publicly funded asset management process.

NRSBU Business Plan

The NRSBU produces an annual Business Plan which is a strategic planning document. The 2015/16 Business Plan is attached (**Attachment R**). As an example of the capital expenditure that is projected to be invested into the pump stations and rising mains Section 8 excerpt is shown in Figure 2. Section 8 shows that there is $230,000 allocated expenditure for the pump stations and rising mains.

8. THREE YEAR CAPITAL EXPENDITURE FORECAST ($'000)

Renewal Plan ($,000)	Budget 2014/15	Projected 2014/15	2015/16	2016/17	2017/18
Miscellaneous	20	20	20	20	20
Pump Stations and Rising Mains	0	0	22	69	139
Inlet, Aeration Basin, Clarifier and Ponds	362	201	450	281	724
Solids Handling	277	277	507	521	51
Rabbit Island	0	0	98	98	0
Roads	0	0	30	30	0
Consents	0	0	0	20	215
Total =	**658**	**498**	**1127**	**1,039**	**1,149**

The renewal programme of NRSBU assets is developed around lifecycle and condition assessment. An iterative process is followed whereby the renewal programme is considered annually with inputs from the Operation and Maintenance operator and the review of remaining useful life of assets.

Condition assessment reports are commissioned where additional information is required to ensure optimal spend on renewals. This approach works well due to the relatively small number of different assets managed by the NRSBU.

The major components that will be considered for renewal during 2015/16 are:

- Driving mechanism on the Secondary Clarifier;
- Electrical renewal at sludge and dissolved air flotation facilities;
- Control upgrade at Activated sludge and sludge facilities.

Figure 2: Section 8 from 2015/16 Business Plan

Section 9 of the Plan then breaks down and describes how allocated funds are intended to be invested. As an example it is stated that:

> *"Airport Pump Station: The airport pump station will be upgraded in 2015/16 through the replacement of the one of the duty pumps with a second storm pump to bring this pump station in line with the other major pump stations."* (p10)

Clearly from the content of the Business Plan not all of the capital invested into the pump stations and pipeline will result in increased pumping capacities (maintenance is also clearly important to avoid failures). But inevitably, in years to come, a proportion of capital expenditure will be invested into pumping capacity and contingency measures to reduce overflow frequency and magnitude.

In **Attachment S** the new 2016/17 Business Plan is provided. Section 8 demonstrates the ongoing future expenditure into pump stations and rising mains.

As previously pointed out in the application, Appendix B of the Business Plan points out that the expected level of service is "*no overflow events*" occurring during wet weather, due to power failure or due to mechanical failure. Clearly no guarantee can be provided that these level of service objectives will be met at all times, but with these objectives in place the consent authority can be confident that the applicant will continue to commit ongoing investment into the pumping capacity and resilience of the pump station and rising main system.

<u>Wastewater Asset Management Plans</u>

The NRSBU also produces an Asset Management Plan (AMP) which is set at a tactical level between the Business Plan and the numerous process plans (operational documents) that are also produced. The AMP is provided as **Attachment S**.

The objectives of the AMP are to demonstrate that the NRSBU:

- Understands what asset capacity will be required in the future, and what issues drive this capacity requirement
- Has shown how it will proactively and continually improve knowledge of its assets
- Has robust and transparent processes in place for managing, operating, maintaining, renewing and extending assets
- Has adequately considered the class of risks its activities face, and has systematic processes in place to mitigate identified risks
- Has made adequate provision for funding asset operations, maintenance, renewals and upgrades
- Outcomes delivered by the assets are increasingly aligned to the five contributors wishes and to other internally and externally imposed levels or standards

The AMP is attached but a number of key excerpts are provided below.

Section 1.7 states:

> ***"1.7 Asset Management Plan Evolving***
>
> *Asset management for the NRSBU will continue to evolve in a continuous cycle of review and improvements so that the quality of outputs matches the changing business and legislative needs. The AMP will act as a vehicle for the development of advanced asset management practices.*

The plan provides budget forecasts for inclusion in the Long Term Plans of NCC and TDC. The Wastewater Asset Management Plan will be reviewed three yearly in advance of the LTP development cycle of the owners. Annual amendments or updates will be recorded in the annual business plan." (p24, emphasis added)

Section 3.3.8 of the AMP reads:

"3.3.8 NRSBU Regional Pipeline Long Term Strategy

In June 2008 the NRSBU considered the Regional Pipeline Strategic Issues and Options Report. That report considered the needs of the region for the next 80 years and identified a number of upgrade options to meet these needs. The main findings of the study were:

…

- *In the longer term, major system-wide upgrades will be required to provide the capacity for future flows of waste water. There are a number of options for the provision of this capacity and work is not required immediately.*

The outcomes of the two main findings were:

- *The duplication of the rising main across the Waimea Estuary from Monaco to Bell Island.*
- *The upgrade of the Beach Road, Saxton Road and Airport pump stations.*
- *The construction of the Songer Street pump station.*
- *The facilitating of the pump stations at Saxton Road, Beach Road and Songer street to be reconfigured in future to pump in either direction.*
- *New rising mains from Richmond to Bell Island that is tentavely (sic) programmed for 2019 to 2022 and will be contingent to increased flow demand in Nelson and Tasman.*" (p57)

A number of these improvements have been completed including the duplicate pipeline, the upgrade of pump stations, the construction of the Songer St pump station. The latter two points refer to the plan to extend the pipeline around the western side of the Moutere Inlet to Bell Island.

Section 3.5 AMP then goes on to identify the capital costs of the upgrade plan. A wide range of projects are identified including, in 2025/26 an upgrade of the Songer Street pump station, subject to demand.

Finally in relation to the AMP Section 4.4.8 reads:

“4.4.8 Climate Change

There has been considerable work undertaken at a national level on the possible effects of climate change and sea level rise. NRSBU is aware that increases in average sea level could have significant effects on the foreshore areas. This may lead to the need for:

- *The development of policies to take into account climate change/sea level rise;*
- *Additional infrastructure requirements.*

The NCC and TDC design standards take into consideration the effects of climate change in the designs for rising mains, pump stations, treatment plant and biosolids disposal. (The Ministry for the Environment recommends that authorities consider the consequences of a sea level rise of 0.8m for infrastructure assessment for the timeframe up to 2099 and to add 10mm per annum beyond that.)” (p81, emphasis added)

The above discussion and excerpts are not intended to show that an upgrade of pumping facilities is imminent, but that as a public asset funded by two TLAs and a number of industry contributors, the NRSBU is a body that will continue asset management planning in response to demand.

Future sea level rise, both measured and predicted, will continue to be integrated into asset planning processes. This could result in, for example, increased pump station pumping capacities, additional pump stations, and completion of the new rising main from Richmond to Bell Island WWTP if required.

It is this ongoing asset management and investment process that makes attempting to predict future discharge events based on today’s pump station configurations unnecessary and untenable.

Functioning of Pump Stations

The pump stations are all approximately 3 metres above mean sea level.

The outlets are currently below the maximum tide level. At each of the overflow outlets to the CMA there are existing flap gates to prevent spring tides or king tides from flowing up the overflow pipes. Under such conditions there can be backup within the pipe and potentially ponding around the pump station until the tide drops and the overflow can be either cleaned up or be discharged if clean-up is not practicable.

Under a sea level rise scenario it is likely that this eventuality may occur more often. It is unlikely that this will be significant within the 20 year term of the consents sought.

However, the comments in relation to asset management and capital investment (above) remain applicable. The applicant will continue to monitor the risks and threats to the system and has the option of relocating pump stations as sea level rise progresses.

ENGINEERING INFORMATION

8. Update Figure 2

Figure 2 is updated as requested.

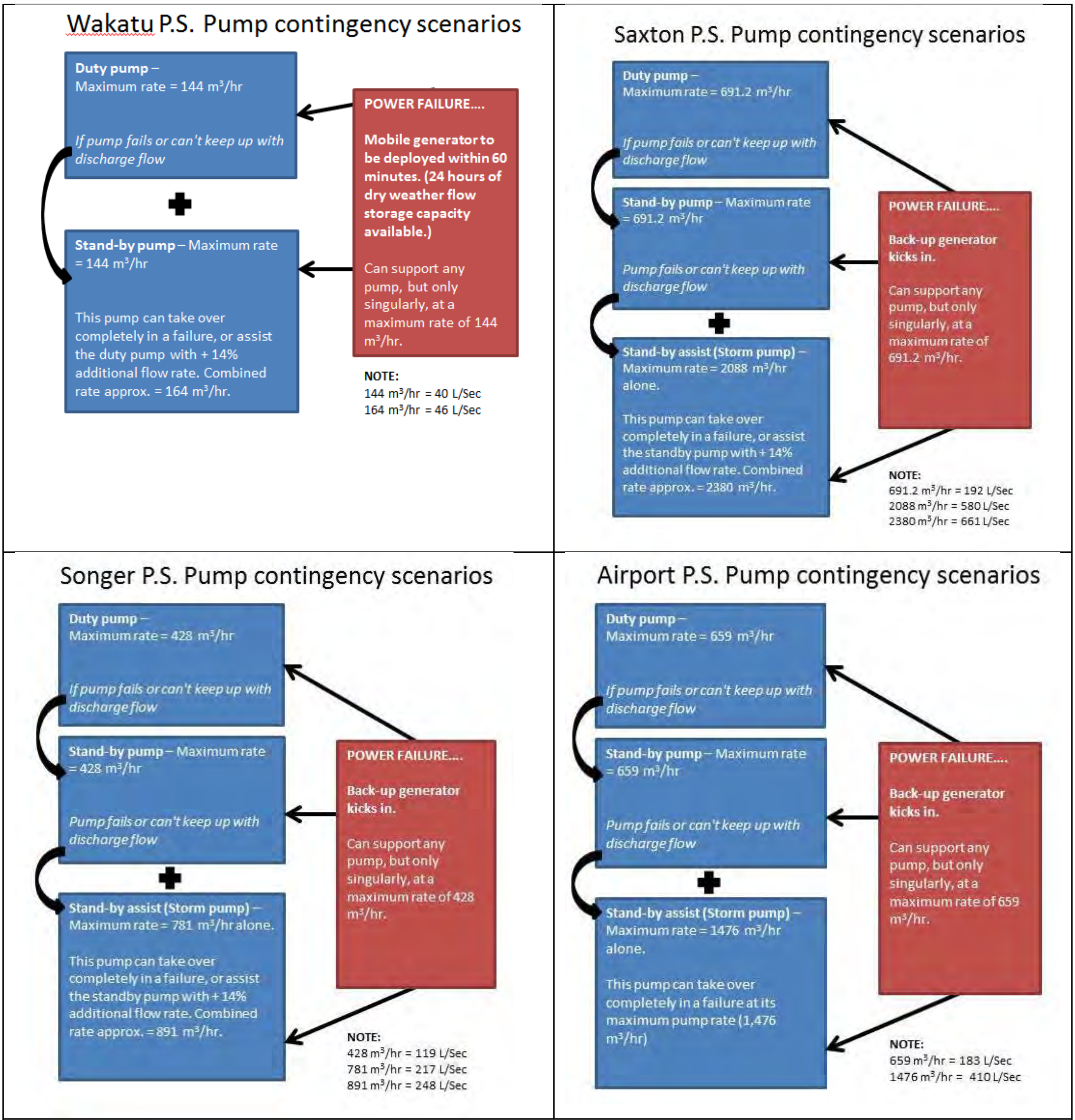


Figure 2: Pump and backup configurations for pump-stations

9. Asset Plan

Yes, a comprehensive asset planning process is in place as previously described. See also: www.nrsbu.govt.nz for more asset planning documents.

10. Figure 6

See above.

11. Paragraph 1.8.12

It is acknowledged that this paragraph is not accurate. The paragraph was framed around an understanding of the breaches as being from relatively fine cracks and seeping discharges. It is acknowledged that the rupture of a reticulation system may result in the discharge of a section of pipe.

12. Gross Contamination

Screens are in place for all pump stations, except the Saxton Pump Station, to collect gross contamination. A basket screen (10mm slots) will be fitted to the Saxton Pump Station overflow system.

13. Network Capacity

This information is provided (in part) within the AMP (particularly Section 3). The spare capacity within the network at each site is also addressed in the Table 4 of the Cawthron Report 2588 (p21).

14. Climate Change

Addressed above.

Please contact me if you have any queries.

Yours sincerely

Jeremy Butler
Landmark Lile Limited
Resource Management Consultancy

APPENDIX A: Ecological Monitoring

Sampling locations:

All four outfall locations (Songer, Saxton, Wakatu and Airport). Sample locations can be obtained by using t-transect sampling methods, similar to those described in Gillespie and Asher (2004). This sort of graded distance method is typical for assessing point source discharges, and allows the applicant to isolate the distance of effects (which can help determine an appropriate spatial mixing zone).

Water/discharge transect sampling sites:

- pump-station specific raw discharge data (end of pipe),
- 5 m, 10 m and 50 m from outfall along the tidal flow path(s),
- reference station >200m from discharge point,
- nearby contact recreation sites.

Sediment transect sampling sites:

- 5 m, 10 m and 50 m from outfall, along the tidal flow path(s),
- reference station >200m from discharge point,
- nearby contact recreation sites.

NOTE: Over time, if it is found that contamination is detectable beyond 50 metres, you may want to add further sites to better determine the extent of the discharges' health/ecological effects in areas of the estuary (e.g. for those areas not designated as 'CR' zones, but still actually used for recreation). Alternatively, you may find that no effects are detectable at 50 metres from the discharge point, at which point it might be appropriate to reduce the number of further afield stations.

Water sampling methods:

Estuarine water samples can be used to determine changes to water quality and pathogen risk from discharges. In-situ field measurements can be obtained using a YSI[1] meter or similar while samples for laboratory analyses can be collected at the same locations using a long-armed scoop.

The analysis suite for water samples (comprised of CR **standards** parameters):

- Faecal coliforms and enterococci/100ml,
- Total suspended solids (TSS),
- Metal/metalloid suite (Cd, Cr, As, Pb, Ni ,Hg, Zn, Cu),
- Semi volatile organic compounds (e.g. PCB/OCP/ Dioxins),
- Nutrients (TP/TN/ Ammonia-N/ Nitrate-N/ Nitrite-N),
- Total oils and grease,
- BOD/COD.

[1] https://www.ysi.com/products/wastewater-process-monitors-and-sensors

Water quality field measurements:

- Black disk /secchi water clarity measurements,
- Visual observations (photos for undesirable biological growths, hue and reflectance),
- In situ sampling using YSI meter or similar - turbidity (NTU) *, conductivity (millisiemens per square metre)*, pH*, temperature (◦C) and dissolved oxygen (DO)*.

Replicates of three water samples should be analysed for each site initially, however the numbers of replicates may be revised for subsequent samplings, if necessary, based on variability of results.

Sediment sampling methods:

Benthic samples can be collected along a transect, extending parallel to the tidal flow from the discharge outfall, and along the high tide mark (Figure 1), at low-tide to determine the effects of the wastewater discharge on sediment physico-chemical characteristics, contaminant status, and macrofaunal community composition. Similar monitoring techniques have been used at a local scale to assess the effects of sewage and sewage overflows in Sydney (ANZECC 2000[2]), and for monitoring the effects of sludge disposal at Rabbit Island in Waimea Inlet (Gillespie and Asher 2004[3]).

Infaunal samples: can be collected using standard infaunal sediment push cores (131 mm diameter by 100 mm depth, 0.0135m^2) and sieving the subsequent sediments to obtain infauna. The residual sample would then need to be processed by a certified taxonomist for macrofaunal identification and enumeration.

Epifaunal counts: Abundance of conspicuous macroinvertebrate species; e.g. crab holes, shellfish and surface animals, can be counted in-situ, using replicate 0.1m^2 quadrats (as described in Gillespie and Asher 2004).

Algal species and % coverage: Where a significant algal cover exists, the percent coverage of the sediment habitat can be estimated using replicates of a randomly placed 0.25 m^2 quadrat containing gridlines (Gillespie and Asher 2004).

Sediment physico-chemical samples can be collected using 63 mm Perspex™ push cores (inserted ~100 mm into the sediment). Sediment core observations should include descriptions of sediment profile, notes on colour

[2] ANZECC 2000. Australia and New Zealand guidelines for fresh and marine water quality. In National Water Quality Management Strategy. Australia and NZ Environment and Conservation Council, Canberra.
[3] Gillespie, P and Asher, R. 2004. Estuarine Impacts of the Land Disposal of Sewage Sludge on Rabbit Island: 2003 Monitoring Survey. Prepared for Nelson Regional Sewerage Business Unit. Cawthron Report 862.

and odour. The cores can then be photographed and subsampled for laboratory analyses[4] of:

- Grain size
- Organic content (TOC)
- Nutrients (TP/TN/ Ammonia-N)
- Metal/metalliod suite (Cd,Cr,As,Pb,Ni,Hg,Zn,Cu)
- Semi volatile organic compounds (e.g. PCB/OCP/ Dioxins)
- TPH (oils and grease)

Replicates of three sediment and three macrofauna samples should be analysed for each site initially, however the numbers of replicates may be revised for subsequent samplings, if necessary, based on variability of results.

In order to determine the likelihood of adverse ecological effects occurring, physico-chemical results can be compared to ANZECC (2000) guidelines (where available).

Sampling timing/frequency:

Ideally, sampling would occur during an incoming tide while the discharge is occurring, and repeated during a similar tidal state after the discharge has ceased. The sediment sampling would be undertaken at the next (or previous) low tide when the sites are exposed. Additional tide coordinated repeat samplings would be required only if test results indicate ongoing or residual discharge effects.

Note: in this instance it is not likely to be feasible to collect background samples, as the timing of the discharge is unknown. Therefore, a reference site and distance based sampling, are suggested as a more practical measure for detecting water quality and ecological changes when discharges occur.

[4] We recommend Hill Laboratories for analyses: http://www.hilllaboratories.com/file/fileid/48279

Attachment K:

Updated Figures 5 and 6

Attachment L:

NMDHB Procedure HPO 014 **– "***Recreational Water Exceedances (for Bacteria & Cyanobacteria) & Sewage Spill Notification***"**

Attachment M:

“*Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas***.” MfE and MoH; June 2003**

Attachment N:

Bathing water results vs overflows vs rainfall: spreadsheet and graphs

Attachment O:

Proposed Sampling Locations Plan

Attachment P:

Cawthron Letter 1636

Attachment Q:

Disposal of Trade Waste Agreement

Attachment R:

NRSBU 2015/16 Business Plan

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