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Far North District Council
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30 October 2017

Attention: Arthur Boyce

Dear Arthur

Kerikeri Wastewater Scheme Review

1 Introduction

1.1 Objectives

This scheme review process has been undertaken by CH2M Beca Ltd (Beca) for Far North District Council (FNDC) in response to the queries from the Ministry of Health (MoH) which are listed in Section 4 below. The objectives of this review are twofold as follows:

1. Investigate and report back on the status of the scheme with respect to each of the 7 MoH queries, and
2. Suggest methodologies and or pathways by which key aspects of the treatment have been or can be future proofed or configured such that extra capacity can be added without undue cost related to items that could be configured (with future proofing in mind) for relatively little cost now.

It is not within the scope of this review to undertake any detailed technical analysis of the reticulation system hydraulics or the treatment plant process.

1.2 Background

1.2.1 Original Scheme Description

Kerikeri was traditionally a town built around early historical sites and, later, horticultural blocks that were predominantly growing citrus, kiwifruit and other sub-tropicals. Over time, the small horticultural blocks surrounding the town centre were gradually broken up for low density residential development, able to be served by septic tank systems and subsequently on site wastewater treatment and disposal systems. The Kerikeri wastewater scheme was first commissioned around 1990 with an area of benefit restricted to the central town area. The scheme had an approximate design capacity of 350m^3/day or approximately 1750 persons or 730 lots. Treatment consisted of screening, very basic primary sedimentation with digestion and Rotating biological contactors undertaking most of the treatment. Discharge of treated effluent is to wetlands in the Waitangi forest, eventually draining out under Inlet Rd to Kerikeri Inlet. The flows and loads were soon in excess of what the treatment plant could adequately cope with. Odour problems and overflows were common. The effluent quality was poor. Tertiary filtration and UV disinfection were added in the early 2000s. Due to overloading, a lack of dissolved oxygen, generation of hydrogen sulphide and poor ventilation, the materials of the original treatment plant deteriorated prematurely.

1.2.2 Kerikeri SWSS Application History

In May 2002, the then Health Minister, Annette King announced government approval for a sewage treatment subsidy scheme to help small to medium sized communities upgrade or build new treatment plants. The Sanitary Works Subsidy Scheme (SWSS), administered by MoH was primarily aimed at improving sewage treatment and disposal for small, largely rural communities that are unable to fund the necessary upgrades to meet public health and resource management requirements. As well as improved sewage treatment, the SWSS scheme was also to cover new works required to add fluoride to community drinking water supplies for those communities that wish to.

The SWSS provides financial assistance to "*assist small or medium sized communities to fund capital cost of new sewerage systems or of upgrading existing sewage collection, treatment and disposal systems to significantly reduce public health risk"*.

In 2003, FNDC, through consultants MWH, made its preliminary application for SWSS funding with an estimated cost of $8M +/- 50%[1].

In 2009, FNDC, through consultants Opus International Consultants, made its provisional application for SWSS funding for Kerikeri. This scheme was to add 635 lots to the reticulation immediately with facility to connect 2,750 lots[2]. The scheme would also decommission the existing WWTP and pipe all raw sewage to an upgraded Paihia/Waitangi WWTP in the Waitangi forest. The estimated cost of the scheme was $42M, of which $26M was estimated to be eligible for SWSS funding. SWSS funding would have been approximately $7.2M based on 27.5% of applicable costs. As part of that stage of the application, an investigation was undertaken of approximately 10% of the on-site wastewater treatment and disposal systems. Of the tanks and disposal fields surveyed, 40% were found to be in poor condition or not suitable for on-site treatment. Recommendations were that the Riverview area (330 lots), Reinga Heights area (175 lots) and Hawkings Crescent area (130 lots)[3] should be sewered.

In 2013, the cost estimates were revisited again, this time bringing in an additional 110 lots from Hone Heke Rd, the new Bypass area and Butler Rd. In 2013, following a FNDC Council value management workshop, Opus and AWT (now Mott MacDonald) undertook due diligence, by way of whole of life cost assessment, of 7 scheme options that Council had short listed from 15 available options and sub-options[4]. 6 of those scheme's excluded Reinga Heights and Riverview from the initial scheme but provided for them in what was termed 'Stage 3' of the scheme development. Thus they were deferred from initial work but not excluded from the scheme.

In January 2014 an internal report was presented to the Council Infrastructure Committee that both questioned the basis for the scheme to date and recommended that the scheme be developed in stages. The factors triggering this review were:

i) affordability/impact on rates,
ii) local authority reform requiring more robust business cases,
iii) fall-out from the over-expended Mangawhai WW scheme development,

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[1] Opus 2009
[2] Opus 2009
[3] Opus 2009

[4] Opus-AWT 2013

iv) review of growth projections and

v) improved management of on-site wastewater treatment systems.

This report concluded that "*…current view is that the primary project drivers are:*

- *Resource consent compliance*
- *Resource consent renewal*
- *Localized reticulation demand*

And that there are secondary drivers which require further investigation being

- *Environmental impact*
- *Growth"*

The primary drivers were to form stage 1 of the project **and** the secondary drivers, formed Stages 2 and 3.

1.3 Current Upgrade and SWSS Application

The 'Final' funding application from Far North District Council to the New Zealand Ministry of Health was dated 23 May 2017.

In the final application, the stated overall objectives of the Kerikeri Wastewater upgrade project are to:

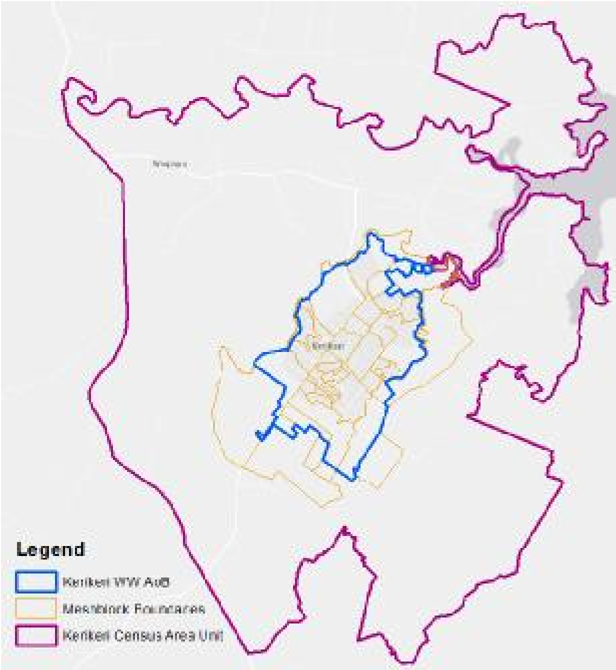
1. Provide an extension to the existing Kerikeri sewerage system and connect approximately 350 properties currently served by on site disposal systems.
2. Construct a new Wastewater Treatment Plant (WWTP) to:
    a. Get the plant out of the residential area to mitigate future potential odour issues
    b. replace the existing old and failing plant, and
    c. to accommodate additional flows and load from an increased area of benefit up to an average dry weather flow (ADWF) of 1,000m^3/day.
3. Include in the design spare capacity to incorporate growth, based on analysis undertaken by FNDC, in a potential Area of Benefit (AoB) also defined by FNDC. Refer fig. 1 below.

Subsequent to that May application:

- FNDC has awarded a contract for construction of the conveyance elements of the project. Construction works are well underway. Construction of the Terminal Pump Station and rising main up to the new WWTP has not commenced.
- FNDC has called for tenders for construction of the new wastewater treatment plant (WWTP) on farmland approximately 1.1km outside existing town boundary or 1.8m outside the proposed area of benefit. FNDC is currently negotiating with a preferred tenderer.
- Ministry of Health has raised a number (7) of queries regarding the scheme composition, principally relating to design horizon and 'future proofing'.

Of the priority areas identified in the 2009 and early 2013 work, only Hawkings Cresent and Hone Heke Rd have been included in the current upgrade.

Figure 1: Kerikeri WW Scheme - Proposed Area of Benefit



2 Glossary

Glossary of Abbreviations			
ADF	Average Day Flow	NPSUD	National Policy Statement – Urban Development
ADWF	Average Dry Weather Flow	OD	Outside diameter
AoB	Area of Benefit	PIF	Peak Instantaneous Flow
FNDC	Far North District Council	PN	Nominal Pressure
ID	Inside diameter	PWWF	Peak Wet Weather Flow
LGA	Local Government Act	SAF	Submerged Aerated Filter
LTP	Long Term Plan	SBR	Sequenced Batch Reactor
MBR	Membrane Bioreactor	SWSS	Sanitary Works Subsidy Scheme
MoH	Ministry of Health	TPS	Terminal Pump Station
MM	Mott MacDonald	WWTP	Wastewater Treatment Plant

3 Methodology

The review process has involved the following:

1. Discussion with John Harding of MoH as to what it is he requires to be peer reviewed.
2. Discussions with FNDC and review of available documentation to confirm the extent of the peer review.
3. Performing the peer review to a scope as agreed between all three parties. The peer review has involved 4 parties. Namely: FNDC (Owner); MoH (Funder / Regulator); Mott MacDonald (MM – Designer) and Beca (Peer Reviewer).
4. A visit to the proposed WWTP site and the extremities of the defined AoB and those less densely developed areas outside of the defined AoB, such as Riverview.
5. After reviewing available information, questions have been posed to FNDC staff and the designers.
6. Each of the seven queries, posed by MoH, have been addressed in the following sections of the memorandum.

4 Review of Concerns Expressed by MoH

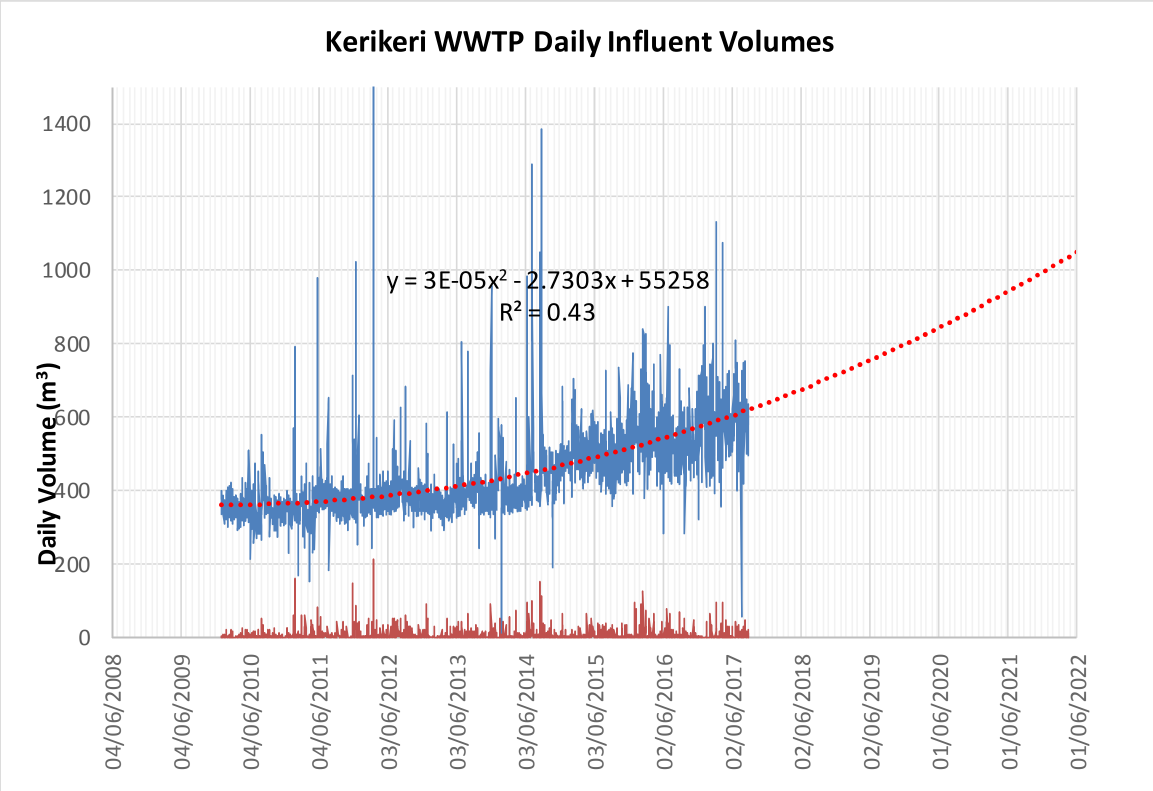
4.1 Historic and existing flow rates into the WWTP and the consequential impact on design horizon. Is the influent flow monitoring record adequate?

a. There are nearly eight years of influent flow data. Provided that the influent flow meter is appropriately calibrated, this is a sufficient record upon which to establish a baseline for design of a new treatment plant and terminal pumping main. Trends in this data can be used as a guide to future flow rates, but not a definitive guide as the flows should be dictated by actual growth and not the other way around.

b. The flow record demonstrates an increasing trend in daily influent volume. Refer figure 2 below. This appears to be quadratic[5] in nature. That is, the rate of growth in inflow volume to the treatment plant appears to be compounding and not linear. This will be due not only to new lots being built on but also existing lots with on-site systems connecting

[5] The quadratic fit to the data is better (has a higher R^2 value) than the linear trend line used in FNDC supplementary report No. 2, Sept 2017.

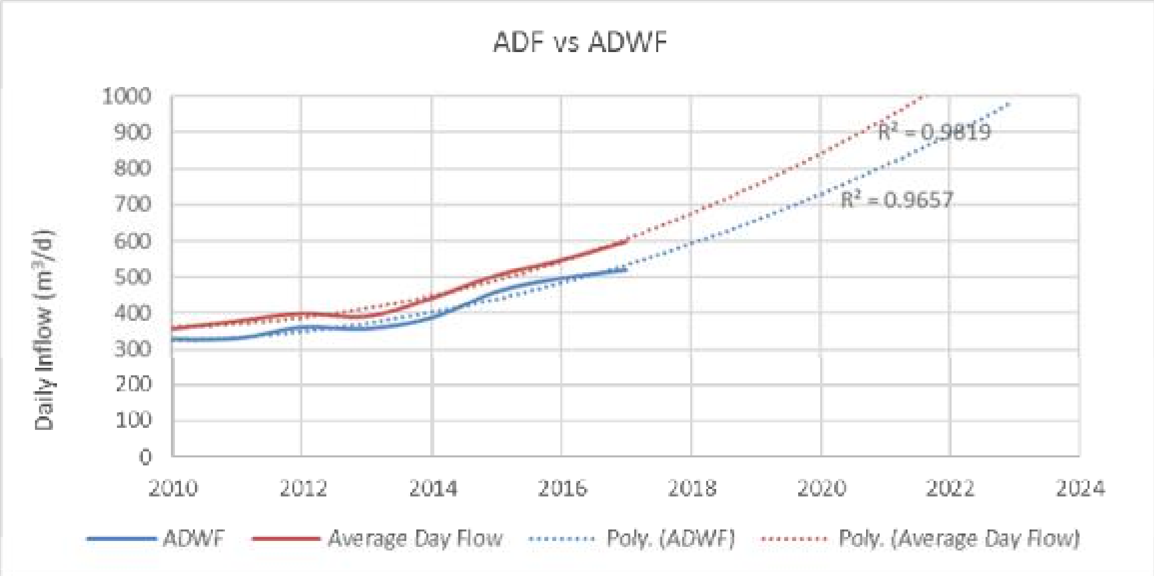
Figure 2: Kerikeri WWTP Historical Daily Influent Volumes



The equivalent plot, presented in the September 2017 FNDC report to MoH uses a linear approximation to the data trend line, giving an approximate design horizon, for the 1,000 m^3/day at 2030. However, that trend line, as is the quadratic trend line presented above, is an approximation of the average day flow and not the average dry weather flow (ADF).

From some analysis of the flow record, the current ADWF is approximately 520m^3/d whereas the ADF is 590 – 600m^3/d. i.e the 1000m^3/d ADWF horizon is reached somewhat later than the 1,000m^3/d ADF. Figure 3 below shows the actual annual ADFs and ADWFs measured since 2010. The actual (not projected) increase in ADWF, 2010 to 2017 has been 6.9% compounding annually. The actual increase in ADF has been 7.7% compounding annually. These rates of flow increase are significantly higher than the assessed rate of population growth. This could potentially be due to existing lots with on-site wastewater systems connecting to the reticulated system. FNDC has noted 40 lots were connected to the wastewater system in the 2016/17 year. That represents an annual increase of approximately 3.7% in number based on a stated existing 1,092 lot equivalents. The ADWF increased 4.6% over the same period. So there is a reasonable correlation between number of lots connected and the increase in ADWF. If the same rate of connection to the scheme continued in a compounding manner, the installed capacity of the new treatment plant (to cater for ADWF of 1,000m^3/d) would be taken up by the end of year 2023. This would likely be the worst (fastest) case scenario. The real answer probably lies somewhere between this and the 2031 date predicted by the FNDC linear interpolation on the inflow data, presented in its September 2017 report to MoH.

Figure 3: Comparison of annual ADF vs ADWF with time



In summary, the available influent flow record is sufficient on which to develop a 'baseline' for the 'basis of design' for the new system components. In terms of predicting future flows however, which will be based on a defined number of additional lots, it is necessary for the number of existing 'lot equivalents' to be reasonably accurately known and for the flow data to be correctly interpreted.

If we used the historical and current influent data as a predictor of scheme design horizon, by extrapolation, the indication would be that installed treatment plant capacity would likely be taken up somewhere between 2023 and 2031. However, that is only one method of prediction of the uptake of capacity and FNDC has based future flows on a baseline and allowance for an assessed population growth rate.

4.2 The historic and potential growth and projected rate of growth of Kerikeri within the Area of Benefit (AoB).

a. The 2014 staff report to Council reports as follows with respect to growth rates:
It is evident that steady growth has persisted in this area despite the recent development slowdown across the district. Therefore it can be assumed that demand for wastewater services will increase naturally in addition to any planning directives resulting from the growth strategy process. Previous growth in the residential zone of the District Plan has been measured at 0.5% while growth in the rural living zone as been 2.5%.

Three methods, using historical data have subsequently been used by Council to predict a growth rate within the area of benefit of approximately 1%. These were presented in the September 2017 FNDC report to MoH.

b. From an anecdotal and non-scientific perspective, there are a number of towns in New Zealand that fit a similar profile to Kerikeri. Actual recent historic and predicted near future growth rates for these towns have been compared to the predicted rate for Kerikeri in Table 1 below. The relevant profile is "small, attractive to live in, attractive to tourists, reasonable broadband network, with reasonably close proximity to a regional airport". Many people have moved or are moving to those areas for the attractive lifestyle and the ability to maintain well paying, remotely run careers.

Table 1: Growth Rate Comparison for Similar Towns

Town	Pop'n	Recent Growth Rate[6]	Projected Growth Rates (Compounding)
Wanaka	9,139	4.3% per annum	2.9%
Arrowtown	2,925	2.0% p.a	0.9% Tightly constrained by ring fencing[7].
Cambridge	17,580	2.2% p.a	1.7% compounding for 33 years
Motueka	8,300	1.5% p.a	
Kerikeri	7,200	0.5% p.a. 2.4% prior 2013. 'Rural Living', surrounding AoB 2.5%	1% p.a

Therefore, from the perspective of other, similar towns around New Zealand, and from the perspective of recent historical growth rate, the predicted future growth rate for Kerikeri, even though it has been derived scientifically, does appear low.

4.3 The future wastewater treatment and effluent disposal strategy for the wider Kerikeri area beyond the existing Area of Benefit (AoB).

a. The present Council has set the AoB for the expanded scheme within a comparatively tight area immediately surrounding the CBD, framed roughly as follows:

i. South - Southeast of the River,
ii. Northeast of Hall Rd
iii. Northwest of Shephard Rd / Campbell Lane
iv. West of the Stone Store and Kemp House

It is understandable that the current Council wishes to impose tight constraints upon the work currently to be undertaken in expanding the scheme as it does not wish to be caught with paying for a large amount of new infrastructure for which there are no development impact levies / contributions quickly flowing to Council. Indeed, it may be difficult to extract such levies for the servicing of Rural Living subdivisions that have already been established for a number of years and an alternative mechanism would likely be required.

Following a Value Management exercise in March 2013, email correspondence from FNDC to MoH (Andrews-Smith - Harding) indicated that the priority areas of the previous work were still included in the proposed scheme. Indeed an internal council report (staff to Infrastructure committee) dated March 2014, still indicated that areas now (2017) omitted would form part of the AoB but as a 'Stage 3' of the scheme development. At some point between March 2014 and appointment of the design consultants, areas such as Reinga Heights and Riverview have been permanently deleted from the intended AoB. I have not sighted documents regarding this part of the decision making process.

A subsequent letter from Council to the Associate Minister of Health, dated 15 April 2014 stated "……. *The solution adopted by Council includes the replacement of the old Kerikeri treatment plant with a modern technology process, expansion of the reticulation system to cover the entire residentially zoned area of Kerikeri township addressing all the known areas of the township where failing septic tanks have been identified as having the potential to pollute adjacent water ways….*" One would need to have an intimate knowledge of the zoning of Kerikeri to understand the implications of this statement. It could be interpreted to mean the residential

[6] Website population.city/new-zealand/* - Data source Statistics New Zealand
[7] Adjacent small communities such as Lake Hayes and Shotover country are growing very rapidly

zone, or it could be interpreted to mean all those areas previously identified as being problematic. The actual intent is unclear. i.e was this letter intended to flag to MoH that areas such as Riverview and Reinga heights were now excluded. That is not clear.

b. In the August 2017 Supplementary Report to MoH, FNDC has stated "*The Area of benefit has been defined by FNDC, and will not change*" ……………. and "*Reticulation of outlying areas such as Riverview, Waipapa Road and Waipapa does not form part of FNDC's long term strategy. They have not been included in the Long Term Plan 2015-25, and it is not intended to include it in the next LTP consultations"*.

The 2025 end of the LTP is very close in the scheme of things. 'Will not change' is quite a strong term to use in this regard. In reality the AoB could be changed by any of the following:

i) a future Council out of choice (or growth pressures) through LTP and or plan change processes. The September 2017 Supplementary Report No. 2 to MoH states that, the District Planning Team will be reassessing infrastructure demand assessments on a five yearly basis in response to the NPSUD requirements and will be updating the Council 30 year infrastructure strategy as part of the 2018-28 LTP process in response to LGA (2002) requirements.
ii) pressure from a regulator/s on health (failing disposal fields, contaminated swimming water), environmental (nutrients and pathogens to foreshore and waters), primary production (contamination of the oyster farms) grounds, or
iii) a well presented, defended and resourced 'Private Plan Change' or 'Resource Consent' process.

As an example, there is currently a private plan change lodged with Council[8] that seeks to zone a 3.57ha block of Rural Living land as Residential. As a Discretionary activity, this could be subdivided into up to 119 lots. The Council Infrastructure department has confirmed that, if the plan change application is successful, connections will be provided to the wastewater scheme, even though it is outside the AoB.

c. There are substantial areas of lower density residential (zoned Rural Living) that are excluded from the AoB which could conceivably need or want to be included in the AoB at some time. There is currently active housing development in a number of these areas. The areas outside the AoB include:

i. Pa Rd area
ii. Reinga Rd / Reinga Heights with lot sizes ranging from 800 to 950m^2 (measured using 'Far North Maps' measurement tool on geocirrus)
iii. Riverview, with lot sizes ranging from 650m^2 to 4,000m^2 (approx. 108ha). In Riverview, it appears to be the areas situated between Kemp Rd, Kendall Rd and Riverview Rd and the river which are in the range 650 – 900m^2 in total. In this area, it is clear from the Lot and DP numbers, that sections that were 3,000 to 5,000m^2 have been subdivided into 3 or 4 lots.
iv. Shephard Rd East / Okura Dv / Urutawa Dv / Riddell Rd 3,000 – 5,000m^2 (approx. 72 ha in total)
v. Multiple subdivisions on either side of Waipapa Rd with sections of approximately 2,500m^2.

[8] Email correspondence from FNDC planner dated 24/10/2017

vi. Areas either side of Kerikeri Rd, Southeast of Hall Rd.

The Northland Regional Plan is silent on the minimum lot size for on-site wastewater treatment and disposal. However:

- It does require a 100% reserve disposal area to be available for primary treatment systems and a 30 % reserve to be available, as well as setbacks to certain other features,
- The Bay of Plenty Regional plan does not specify a minimum land area but does give very strong guidance that a 1,000m^2 lot size is too small for on-site wastewater treatment and disposal systems and
- The Waikato Regional plan provides for a minimum lot area of 2,500m^2.

Previous iterations of the scheme expansion, dating back to 1999[9] (and subsequently) have included some or all of these areas in the potential area of benefit. The 1999 study, an investigation of land disposal options for treated wastewater, was based on Council's projection of an ultimate population of 30,000 persons and an average day flow (ADF) of 7,200m^3/day.

Therefore, while current Council strategy is to manage and maintain OSD systems in these areas, this strategy could conceivably change again with a future Council.

d. The District Plan identifies the role of the Rural Living Zone policy as providing a transition between town and country and this transition is expressed in terms of residential intensity and lot sizes. The Plan does not provide any certainty that reticulated services will be made available in this zone. The minimum lot size in the Rural Living Zone is 4000m^2 (Controlled activity status) and 3000m^2 (Discretionary activity status). The following policies are relevant:

8.7.4.3 That residential activities have sufficient land associated with each household unit to provide for outdoor space, and where a reticulated sewerage system is not provided, sufficient land for on-site effluent disposal

8.7.4.12 That the Council maintains discretion over new connections to a sewerage system to ensure treatment plant discharge quality standards are not compromised (refer to Rule 13.7.3.5).

In addition to the above, FNDC planners have made the following relevant comment in regard to growth and how Council will accommodate the need for services:

Amendments to the Resource Management Act this year [2017] *has created a more focussed role for Councils to ensure that there is sufficient development capacity in respect of housing and business land to meet the expected demands of the district. A consolidated review of the plan is underway and policies and provisions that manage growth are being developed. This role* [see above] *of the Rural Living Zone is being re-examined in this context to determine if it is the most appropriate spatial planning tool to provide for future integrated growth adjacent to existing residential zones. The new Regional Policy Statement will also require close consideration in this process which has introduced*

[9] Opus 1999

policy approaches that recognise the value of highly versatile soils in Rural Environments – which may also lead to consideration of adequate supply of lifestyle development in near urban environments.

As a consequence, it is therefore conceivable that there could be planning changes that relate to the Rural Living Zone of Kerikeri, that affect the subdivision of new 3,000, 4,000m^2 lots and result in more infill of the existing such as appears to have happened in parts of Riverview in the past.

4.4 The capacity of new reticulation, pump stations, rising main, inlet works and effluent pipeline to accommodate future growth within the AoB or a wider future treatment strategy

a. The newly designed and installed reticulation largely consists of small bore pressure sewers with individual pump stations at each lot, although there is some newly installed gravity sewerage. The small bore pressure sewers have been designed to convey only the calculated PIFs from the individual sub-catchments, with growth, but not a wider AoB. Therefore, for example, the new trunk pressure sewer servicing the 'Waxeye' sub-catchment of Shephard Rd does not have capacity to convey those parts of Shephard Rd that are not in the AoB, should those ever need to be connected. Similarly, the pressure sewers on Kerikeri Rd, in the vicinity of the Bypass roundabout, would not have spare capacity to convey flows from Riverview should those ever be required to be connected. Neither is there a gravity sewer adjacent that point.

b. The design philosophy for current pump station and rising main designs is to enable pumping of the calculated peak instantaneous flow for each catchment without flow buffering in the conveyance system. It is beyond the scope of this review to undertake a check of the calculations.

c. The reticulation system has been configured / designed without trunk sewers that would convey sewage from all of the surrounding AoB but allow future areas to be connected (even if downstream pump stations etc needed to be upgraded in future).

d. The siting of individual pump stations, on their designated sites, is generally such that duplicate wetwells could conceivably be built along side. In some cases larger pumps could be installed. However, with the availability of modern, pre-constructed wetwell pump chambers, the installation of parallel wetwells is likely to be an attractive option in future that minimises shut down times

e. The terminal pump station (TPS) can be fitted with larger pumps, or a duplicate wetwell can be installed alongside with additional pumps.

f. The raw sewage transfer rising main has been designed as a 225mm OD, 191mm ID PE pipeline. This does not provide for a flushing velocity under dry weather, average flow conditions. However, it appears to be a pragmatic compromise that allows conveyance of peak flows within a reasonable velocity limit, yielding a velocity at PIF of 1.7m/s. If pumped at a flushing velocity of 0.85m/s, the pipe would convey a flow of 2104 m^3/d, equivalent to four of the currently planned SBR reactors. However, the same pipe would be unlikely to convey the associated peak wet weather flow within a reasonable velocity range (and therefore dynamic head and power range).

Table 2: Alternative Transfer Main Velocities and Flows

	Flow (L/s)	Day Q	Nature of Flow	v OD225 (m/s)	v OD250 (m/s)	Q OD250 (L/s) at v OD225
Now	15.4	1,330	DW	0.54	0.41	19.1
Future	19.2	1,659	DW	0.67	0.51	23.7
Now	36.6	3,162	WW	1.28	0.98	45.2
Future	49.8	4,303	WW	1.74	1.33	61.4

A summary of pipe flow velocities is shown in Table 2, including those for an alternative, slightly larger pipeline that has been mooted as a future proofing measure.

g. The designers advise that the inlet works is provided with the following capacity:

Screens: Two screens in a duty standby configuration that are sized for 90 l/s each. Therefore, even without moving to a duty assist mode of control (which is also common, the capacity is 80% above the PIF of the defined AoB.

Grit channel: There is a single grit channel sized to provide full treatment to a flow of 58 l/s (16% more than the PIF). The grit system can be run to higher flow rates (up to 70 l/s – 40% above PIF) but with some loss of efficiency. This would not be an unusual situation for treatment plants incorporating grit removal as full grit removal to PIF can lead to prohibitively large installations whose capacity is only utilized in very rare circumstances.

4.5 The marginal cost to extend the design horizon for these elements past 2036

a. For the small bore pumped sewers, it is not possible, within the scope of this review to calculate the total incremental cost of

b. ensuring the design horizons are extended beyond year 2036. However, the following table gives an indication of the percentage increase in capacity and cost based pipe ID of SDR11 PE100 pipe.

Table 3: Comparative small bore pressure sewer capacities and costs

Pipe OD (mm)	Pipe ID (mm)	Bore Area	Capacity Diff	Rate / m	Cost diff
63	51	2043		$39.75	
75	61	2923	43%	$45.66	15%
90	73	4185	43%	$47.93	5%
110	89.4	6277	50%	$51.08	7%
125	101.5	8091	29%	$107.10	110%
140	113.9	10189	26%	$111.15	4%

Therefore, for example, doubling capacity from 63 to 90mmOD would bring a cost increase of 21%.

c. For the Transfer main from the terminal pump station to the new WWTP, the estimated incremental cost is between $50,000 and $100,000, to increase the pipe size from 225mm OD to 250mm OD.

d. Extension of the 300mm dia. Jacaranda trunk sewer to Kerikeri Rd (450m x $354 + 7 manholes x $6050 + 21% (TC and P&G)) would cost approximately $244,000. However, there would also be consequent additional uprating of Jacaranda PS and the rising main dos downstream of that.

4.6 What is an appropriate design horizon for these elements [listed in s4.4 above]?

The Local Government Act requires that infrastructure of this nature is provided for in accordance with a 30 year strategy and it would seem appropriate that this is a starting point as to a design horizon for elements of a new system. However, there are issues which mean that shorter or longer horizons are appropriate. For example:

- Gravity sewers are one of the most expensive elements in the network and, if constructed properly, will last 80 years. If laid at an appropriate grade, they do not suffer flushing velocity issues and can therefore be readily installed with capacity beyond what can initially be envisaged. Most cities develop trunk sewer infrastructure in this manner.

- Rising mains are problematic for raw sewage and need to be matched reasonably closely to projected demands. If the pipe is too large, septicity and solids settlement issues can arise. It is therefore reasonably common for rising mains to replaced or duplicated due to growth needs. It the correct class of pipe is chosen and installation is appropriate, the individual rising mains should last 80 years.

- Submersible pumps need only be sized for a design horizon of 20 to 25 years. After that time, they require replacing and larger units can be installed.

- Electrical systems are typically regarded as having approximately 25 years economic life after which electronic components are long since obsolete and safety standards have advanced.

Year 2036 is only year 19 in the life cycle of the new infrastructure. It should all be designed to be still functional beyond that date.

4.7 The adequacy of the brief for peer reviews undertaken previously.

I have seen evidence of three peer reviews undertaken of the scheme development and design as follows. These reviews were undertaken by CH2MBeca.

1) NZ1-12717899-2 0.2 Kerikeri WWTP Options Assessment – Peer Review (1 July 2016). This was a review of an assessment of options being considered, by MM, for the main treatment plant configuration. The processes being considered were SAF, SBR and MBR,

2) NZ1-12876075-1 0.1 Kerikeri Wastewater Reticulation Expansion – Peer Review (29 July 2016). This was required to be a review of the 10% design documentation produced by MM for the reticulation system upgrade.

3) NZ1-13643005-Kerikeri WWTP Process Design Peer Review (1 Feb 2017). This was a review of the actual basis of design and process design (again by MM) for the SBR treatment style that had previously been selected.

These three peer reviews appear to have covered adequate ground, within the scope of the briefs provided. FNDC has indicated that the recommendations of the two process reviews have been acted upon. It is not within the scope of this current review to verify that those actions have been taken.

The likely rate of growth of flow and loading onto the new treatment plant could have been peer reviewed. This might have provided a more accurate assessment of the likely year in which treatment plant capacity would be exceeded. However, I do not believe that is the real key issue. It does appear that the plant has been conceptualised in sensible module sizes and with ultimate capacity (after the first upgrading) beyond what is envisaged to be derived from the current Council defined AoB.

In the report prepared in August 2017, by FNDC and addressed to MoH, FNDC has stated:

"*MM was not required to undertake a review of the decisions made by FNDC in respect of growth.*"

Therefore, neither the scheme designers nor the peer reviewers have been required to review decisions made by Council with respect to growth within the chosen AoB or with regard to 'need' external to the chosen AoB. These decisions are not really technical in nature and the reticulation reviewer, if unfamiliar with the scheme history would not have been in a position to query why certain trunk infrastructure was not being provided that could serve a wider AoB sometime in the future. Such a review would need to have been undertaken at a higher level than the technical peer reviewers and potentially involve MoH, as a funding agency, directly. This is particularly so since early versions of the scheme included other areas and because there appears to have been a decision taken some time between the last involvement of MoH and final scheme definition, which excluded, from a future proposed stage3, areas that had previously been regarded as being in need of a sewerage service.

Conclusions

1. The pre-existing flow record is considered to be adequate as a baseline for design purposes.

2. Council appears to have selected a comparatively low future growth rate, when compared to historical growth and contemporary growth. However, this is really only a timing issue. If the growth is happening, then the development contributions should be available at the appropriate time to fund treatment plant expansions. The WWTP needs sufficient spare area for future growth and the reticulation system should be designed to enable extension to new serviced areas without having to be duplicated or pipes ripped up and replaced with larger pipes well before the end of their economic lives.

3. FNDC appear to have taken a very strict view on the AoB for the scheme based on "what we can currently afford". In my opinion, the current strategy around an AoB that will not be changed appears unrealistic. There appear to be a number of drivers and circumstances which could readily lead to the AoB needing to be expanded. As the new reticulation system is already advanced in construction, there will be some service lines and pump stations that would now need to be uprated in future if the AoB is ever expanded.

4. Apart from individual, on site pump chambers, which can pump 2.5m^3/day each, the reticulation system has been designed to provide for the PIF from the respective sub-catchments within the defined AoB. Most of the pipes leading up to the terminal pump station have been built and thus it is not practical at this stage to consider 'up-sizing' key pipes which could have been the receptors for future AoB extensions. Table 4 below presents a number of potential future solutions.

5. Section 4.5 considers some of the marginal costs that would be or would have been involved in uprating a number of the scheme components. Most of these are currently academic as the respective pipelines have already been build or are well progressed. The key uprating consideration left to be made is that of the transfer main from the TPS to the WWTP. There will also be some additional marginal costs for ensuring structural works to be incorporated into the WWTP are future proofed.

6. The design horizon for the scheme is not time based. The horizon is defined by the ultimate filling up of the defined AoB and depending upon the type of projection used, this could be anywhere between 5 and 14 years for the first 1,000m^3/day of treatment plant capacity, but with an additional 50% capacity available to be constructed beyond that date. It would be normal, with current local government legislation to provide for a 30 year design horizon when planning major infrastructure investments.

7. The peer reviews previously undertaken appear to have been adequate from a technical perspective and within the respective defined scopes. However, there does not appear to have been an external review undertaken of the final scheme defined by FNDC for the designers to work to. FNDC seems to have been the arbiter on the "scheme size/extent" and therefore the validity of unserviced areas being "in" or "out" of the scheme has not really been in the hands of the various consultants.

8. Suggested methodologies and/or pathways by which key aspects of the reticulation and treatment system have been or could be future proofed or configured such that extra flow and or loading could be added, in future, without undue cost are summarised in Table 4.

Table 4: Possible Future Proofing Measures

Scheme Feature	Future Proofing Measure/s	Timing
Example Requirements for AoB Extensions		
Areas West of Hall RD	Would require a long new rising main or gravity sewer through the town to the TPS. This would have to run in parallel to existing or new infrastructure.	Future
Riverview & others North of River	i) Extend 300mm gravity main from Jacaranda Pl up to Kerikeri Rd near bypass roundabout. Receive pumped flows at that point. Ideally build now as a future trunk main. However it is probably too late given the status of the reticulation contract. ii) Upgrade or duplicate Jacaranda Pl wet well PS. Upgrade rising main from Jacaranda Pl to TPS.	Future Future
Shephard Rd south	Provide wet weather and diurnal buffering at a new pump station. Pump direct into the new transfer main from the TPS, part way along the length. Waihi Beach in Western Bay of Plenty District uses this methodology.	Future
Reinga Heights, Pa Rd, Inlet Rd areas	Provide wet weather and diurnal buffering at a new pump station/s. Pump directly into the new transfer main from the TPS, part way along the length.	Future
Terminal Pump station	i) Construct (in future) a duplicate, interconnected wet well adjacent the wetwell that will be built as part of the current contract. ii) Build in the interconnectivity (a short pipe with two blank flanges) to the new TPS wetwell now to avoid or mitigate lengthy, expensive shutdowns at a future date.	Future Now
Transfer Rising Main	Initially buffer additional diurnal and wet weather flows. Eventually duplicate the transfer main, or A larger (250mm OD, 212mmID) transfer main could be built now, at between \$50 and \$100,000. The volume of the pressure section of the pipe would be approximately 60m^3 compared to 49m^3 for the 191mm ID main that has been designed and tendered. The respective hydraulic retention times for the two pipes are 2.8 and 2.3 hours at the ADWF. Neither pipe would provide minimum	Confirm strategy now. If chosen, build

	flushing velocities and so daily flushing routines would need to be programmed into the control system. This is an attractive future proofing option that could still be built into the scheme now. The scheme designers have some concerns over use of the larger pipe and a technical review of the implications would be required prior to implementation.	larger rising main now.
Treatment Plant		
Site	The treatment plant concept provides for ADWF of 1,500m^3/d (3 x 500m^3/d reactor trains) inflow and associated contaminant loads. In terms of flow this equates to approximately 3,300 lots at the assessed[10] 2017 ADWF (191 L/hd/d and 2.4 persons per lot). This exceeds the likely demand of the defined AoB, but not by a great deal.[11] Ensure that placement of the treatment plant on the new site under investigation is to one side, such that 4 reactor trains could ultimately be built alongside each other, in the very long term, if necessary.	Now
Inlet Works	i) The likely capacity of the inlet works as designed (Screens 90 l/s each and Grit channel 59 l/s before efficiency reduction) is significantly greater that the PIF for the area of benefit. ii) However, ensure this is designed and configured now in a way that allows another train to be added without a major shut down. Ensure that it is set up so that accurate 3 or 4 way flow splits can be achieved in future. Preferably include a weir overflow grit system bypass for very high flows	Done Now
Reactors	i) At 3 x 500m^3 ADWF, the allowance for reactor capacity exceeds the likely demand of the AoB. ii) Recommend that reinforcing steel is or re-steel connectors (Reidbar Couplers or similar) are set up now for direct connection of the new, third,tank (the nominated 500m^3/d expansion) alongside, sharing one long wall. Ensure walls are designed for water loading on either or both sides.	Done Now
Decant Tank	i) Ensure that reinforcing is or re-steel connectors (Reidbar Couplers or similar) are set up now for direct connection of a tank sideways extension. ii) Ensure external side walls are designed for water loading on either or both sides. iii) Ensure connectivity is provided now between the initial and future parts of the decant tank.	Now Now Now
Treated effluent	Increase pump size sometime in the future. The initial pumps may be near replacement when the need arises	Future

[10] KerS - Logbook

[11] 2016 10%DesRep defines this is 838 existing + 366 extra = 1204 in yr2017 & 2556 ultimate (i.e Plus 1352 lots > yr2017). However, later reports state existing is 1092 equiv, including industrial, in 2016. So, total for AoB becomes 1092 + 366 + 1352 = 2810 lots. So. 3,300 represents 17% extra capacity.

Yours faithfully

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