BEFORE A HEARINGS PANEL OF THE GREATER WELLINGTON REGIONAL COUNCIL AND MASTERTON DISTRICT COUNCIL

[GWRC Ref: WAR 070077]

IN THE MATTER	of resource consent applications to Greater Wellington Regional Council pursuant to section 88 of the Resource Management Act 1991
AND	
IN THE MATTER	of a Notice of Requirement to Masterton District Council pursuant to section 168, 168A and 181 of the Resource Management Act 1991
BY	Masterton District Council
FOR	the proposed upgrade of the Masterton Wastewater Treatment Plant

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CONTINUATION OF SUPPLEMENTARY STATEMENT OF EVIDENCE OF HUMPHREY ARCHER
ON BEHALF OF MASTERTON DISTRICT COUNCIL

RESPONSES TO OFFICER'S REPLY AND SUBMITTERS – 30 MARCH 2009

Subject: Engineering Aspects Of The Scheme And Consent Conditions

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1. INTRODUCTION

I will first present additional information that responds to key matters raised by submitters and officers, then I will address revisions that the applicant wishes to make to the Consent Conditions proposed in the Officer's Report. Finally, I will address concerns raised by neighbours regarding the borrow areas and issues raised by other submitters.

The additional information topics, which clarify the AEE proposal and respond to submitter's key concerns, are:

- Effectiveness of disinfection in the proposed pond system and removal of pathogens in relation to microbial indicators (raised by Dr Palmer).
- Effect of flooding of the berm and the loss of irrigation area during clean-up after a flood and influence on storage required (raised by Gunn, Bell, Forbes and Holmes).
- Revised detail for sealed wipe off drains to prevent infiltration to underlying gravels (raised by Lowe).
- Patterns of pond discharge to river during freshes and feasibility of achieving greater dilutions, or avoiding discharges during fresh recession periods (raised by Dr Ausseil and J. Milne).
- Early construction of the new diffuser in the Ruamahanga River to remove the pond discharge from Makoura Stream (raised by WRC Officers).
- Issues relating to the use of surrounding farmland for irrigation of pond effluent including – cost of winter storage, value of fertiliser in pond effluent and contractual/consent compliance risks (raised by Forbes, Holmes, Stewart).

2. DISINFECTION AND PATHOGEN REDUCTIONS BY PROPOSED PONDS

2.1 *Dr Palmer suggests that a Protocol be agreed with Local Authorities, Regional Council, Public Health and iwi groups, regarding the timing of discharges from the ponds to the Ruamahanga River.*

Response:

It is noted that a Risk Communication Strategy was a requirement of the Interim Consent Condition 19 and it has been implemented. This Strategy was noted in my main evidence in Attachment E "Draft Masterton Wastewater Treatment Plant Operations and Management Plan". This Communication Strategy could be adapted to achieve the objectives suggested by Dr Palmer. Mr Harding will

be outlining a proposal for developing a Regional Risk Communication Protocol and a process for grading of the river at various points. (I understand that the river is not currently graded).

Pathogen vs. Indicator Bacteria Removal

2.2 *Dr Palmer (page 6) advocated the use of a tertiary disinfection stage (UV disinfection) and also questioned whether pathogens were reduced in a pond system at the same rate as indicator bacteria (E Coli).*

Response:

I described the disinfection effectiveness of multiple ponds–in-series in paragraph 4.6 to 4.9 of my main evidence. The proposed six ponds-in-series system at Masterton will produce a tertiary disinfected effluent, equivalent to a UV system following an "in-tank" treatment process.

I have attached a review of all the published information on ponds we have been able to find regarding actual pathogen reductions in comparison with indicator reductions. Refer to Attachment I. It can be seen from Figure 4.1 (note log scale) and Table 4.4 from Attachment I, that pathogens are substantially reduced by ponds and are correlated to indicator reductions. Note the pond temperature in the Brazil study of 25^0C, is reached in the existing Masterton Ponds during summer.

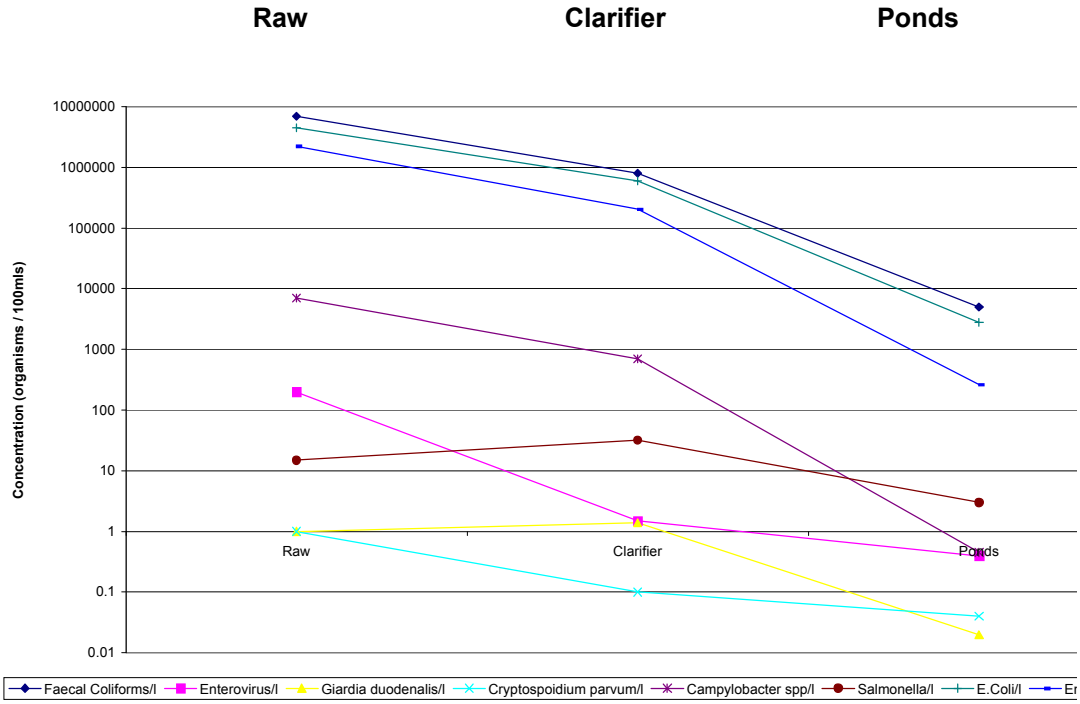


Figure 4.1: Pathogen Reduction Profile Through Christchurch WWTP - 2002

Table 4.4 - Die off of Micro-Organisms in Ponds/Maturation Cells in Brazil

Organism	Raw	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	% Removal
Faecal coliforms	2×10^7	4×10^6	8×10^5	2×10^5	3×10^4	7×10^3	99.97
Faecal streptococci	3×10^6	9×10^5	1×10^5	1×10^4	2×10^3	300	99.99
Clostridium	5×10^4	2×10^4	6×10^3	2×10^3	1×10^3	300	99.40
Campylobacter	70	20	0.2	0	0	0	100.00
Salmonella	20	8	0.1	0.02	0.01	0	100.00
Enteroviruses	1×10^4	6×10^3	1×10^3	400	50	9	99.91
Rotaviruses	800	200	70	30	10	3	99.63

Source: Curtis et al (1987) – pond temperature 25 ^{o}C.

Notes: 1. Bacterial numbers per 100 ml; 2. Viral numbers per 10 L

Testing for pathogens is expensive and hence is not done routinely done. The pathogen results for the Christchurch Ponds are the only available data in New Zealand to our knowledge.

Included in the review, is a paper presented to the NZWWA 2006 Conference on the performance of the Christchurch pond system, which also contains a comparison with UV disinfection after an activated sludge process at the Hamilton WWTP. The Christchurch ponds produce a more reliable effluent quality than UV disinfection after a modern activated sludge process at Hamilton, which discharges to the Waikato River upstream of industrial and other water takes. Refer to Tables 1 and 5 from the paper.

Table 1: Summary of Pond Effluent Faecal Coliform Concentration Results Before and After Upgrade

Statistic	Faecal Coliform Concentration (cfu/100 ml)	
	Before Upgrade	After Upgrade
10th Percentile	450	80
Median	4,500	210
Average	22,400	340
90th Percentile	36,500	660
95th Percentile	69,500	930

Table 5: Comparison of Faecal Coliform from Christchurch Ponds (without UV) to Hamilton WWTP (Activated Sludge with UV)

Statistic	Christchurch Ponds After Upgrade (no UV)	Hamilton WWTP (Activated Sludge with UV)
10th Percentile	80	30
Median	210	185
90th Percentile	660	3,000
95th Percentile	930	9,000

It should be noted that the contact time in a UV lamp channel is less than 1 minute compared to 30 days of UV (from sunlight) exposure in the ponds. There is more opportunity for short-circuiting in a UV lamp channel, and hence insufficient UV dose, than in a six ponds-in-series system.

I also draw attention to the multiple papers by Dr Davies–Colley (NIWA) on sunlight disinfection, and by Dr Leonard (ESR) on pathogen and indicator reductions by ponds. The work by these New Zealand authors is at the forefront of worldwide research in these areas.

The case history of the Christchurch ponds (without UV disinfection) provides a relevant example of how recreational users of the Estuary (into which the ponds discharge) have not experienced noticeable health effects. The Christchurch Ponds discharge on the ebb tide, but because of the large volume discharged and shallow depth of water (mud flats at low tide), dilutions are typically less than 10 times, and 30 times dilution is only reached when the plume reaches the Estuary mouth.

Three Yacht Clubs plus numerous wind and kite surfers (and shellfish gatherers – although not recommended), use the Estuary and there is swimming near the mouth of the Estuary at the popular Sumner Beach. Members of the Yacht Clubs mainly sail dinghy yachts and are affected by spray continuously, plus Optimist and P class yachts capsize frequently!!!

The Christchurch Ponds will discharge to the new ocean outfall which is nearing completion. The main driver for the ocean outfall is to reduce the nutrient load on the Estuary and to reduce the amount of sea lettuce growth (the wastewater treatment plant contributes more than 90% of the N and P to the Estuary). Some submitters wanted UV disinfection, even for the ocean outfall discharge, but long term consents were granted without UV disinfection.

For the above reasons, I do not share Dr Palmer's uncertainties regarding risks to health from a multiple ponds-in-series system, discharging into a receiving water when there is little contact recreation and adequate dilution. Nor do I consider his comparisons with UV lamp treatment at Wellington, Hutt, Kapiti and Porirua to be relevant. Those discharges are all to the coastal environment and are continuous discharges from "in-tank" processes (without ponds). It is unfair to imply that Masterton does not have disinfection when others do. As discussed above, the level of disinfection from modern ponds is better than for UV lamp disinfection. Of the other Wellington examples he uses, three had artificial UV disinfection from the outset and the fourth Porirua, was required to retrofit UV lamps to the previously non-disinfected effluent, which was discharged in the proximity of Titahi Bay, for a number of years.

Virus Outbreak Warning Time

2.3 *During questions from the Panel, Dr Palmer stated that it can take 10 days for a virus outbreak in a community to be notified.*

Response:

Because the proposed ponds will have a 30 day retention time, there will be adequate time for warning to be given, in the event of a virus outbreak in the community. It should also be noted that pathogens are reduced in ponds and the storage level could be deliberately increased to lengthen the storage time, thereby increasing disinfection. There would be time to sample the pond effluent before discharge to the river recommenced. A higher trigger flow could be used in these circumstances, so that the discharge occurred only in a major fresh, when there would be no recreation.

Thus ponds provide a very good public health buffer because of the inherent long retention time.

Risk after discharge events

2.4 *Dr Palmer has recommended that swimming should not occur within 48 hours of the end of a discharge.*

Response:

Others will discuss health risk issues. I note however, that the proposed discharge protocol aims at minimising discharges during the recession of freshes. Mr Ball's assessment of health risk was based on a 30:1 dilution. In practice dilution rates will be much higher (refer to Section 5 later in this evidence) and can and will be managed to be higher on the recession. The

consequence of that is that the health risk during a recession and following cessation of discharge will be less than has been estimated. Given the distance between the modelled site (Wardells bridge) and the Cliffs, and the added dilution upstream of the Cliffs, it seems likely that post discharge risks will prove to be low. This can be verified by monitoring of E.Coli (at Wardells) during the last phase of the recession and after the discharge has ceased.

Use of the Term Sewage

2.5 *Both Dr Palmer and Ms Fox repeatedly referred to the "sewage discharge" to the river.*

Response:

Sewage is defined as the raw wastewater collected from domestic and commercial sources in a community. It is industry standard practice to use the terms "treated effluent" or "treated wastewater" when referring to the discharge from any Wastewater Treatment Plant. Use of the term "sewage discharge" to a river, is not accurate and leads to confusion among lay people.

2.6 **Scope of Health Impact Assessment (HIA)**

Dr Palmer recommended that a proper health impact assessment should have been done following the NZ guidelines.

Response:

I was not involved in the communications with Public Health (PH) but I have made enquiries and my understanding of the main historical communications is as follows:

- Letter from PH to Beca signed by Dr Margot McLean dated 14 June 2005, which stated: *"We have asked that a comprehensive Health Impact Assessment (HIA) be undertaken to determine the risks to the public at times when direct discharge to the river may occur. This will aid in determining the potential risks and whether a form of tertiary treatment, for example ultra violet disinfection, may be required to reduce health risk to an acceptable level. Masterton District Council has indicated that an HIA will be undertaken. I also enclose a Guide to Health Assessment produced by the Public Health Advisory Committee (2004) which, while very high level, may be of interest."*

- Letter from Beca to PH dated 29 September 2005 which stated that: *"We understand the two main issues for the Regional Public Health (RPH) are:*

- *RPH's desire to see a more comprehensive Health Impact Assessment (HIA) undertaken; and*

- *RPH's desire to better understand why Ultraviolet Disinfection is not part of the shortlisted options being promoted.*

We confirm that the HIA is currently being progressed with Andrew Ball of ESR leading the work. With regard to your discussion on UV disinfection, we offer the following comments. We consider that the options of providing maturation cells as secondary treatment, provides excellent pathogen reduction that this method being selected for the long term upgrade rather than the use of UV disinfection. The reasons for this were outlined in the 'Issues and Options Report', Beca 2004." (and a quotation from the report was included in the letter).

I acknowledge that what was meant by HIA in the Beca letter, was not what had been referred to in the letter from PH dated 14 June 2005. I note that at no time has MDC indicated that it intended to carry out that type of HIA. The project team did not regard a full HIA as being necessary or appropriate, however it did decide that a quantitative health risk assessment was appropriate because of the concerns raised by submitters and the nature of the proposed mitigation measures. I am of the view that Mr Ball's approach is very useful and goes further than most WWTP discharge applications that we are aware of (refer to later discussion).

I acknowledge that confusion has arisen over what was expected by PH and intended by MDC.

- Email dated 28 March 2006 from Rebecca Fox (Senior Health Protection Officer, Choice Health Public Health) to Kevin Montgomerie (MDC) stating: *"ESR are currently working through a draft health impact assessment for the Masterton Sewage Treatment Plant. Choice Health have some contributing material to this and before we can provide a response to ESR we need to determine:*

    1. *What is the level of trade waste load that makes up part of the sewage?*

    2. *What chemicals are likely to be included in this?*

    3. *Are treatment chemicals ever added to the sewage or the ponds themselves?*

The information requested by Ms Fox was sent in May 2006.

I understand that Mr Ball had a number of discussions with Ms Fox from 2006 onwards and no concerns were raised regarding the scope of the "HIA" under preparation. In fact, Ms Fox made contributions to the "HIA" as outlined above.

- It seems that the final HIA was not sent to PH directly, but it was attached to the 2007 AEE which was publicly notified. PH submitted on that application but didn't refer to the HIA specifically.

The 2008 AEE (for the proposed new ponds) was notified in September 2008.. PH made a submission dated 14 October 2008 which stated: *"Wairarapa Public Health notes the health impact assessment undertaken by Environment Science and Research Limited which concludes that under the proposed discharge regime that the estimated risk to swimmers emanating from pathogens in the wastewater treatment plant effluent will reduce significantly following the upgrade to levels that are not excessive as gauged by the Recreational Water Quality Guidelines."*

It is noted that there was no criticism regarding the scope or title of the "HIA" in the PH submission. There have been further discussion with Public Health since that submission. The focus of those discussions was not on the methodology which had been adopted by Mr Ball.

In my Attachment O, I have included the full Executive Summary of the Public Health Advisory Committee's "A Guide to Health Impact Assessment; A Policy Tool For New Zealand" and copies of the main historical communication referred to above. There are other records of communications with PH, but they are not substantive.

To our knowledge, the PHAC's version of a HIA has not been prepared for any wastewater treatment consent application and I note that in the 14 June 2005 letter, Dr McLean referred to the PHAC type of HIA as *"while very high level, it may be of interest"*. This suggested that it was for general information and not to be followed precisely.

As well as ESR, NIWA has prepared Quantitative Health Risk Assessments for eight wastewater consent processes (refer to Attachment O for a full listing). These have had various titles including:

- Quantitative Human Health Risk Assessment
- Calculating Risks for Recreational Water Users
- Quantitative Microbial Risk Assessment

It is now accepted by the Project Team, that the term HIA should be reserved for policy type situations as intended by the PHAC, and that the terminology used by NIWA be adopted for wastewater consent applications – although standardisation of report titles would be helpful!!

2.7 In summary, I wish to record that –

- There were ongoing discussions with Wairarapa Public Health from 2005 regarding the "HIA" preparation.
- The issue of UV disinfection not being required, had been addressed at the Issues and Option Report Stage in 2004 (multiple ponds-in-series achieving more pathogen reduction than UV after an in-tank treatment process).
- In hindsight, the "HIA" prepared by ESR should have been termed "Quantitative Health Risk Assessment" or similar. Regardless of the title, the ESR analysis has been of significant value to the assessment of effects.
- The project team remains of the view that the QHRA approach was more relevant to the current hearing than an HIA.

3. FLOODING OF THE BERM

3.1 It appears that flooding of the berm to the north of the ponds, has been at more frequent intervals than expected for a 5 year return period predicted by the river flood model which was based on WRC surveyed cross-sections at 500m spacing (Refer to 14.9 of this evidence). This floodwater is entering the north berm mainly at two localised low areas and the depth of floodwater entering the berm appears to be less than 0.5m, during the minor floods less than 5 year return period. It was proposed in AEE Dwg C605 to construct a 0.5m high levee (bund) at the river's edge to prevent floodwater affecting the berm, other than in greater than 5 year return period floods – refer to Figure on next page. It would be straightforward to raise this levee

to about 1.0m high if necessary, which will be confirmed during detailed design.

WRC has improved the erosion protection along the north berm since the 1998 flood, by planting of trees and installation of groynes as stated in the main evidence of Mr William's at Paragraph 6.5. As stated on Page 101 of the AEE, the need for further erosion protection would be assessed during detailed design, given that the value of the asset being protected, will have increased.

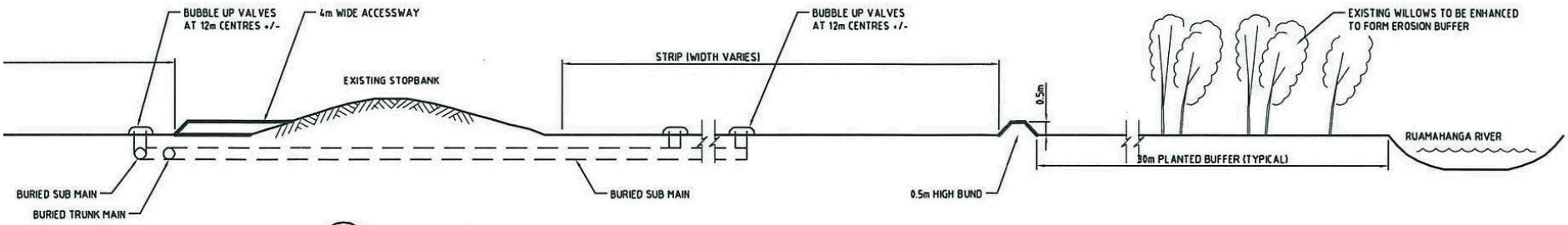
3.2 The 17 events of flooding of the berm over the past ten years (identified by Bell and Gunn) have been analysed and Attachment K contains plots of river flow rate after the floods and the pond storage required, assuming that all of the berm areas cannot be irrigated for 4 to 8 weeks following a flood. This analysis was on the basis that the river edge would remain at its present levels, i.e. a river edge levee would not be constructed.

3.3 In half the events, the river flow rate remained above the trigger value after the flood, which allows the ponds to discharge to the river with no storage required. The other events required storage in the ponds with a maximum storage required of 235,000m^3 which is within the 275,000m^3 proposed. Note 12 event periods are plotted because the other floods occurred in quick succession over 2 to 3 weeks, and can be taken as a single event.

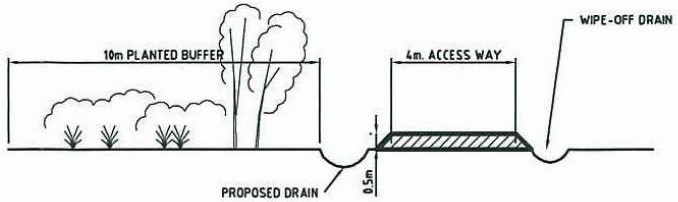
Thus the proposed scheme could have handled the berm flooding periods over the past ten years, even if the full berm area was out of service for 4 to 8 weeks.

3.4 It is likely that only part of the berm area could not be irrigated in the post-flood period and sub-areas would be returned to service when cleared of debris. It is noted that the flood flows could mainly affect the berm to the north of the existing ponds if not protected by a river edge levee as described in 3.1. The proposed irrigation area in the existing ponds, will be protected by the remaining pond banks. The bank between Ponds 1 and 2 could be left at the 1 in 10 year flood level to direct berm flood flows back into the river thus avoiding debris accumulation or erosion of the Ponds 2 and 3 irrigation area. Thus the non-usable portion of the berm area after a flood will be less than 40% of the total irrigation area, as claimed by Gunn and Bell.

- / C601 DEVELOPED SECTION THROUGH PONDS
NTS



9 / C604 TYPICAL SECTION
1:125-A1



10 / C603 PROPOSED DRAIN SECTION
1:125-A1

NOTE:
POND LEVELS TO BE CONFIRMED WITH DETAILED DESIGN.

DATUM:
NEW ZEALAND GEODETIC DATUM 2000
MEAN SEA LEVEL ELEVATION, metres
NEW ZEALAND TRANSVERSE MERCATOR PROJECTION (NZTM2000)

RESOURCE CONSENT
NOT FOR CONSTRUCTION

Original Scale (A1) / Reduced Scale (A3)	Design	AMN	23.01.08	Approved For Construction*
	Drawn	SMB	23.01.08	
	Dsg Verifier	HEA	24.07.08	
	Dwg Check	RPH	18.04.08	Date
	* Refer to Revision 1 for Original Signatures			

Client: Masterton District Council — SERVING THE COMMUNITY

Project: MASTERTON WWTP NEW PONDS AND LAND TREATMENT AREA (2008)

Title: POND AND LAND TREATMENT SECTIONS

Discipline: CIVIL

Drawing No.: 3202216-560-C605

Rev.: C

DO NOT SCALE

IF IN DOUBT ASK.

Document No. p:\320\3202216\cad\phase 560\3202216-560-c605.dwg

3.5 Submitters have raised the concern that during formation of border strips on the berm, that floods could wash away soil from the areas that are not grassed. The risk during construction will be managed by doing the berm earthworks in multiple stages, so that large areas are not exposed to soil erosion.

The original stopbank near the north of the berm will remain and the river edge levee will be raised up to 1m to protect against floods in the 1 to 5 year return period range.

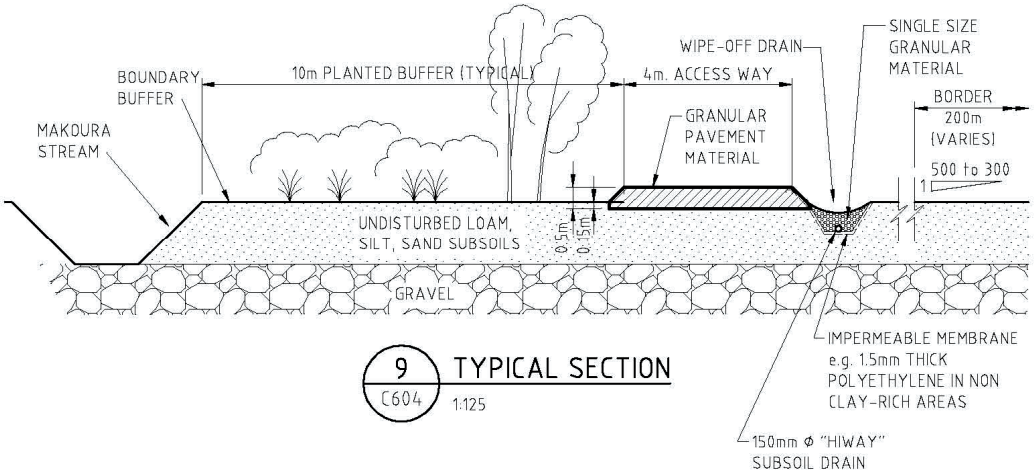
As soon as a border strip bay is completed, it will be sown in grass to stabilise the surface. The river edge levee could have geomesh strengthening (to provide a matrix with grass roots) if that is considered necessary during detailed design. It is noted that the old and new stopbanks are grassed and have not been eroded during floods.

4. REVISED DETAIL FOR WIPE-OFF DRAINS AND RECYCLE TO PONDS

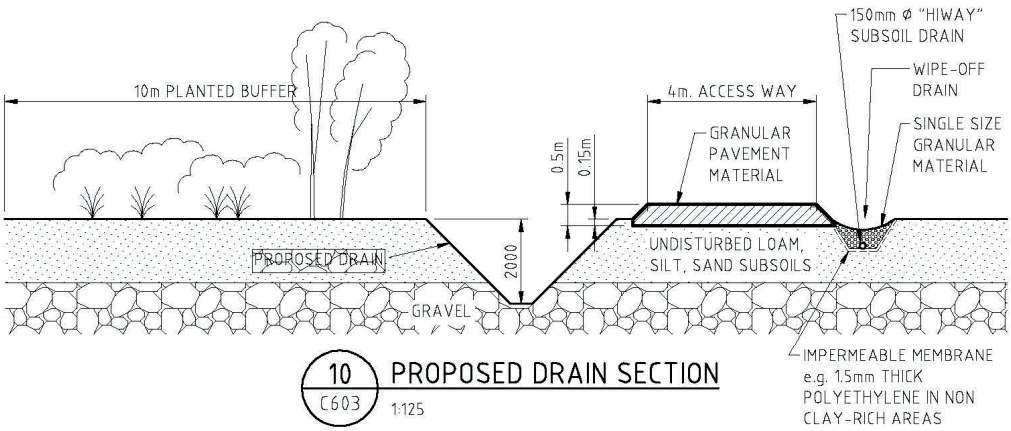
4.1 Cross sections of the wipe-off drains were shown in Attachment D of my main evidence. The wipe-off drains were proposed to have a sandy gravel base which would have allowed infiltration to the underlying gravels. The sandy gravel base was intended to avoid the wipe-off drains becoming "bogs", if they were formed in the naturally occurring soils.

4.2 Mr Lowe expressed concern regarding these "infiltration drains" and while pond effluent run-off to the drains could have been minimal through close operator control, a revised detail is now proposed which "seals" the wipe-off drain but still has a free-draining surface which would allow tractor access to the border strips – refer to revised Attachment D. The naturally occurring clay rich subsoils will have sufficiently low permeability but in free-draining areas, a polyethylene liner will be placed under the wipe-off drains.

4.3 If there is pond effluent run off to the wipe-off drains, it will be pumped into the ponds. The 2 hour "first flush" runoff during rainfall will also be pumped into the ponds. After 2 hours, the pump will stop and rainfall runoff will overflow to infiltration areas formed in irregular shaped portions of the site (not suited to border strip development). It is estimated that these infiltration areas will handle a 5 year return period rainfall and during higher rainfall events, the runoff will discharge to Makoura Stream, which will be in flood at that time.



9 / C604 TYPICAL SECTION 1:125



10 / C603 PROPOSED DRAIN SECTION 1:125

SECTIONS OF MAKOURA STREAM AND DRAINS

SCALE A4: 1:125

PROJECT No. 3202216
CAD FILE No. 3202216 ATTACHMENT D

ATTACHMENT D
REVISED 23.03.09

5. PATTERNS OF DISCHARGE TO THE RIVER AND DILUTIONS

5.1 It appears that the Officers recommended reducing the pond discharge rate to the river from 1200 l/s to 700 l/s because of concerns that dilutions would be less in future compared to the existing discharge. At face value, it might appear that the 1200 l/s discharge rate during freshes could result in reduced dilutions, compared to the existing discharge. However, the opposite is the case as demonstrated by the figure below which compares durations of existing and future dilutions, and is summarised as follows:

	Dilution (river flow x discharge rate)	
Dilution Percentile	Existing (Curve A)	Proposed (Curve B)
95	18	40
90	23	55
50	53	112

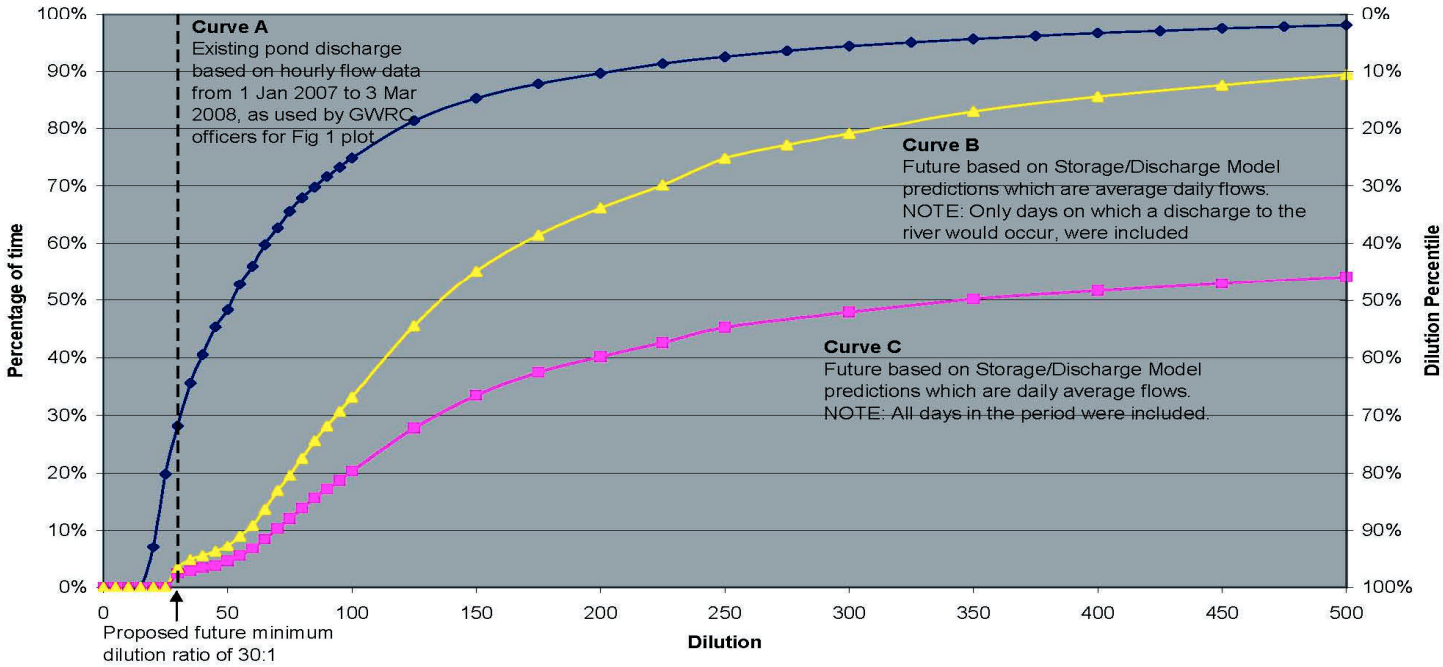
Note – dilution percentiles are expressed in the convention that 90/95 percentiles are the "worst case" end of the range.

The significant improvement in dilutions with the proposed discharge regime, can be explained by:

- The pond discharge will mainly occur at high river flows
- The annual volume discharged to river will be reduced
- The peak discharge rate of 1200 l/s rarely occurs (refer to later discussion)
- The peak discharge rate of 1200 l/s is sustained (for a day) only when storage level in the ponds needs to be lowered. When the storage level reduces, the discharge rate drops to the plant inflow rate, minus the flow discharged to land.

5.2 Included in Attachment L are trend plots for summer river flows and corresponding pond discharge rates and durations. For the 12 years of data, there are only 11 days when the pond discharge rate would have been sustained in the 1000 to 1200 l/s range for a full day – once per summer on average. Thus the effects of the maximum discharge rate will be negligible in terms of duration and the dilutions achieved during the freshes.

Cumulative Frequency and Percentile Distribution for Dilution of Existing and Future Pond Discharge in the Ruamahanga River



5.3 It is also evident that the pond discharges typically drop to low rates or cease, before the fresh recession reaches the trigger value of 12.3m^3/sec. This feature will avoid pond effluent not being flushed from the river. It should be noted that the plots in Attachment L are from the storage / discharge model which is based on daily averages for river and pond discharge flows (each dot represents one day). The instantaneous river flows will peak higher and there will be portions of the preceding and following days when a pond discharge may have occurred. Thus the model predictions are conservative regarding the durations of discharge to the river. As a consequence, there is likely to be flexibility to:

- Cease the discharge during a fresh recession
- Stop the discharge during periods of flow between half median and median flow and use say 10% of the storage volume
- Maintain a 40 times dilution factor at most times
- Only discharge during freshes of more than approximately 6 hours duration (as determined by comparison with the Mt Bruce flow recorder)

The above features are included in the "discharge protocol" which has been proposed as Condition 6A. The discharge protocol is proposed as an operational target but not a compliance condition, because there will be some extreme periods when the AEE discharge rules of 30 x dilution and winter/summer triggers will be needed, as discussed below. If the protocol was imposed as a compliance requirement then there would need to be corresponding provision for occasional discharges outside of the currently proposed flow constraints. That is there would need to be provision for occasional discharges below the trigger flows to make up for the storage lost by complying with an inflexible discharge protocol.

5.4 We have modelled the storage required if dilutions greater than 30X were to be stipulated, as follows:

- the storage volume for 40X dilution would be 350,000 cubic metres
- the storage volume for 60X dilution would be 550,000 cubic metres.

These amounts can be compared to the proposed 275,000 cubic metres and substantial extra costs would result from 40X or 60X dilution requirement being applied at all times.

The trend plots for storage at 40X and 60X dilution are shown in my Attachment M. It can be seen that the proposed storage of 275,000m^3 was

exceeded only during the 2007/08 period of low flows (about a 10 year return period). If allowance to discharge to the river in "extreme conditions" was made, the 40X dilution target could be implemented. I do however, note that the AEE concluded that 30 times dilution would have negligible effects and Dr Cooke demonstrated in Figure 6 of his evidence, that upstream river water clarity substantially reduces at flows approaching, and greater than, median. Thus effects from the discharge of pond effluent at flows above median, will not be conspicuous against that background of turbidity. Accordingly, in my view there is no justification for a mandatory 40:1 requirement.

I believe that the best approach is that set out in the proposed protocol. That aims to minimise discharges to the river during the the last part of summer recessions and at winter flows between median and half median. Although I do not consider that this is necessary to manage potential adverse effects, it can be achieved and will have some small beneficial impact in terms of winter clarity and post discharge health risk. The storage plot in Attachment M for having 40X dilution for flows between half median and median in winter, indicates that 40X dilution will be achievable.

5.5 Attachment M also includes storage plots for other scenarios that have been modelled:

- For discharge at median trigger flow for the whole year and 30X dilution, the 275,000m^3 storage was exceeded on four occasions from 2003 to 2008, and would not be viable.
- For discharge at a trigger flow of 19 m^3/s and 30X dilution, the 275,000m^3 storage was exceeded (or just reached) on four occasions from 2000 to 2008, and would not be viable.

6. EARLY CONSTRUCTION OF THE DIFFUSER IN RUAMAHANGA RIVER

6.1 The Officers have recommended that the pond discharge be moved from the Makoura Stream to the Ruamahanga River, within 12 months of the consent being granted. In my opinion this action, while providing benefits for Makoura Stream, has the following disadvantages or limitations:

- There will be a discharge to Makoura Stream of stormwater and groundwater from the existing ponds while sludge is removed and this operation could extend for up to 4 years, if there are wet summers. This discharge will comply with the existing effluent quality conditions.

- The early discharge to the river without any of the irrigation area being available, will require a continuous discharge that will affect the neighbours on the eastern bank (Wardells and Ternents) in terms of recreation and water take. This situation will improve only marginally when the existing pasture effluent irrigation area is completed (without irrigation in the existing pond area) during which time a half median trigger will be needed for pond discharges in both summer and winter.
- The river diffuser would need to be constructed under a separate contract and there will be significant cost allowances made by tenderers for "waiting time" (for sustained low flows in the river) and unexpected freshes/floods, plus the associated mobilisation and separate administration costs. In comparison, if the new diffuser is installed in conjunction with the new ponds construction, the contractor could readily divert equipment to the river work when flow conditions are favourable and move out of the river when a fresh occurs, to do work on higher ground.

6.2 I also note that the Regional Council declined consent for shifting of the discharge at the Interim Consent Hearing. In my view, shifting the discharge 12 to 24 months earlier, will have little environmental benefit.

In summary, the Applicant does not support the early construction of the diffuser in the Ruamahanga River.

7. USE OF SURROUNDING FARMLAND FOR IRRIGATION OF POND EFFLUENT

7.1 Submitters referred to the desirability of reusing all the pond effluent on surrounding farmland so that the benefits could be gained from the nutrient content as well as water to meet soil moisture deficits (Holmes, Forbes, Stewart and others).

7.2 If all pond effluent was to be used on farmland (nil discharge to river), a large storage basin would be needed to hold the effluent over winter for irrigation in summer when the crops need water and nutrients. The average winter inflow to the plant is 17,800m^3/day and based on storage needed for approximately 200 days per year, the storage volume required is 3.5 million m^3. Figure 1 in Mr Borrie's evidence shows that soil moisture deficit typically occurs from mid-October to mid-March, a five month period – therefore storage would be needed for about seven months (or 200 days).

7.3 Beca has experience of designing large river water irrigation storages in Canterbury in the order of 5 million m^3. Scaling to the Masterton situation, a

winter storage of 3.5 million m^3 would have a cost of approximately $8 million without including pipeline connection costs. Any storage basin site near Masterton would need to have appropriate soils available on site – e.g. silty clay for the liner could not be economically trucked in from remote sites. The above cost is for storage basins constructed above ground. If a natural gully or basin could be found, the capital costs could potentially be reduced.

7.4 Identifying a suitable site could be problematic because 50ha to 100ha would be needed, depending on depth. Assuming that such a site could be found there would need to be a full assessment of environmental effects. Neighbours may not necessarily embrace the concept. There would be costs of piping and pumping to the storage site, and from the site to the additional irrigation area.

7.5 Mr Forbes has estimated that the value of fertiliser in pond effluent is $138,000/year. Such savings need to be seen in comparison with the additional capital required of at least $8 million and debt servicing charges. Furthermore, if the Fonterra Guideline for disinfection has to be met, additional treatment capital costs would be $4 million (DAF + UV), or $6 million (Microfiltration), with operating costs of $0.5 million/year. Thus the fertiliser value of the pond effluent cannot justify the full reuse on surrounding farmland.

7.6 As stated in AEE Section 6.7.9, there is potential for groundwater to be taken from the MDC site and supplied to surrounding private farmers without incurring additional treatment costs. This is expected to be a more financially viable alternative. As stated by Mr Hopman in Paragraph 3(g)

"The proposed upgrade allows for future third party use of the treated effluent without risking potential operational or environmental consequences of any commercial arrangements failing, or the imposition of uneconomic constraints on the use of the treated effluent. This third party use, combined with ongoing network improvements, will over time further reduce the volume of river discharges required."

And at Mr Hopman's Paragraph 5.15;

"Policies have now also been adopted by the Council to provide a basis for the treated effluent to be utilised by third parties as an irrigation/nutrient resource in the future".

The above approach is based on MDC having a "standalone scheme" at its Homebush site, without having to rely on third party users of pond effluent for compliance with discharge to river conditions. There are significant risks to MDC if it had to rely on contractual arrangements with third parties, as outlined in my main evidence at Paragraph 13.60.

I understand that Mr ten Hove will be outlining to the panel a proposal to ensure that the Council periodically reviews options for zero discharge to the river.

8. SUBMITTERS CONCERNS REGARDING OPERATION OF BORROW AREAS

8.1 The submitters closest to the proposed borrow areas, raised concerns regarding construction effects from the proposed borrow areas. The Hearing Panel requested that further information be presented regarding the operation of the borrow areas. This information is included in the draft Gravel Borrow Area Management Plan, which is Attachment H (presented on 12 March).

8.2 In summary, it will be possible to comply with the requests of Wullems that use of the southern borrow areas be avoided during the flower growing season from July to December, and by Martins, that the northern borrow area be not used in January. Thus, excavation will start on the northern borrow area from September to mid-November, and move to the middle area from mid-November to January, and then the Southern area from February to May.

8.3 Working hours have been discussed with a Wairarapa based contractor and normally accepted hours are stated in section 2.3 of the draft Borrow Area Management Plan. It is noted that in Appendix 2 of Susan Southey's Supplementary Report (11 March) Condition 3.2 should add "construction" prior to "works" to make it clear that the hours of work apply only to construction activities and not ongoing operational activities such as pasture harvesting and clean-up after flood events. The heading of Condition 3 could be worded "Construction Hours of Work".

8.4 Dwg C625 which was in Appendix D of the AEE, has been updated to show sight lines from houses and is included in Attachment H. With a hay bale

noise and dust control barrier located in the 20m set-back area, the residents will not be able to see the excavation activity in the borrow areas.

9. RESPONSES TO ANDREW STEWART SUBMISSION

Clause 4.3 to 4.5 (Fulltime Land Treatment Area needed for Peak Wet Weather Flows).

9.1 *Mr Stewart questions the derivation of the 800 ha irrigation area needed to cope with peak wet weather flows (PWWF) and the 340ha area needed for average flows in winter.*

Response:

The highest recorded inflow to the Masterton WWTP (and the maximum hydraulic capacity of the trunk sewer) was 60,480m^3/d. The typical effluent irrigation rate proposed for free-draining soils in the Homebush area is 7.5mm/d (excluding rainfall). Thus 60,480m^3/d inflow at 7.5mm/d irrigation rate would require 800 ha.

As an illustration, the initial Taupo effluent irrigation area of 145 ha was restricted to a maximum application rate of 9,000m^3/d. Scaling up to 60,480m^3/d peak flow for Masterton, gives 974 ha required.

I reiterate clause 13.43 of my main evidence, that the 340 ha area stated in the AEE, was for average winter flows irrigated to land, coupled with PWWF events discharged to the river. Mr Stewart did not make that clear.

9.2 *Mr Stewart stated "Once the effluent was treated by UV, it would be suitable for use on any agricultural land without question".*

Response;

This statement requires the qualification that "agricultural" refers to crops not used for dairy farming. UV disinfection of pond effluent could not meet the very stringent Fonterra guideline for irrigation of effluent to pasture grazed by dairy cows, because of the suspended solids content which inhibits UV transmission.

In order for UV disinfection to meet the Fonterra guideline, algae would need to be removed from the pond effluent by DAF at a capital cost of approx $3.7 million (for DAF + UV). Alternatively, membrane filtration would be needed at a

capital cost of approx $6.0 million. Annual operating costs would exceed $0.5 million for either options.

Clauses 4.24 to 4.34 (Phosphorus Loads in the Catchment)

9.3 *Mr Stewart quotes from the Chrystall thesis and also states "the applicant presented some circular diagrams talking about the percentage of the WWTP discharge in relation to the whole catchment and indicating that MWTP only contributes a low percentage of the total".*

Response;

Mr Stewart did not acknowledge the author of "some circular diagrams". For the record, these were presented by Dr Cooke and are the outputs from authoritative calculations of nutrient mass load contributions in the catchment based on actual flow records and concentration data. Dr Cooke's evidence on this topic supersedes earlier information published by others.

Clause 5.59 (Greater Storage Capacity)

9.4 *Mr Stewart suggests "that it would be possible to increase the trigger level in summer to more than 12m^3/sec by requiring greater storage capacity. This may prevent the conspicuous change in clarity which is going to occur with the current discharge regime".*

Response;

Dr Hickey has predicted that the change in clarity will be 10% to 20% which is well within the guidelines. In addition, the upstream water clarity reduces substantially as river flows approach the median value - refer to Fig 6 in Dr Cooke's evidence. Thus a higher trigger flow is not warranted.

A higher trigger flow would require significantly more storage e.g. 19m^3/s trigger would require 500,000m^3 of storage as shown in Attachment M. If pond storage is increased, the pond area would most likely need to be increased (thus reducing the effluent irrigation area) because bank height is nearing the normal maximum limits. Increased storage would increase construction cost significantly, as described on page 203 of the AEE.

10. RESPONSES TO IAN GUNN SUBMISSION

10.1 *Mr Gunn comments on the discharge to the waterways in Section 9 of his evidence. In paragraph 9.7, Mr Gunn suggests that the Ruamahanga River Mt Bruce site will provide 4 to 6 hours warning for a fresh at Wardells Bridge.*

Response;

We had analysed hourly river flow data for summer periods from the Mt Bruce and Wardells Bridge gauging stations and calculated the time difference in the peak flows for a number of flood events. We found that the Mt Bruce site provides 6 to 9 hours warning of freshes arriving at Wardells Bridge.

10.2 *Mr Gunn refers to GW's flow predictions for peak floods being used to determine when there is a discharge to the river.*

Response:

It is not proposed to use "flow predictions" to determine when a discharge can occur. The decision to discharge will be based on actual flow data at Wardells Bridge. Flows at Mt Bruce will be monitored to confirm whether the duration of the discharge is likely to be greater than 6 hours and if so, a discharge can be initiated. This will avoid discharges during minor freshes, which would have effects on recreation usage downstream.

10.3 *Mr Gunn comments on border strip irrigation on the river berm area in Section 10 of his evidence. In paragraph 10.4, Mr Gunn states that it is not clear where berm area topsoil is to be stockpiled and that there will be insufficient topsoil. Also that the addition of inferior topsoil will change the soils characteristics.*

Response:

Topsoil will be stripped from the berm before grading these areas and stockpiled adjacent to the border strips to minimise the cartage distance. Where gravels on the berm area are close to the surface, these will be over-excavated and restored with topsoil as explained in Section 6.4.4 of the AEE. Topsoil will also be sourced from the 150 mm of soil that will be removed from the new oxidation pond site. Inferior soils are not being added as stated by Mr Gunn, but silty loam topsoils will be sourced from the new oxidation pond area and placed on the berm area where needed.

10.4 *In paragraph 10.6 and 10.8, Mr Gunn suggests that during flooding, the berm border strips will fill up and flow from one border to the next and down the wipe-off drain. He expresses concern about erosion of the levees.*

Response:

During a significant flood, the berm will act as one continuous floodway and the issue of water flowing from one border strip bay to the next is of minor consequence. The border strip levees will be only 300 mm to 500 mm high with sloping sides and will be grassed and therefore not be prone to erosion. At detailed design, consideration will be given to incorporating geomesh reinforcing in the levees so that grass roots intertwine with the geomesh to resist erosion.

It is noted that existing stopbanks (both the original and current) have grassed slopes which have not suffered erosion, other than where the river undercut sections of the original stopbank.

10.5 *In paragraph 10.7 and 10.7, Mr Gunn states that significant deposits of silt can be expected during floods and deposition will reduce infiltration rates by clogging the pores.*

Response:

It is acknowledged that the riverside area is subject to flood events. During flood events there will be some deposition of silt on the berm area, the effect of which will depend on the severity of the event. During the 1998 flood when the old stopbank was breached, which was a significant flood (approximately 40 year return period), strips of sand and gravel were observed, rather than deposits of silts (K. Montgomerie pers. com.).

The river gradient in this area is approximately 1:350 which causes higher velocities so finer silt particles do not settle readily. In addition, the lowering of the existing Pond 1 bank at the north end, will result in an unhindered flow path through the area of existing Pond 1. Mr Forbes confirmed that up to about 50 mm of silt is deposited just upstream of existing Pond 1 bank and that little silt was deposited further north on the berm. Mr Lowe agrees that major silt deposition is unlikely.

It is noted that Mr Gunn states *"In places, silt deposition has exceeded the height of fenceposts."* Presumably such deposition was not at Homebush and was elsewhere in the catchment.

If significant silt deposits were to occur, these may need discing or re-sowing of the grass by direct drilling. I disagree that silt will have a negative impact on the soils properties. Minor siltation that occurs during flood events, will have a beneficial effect in providing silts on what is typically free draining sandy gravel berm and will improve filtration treatment and nutrient removal from the wastewater.

10.6 *In paragraph 10.9, Mr Gunn notes that heavy equipment cannot cross flooded areas without damaging the surface of the pasture for 10-14 days following floods.*

Response:
Refer to Section 3 of this evidence which explains how the flood events and the recovery phase, can be handled by the proposed scheme.

10.7 *In paragraph 10.10, Mr Gunn suggests that debris will be deposited in stilling basins which will cause further turbulent flow and more damage to the structure of border strips and wipe off drains.*

Response:
Mr Forbes stated that when tree trunks are deposited on the berm, there is a build up of silt behind the trunk. It is not expected that pasture and the border strips will be significantly damaged, just as the existing pasture has not been significantly damaged and has remained productive.

10.8 *In paragraph 10.13, Mr Gunn suggests that the irrigation area in the existing ponds needs topsoil to be effective.*

Response:
The new ponds will have a similar area to the existing ponds. Topsoil will be removed from the new pond area and will be stockpiled and then spread over the area of the existing ponds. This will provide a good medium for grass growth and ongoing minor siltation will enhance the topsoil.

10.9 *In paragraph 10.14, Mr Gunn states that there has been no assessment of flood hazard for the river berm and that since 1998 the berm has been breached 18 times.*

Response:

Masterton District Council commissioned the preparation of a calibrated flood model for the Ruamahanga River prepared by P. Wallace who is an experienced river flow modeller (Hydraulic Modelling of Ruamahanga River: Te Ore Ore Bridge to Wardells Bridge, Wallace P. (2004)). The model predicted that the berm area is flooded in a 5-year return period event, but this was based on WRC surveyed cross-sections at 500m spacing. As described in Section 3 of this evidence, there are low points which can be corrected by the formation of a river edge levee up to 1m high where needed and thus prevent flooding of the north berm during floods of less than 5 year return period.

10.10 Mr Gunn has estimated that the flooding is an annual event because the berm has flooded 18 times since 1998 but this has been the result of the low points as stated in 14.9 and my Section 3 earlier. Mr Gunn shows the incorrect flow value for the annual flood in his Figure 2 which is drawn at approx 470 m^3/s. The annual (1-year return period) flood is in fact 237 m^3/s. The flows for various return periods floods in the Ruamahanga River are provided in the table below (from Wallace 2004).

Return period (Years)	***River Flow (m^3/s)***
1	*237*
2	*460*
5	*591*
10	*674*
20	*760*
50	*871*
100	*955*

10.11 *In paragraph 11.6, Mr Gunn states that the sludge landfill will be 12 m high.*

Response:

The sludge landfill will be 3 m high as shown on the pond cross-sections, Drawing C617. Mr Gunn incorrectly states that the sludge volume will be some 80,000 m^3. This is the volume of insitu sludge at approximately 7% dry solids and will be reduced significantly when air dried to approximately 50% dry solids, with the dried sludge volume in fact being reduced to around 15,000 m^3.

10.12 *Mr Gunn expresses concerns about the sludge being landfilled in a flood plain.*

Response:

The sludge will be stored within a compacted soil embankment and with a 300 mm thick silty clay liner and cap to seal the sludge and restrict water ingress. Because pond sludge will have been stabilised by anaerobic digestion and any mobile contaminants will have been leached by leakage from the base of the existing ponds, sludge in the landfill will not have contaminants of concern. The outer banks of the sludge landfill will have rock protection sourced from the existing ponds, to prevent scour during floods, which is expected to be of low severity in this locality because of the protection provided by "Holmes Bend".

10.13 *In paragraph 12.3, Mr Gunn states that the MDC will spend $40 M on the scheme to reduce the discharge to the river by a small percentage.*

Response:

The actual capital cost of the scheme including land purchase is approximately $25M ($ 2007). Mr Gunn may have confused NPV with capital cost. NPV was included in the BERL Report and includes the annual operating costs converted to present value using a discount factor.

10.14 *In paragraph 12.8, Mr Gunn states that more storage and land may be required and over 90% of the pond effluent will be discharged to the River.*

Response:

Table 27 in the AEE provides data on the percentage of wastewater inflow discharged to the river. In the summer months, 33 to 51% of the inflow will be discharged to the river and in the winter months 65 to 93%. The annual average of the 11 years modelled, was 66% to the river and 34% to land.

11. RESPONSES TO STUART FORBES SUBMISSION

11.1 *At Paragraph 39, Mr Forbes stated "the flood (7 October 2008) did not even reach the five year flood level".*

Response:

The 7 October 2008 flood was 590m^3/sec which is a 5 year return period flood, as stated earlier in my Paragraph 14.10 responding to Mr Gunn's submission (Gunn's Figure 2 plotted the annual flood incorrectly).

11.2 *At Paragraph 14, Mr Forbes questions the trunk sewer pipe being shallow and having an effect on border strip formation and infiltration.*

Response:

The site gradients are such that cover over the existing pipeline will not be reduced and will be increased where possible. In operation, infiltration rates down the length of a strip area are self-correcting and the presence of the pipeline will not affect the irrigation operation.

11.3 *At Paragraph 46, Mr Forbes states that "it is not possible to separate out the soils like that".*

Response:

It has been my experience as Project Director for major contracts involving pond construction and irrigation areas at the Oamaru, Leeston and Blenheim WWTPs, that major contractors such as Doug Hood Ltd, Fulton Hogan Ltd and Morris Contractors Ltd, were able to readily select layers of topsoil and subsoils, even separating thin silt rich layers from sandy layers, and also separating from gravel layers. At all locations, topsoil was replaced after stockpiling and healthy pasture was re-established.

11.4 *At Paragraph 60, Mr Forbes stated "Council have been unable to pump dry the old ponds……. because they are at a lower level than the river aquifer".*

Response:

The attempt to lower the level in Pond 2 was while adjoining Ponds 1 and 3 were still full. These ponds would have influenced the local groundwater level more than the river when it was at normal flow depths.

Actual groundwater levels have been recorded at the site and were plotted on Drawings C622 and 623 in Appendix D of the AEE. There are low spots in Pond 2 and these will be filled with material from the existing pond banks. However the groundwater generally is 1m below the proposed future surface level, bearing in mind that at least 150mm of topsoil will be relocated from the area of the new ponds. The proximity to the river, results in the groundwater level being drawn down to the normal river level, given the good permeability of the underlying gravels.

The groundwater levels shown on Drawings C622/623 also show the influence of 2 and 5 year return period floods in the river. During such events, groundwater will upwell in the existing pond area, but this will be temporary and have little impact on pasture in this area.

11.5 *Mr Forbes also questioned the effect of flooding during construction*

Response:

As noted on Drawing C602 and in consent applications on pages 26 and 38 of the AEE, a cut off trench will be formed at the north end of the new ponds so that groundwater from the river upstream during floods, can be pumped across the existing stopbanks. The groundwater levels on Drawings C622/623 show the effect of extraction pumping on lowering the groundwater levels to protect the liner in the new ponds during construction.

11.6 *At Paragraphs 62 and 63, Mr Forbes stated that the border strip gradients between 1:300 and 1:500, are very flat and that the use of equipment right at the leading edge of modern technology, results in the $7 million estimated cost.*

Response:

Firstly, the average gradient on the north berm is 1:350 so the re-grading earthworks required to achieve the proposed gradients will be relatively minor. Secondly, it is now standard practice for equipment to be fitted with laser guided levelling and GSP location units. Thirdly, the estimated costs are dominated by the proposed buried pressure pipe, valving and automated control systems, needed to deliver flows up to 300 l/sec to the border strips plus access roads and drains. Earthworks for border strips will be a minor portion of the total cost.

11.7 *At Paragraph 64, Mr Forbes states that the effluent will bubble up at 800 l/s and that the effluent will want to run the other way because the gradient is so subtle.*

Response:

The proposed application rate at each bubble up valve is 100 to 150 l/s, with two bubble up valves for wider strips giving a total of 200 to 300 l/s (not 800 l/s). The standard gradients for border strips in Canterbury and elsewhere, is 1:300 to 1:500. There will either be a raised access road or 300mm high levee at the top end of each strip.

11.8 *At Paragraph 99, Mr Forbes states that the solids would need to be separated from the wastewater as soon as it arrives on site. This is a*

simple process and could be done by constructing a screen or via a compressed air separation process like the one at Palmerston North.

Response:

I am very familiar with inlet screens and other solids separation processes (known as primary treatment) at plants such as Palmerston North. None of these processes are "simple". They have substantial capital and maintenance costs. It is noted that there is already a screen at the Masterton inlet to remove coarse debris. The primary ponds allow wastewater solids to settle which is a "simple process" and has very low operating costs.

12. RESPONSES TO JANICE DUNCAN (DOC) SUBMISSIONS

12.1 *At Paragraphs 40-43, Ms Duncan states that irrigation of effluent in the buffer along the river frontage, would not be supported by DoC.*

Response:

The buffer along the river edge is primarily for erosion protection and is already planted in most places. The proposed border strips will be set back from the river edge typically 30m on the north berm, as shown in Drawing C605 (part of which is included in my Paragraph 3.1). In the area of the existing ponds, there will be a 60m wide erosion buffer that will be planted and will not be used for border strips.

While effluent drip irrigation of plantings in the buffers elsewhere on the MDC land is proposed, it is not intended to drip irrigate the plantings in the river edge buffer.

13. RESPONSE TO SUBMISSION BY PERRY, GRIFFITH, COTTER AND LIMBRICK (NEIGHBOURS ON NORTH BOUNDARY)

13.1 I will address the concerns raised by these submitters regarding drainage, retention of significant trees where possible and to exclude a small area from the Designation.

It is proposed to construct a deep drain at the western edge of the border strip area on the west side of Makoura Stream. This drain will be approximately 2m deep and will collect water from the gravel layer and will reduce ponding presently experienced near the north boundary.

The proposed drain will branch if needed near the north boundary, to intercept surface runoff and underground springs.

Where possible, mature trees will be incorporated into the buffer and from the aerial photos, only 2 or 3 trees may need removal. The removal of trees and reinstatement planting in the buffer, will be discussed with the adjoining property owners prior to construction starting.

In my view, it is appropriate for all the MDC owned to be designated as advertised. Substantial buffer distances are proposed at this locality and the designated buffer will provide separation of potential odour and noise effects.

14. RESPONSES TO HAMISH LOWE'S SUPPLEMENTARY EVIDENCE (the responses by Dr Proffitt and Mr Borrie address other aspects)

14.1 Land Disposal versus Land Treatment and Other Examples (Lowe's Paragraphs 24 to 41).

Mr Lowe has continued to debate the semantics of terminology and I maintain that the definitions used in the USEPA Land Treatment Design Manual (2006) be used when writing the Decision especially in regard to the proposed scheme being termed Slow Rate Irrigation.

While not explicitly stated in the AEE, the Limited Design Parameter (LDP) has been DRP uptake by pasture and absorption by soils, so that the percolate does not have effects on the river. DRP removal rates drove the decision to use cut and carry pasture rather than coppice tree crops.

Mr Lowe refers to the issue of DRP breakthrough at Rotorua due to the subsoils capacity for P retention being exceeded. It is noted that the forests at Rotorua will not be removing as much P as the pasture proposed for Masterton (which will remove the majority of the applied P).

Mr Lowe stated that the *"Werribee system has a lot of problems because of water logging in large areas and salinisation".* It was stated in the AEE on page 200, that the subsoils at Weribee were more clay rich than the free-draining portions of the Masterton site. It is also noted that the Werribee annual rainfall is only 550mm compared to 950mm at Masterton. The extra rainfall and dilute wastewater at Masterton (caused by groundwater

infiltration) will prevent salinisation occurring at the same rate as at Werribee.

14.2 Suitable Application Rates

At Paragraph 43 Mr Lowe states that *"it was agreed to remove the proposed application uniformity condition".*

Mr Borrie and I considered that numerical measurement of application uniformity could not be done economically in the field and agreed with Mr Lowe that a visual assessment of application uniformity would be included in the Conditions.

At Paragraph 44, Mr Lowe states that he had sought clarification regarding *"the application rates will be varied based on soil conditions".*

My advice to Mr Lowe was that experience at Leeston has demonstrated that when soils are dry, it takes hours for the wetting front to move down the strip and when the soil is wet or the groundwater level rises to about 1m from the surface, the time reduces to about 30 minutes. Thus the varying soil moisture content and groundwater level will inherently determine the time that a discharge can be made to a strip and the operator will adjust the timer control accordingly. The volume applied to each strip (application depth) will therefore vary according to soil and groundwater conditions.

14.3 Suitability of Border Strip Irrigation

To clarify Mr Lowe's Paragraphs 60 to 62, the Landcare Research (2008) report on soils in the 107ha site prepared by Wilde, contains a statement that *"a large portion of the 107ha site is not suitable for border strip irrigation".*

Mr Webb (also with Landcare Research) disagreed with Mr Wilde's view and as noted by Mr Lowe, more weight can be placed on Mr Webb's opinion because of his greater understanding of border strip irrigation and irrigation of effluents in general.

Mr Webb's opinion is also confirmed by the design guidelines in Tables 7.5 and 7.6 on Page 7.7 of the USEPA Land Treatment Design Manual, which shows border strips being suitable for soil types ranging from sand, to clay loam, and clay.

14.4 Use of the Wipe-off Drains (Paragraphs 68 to 73)

In response to Mr Lowe's comments, a revised wipe-off drain and recycling system is now proposed as described in Section 4 of this evidence. The revised system will reduce the criticality of application timing to avoid effluent runoff to the wipe-off drains, and will prevent effluent infiltrating directly to the underlying gravels.

14.5 Consent Term and Management

In his Paragraphs 112 to 120, Mr Lowe states that he is uncertain that the applicant will manage the effluent irrigation system correctly and uses that uncertainty to justify *"conditions that were a lot more stringent than what the applicant was initially expecting"* and also a 15 year term.

Firstly, I note that the applicant only proposed outline conditions. What has now been agreed is not significantly more stringent than what was anticipated. The agreed conditions are comprehensive and in my opinion more than adequate to avoid remedy and mitigate. There is appropriate provision for adaptive management. The proposed form of operation, the conditions and adaptive management will ensure that the scheme is sustainable for the 35 year term of consent sought.

Secondly, in my opinion, the irrigation system will not be difficult to manage. The proposed Masterton system is based on that used at Leeston since 2003 and a trades qualified person operates the Leeston system with very little engineering inputs from the District Council staff for day to day operation. The office staff collate the monitoring data and analyse N loading rates periodically, and the same would apply at Masterton.

Mr Lowe described the proposed Masterton system in terms of a District Council manager being asked to drive a Ferrari on a gravel road in hill country. While this analogy is colourful, it creates the wrong impression.

The elements of the proposed irrigation are simple and all are standard industry practice –

- Feed pump station
- Buried pipelines
- Automated and manual valves
- PLC based automatic control system
- Wipe off drains
- Recycle pump stations
- Pasture growing and harvesting

MDC already operates and maintains pumps and valves in its water supply and wastewater collection systems.

The irrigation operator will need to tour the site each week day (and possibly at weekends) to select strips for irrigation and to check that the system is working as intended, with no excessive runoff or ponding, and adjust timer settings as required. Thus the operation will not be complicated, nor difficult to manage.

In my opinion, the proposed Conditions will provide assurance that the system will be operated as intended and there is no justification for a 15 year consent term as an additional precautionary measure. I disagree with Mr Lowe's suggestion that if there was mis-management, that the consequences of that would be such as to require the land disposal area to be decommissioned at the end of 15 years. In my view that is implausible. The proposed irrigation system is well suited to adaptive management. I cannot envisage any system failure which would lead to the operation having to be decommissioned 10 years after commissioning.

15. COMMENTS ON REVISED CONDITIONS SCHEDULE 2 WAR 090066 (27160, 27161, 27162, 27163)

(Minor grammatical changes to the conditions will not be discussed here)

15.1 **Condition 1 -** Stockwater Standards can be met. While an alternative water supply, or management provisions, are under consideration, there is no need for that to be a requirement of consent. It is noted that the duration of the Ternents take is quite limited and could be scheduled when the discharge is not occurring.

15.2 **Condition 2 -** The 15,750 m^3/d value is the average raw wastewater daily inflow volume and cannot be linked to the discharge rate because of storage in the ponds and reduced duration of discharges to the river.

The 40X dilution is opposed as a mandatory condition. It can be accepted as part of the "discharge protocol" as described in Section 5 of this evidence.

The early cessation of discharge to Makoura Stream is not supported as stated in Section 6 of this evidence.

The trigger for the discharge to the river until the existing pond area is available for land treatment, should be half median all year round – refer to Archer main evidence, Para 14.22

15.3 **Condition 3 -** Consents need to allow for the possibility of appeals, hence *"from commencement"*. The 5 year period allows for the existing ponds to be converted to land treatment area and for two wet summers during construction. Four construction seasons are required for the full scheme to be commissioned. That could be achieved in 4 years after commencement but that depends upon what time of year the consents commence. There needs to be time for the final design and tendering process. So for example if the consents commenced a few months before the start of the construction season, that season may be missed. Refer to Construction Timetable (Attachment J) which was presented on 12 March.

The scheme has been designed with a pond discharge rate of 1200 litres/sec and is not viable with a maximum pond discharge rate of 700 litres/sec, which would require a further 55,000 cubic metres of storage to be provided. Because the pond banks are nearing maximum height, the extra storage would likely be provided by increased pond area (with reduced area for irrigation). I have discussed in greater detail dilutions and discharge patterns in Section 5 of this evidence.

15.4 **Condition 4 -** There will be no treated wastewater discharged directly to Makoura Stream. Stormwater runoff from pasture will be discharged to Makoura Stream in high rainfall events, which will be difficult to measure accurately. Event durations will be recorded

15.5 **Condition 6 -** The adequacy of mixing can be checked in the long term by the monitoring at Wardell's Bridge. The applicant agrees to a one-off verification of mixing. This would require monitoring of various parameters at 300m downstream of the diffuser and comparing that to the dilution predictions in the AEE. For the reasons explained by Dr Hickey, that need

not and should not be a compliance standard. If dilution was significantly less than predicted then the operation of the diffuser could be adjusted. The review condition already takes care of potential environmental effects.

15.6 **Condition 7 -** It is less confusing to just state the compliance point. It should be 300m (the AEE describes reasonable mixing as being between 300m to 500m and nominated 400m as the point of reasonable mixing for compliance purposes, but 300m was used in assessment of effects to be conservative.).

The following sub-clauses were deleted, for these reasons;

(g) numerical standards are not proposed for in river monitoring.

(h) is addressed by condition 19

15.7 **Condition 15 -** Permanent flow measurement devices in Makoura Stream would be expensive and are not needed. Also the size to handle flood flows would prevent good accuracy at normal flows. Flow measurement is only needed at the time water quality samples are taken to determine mass loads. Hence portable velocity meters can be used to measure flows.

15.8 **Condition 16 -** The Applicant opposes the numerical limits proposed in the Officers Report and requests the Table 54 AEE values. It would not be possible to comply with a number of the WRC limits as illustrated by the trend plots in Attachment N to my evidence. I reiterate that it is not possible to reduce specific contaminants in a pond discharge as may be the case with an “in-tank” WWPT.

The Applicant opposes more stringent numerical limits, because there will be no effects in the river, noting that the AEE assumed only 20X dilution, and actual dilutions are much greater as outlined in Section 5 of this evidence. Refer to analyses in Attachment N.

Effluent standards need to apply to both land and to river, as the discharge may occur to both simultaneously. The 90/95 percentile standards are in accordance with NZ Municipal Wastewater Monitoring Guidelines and will provide better protection for receiving water quality. Rolling geometric mean compliance standards are not appropriate for receiving waters, but are useful for monitoring trends in pond performance.

It is noted that composition of the effluent will not "vary significantly". Reduction of inflow due to reduced infiltration into the sewerage system may occur, but the changes will be minor and gradual.

15.9 **Condition 17 -** Weekly measurements of DO and temperature using a portable meter, are standard practice to confirm that there is sufficient DO in the ponds. This would not be done by sending a sample to a Laboratory.

The ponds have long retention time and effluent quality variations are buffered and are gradual with time. Weekly measurement would be expensive and is not needed. All other similar pond systems in NZ, have monthly monitoring for most parameters.

15.10 **Condition 19** - Numerical nutrient limits are not appropriate for compliance enforcement of the "*not cause undesirable biological growths*" objective. Biological growths result from complex interaction of nutrient concentrations and river flows. There is no need for an instream DRP standard, however if such a standard is included, it should only apply at flows below median flow and should apply at Wardells Bridge (downstream of all of the diffuse discharges including Makoura Stream). The evidence from Dr Hickey and others is that if there is to be an in stream standard it should be 0.03 $g/m^{3.}$

The proposed "not greater than 20% increase in DRP and DIN", could not be complied with at low river flows when nutrient concentrations drop to detection limits, e.g. DRP upstream is < 0.004 g/m^3 and leachate from irrigation area is predicted to be 0.003 g/m^3 – refer to Table 39 of the AEE (page 140). The evidence from Dr Hickey and others is that such a standard is not necessary and is therefore inappropriate.

It could be made clearer that this Condition applies to when there is no direct discharge to the river.

15.11 **Condition 20 -** It will take three years for groundwater concentrations to "ramp up" and six years of annual monitoring, will be a long enough period to assess effects, with reviews at five intervals thereafter.

Clauses (b) and (c) were deleted because of excessive cost and they were not needed to monitor overall effects.

The main monitoring point should be the current monitoring point at Wardells Bridge. Monitoring at that point will detect changes from upstream

values attributable to the indirect discharges, including contribution from Makoura Stream.

There needs to be provision to reduce this monitoring once it has been verified that any effects on these parameters is minor. The condition also overlaps with conditions 14 and 23 and clarification is needed so that data gathered for Condition 20 is not additional to Condition 14. In fact, Condition 20 could be deleted or merged with 14.

15.12 **Condition 22 -** Sampling from the Bridge during a river fresh would be safe but possibly not safe at the upstream location. The sampling at 300m from the diffuser is not needed to assess overall effects and would be an unnecessary expense. The Applicant strongly opposes the 300m water quality sampling site.

15.13 **Condition 25 -** Intermediate sampling locations were deleted because downstream sampling point will determine effects, which are predicted to be minor. Provision needs to be made to reduce (or delete) this monitoring if effects are negligible, after 4 or 6 years – also applies to other Conditions.

15.14 **Condition 26 -** Deleted original (b) because difficult/impossible to measure numerically in practice, but will be practical to assess the application uniformity visually as in new (c) and (d).

For new 26(f), the minimum buffer shown on the Drawings in the AEE is 50m. This buffer distance agrees well with those issued by Environment Waikato for the Taupo DC effluent **spray** irrigation system, as set out below which is provided for information purposes. It should be noted that the Taupo effluent, which is treated by sedimentation tanks and trickling filters, is **not disinfected** and would have median faecal coliform concentrations about 500,000 cfu/100ml. The proposed ponds at Masterton will have faecal coliform (similar to E Coli) median concentrations of 300 cfu/100ml. Allowing for the fact that Masterton pond effluent will not be spray irrigated, the proposed buffer distance of 50m to property boundaries and roads at Masterton, is generous and does not need to be extended in my opinion.

The amenity separation distance of 150m in Taupo condition 7B, needs to be appreciated in the context that the Taupo effluent is not disinfected at present.

Environment Waikato presumably incorporated a range of faecal coliform values into the condition, because Taupo DC is considering the installation of UV disinfection of the effluent (which is treated by in-tank processes – not ponds), and buffer distances could be reduced if that happens.

7A *"At all times the consent holder shall maintain a specified irrigation free buffer zone from areas of sensitive development (housing, gardens, play areas, intakes to drinking water supplies and crops for human consumption). The size of the irrigation free buffer zone will be determined by the quality of the irrigated waste water determined by median faecal coliform concentrations. Buffer zone distances will apply as detailed below:*

Disinfection Standard, median values	***Buffer Zone Distance***	***With 10 m width of tree planting, >5m high***	***Roads and water courses***
No Disinfection	*150m*	*150m*	*50*
10,000 cfu/100 ml	*100m*	*75m*	*50*
1,000 cfu/100 ml	*50m*	*40m*	*30*
200 cfu/100 ml	*40m*	*30m*	*30*
25 cfu/100 ml	*20m*	*20m*	*20*

7B. *For amenity reasons a separation distance of 150 metres will be maintained between irrigation areas and existing neighbouring residences. The separation distance may be reduced with the prior written approval of both the owner and occupier of that residence or property. At no time will the amenity separation distance be less than the buffer zone distance, as detailed in Condition 7A.".*

15.15 **Condition 27 -** Deleted Officers Report (i) because not practical to measure numerically in the field and is covered by 26 (c) and (d), based on visual assessment.

15.16 **Condition 33 -** Refer Archer evidence Attachment D for proposed separation distance of 5m of the wipe-off drain from the proposed deep drain. Note revised Attachment D is included with this supplementary evidence – refer to Section 4 of this evidence.

15.17 **Conditions 36-40 and 46-18 –** These relate to groundwater and are addressed in the further Supplementary Evidence of Dr Proffitt.

15.18 **Condition 41 -** Infiltration capacity and bulk density of a disturbed soil sample will not indicate the in situ values. Thus in situ testing has been agreed for infiltration testing.

16. CONSENT WAR 090066 (27164) SLUDGE LANDFILL

16.1 **Condition 6 -** It will be difficult to distinguish between leachate from the area of the existing ponds and up gradient sources. Also leaching of contaminants from the lined sludge landfill will in my opinion be insignificant.

Therefore this condition could be deleted. The overall groundwater and river monitoring will detect if leaching of contaminants is occurring.

16.2 **Condition 7 -** Convention for sludges is the normal scientific basis where moisture is expressed as a % of oven dry weight. Therefore change "wet" to "dry". Also applies to Condition 9(b). Mr Lowe has stated that the NZ Biosolids Guidelines state "wet weight" basis but I have checked the Guidelines and all references are to DS (dry solids) or dry weight e.g. Table 4.1 and Table 7.1 of the Technical Manual. Standard Methods for Water and Wastewater Testing states dry weight basis.

17. CONSENT WAR 090066 (27166) UPGRADING OF EXISTING STOPBANKS

17.1 **Conditions 4 and 5 -** GWRC owns the stopbank and is therefore responsible for monitoring and repairs. GWRC could instruct MDC to carry out repairs if required under the normal provisions of the river scheme.

18. CONSENTS WAR 090066 (27170, 27171, 27172) DEWATERING OF EXISTING PONDS

18.1 **Condition 8 (27170) –** There is a note [specify distance downstream]. This should be the Wardells Bridge location.

18.2 **Condition 1 (27171) -** WRC Condition limit is 200 l/s but AEE Section 6.3.7, page 97 requested 500 l/s, in order to control groundwater during river floods, which is less than the existing consent maximum discharge rate of 700 l/s. Therefore effects on the Stream will be no more than at present.

18.3 **Condition 2 (27171) -** By using a geomean, the first few results will have to comply with the standard, so the intent of the condition will be achieved – i.e. to continue discharging to the Stream at a similar quality as at present.

Attachments (continuation from main evidence)

H – Gravel Borrow Area Plan (tabled 12 March and not included in 30 March version)

I – Pathogen Reductions in WSP

J – Construction Timing and Discharge Location (tabled 12 March, and not included in 30 March version)

K – Flood Events and Recovery Period after the Floods

L – Pond Discharge to River Patterns and Dilution Statistics

M – Storage Predictions for 30X, 40X and 60X Dilutions and Different River Flow Triggers

N – Effluent Quality Compliance Limits

O – Copies of Communications Regarding Health Impact Assessment

Attachment I
Pathogen Reductions in WSP

Attachment K
Flood Events and Recovery Period after the Floods

Attachment L
Pond Discharge to River Patterns and Dilution Statistics

Attachment M
Storage Predictions for 30X, 40X and 60X Dilutions and Different River Flow Triggers

Attachment N
Effluent Quality Compliance Limits

Attachment O
Copies of Communications Regarding Health Impact Assessment