KENSINGTON CONSULTING
///// Civil and Structural Engineers

18201

August 20, 2018

Dairy Green Ltd
PO Box 5003
Waikiwi
INVERCARGILL

Attention: Mr J Scandrett

Dear John

RE: WHITE WATERS LTD – 893 KAKAPO ROAD TE ANAU
MEGAPOND STRUCTURAL REVIEW

As requested we confirm that we have inspected the Megapond 1500 structure at 893 Kakapo Road, Te Anau, accompanied by yourself on the afternoon of 17th August 2018.

The purpose of the visit was to review and assess the present structural integrity of the pond structure and assess its suitability for ongoing use as on farm effluent storage.

This report forms a brief summary of our assessment and recommendations.

GENERAL BACKGROUND

The Megapond 1500 is a standardized open top storage tank from Hynds, and available in various storage capacity volumes. The construction drawings for the tank were available to review but not the actual panel construction details. The tank walls are formed from flat ribbed precast concrete panels, which are formed into a ring with an insitu poured concrete floor, with integral outer reinforced concrete ring beams at base level and another ring beam at mid height. The mid height beam is constructed after the lower half of the tank is backfilled with compacted fill to the perimeter.

The top of the wall between adjacent panels is further tied together with a high tensile galvanized steel bolt through matching holes in adjacent ribs. Each wall panel has a half round grout void down the end face both sides. Each panel when butted together then forms a cylindrical void full height of the panel wall, between panels, which is then subsequently filled with grout to form a shear key. The inside and outside edges of the joint are filled with mastic sealant to seal the tank joint. The grouted shear key also doubles as the solid backing for the interior sealant, compressing it further and providing more effective sealing when subjected to the pressure from the effluent fluid.

OBSERVATIONS

Our initial observation is that the tank is brim full rather than at a normal maximum operating level. At the time of inspection substantial rainfall had occurred in the preceding 48 hours with 23mm of rainfall recorded at a neighbouring property. There was clear liquid, presumably rainwater, ponded on top of the effluent crust and at a couple of low points in the tank wall, was weeping over the sides. The flow was insufficient to cause ponding at ground level though. (refer to photos). The tank appears to have a slight low spot to the west quadrant and was probably constructed that way. This has no effect on the structure's integrity. Many joints in the lower section of the wall were observed to be damp from minor weeping but no observable flow was

noticeable at any joint even with the excess hydraulic head presently created by the overfull pond (refer to photos).

Many of the post grouted panel to panel shear key joints exhibit vertical cracks within the grouted joint, which is a function of the high strength grout used and shrinkage as it cured. This shrinkage would most likely have occurred shortly after construction. It is considered that the rainwater could be tracking down these joints and weeping through the external mastic. During extended cold winter periods trapped water behind the outer sealant may become frozen, especially on the south side of the tank, resulting in expansion forces that could ultimately break the concrete to sealant bond and ultimately push the sealant out. The grouted joints however still continue to transfer shear with the ring beams in place but should be regrouted and the tops sealed.
The exterior mastic sealant was observed to be intact and in good condition over its full observable length. Only a small section of the internal mastic sealant was visible at the top but is assumed to have been installed correctly at the time and continues to function effectively. The tank construction was independently overviewed and a construction producer statement PS4 issued for the tank by OPUS Consultants verifying to that effect.

These joints will continue to function as intended if the mid height ring beam and top tie bolt remain effective.

Our observation of each and every panel showed that only one panel rib had a fine hairline shrinkage crack at the top corner near the tie bolt. No other visible cracking was observed elsewhere either around these top tie bolts at the supporting ribs or anywhere within the flat panel areas of the other panels. (refer appended photos).
These areas around the top bolts are the most vulnerable highly stressed areas and the absence of any observed open movement type cracking would indicate that the concrete has not been overstressed and continues to function as designed.
Shrinkage cracking was observed in the ground level ring beam generally at each of the smaller intermediate ribs where these would tend to initiate cracking. (refer to attached photos). This form of cracking is to be expected in a small beam cross-section, which is lightly reinforced and most probably poured as a continuous pour during construction. The ground level ring beam has settled slightly also as the perimeter external fill has consolidated slightly over time, which could have also contributed to these observed cracks. Structurally, this is not considered detrimental to the tanks performance at this time provided the fill level remains consolidated at its present level. Controlling the site drainage around the tank would therefore be beneficial to prevent the fill material being saturated then drying out during drier weather, creating a possible shrink / swell effect that could cause further settlement.
On the day of the inspection standing water was present in the low depression behind the tank and bank beyond. Field drainage also appeared to be draining into this area.
Creating a drainage swale around the tank perimeter at the toe of the excavated bank and directed downslope would be very beneficial in maintaining drier fill. Saturated fill to the perimeter of the tank while being emptied could also impose significant loads to the walls and the floor of the tank.

CONCLUSIONS

As a result of our inspection and the observations made at the time, we would conclude that the ponds structural elements all appear to be in good condition, with no visible signs of distress noted.

We would therefore conclude that the tank can remain in service and would strongly recommend a maintenance review of the joints is undertaken at the earliest opportunity as outlined more fully below and that regular inspections are maintained.

The ribbed precast tank walls are a very robust design and it is unlikely that any catastrophic failure would occur in these wall elements. Loss of the top tie bolt would simply see the panels effectively cantilever above the ground level ring beam. As a result, the top section of the joints

may open very slightly allowing some controlled release of effluent but it is likely to be very minor. Any discharge would likely occur only in the upper region of the joint and this is dependent on both the effluent level at the time creating sufficient hydraulic pressure and failure of the mastic sealant on both sides which may bridge any slightly increased joint width.
More than half the tank's depth is buried below ground so none of this lower effluent would be released.
The construction documents state that the tank has been designed for a seismic hazard factor Z based on the Te Anau region which is appropriate.

RECOMMENDATIONS

We would however, recommend that the condition of the minor weeping of the joints is assessed further and any remedial maintenance work undertaken. The pond level initially should be pumped down to the normal operating level and the joints all inspected for any further weeping. These inspections should be undertaken during a dry period and then also after a period of rain to assess where any weeping may be initiated from i.e. from the interior joint or simply from water entering through the vertical cracks in the grout of the panel to panel shear key. It is suspected that many of the weeping areas will likely cease with the reduced hydraulic gradient. It is unknown what the likely permeability of the particular mastic sealant is under an elevated hydraulic head. The storage level should be reduced further to the minimum and all the interior joints inspected for any damage and remedial work undertaken as necessary. Again, the inspections should be during a dry period and also after rain. To achieve a long term service life from the pond we would also recommend that the top of the panel to panel grout joints are fully cleaned out and further grouted with a highly fluid grout. This will seal the present cracks and also those voids that are not completely full to the walls top surface.

We have summarized below our recommendations and possible time frames for their implementation as follows:

1) The drainage swale around the pond should be established to improve drainage within the next six months.

2) The external panel joint mastic should be inspected for weeping before rain and after rain when the pond is next pumped down to normal freeboard levels.

3) Within the next 12 months the pond level should be lowered as much as practical and the internal mastic checked for continuity and soundness.

4) Within the next 6 months after the summer months and before the next winter period, seal the shrinkage cracks in the grout key and surface depressions with a highly fluid grout.

We trust this brief summary report is suitable for your reporting needs.

Yours faithfully
KENSINGTON CONSULTING

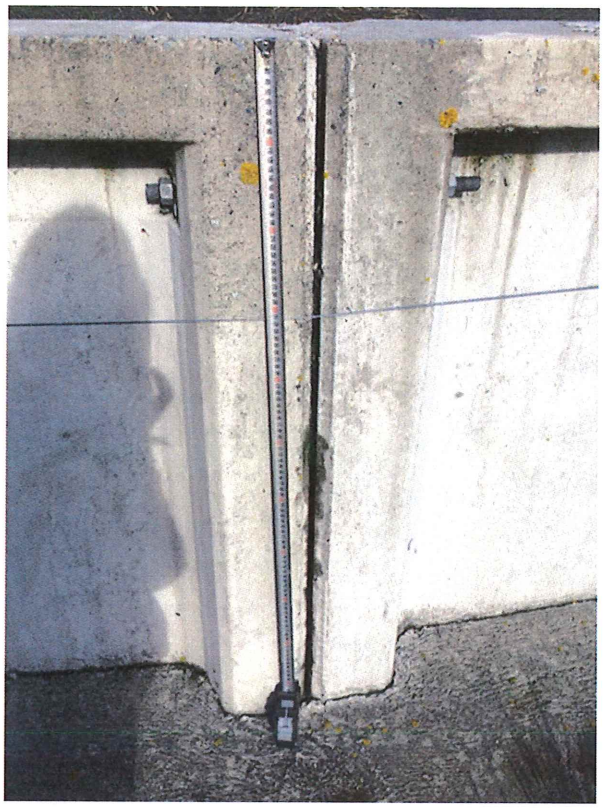
Darryl Kensington
BE, CMEngNZ, CPEng(civil, structural), Int PE(NZ)

Director

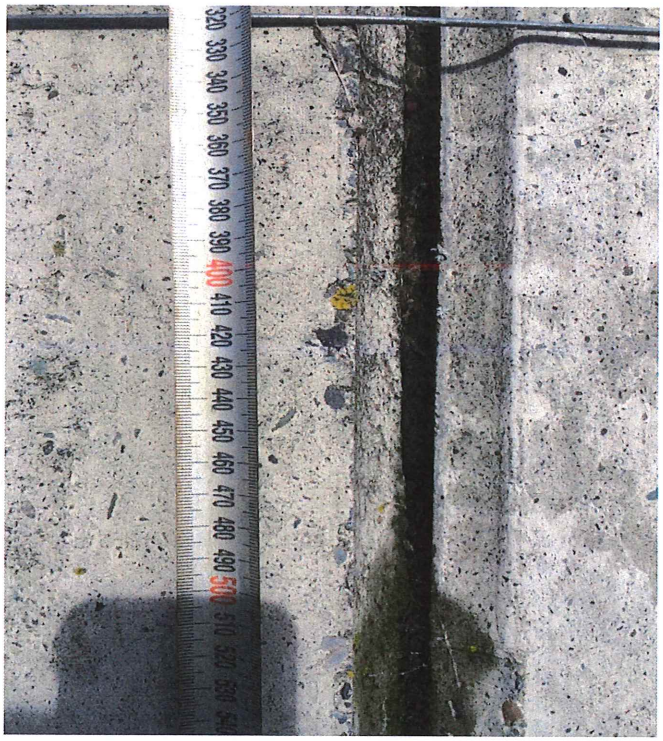
Encl: photos

View of typical pond construction pond looking towards South East

Similar view looking towards the North west

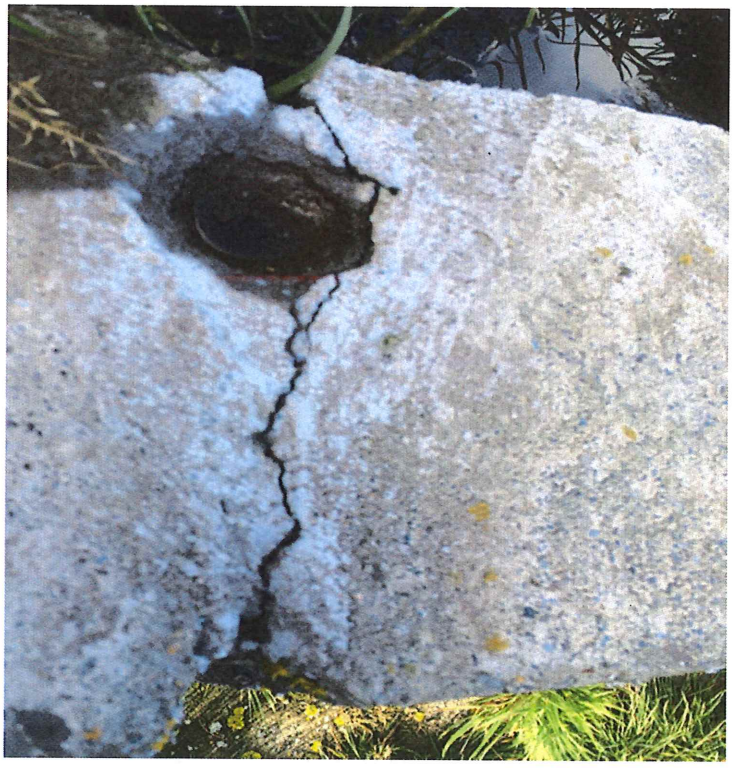


View showing typical level of damp concrete below the top level observed in a few locations. Minor diagonal shrinkage crack in top right hand pier - only cracking observed



Closeup view of level of damp concrete below top of pond.

Typical overflow down joint from overfull pond at low side of the pond. Grout infill and sealant are all in good condition.



View of shrinkage crack in grout through top of the panel and low level of grout in shear key. Several areas like this noted, which require cleaned out and additional grout.

External view of previous top joint showing sealant in good condition and minor damp concrete at the lower level.

Typical view of ground level ring beam and close up view in RH photo of typical shrinkage crack initiated at smaller centre panel rib.