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7 February 2017

Attention: Bridget O'Brien

Dear Bridget

Akaroa Wastewater Project – Report on Thacker Property Inspection

Please find set out below our report of an initial walkover of the 114ha Thacker property in Robinsons Bay on Wednesday 25th of January 2017.

1 Introduction

Christchurch City Council and Mr Thacker are in discussions over the potential purchase of the Thacker property in Robinsons Bay for use as a wastewater irrigation area, as part of the Akaroa Wastewater Scheme. CH2M Beca was requested by the Council to conduct an investigation into the feasibility of using this land for irrigation of trees using drip irrigation.

A site walkover inspection of the property was undertaken with Messrs Luis Thacker, Greg Offer, Richard Young, and Steve Christensen from CH2M Beca, and Andrew Brough from PDP on 25 January 2017. The weather was overcast and warm. The NIWA electronic weather station at Akaroa recorded 105mm of rainfall between the 1st and 24th of January 2017 and the local hills were unusually green for the time of year.

The inspection started from Sawmill Road, near to the Robinson Bay Valley Stream and traversed around the property in an anti-clockwise direction. The purpose of the visit was to directly witness landforms, waterways, vegetation and soils of the farm and assess the placement and operation of an irrigation network and potential pond storage sites.

Following the site inspection a draft of the potential irrigable area and potential pond storage locations has been developed. This is provided in Appendix A. The plan employs a number of criteria for selecting potentially irrigable land, and for section of potential storage pond sites. These are set out in Tables 1 and 2 overleaf.

Table 1: Selection Criteria for Land Suitable for Dripper Irrigation

Selection Criteria	Dripper irrigation option	Basis for Criteria Selection
Land Stability	- Irrigation area less than 19 degrees slope and land below the site to coastline at 15 degrees or less - No identified instability within or downhill of area - Account for downslope residences and infrastructure	To minimise risk of land instability resulting from irrigation. Based on irrigation to trees which allows a steeper grade than for pasture (19 degrees instead of 15 degrees)
Residential setback	5m buffer zone around the Thacker property boundary	To provide a suitable exclusion zone around rural residences
Stream setback	25m to centreline of permanently flow streams 10m to centreline of ephemeral streams	To minimise the potential for nutrients in irrigated wastewater to migrate through shallow groundwater into surface water courses.

Table 2 – Selection Criteria for Storage Pond Sites

Factor	Criteria	Basis for Criteria Selection
Waterways	Exclude 25m buffer on either side to centreline of permanent watercourses	To avoid impinging on stream floodplains and to reduce risks of storage pond embankment erosion due to flooding
Road	Exclude 25m buffer on either side to centreline of road	To provide protection against visual impacts from a storage pond which may incorporate above ground embankments.
Residential Dwelling	Exclude 100m buffer around residential dwellings	Odour risks associated with the pond operation are considered to be low based on initial assessment (provided in separate report). The 100m buffer is proposed to minimise any potential nuisance effects from the pond including noise from an aeration bubble curtain compressor and potential for midge populations.
Elevation	Exclude consideration of land above 200m (with specific exceptions shown)	Pumping treated wastewater to a pond located above 200m would be comparatively costly. Pond construction costs above 200m are also likely to be higher due to the limited depth of loess and higher risk of encountering rock at shallow excavation depth.
Planning	Included all planning overlays including Silent File Areas	To take into account land planning status and other protections in the selection of potential pond sites
Property boundaries	Include property boundaries	To understand where pond sites cross property boundaries and how many land parcels would be involved in a given scheme configuration.
Land slope	Exclude land greater than 4 degrees slope	Land greater than 4 degrees slope requires more extensive groundworks resulting in higher costs

The criteria selected are specific to the circumstances of the Thacker site and for this reason are not necessarily exactly the same as the initial site screening criteria which apply to a range of different site types and irrigation methods, and to both tree and pasture options.

2 Site Observations

2.1 Irrigation Observations

The walkover showed that the lower slopes (up to approximately the 200m contour) were characterised by gentle slopes and ridge lines separated by gullies. Two of these gullies carry water in winter but are normally dry over summer. The ground cover observed was a mixed sward of grass over the ridge lines with kanuka (predominantly), manuka and other natives in the gullies. There is a mature stand of oak trees occupying about 1.5 hectares centrally located in this area which has been fenced off from stock approximately 4 years ago. An understorey of native species is starting to develop.

Closer to the Robinsons Bay Valley Stream there are flatter areas with large volcanic rocks on the surface which originated from the hill slopes above. These are situated around 1m above the stream bed. The ridge lines are generally situated from 20 to 24m above the stream bed.

Above the 200m contour the landform is steeper with variable slopes (steep faces with flatter areas beneath). Smaller local features are indicative of rain or seismically induced shallow landslips indicating the potential for there to be slips if irrigation was to occur.

On the lower slopes the near surface soils appear to be a loess based clayey silt which was light brown in colour. Mr Thacker indicated there were two surface soil types including one that dried out more quickly than the other. On the upper slopes the soils appear to be a darker brown and have a nutty texture based on cuttings observed. There are a number of springs (either seasonal or permanent) evident on these upper slopes.

On one cutting close to the base of the upper slope a low permeability soil layer (fragipan) was clearly visible several hundred millimetres below the ground surface. This extended towards the base of the visible cutting (a further 0.5m approx.). The depth to this layer and the visible depth of the fragipan layer at that location are unlikely to be modified by deep ripping. The fragipan layer will inhibit vertical flow to groundwater. This would need to be taken into account in the assessment of year round irrigation potential.

Based on the observations the land below the 200m contour appears to be suitable for irrigation with appropriate buffer separation to streams and the gullies, subject to confirmation of its technical suitability on other grounds. It is recommended that field investigations are concentrated on these lower slopes to confirm the irrigation feasibility.

During the initial investigations of the Robinsons Bay area in September 2016 one test pit, two bore holes (adjacent to each other) and three infiltration tests (both surface and subsurface) were carried out on the Thacker land. The infiltration rates that were measured on loess based material were 15 and 44mm/hr on the surface and 4 and 11mm/hr in the subsurface material, while the test adjacent to the bore holes (which are close to stream) were 2mm/hr and 229mm/hr respectively. At this initial stage, the soils on the land adjacent to the stream are considered unsuitable for irrigation due to the potential for higher permeability pathways. Further investigations on these soils may be warranted depending on the outcome of investigations of other more favourable land within the property. The other infiltration rates are typical of those observed previously in loess based material. However the locations of those tests do not give a good representation of the potential range of conditions, based on observations during the site walkover.

It is recommended that to characterise the soil and sub-soil conditions on the property (and particularly on the land below the 200m contour) that test pits are dug and further infiltration testing be carried out (subject to what is observed in the test pits). The test pits should be excavated to a depth of at least 4m to ascertain

the presence and depth of any low permeability layer that might be present. Based on the site visit around 10 further test pits are recommended along with further infiltration testing possibly at 2 to 3 sites. Also hand auger holes should be carried out around the test pits to assess any variability in the soil conditions between the test pits. In particular if fragipan layers are observed in the test pits the extent of these layers will need to be determined to assess the overall irrigation potential of the site.

Given the height of the land potentially suitable for irrigation above the stream no further bore hole installations are recommended. However if groundwater is encountered in a test pit then consideration should be made to installing a monitoring bore at that location.

2.2 Geotechnical Observations

The general published geology of the area comprises Quaternary loess, loess colluvium/ fans and alluvium overlying the Akaroa Volcanic Group. Typically the loess is thinner higher on the slopes, thickening with decreasing elevation, although the depth is likely to vary based on the underlying bedrock profile. Loess colluvium/fans are composed of reworked loess and miscellaneous pieces of bedrock that have accumulated on the lower slopes as a result of various gravity induced geological processes. The alluvium is expected to be limited to the valley bottoms.

Generally on the lower elevation slopes the land surface is undulating with little or no evidence of instability away from the steeper gullies. There is evidence of shallow instability and/or erosion locally on the gully boundaries and next to the banks of Robinsons Bay Valley Stream. The surface expression of these features indicates shallow translational movement, typically in the range of 1m to 2m, occurring where the slopes/banks have been over-steepened. The movement is limited to the loess and loess colluvium/fans, except adjacent to the main creek, where they occur in the alluvium. Based on visual observations it appears that the loess or loess colluvium/fans are less stable than the alluvium.

On the mid-slopes, typically of elevations between approximately 100m and 200m above sea level (ASL), the ground rises and the inclination of the slopes increases. In the gully areas the ground surface is often hummocky (indicative of ground movement), with this being particularly noticeable towards the eastern boundary of the Thacker property.

On the higher slopes, above an approximate elevation of 200m ASL there is evidence that the bedrock is at shallow depth, being exposed on some of the steeper slopes. The flatter areas, between the steeper slopes, suggest terraces or other geological features within the bedrock influencing the surface morphology. The scale of these features are not expected to relate to deep seated instability. However where the surficial soils are thicker, typically in the gully areas, there is evidence of shallow ground movement and locally there is evidence of debris flows.

A number of seeps and springs were noted across the area which are expected to be controlled by the hydrogeology of the bedrock.

A preliminary assessment is that the increased risk of instability caused by irrigation of preferred areas within the site is low. This is based on applying dripper irrigation to the lower areas and mid-areas as shown in Appendix A, where the application is set back from steeper features such as gullies and away from hummocky ground above steeper slopes.

2.3 Pond Storage Observations

The Appendix A plan shows pond sites viewed during the walkover. The selected sites all conform to the proposed minimum dwelling buffer distance of 100m[1]. A commentary on the visual observations and recommendations of these potential pond sites is set out below.

The volume of storage required for the pond system has been previously reported at around 12,000m^3. However, based on further assessment work by PDP it is recommended to increase the pond storage to 17,500m^3 to provide a more conservative irrigation application rate, and to include for a base storage volume of 2,500 m^3 to maintain resident biomass in the pond. The storage volume remains indicative at this stage and can only be confirmed accurately once the irrigation area has been identified in terms of specific land parcels and the infiltration characteristics of these areas has been fully investigated.

Assuming a pond water depth of 3.0m and a based storage depth of 0.5m then an active storage of 2.5m would be provided. A total water depth of 3m is considered well suited to meeting the storage requirement while also assisting to maintain the pond dissolved oxygen levels to full depth. Based on this depth, for an active storage volume of 17,500m^3, a rectangular pond would need to be around 90m in length and width at its wetted perimeter, with a water surface area of 8,100m^2. Detailed investigations and design will be required to better define these figures.

In the comments below, the visual amenity of any particular site is not discussed in detail and this aspect requires further assessment.

Site Thacker 1 (T1): Elevation 40m

This site is the one of the more favourable viewed on the property. Although it is not flat, which would assist with optimising the earthworks required for the pond, it is relatively gently sloping and falls around 8m down the slope (over a distance of 130m). Depending on the pond volume required and the depth to bedrock, it is possible that one, two or three ponds would contain the necessary volume (multiple ponds cascading down the hill). The geomorphology of the site indicates that the landform is relatively stable with limited to no stability issues.

At this location there appears to be thick deposits of loess as witnessed in adjacent stream cuttings. Provided that there are many meters of loess at this location, the loess could be used in a cut and fill process to form the structural foundation of a lined pond system. If the volcanic bedrock was present at relatively shallow depths then this would make the pond location more problematic and lead to higher construction costs and potentially a greater cumulative pond area. An alternative would be to have the pond site on the slope and use nearby borrow soil to form the pond. This option would likely be more visually intrusive. The site has an upstream catchment, so the stormwater would need to be diverted in a shallow swale around the pond site.

[1] A minimum buffer distance to any dwelling of 100m is proposed. Refer to Table 2. This is based on an assessed pond wastewater BOD in the range from 5 – 9 mg/l and water depth of 3m. Odour risks associated with the pond operation under these operating conditions have been initially assessed as low. A separate letter report on this topic is in preparation. The 100m buffer is proposed to minimise potential nuisance effects from the pond including noise from an aeration bubble curtain compressor, and potential for midge populations.

For a conceptual design the depth and nature of the soils above the bedrock should be investigated to determine if at least four meters of soil exists at this location. Furthermore, if groundwater is intercepted, then this should be recorded and monitored.

Sites Thacker 2 (T2): Elevation 140m

This site is located at the top of a gully and immediately below site T3. It could be developed as a dam positioned across the upper gully in order to minimise the earthworks required. The site has limited upstream stormwater catchment and small diversion swales could divert water around them. Site T2 has a problem in relation to the proximity to the adjacent trees which can be hazardous for pond systems (either if they were to fall in a wind storm or their roots hunt out the water source). Along with Site T3, the soils at this location should be investigated as an alternative to Site T1.

Site Thacker 3 (T3): Elevation 150m

This site is situated on a knoll at the head of the main irrigation area, directly adjacent to the property to the south. The neighbouring property has mature eucalypt and other exotic trees directly on the boundary, which is not favourable for the positioning of a storage pond. Notwithstanding this, the site is relatively flat over a wide area. The site has virtually no upstream catchment and consequently limited stormwater issues. There is no indication of the depth of loess at this location, but is expected to be favourable for the construction of a single shallow pond. It is noted that this site is at an elevation of 150m, which is around 40m higher that the wastewater treatment plant site at Akaroa. Consequently, this site and higher ones would require pumping from the plant to fill the pond (whereas lower pond systems may be feed by gravity flow from the treatment plant, but would then need to be pumped up the irrigation fields). The soils at this site should be understood in order to provide an alternative to Site T1.

Site Thacker 4 (T4): Elevation 220m

This is a relatively small site and may only be of use for a distributed pond system. No investigations are required at this stage for this site.

Site Thacker 5 (T5): Elevation 206m

The land directly to the north of this site is reported to be continuously wet in the winter. Given the hummocky nature of this area, and its wet nature the area is not likely to be used for irrigation. Nonetheless the ridge to the northwest is more favourable as a possible irrigation area, hence this site may be of some use in a distributed pond system. The geomorphology of the area is uncertain and would require detailed examination to the determine stability of the site. No investigations are required at this stage for this site.

Site Thacker 6 (T6): Elevation 314m

This site is a relatively flat, large, amphitheatre like area at the top of the property. The site is very steep both upslope and downslope. Upslope of the site, and within it, there are areas of active rock sliding. Much of the floor of the amphitheatre is covered in rock. Interestingly from a geomorphology perspective there is no obvious rock accumulation on the floor of the amphitheatre (it may have been used as a rock quarry?). It is unlikely that there are suitable soils for the construction of a pond at this location and soils would need to be hauled upslope to this location to create a pond. While possible to build a pond here, rock fall issues would need to be addressed and cartage costs for fill from downslope are likely to be prohibitive. No investigations are required at this stage for this site.

Site Thacker 7 (T7): Elevation 316m

This is a large site in a transition zone between a steep ridge above and hummocky land below to the northwest. It is a long thin site that contours around the slope directly adjacent to the property boundary. This site is likely to be underlain by a thin layer of volcanic colluvium based on the small cuttings observed. Rock fall appears to be relatively limited in this area. The location on the property is not suitable for the irrigation system which is likely to be situated on the lower slopes. No investigations are required at this stage for this site.

3 Recommendation for Physical Investigations

Recommended initial physical investigations are as follows:

- 12 test pits to 4m depth minimum at locations shown on the layout plant in Appendix A
- A smaller number of infiltration tests at selected areas
- Hand augers to 1.8m depth at intermediate sites between the test pits

4 Initial Conclusions

The 114ha Thacker property in Robinsons Bay offers a number of favourable features for wastewater application including a large area, suitable land slopes, and potentially suitable areas for wastewater irrigation and pond storage. Further work is required to assess soil suitability and characteristics in order to develop a concept scheme for the site and to confirm the overall feasibility.

Physical testing of land based on 12 test pits and 4 infiltration tests was conducted on 1st – 3rd of February. The results from this testing have not yet been obtained.

Yours faithfully
Greg Offer
Project Director

on behalf of
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Legend

- Stage 1 Bore Hole Locations
- Stage 1 Test Locations
- Proposed Stage 2 Test Locations
- Potential Pond Sites
- Approximate boundary of preferred area with slope generally < 19 (30.71 ha)
- Approximate boundary of less preferred area with slope generally < 19 (1.49 ha)
- Thacker Property
- River 25m Buffer
- Stream 10m Buffer
- 200m Contour

Slope 0º - 19º (62 ha)

- < 15º
- 15º - 19º

Note: Discharge Area Calculated using 15m LINZ DEM
Building Footprints used from LINZ Topo 50, 2005

Kingstons Hill
Robinsons Bay Valley Road
Sawmill Road
Christchurch Akaroa Road

T1 T2 T3 T4 T5 T6 T7

File: \\Beca.net\projects\6517986\TGI\01 Map\6517986-20-31_AkaroaNewWWTP_ThackerProperty_DripperIrrigation_10.3.mxd Author: Date: 17/02/2017

Map Scale @ A3: 1:8,000
0 80 160 320
Metres

1 Ha @ 1:10,000

N

Revision	Author	Verified	Approved	Date
4	BDJ	JAF2	GO	17/02/2017
3	BDJ	DRAFT	DRAFT	31/01/2017
2	BDJ	DRAFT	DRAFT	27/01/2017
1	BDJ	DRAFT	DRAFT	09/01/2017

Title: **Thacker Property, 11 Sawmill Rd, Robinsons Bay**
Preliminary Assessment of Irrigable Areas and Provisional Test Pit Locations

Client: **Christchurch City Council**

Project: **Akaroa Wastewater Upgrade**

CH2M Beca

Discipline: **GIS**

Drawing No: **GIS-6517986-20-31**