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PATTLE DELAMORE PARTNERS LTD

# Blue Sky Meats Groundwater Take Consent Application: Technical Assessment of Environmental Effects

Blue Sky Meats Limited

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# Blue Sky Meats Groundwater Take Consent Application: Technical Assessment of Environmental Effects

Prepared for

Blue Sky Meats Limited

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# Quality Control Sheet

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## 1.0 Introduction

Pattle Delamore Partners Limited (PDP) has been engaged by Blue Sky Meats (the applicant) to prepare a technical assessment of effects (AEE) to support an application for a new consent to replace an existing resource consent to take groundwater.

The existing water permit 201190-V1 allows the take and use of groundwater "for a meat processing plant and a rendering and blood drying plant" at Morton Mains (the plant, Appendix A, Figure 1). No changes are proposed to the activity with the exception that Blue Sky Meats is proposing a change to allow an increase in the maximum abstraction rate from 1,200 cubic metres to 1,500 cubic metres per day. Consent 201190-V1 also currently specifies a weekly limit of 7,000 cubic metres. No change to this weekly volume is being sought. This will ensure that, whilst daily abstractions may be larger than previously consented, the environmental effect of the take will remain within the envelope of the existing consent.

This technical report has been prepared to support the consent application and provides a description of the proposal, the existing environment, pumping test information and assessments of any actual or potential effects that the activity may have on the environment.

## 2.0 The Existing Take and Details of the Proposed Take

The current consent 201190-V1 sets out the maximum daily and weekly rates of the water take in Condition 3. A copy of consent 201190-V1 is included in Appendix B. Condition 3 of that consent currently states:

3. *The rate of abstraction shall not exceed:*

   *(a) 1,200,000 litres per day; and*

   *(b) 7,000,000 litres per week.*

In seeking a new consent, Blue Sky Meats proposes to allow a greater daily take limit (up to 1,500,000 litres per day, without altering the weekly rate of abstraction). A suitable limit condition would read as follows:

3. *The rate of abstraction shall not exceed:*

   *(a) 1,500,000 litres per day; and*

   *(b) 7,000,000 litres per week.*

This change would allow an additional 300,000 litres per day to be taken to meet peaks in processing demand. The inclusion of the same weekly total ensures that the increased take on some days is offset by a reduced take during the same week, and therefore that the longer-term sustainability of the water resource is maintained.

# 3.0 The Existing Environment

Establishing the existing environment is important because it sets up the baseline from which actual and potential effects of allowing the activity are assessed. In this case, and in accordance with accepted practice, the environment includes the effects of any consented activities (but not those that are set to expire, such as this consent) and the effects of any activity permitted by a Regional Plan.

## 3.1 Existing Takes – This Take

Under Resource Consent No. 201190-V1 Blue Sky Meats is authorised to take water from three bores F46/0517, F46/0561 and F46/1128 for use at the plant. Historically water was also taken from bore F46/0518 (now decommissioned as of 23 November 2017).

The current consent was issued on 23 May 2003 and will expire on 31 December 2022. Under this consent the take is restricted to a combined daily volume not exceeding 1,200 cubic metres per day. The consent was varied on 11 May 2021 to increase the daily volume from 1,000 to 1,200 cubic metres per day.

The volume of water taken and used at the site is variable. Available water usage data between June 2018 through to February 2021 is presented in Appendix A, Figure 3A. This shows the recorded total daily water use occasionally peaked over the previous 1,000 $m^3$ daily limit while the moving weekly average daily use appears to have fluctuated around half of that daily limit.

Peak daily usage is anticipated to reach up to 1,500 $m^3$/d with further development at the site. However, the total weekly abstraction is expected to remain at not more than 7,000 $m^3$ per week.

The current abstraction bores and historic abstraction bores are detailed in Table 1. Their locations and the immediate surroundings are shown in Appendix A, Figure 2. Driller's logs for the bores and further information relevant to the historically used bores and the aquifer test conducted in 2002 are presented in Appendix C.

Further information presented in the report on the original aquifer pump test report (Appendix C) describes the static water levels for the original two wells during the plant shutdown in 2000. Although the aquifer test report also notes natural static groundwater levels rose by about 4.5 m between 2000 and 2002, the static water level recorded in the most recent bore F46/1128 in 2018 suggests static water levels have returned and/or fluctuate around 26 m bgl.

Figures 3A and 3B in Appendix A show usage and groundwater level data that suggest the three currently used bores have experienced higher static groundwater levels during plant shutdown in 2019 and 2020 compared to the static groundwater levels observed during the plant shutdown in 2000.

Well F46/0561 and a smaller-diameter test-borehole for the well F46/0517 were originally drilled to deeper investigation depths (about 137 m bgl and 160 m bgl respectively) though confining strata underlying the targeted confined aquifer zone (gravelly strata between about 115 and 121 m depth) and then collapsed back to the well depths shown below in Table 1.

According to the borelogs for the applicant's wells (Appendix C), the current abstraction bores are screened within the same zone of gravelly strata (a deep aquifer within the Middle Gore Lignite Measures comprised of a sequence of gravelly strata between about 115 and 121 m depth) screened by the original production bores.

**Table 1: Bore Details**

| Bore | Status | Well Depth (m bgl) | Screened Interval (m bgl) | Static Water Level (m bgl) | Diameter (mm) | NZTM Coordinates | Year Drilled |
|---|---|---|---|---|---|---|---|
| F46/0561 | Currently Used | 118 | 115 to 118 | 29 | 150 | 1264667, 4857892 | 2003 |
| F46/1128 | Currently Used | 118 | 115 to 118 | 26 | 150 | 1264792, 4857972 | 2018 |
| F46/0517 | Currently Used | 119 | 116 to 119 | 26 | 150 | 1264805, 4857902 | 1987 |
| F46/0518 | Decommissioned | 119 | 116 to 119 | 27 | 150 | 1264771, 4857957 | 1987 |

## 3.2 Existing Water Takes – Other Takes

The ES database provides information for 29 bores within a 2 km radius of the Blue Sky Meats bores. Twelve of the 29 bores are recorded as 'drilled' (likely exist and not abandoned), and five are recorded as 'proposed' (but have been drilled since ES was last updated) including:

- Domestic supply – 3 bores;
- Stock supply – 1 bore;
- Dairy use – 5 bores; and
- Groundwater Quality Monitoring – 8 bores.

The initial standing water level recorded in these bores varies from approximately 2 m to 14 m bgl, which reflects the difference between the water table depth in the unconfined aquifer and the deeper static water levels/pressures within strata confined within the Gore Lignite Measures.

The 12 to 14 m deep static water levels in the 60 to 64 m deep wells to the south of the site (Appendix A, Figure 5) indicate there is potentially another (separate and shallower) layer or lenses of permeable strata interbedded within the Gore Lignite Measures to the south of the site with intermediate static water levels (between the shallow unconfined system and the deeper aquifer targeted by the applicant's bores). This further suggests a downward vertical gradient transitioning to the deep system pressures and a degree of hydraulic separation from the aquifer the applicant currently utilises.

One of the neighbouring bores within 2 km of the applicant's bores (F46/0563) could be screened within the same confined aquifer strata based on its depth, however no static water level is recorded on the ES database for this bore. This recently permitted (2018) abstraction well (133 m total drilled depth about 2 km southeast of the applicant's bores – Figure 4) does not have a geologic log or screened interval data according to information provided by ES. Given the total 133 m drilled depth of this bore, it is probable that it was drilled in a similar manner to the applicant's bore F46/0561 (drilled in 2003 to 137 m investigation depth) and is screened within the same confined gravelly strata as the applicant's bores. In this report the lower static water levels in bores F46/0561 and F46/1128 have been applied to this neighbouring bore since it is a similar depth.

The other neighbouring bores are shallower (between 11 and 64 m depth) and are interpreted to be separated from the applicant's abstraction bores and targeted aquifer zone by about 51 m to 104 m of bulk aquitard thickness. The groundwater bores within a 2 km radius of the three current bores are presented with details from the ES database in Appendix A, Figure 5. This includes a number of shallow monitoring bores for groundwater quality monitoring (GQM) that Blue Sky Meats has recently installed.

## 3.3 Wider Geological And Hydrogeological Setting

The site is underlain by a shallow unconfined aquifer classified as the Waihopai Groundwater Management Zone and a deeper confined aquifer (interbedded at depth within the Gore Lignite Measures) where the abstraction bores are screened. The shallow aquifer system across the site is up to approximately 10 m thick and comprised of sandy gravels within a matrix of weathered clay. The deeper confined aquifer, utilised by the current and original abstraction bores, consists of a sequence of gravelly strata between about 115 and 121 m depth, overlain by a 105 m thick aquitard at the bore locations. This aquitard is comprised of a sequence of silty/clayey strata up to the base of the unconfined aquifer zone. The currently used bores are screened in the same deep aquifer zone used by the original production bores. The original bores were drilled in 1987 with a 24-hour aquifer test conducted in 2002 (Appendix C).

The lateral extent of the Middle Gore Lignite Measures and the confined aquifer targeted by the applicant's bores and neighbouring bores greater than 100 m depth perpendicular to the interpreted southwestern groundwater flow direction could be interpreted to range from about 6.5 km to 10.5 km in the vicinity of the site according to the mapped extent (Figure 4). A deeper bore (F46/0313, 250 m deep) to the northeast of the site within the upgradient area of the Middle Gore Lignite Measures (Figure 4) is possibly targeting a deeper, separate, confined aquifer, however there is no geologic log or screened depth information available from ES to support this. The deep confined aquifer from which the applicant's bores abstract groundwater is interpreted to be locally recharged primarily through lateral groundwater inputs sourced from rainfall infiltrating to deep strata (primarily upgradient and northeast of the site), however, there is expected to also be a component of vertical recharge via slow leakage through the 105 m bulk thickness of the aquitard at the site. Potential slow vertical leakage through the aquitard at the site is interpreted to occur as a result of the natural static water levels in the confined aquifer (Figure 3B, Appendix A) being lower than the water table within the overlying unconfined aquifer zone.

According to the Geology of the Murihiku Area (Turnbull and Allibone, 2003; 1:250,000 scale) the unconfined strata near the land surface across and around the site are Middle Pleistocene (Quaternary) river deposits comprised of gravel, sand, silt, and clay. A review of borelogs in the vicinity of the Morton Mains site appears to corroborate this and further indicates the shallow unconfined aquifer system exists within around a 10 m thickness of claybound gravels in and around the vicinity of the site. The borelogs show that deeper lenses of sandy and gravelly strata below the unconfined aquifer zone are interbedded within thick sequences of siltstone/mudstone (sometimes described as non-cemented clay, silt, or pug) and other fine grained/low permeability strata such as lignite that occur at variable depths and thicknesses.

The unconfined aquifer is described by ES to be low-yielding and up to approximately 30 m thick while a review of borelogs at and around the applicant's land use areas suggest it is around 10 m thick in the site vicinity. The unconfined aquifer is comprised of poorly sorted gravels in a matrix of weathered clay and is incised by surface waterways across the groundwater management zone.

Sheet QM418 (Bluff) of the Geological Resource Map of New Zealand (Lindqvist et al., 1994) describes the groundwater yield of the underlying Quaternary fluvial/alluvial gravel, sand and silt deposits of the unconfined aquifer as uncertain. Discrete coarse gravel strata and channels with poorly sorted gravels and a sand, silt and clay matrix are noted to have yielded sufficient water for irrigation, but there is no certainty in the occurrence of these aquifers. Other strata may have a yield sufficient only for domestic and stock supplies.

According to the ES Waihopai Groundwater Management Zone information factsheet, the Waihopai groundwater zone generally follows the boundary of the Waihopai River catchment bounded by the Makarewa River catchment to the north, and by the coast to the south. ES has interpreted that surface waterways incised into the unconfined aquifer zone generally gain from shallow groundwater inputs across their reaches. Surface water modelling available through NIWA shows 1 in 5 year low flows in the Waihopai River and its tributaries increasing in the downstream direction towards the southeast across the catchment.

### 3.4 Surface Water Environment

In regard to the nearby surface water environment, the current bores are located in the middle of the Waihopai River surface water catchment about 3.3 km southeast of the mainstem of the Waihopai River and within about 5 m of a channelised section of a first-order tributary to the Waihopai River (Figure 2, Appendix A). According to analyses by NIWA (NZ River Maps), the Waihopai River tributary adjacent to the applicant's bore has a simulated 1 in 5 year low flow of 2.99 L/s (median flow simulated at about 19.86 L/s). This suggests that this reach of the tributary is permanently flowing due to shallow groundwater contributions. This appears to align with the interpreted hydrogeologic setting, where the shallow unconfined aquifer system exhibits a relatively shallow water table and discharges to the surface waterways that incise the land within and around the site vicinity. The potential degree of hydraulic connection between the confined aquifer strata targeted by the applicant's bores and the overlying unconfined aquifer system/connected stream is further explored and analysed in the following assessment of effects in Section 3 of this report.

The closest regionally significant wetland to the site is Spurhead Swamp about 8.2 km northeast of the applicant's bores. This swamp is in a separate surface water sub-catchment of the Waihopai River (within the upstream headwaters of the Waihopai River mainstem catchment).

## 4.0 Assessment of Potential Effects

### 4.1 Scope of Potential Effects

The following effects assessments have been carried out and are summarised in this section of the report:

- Effects on the groundwater resource
- Effects on neighbouring bores
- Effects on surface water
- Cumulative effects on groundwater and surface water resources
- Positive effects of the proposal

- Other effects (including aquifer stability, seawater intrusion and water quality)

The key assessments related to this application are the potential effects on neighbouring bores, and on groundwater/surface water resources.

## 4.2 Effects on the Groundwater Resource

### 4.2.1 Confined Aquifer Resource

Groundwater, with respect to the confined aquifer, is allocated in accordance with Appendix L.6 of the proposed Southland Water and Land Plan (pSWLP) because allocation limits for the specific confined aquifer zone within the Middle Gore Lignite Measures (Appendix A, Figure 4) are not established under the pSWLP Appendix L.5. According to the pSWLP Appendix L.6, primary annual allocation for the confined aquifer where the current abstraction bores are screened is 75% of the throughflow at the well location estimated with Darcy's law following Rule 54(e).

In the absence of sufficient groundwater level/elevation data specific to the confined aquifer zone utilised by the applicant, the lateral hydraulic gradient within the deep aquifer could be expected to generally track the southwest alignment of the Waihopai Groundwater Management Zone and Middle Gore Lignite Measures, which appear to correspond to the overall slope of the land surface elevation and the general direction of surface water flows. The NZ 8 m digital elevation model available through LINZ suggests the lateral gradient across the southwest alignment (between the site and the lower southwestern area of the Middle Gore Lignite Measures) is about 0.0093 m/m. Considering the expected potential range of aquifer transmissivity values described in Appendix D (about 60 to 100 $m^2$/d) and the potential range of confined aquifer dimensions (about 6 m thick allowing for the pumped aquifer only across a 6.5 km to 10.5 km throughflow area as shown on Figure 4) aquifer throughflow on a daily basis is estimated to range from about 3,630 $m^3$/d to 9770 $m^3$/d.

The applicant's proposed maximum daily take at 1,500 $m^3$ is therefore expected to potentially intercept between approximately 15% and 41% of the throughflow on a maximum daily basis and therefore not result in the primary allocation limit (75% of throughflow according to the pSWLP Appendix L.6) being exceeded in terms of its individual effect. No change in the weekly and annual consented rate of take is proposed, so there is no actual effect on overall allocation. Other consented abstractions in this confined aquifer zone from bores F46/0857 and F46/0636 (Figure 4) are only consented to take 168 $m^3$/d and 78 $m^3$/d. Other deep bores potentially in the same deep aquifer zone within the Middle Gore Lignite Measures area (bores F46/0563, F46/0945, and F46/0313 shown on Figure 4) do not appear to be associated with a current groundwater take consent according to the ES database.

The current information and assessment above confirm that the effects on the overall confined groundwater resource are expected to be less than minor. In terms of the pSWLP Appendix L.6, the take is not expected to cause the primary allocation for the confined aquifer zone where the current abstraction bores are screened to exceed 75% of the estimated throughflow. Additionally, the proposed new consent does not seek to alter the currently consented long term abstraction rate; thus, the proposed authorised take will not result in any change to the current allocation status of the aquifer. Furthermore, Figure 3B in Appendix A shows that the three currently used bores have experienced higher static groundwater levels during plant shutdown in 2019 and 2020 compared to historic static groundwater levels, which suggests there is not a long term declining trend in groundwater levels or resources occurring in the deep confined aquifer the applicant utilises for their supply.

### 4.2.2 Unconfined Aquifer Resource

In terms of allocation from the unconfined aquifer, the site is in the Waihopai Groundwater Management Zone under both the Regional Water Plan (RWP) and pSWLP.

ES has noted (as of November 2020) that:

- under the RWP, allocation in this zone is much less than the defined limit (only 7% allocated), with over 50,000,000 $m^3$/year available for allocation as a discretionary activity, while
- under the pSWLP it is only 6% allocated, with over 40,000,000 $m^3$/year available.

The assessment of stream depletion and drawdown effects (below) suggests the take could potentially result in only low-level effects within the upper aquifer zone. In accordance with ES's plans, the take should be fully allocated to the deeper, confined, groundwater resource and no allocation is required from the overlying unconfined aquifer.

## 4.3 Effects on Neighbouring Bores

Appendix L.3 of the pSWLP sets out the criteria for assessing drawdown interference effects in neighbouring bores. The criteria require that the cumulative drawdown effect should not be more than 50% of the potentiometric head (metres between the mean annual maximum groundwater level and the top depth of the confined aquifer strata) in any existing bore screened in a confined aquifer. For shallower bores in the unconfined aquifer, the cumulative drawdown effect should not be more than 20% of the available drawdown (metres between the mean groundwater level and the top screened interval). There are no long term groundwater level monitoring bores neighbouring the site (Figure 5, Appendix A), so criteria for interference effects on monitoring bores are not considered relevant.

The pSWLP states that the effects must be calculated assuming pumping at the maximum rate and/or duration. In this case, there are two scenarios to consider; short term pumping at the proposed 1,500 $m^3$/d until the proposed 7,000 $m^3$ weekly allocation is used up (17.4 L/s for 4.7 days) and longer term effects at the 7,000 $m^3$ weekly limit (average of 11.6 L/s) after a year.

#### 4.3.1 Effects on Confined Aquifer Bores

Figure 5, Appendix A, shows the location of active neighbouring bores including those owned by the applicant. Given the interpretation of the hydrogeologic setting, only one neighbouring bore within 2 km of the applicant's bores could be screened within the same confined aquifer strata (F46/0563 with a 133 m total drilling investigation depth about 2 km southeast of the site). As no static water level is recorded on the ES database for this bore, the potentiometric head[1] is conservatively assumed to be 86 m based on the lower static water level of 29 m exhibited by the applicant's bores and the 115 m top depth of the confined aquifer at the site. Applying the most conservative estimated parameters described in Appendix D that result in the greatest estimated effect with no vertical leakage (recharge) effects, short term effects on this bore estimated with the Theis (1935) solution approach 0.6 m after 4.7 days of pumping at 1,500 $m^3$/d. This is based on a transmissivity of 100 $m^2$/d and storativity of $2.6 \times 10^{-4}$. The predicted drawdown has a one-day delayed peak effect at about 0.7 m followed by delayed recovery.

Maximum potential long term effects at this neighbouring bore appear to approach 5.1 m after a year of constant pumping at 1,000 $m^3$/d (transmissivity at 60 $m^2$/d and storativity at $2.6 \times 10^{-4}$ with no recharge effects) with rapid water level recovery following the simulated pumping shutoff.

Considering long term average use (Appendix A, Figure 3A) could be around 400 $m^3$/day, the long term effect could be lower at about 2.0 m, however it should be noted that the bores are usually operated intermittently for four to five days at a time and then shut off over the weekend with recovery of groundwater levels.

Figure 3B also shows that during the 2019 and 2020 plant shutdowns static groundwater levels recovered beyond the historic static groundwater level recovery during the 2000 plant shutdown indicative of a possibly neutral or positive groundwater level trend within the confined aquifer since 2000.

Given the scenarios above, maximum drawdown interference with no induced recharge effects specific to the applicant's proposal are estimated to be about 1% to 6% of the possible 86 m potentiometric head at the neighbouring deep confined aquifer bore F46/0563.

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[1] The potentiometric head in a bore screened in a confined aquifer is defined in the pSWLP as the head between the mean annual maximum piezometric level and top of the confined aquifer.

Figure 4 (Appendix A) suggests there are only two other possibly active abstraction wells in the greater surrounding area of the Middle Gore Lignite Measures that are potentially screened within the same deep confined aquifer (F46/0857 and F46/0636). According to the ES database, these other neighbouring bores are consented to take 168 $m^3$/d and 78 $m^3$/d respectively and are therefore expected to create a relatively smaller interference effect on bore F46/0563.

Considering the above, the applicant's proposal is expected to not add to cumulative drawdown effects more than 50% of the potentiometric head at the neighbouring confined aquifer bore, which is acceptable in terms of the pSWLP Appendix L.3 criteria. It should also be noted that the long term consented interference effect will not change as a result of the proposed consent, and only very minimal changes could occur in the short term (5 day effect).

#### 4.3.2 Effects on Intermediate Depth Bores

Effects on somewhat shallower (intermediate depth) confined aquifer bores (F46/0722, CG11/0005, F46/0648 between 60 and 64 m deep at least 1.8 km south of the applicant's bores as shown on Figure 5) cannot be reliably estimated with the Theis (1935) solution or the Ward and Lough (2011) solution. This is because this intermediate aquifer zone is separated by a significant aquitard thickness both above and below; between the deeper confined aquifer zone utilised by the applicant and the overlying unconfined aquifer zone. An aquitard thickness of around 57 m is expected based on the geologic logs between the top of the deep confined aquifer zone (115 m depth at the applicant's bores) and the bottom of the intermediate aquifer zone (58 m depth at bore F46/0722). This suggests the drawdown effects should not be estimated under an assumed full lateral connection due to the vertical separation provided by the aquitard (mudstone).

Only one of these bores is consented to take water at a relatively low rate (60 $m^3$/d at F46/0722, which is around 1,800 m from the closest Blue Sky Meats abstraction bore, which is bore F46/0561) and the potentiometric head in this bore could be on the order of 35 m (between the 12 m deep static water level and the top of the confined/semi-confined gravels and sand at 47 m depth according to the F46/0722 geologic log). Given this, the applicant's proposal would, in the unrealistic scenario of a full lateral connection, result in drawdown up to about 0.8 m and 5.4 m in the short and long term respectively (up to about 15% of the potentiometric head at bore F46/0722) using the most conservative parameter combinations, which is acceptable in terms of the pSWLP Appendix L.3 criteria but not expected. The 57 m aquitard thickness providing hydraulic separation is expected to result in much lower-magnitude potential drawdown interference effects for this intermediate aquifer. As such, the maximum long term specific drawdown effect in the intermediate aquifer at bore F46/0722 is likely to be much less than the 15% in the unrealistic full lateral connection scenario described above. Even for the conservative scenario, the proposed abstraction is considered acceptable in terms of the pSWLP Appendix L.3 criteria for cumulative drawdown effects. It should also be noted that the long term consented interference effect will not change as a result of this new consent, as only a change in the short term rate is sought, and only very minimal changes could occur in the short term (4.7 day effect) although in reality no change in consented effect is expected to occur due to the hydraulic separation.

#### 4.3.3 Effects on Unconfined Aquifer Bores

The closest neighbouring bore that is likely to be screened in the shallow unconfined aquifer system is domestic supply bore F46/0376 about 1.1 km to the northeast (Figure 5, Appendix A). This bore is located adjacent to domestic bore F46/0874, which has a static water level recorded at 2 m depth. Although neither of these bores have a record of well depth on the ES database, they are located at residences along Dacre-Morton Mains Road near other domestic and stock supply bores 11 to 13 m depth, so it is expected that they are also of similar depth given their locations and the similar static water level (Figure 5, Appendix A).

Application of the Ward and Lough (2011) solution using the most conservative parameters outlined in Appendix D and the pumping scenarios described above indicates minimal short term drawdown effect of less than 0.01 m (based on the proposed 1,500 $m^3$/day for 4.7 days) and a delayed long term effect peaking at less than 0.1 m (which is the same as for the current consent given no change in weekly volume) at the domestic supply bore F46/0376. This particular assessment has considered the specific position of the bore on the opposite side of the stream and holds even for a low streambed conductance of 0.1 m/day. The top screen depth at this bore is expected to be similar to that of bore F46/0805 (Figure 5), which has construction information showing a top screen depth at 9 m. Given this and the 2 m deep static water level in the adjacent domestic bore F46/0874, the available drawdown at bore F46/0376 can be estimated at about 7 m. Drawdown effects from the neighbouring domestic bore F46/0874 on domestic supply bore F46/0376 are not expected to be significant given the likely low total daily abstraction as per the domestic usage. As such, the applicant’s worst-case drawdown effect is a minimal percentage of the estimated available drawdown, and is acceptable in terms of the pSWLP Appendix L.3 criteria for cumulative drawdown effects. It should also be noted that no change in the consented interference effect is expected as a result of this consent, as only a change in the short term rate is sought. In addition, the method of assessment is very conservative as no significant lateral flow is provided for in any other layers other than the pumped aquifer.

## 4.4 Effects on Surface Water

### 4.4.1 Cumulative Effects on the Surface Water Resource

The assessment of stream depletion effects (Appendix E) classifies the estimated stream depletion effect as low according to the pSWLP Appendix L.2, and the proposed take should therefore be managed solely as a groundwater take with the full abstraction applied to groundwater allocation. The stream depletion assessment in terms of the RWP would also categorise the take in the low stream depletion category with no need to place any minimum flow restrictions on the proposed consent.

According to the ES database, there are no regionally significant wetlands or sensitive waterbodies that could be expected to be affected. The closest regionally significant wetland, Spurhead Swamp, is about 8.2 km northeast in a different surface water sub-catchment of the Waihopai River (within the upstream headwaters of the Waihopai River mainstem catchment).

## 4.5 Positive Effects of the Proposal

A new groundwater take consent for the Blue Sky Meats Ltd processing plant water supply will allow for the applicant to continue their processing activities at the site. The processing plant water supply during days of peak operation is important for the business and provides an economic benefit to the region. Significant financial investment has been provided by the applicant in the form of the current bores and the processing plant. The granting of the consent will ensure the plant can operate to capacity and thus provide economic resilience to the applicant's business and those employed.

The proposed daily increase in groundwater take to 1,500 $m^3$/day enables Blue Sky Meats to achieve processing growth of approximately 10%. Furthering Blue Sky Meats' economic contribution without impacting their overall allocation (weekly water take limits are proposed to remain as previously consented).

## 4.6 Other Effects

For completeness, other environmental effects assessed but not likely to occur are summarised here briefly.

### 4.6.1 Changes in Groundwater Quality

The abstraction does not directly result in the discharge of any contaminants as the proposal is to replace the existing groundwater take consent. As such, no effect on groundwater quality is expected as a result of the proposed groundwater take activity. Groundwater quality data available through ES suggests that the deeper aquifer system used by the current bores has lower nitrate-N concentrations compared to shallow bores in the area. The discharge to land is consented separately.

### 4.6.2 Surface Water Quality

No discharges to surface waterways will occur as a result of the groundwater abstraction. As the proposed new consent is to authorise a small daily limit increase (300 $m^3$/d) in groundwater take activity with no change in weekly take, no additional effect on surface water quality is expected to occur.

### 4.6.3 Effects from Seawater Intrusion

The abstraction bores are located approximately 25 km north of the coast. Based on this separation distance there is little risk of inducing a landward shift of the coastal freshwater/seawater interface and no increase in allocation is sought, therefore effects from seawater intrusion are considered less than minor.

### 4.6.4 Effects on Aquifer Stability

The aquifer from which the current production bores abstract groundwater is composed of clast supported alluvial deposits forming a sequence of gravelly strata between about 115 and 121 m depth. This layer is not expected to consolidate as a result of lowering groundwater pressures due to being clast supported and the static water level for this confined aquifer zone is around 26 to 29 m bgl in terms of the static groundwater levels during the 2000 plant shutdown. The static water level data (Figure 3B, Appendix A) shows that the static groundwater levels have recovered higher (between 21 and 26 m bgl) during the 2019 and 2020 plant shutdowns, which suggests the current abstraction is not resulting in a long term decline of deep groundwater level pressures. This would in turn suggest that water level pressures within the overlying strata have been similarly unchanged in the long term.

In addition, the same long term quantities of groundwater will be taken under the proposed consent as have been taken historically so there will be no increase in drawdown and therefore no increased potential for impacts on the stability of the overlying deposits. Overall, the potential effects on aquifer stability are expected to be less than minor.

## 5.0 Conclusion

The applicant currently takes groundwater from three deep bores for the Morton Mains lamb and sheep processing plant water supply at up to 1,200 $m^3$/d as per their current resource consent (No. 201190-V1). The bores are screened within a deep confined aquifer interbedded within the Middle Gore Lignite Measures.

The applicant is seeking a new consent to allow groundwater to continue to be taken from the same bores with an amended maximum daily abstraction limit at 1,500 $m^3$/d (but with the same weekly abstraction limit at 7,000 $m^3$) to accommodate periods of increased demand. The application does not seek to alter the currently consented weekly or long term abstraction rate; thus, the proposed authorised take will be no greater than what is currently authorised in terms of allocation and other potential long term effects.

Aquifer testing data derived from the constant rate pumping test of the original two bores (situated next to the newer two bores and screened within the same aquifer) was re-assessed as part of the 2021 consent variation to further consider both aquifer and aquitard parameters, and this has also been included with this technical report (Appendix D). The parameters derived from this re-assessment of the original pump test data have been used to assess potential environmental effects of the abstraction, including effects on neighbouring bores, surface water and the overall groundwater and surface water resources. Assessments presented in this report also evaluate the potential effects on water quality, seawater intrusion and aquifer stability.

The assessments summarised in this report have shown that the potential effects of the proposal are considered less than minor.

## 6.0 References

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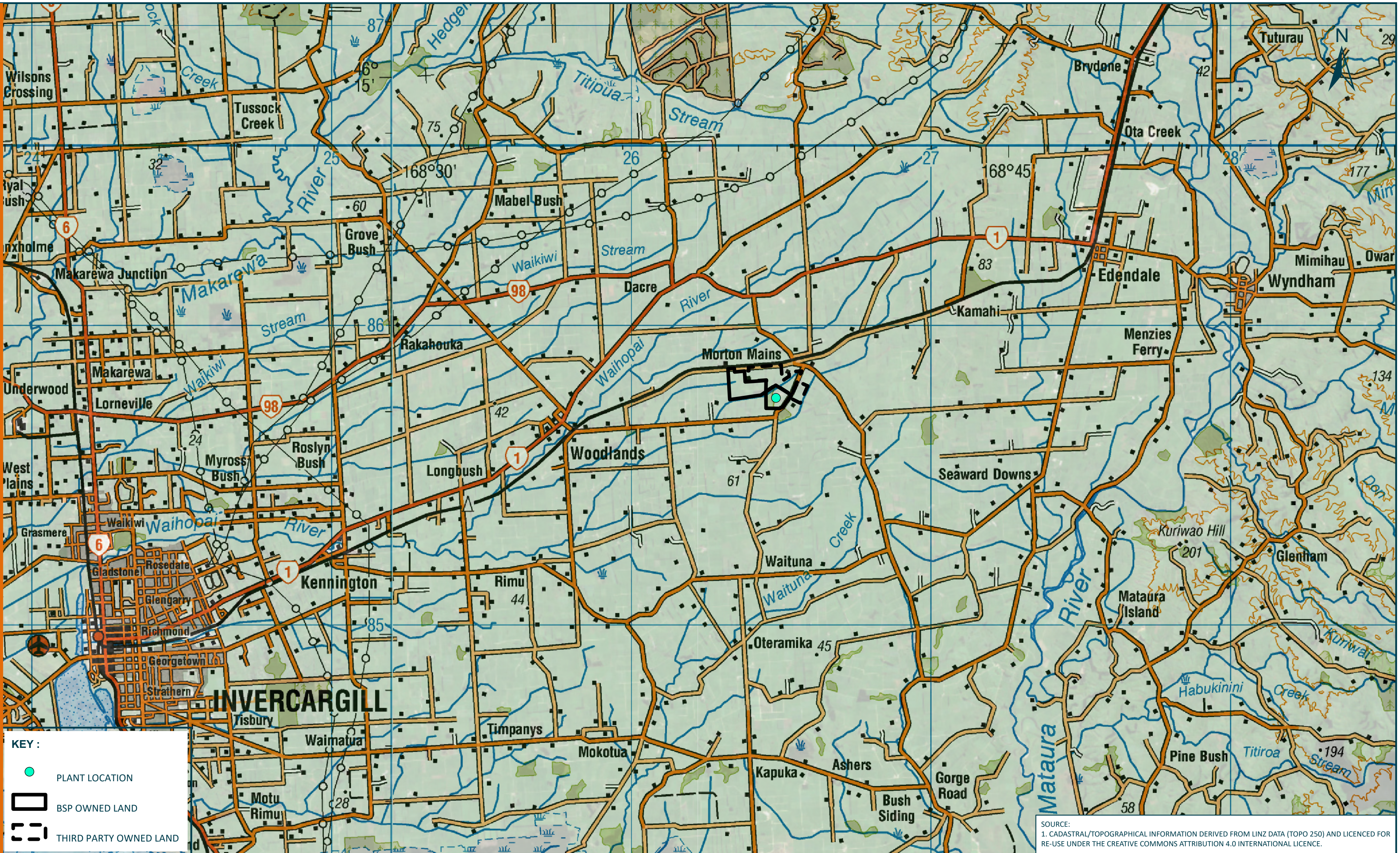
# Appendix A: Figures

A03220500Z001.aprx - A03220500_FIGURE1_SITELOCATION




SOURCE:
1. CADASTRAL/TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA (TOPO 250) AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

pdp

0 1000 2000 4000
METRES
SCALE : 1:170,000 (A4)



| NO. | REVISION | DATE | BY |
|---|---|---|---|
| A | ISSUED FOR REVIEW | JAN 22 | CF |

CLIENT

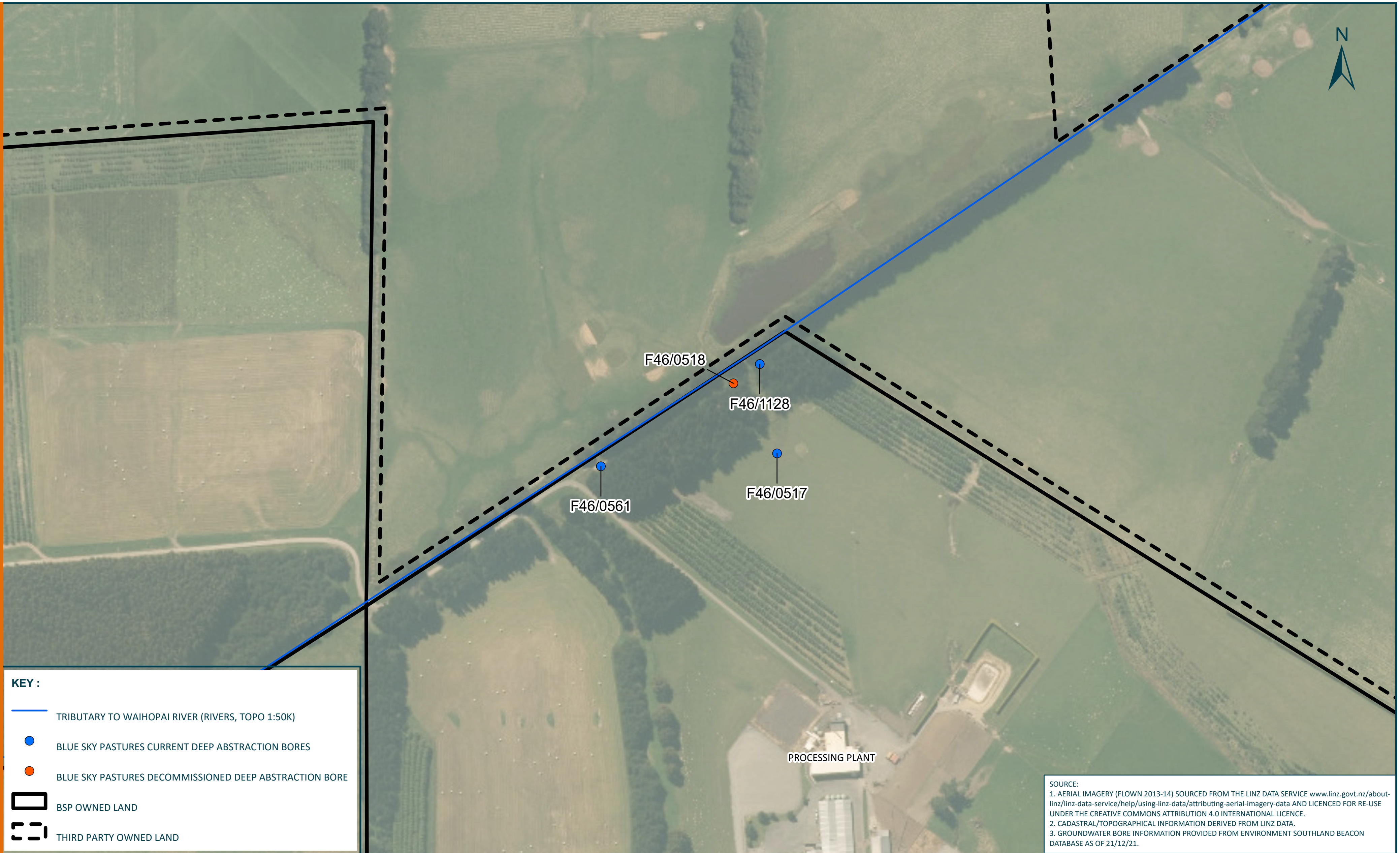
BLUESKY PASTURES

FIGURE

# FIGURE 1: SITE LOCATION

PROJECT

BLUE SKY PASTURES RESOURCE CONSENT APPLICATION

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| NO. | REVISION | DATE | BY |
|---|---|---|---|
| A | ISSUED FOR REVIEW | JAN 22 | CF |

CLIENT

BLUESKY PASTURES

FIGURE

# FIGURE 2: WELL LOCATIONS

PROJECT

BLUE SKY PASTURES RESOURCE CONSENT APPLICATION

A03220500Z001.aprx - A03220500_FIGURE2_WELLLOCATIONS

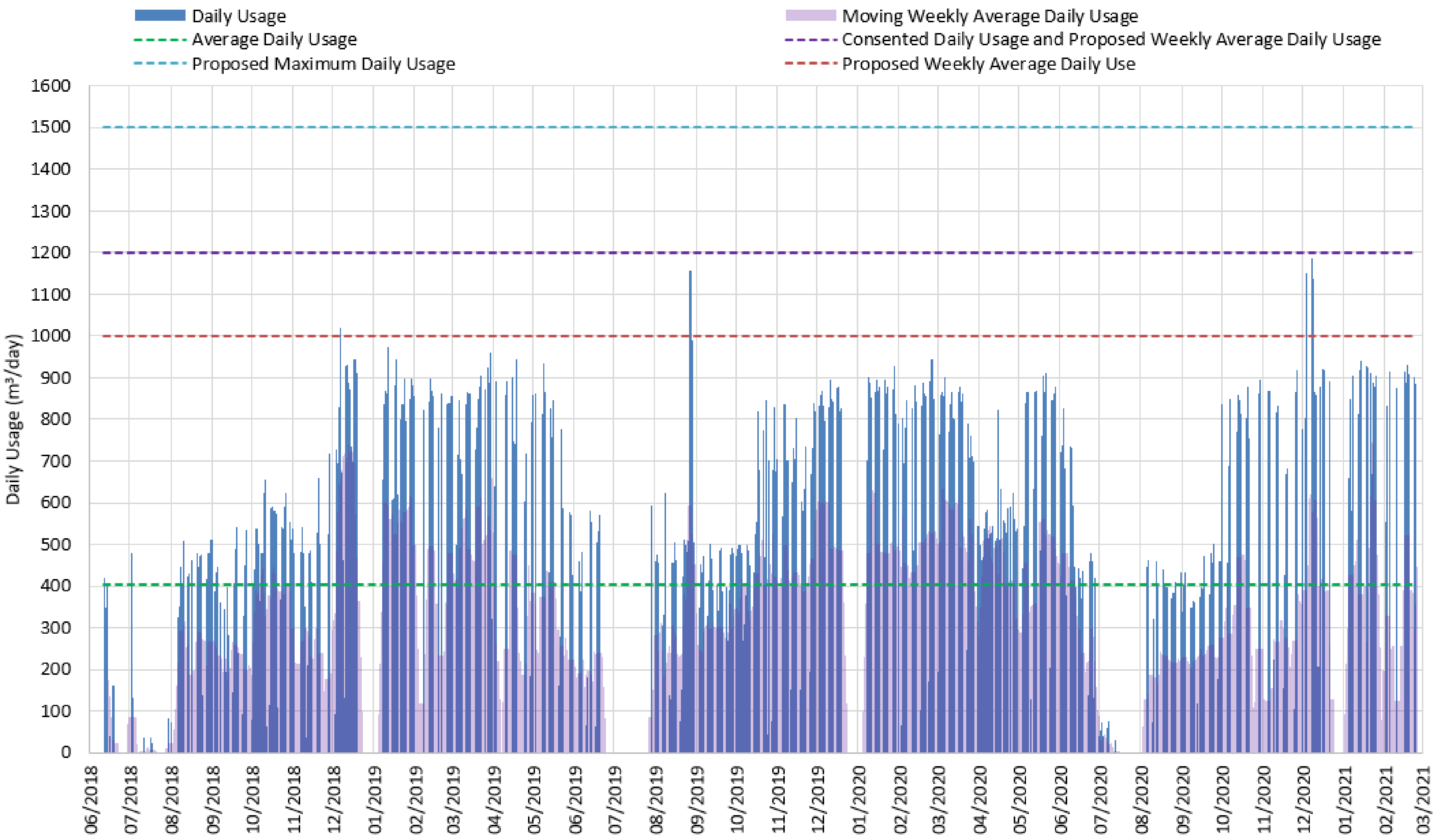



**Figure 3A: Usage Data (June 2018 through February 2021)**

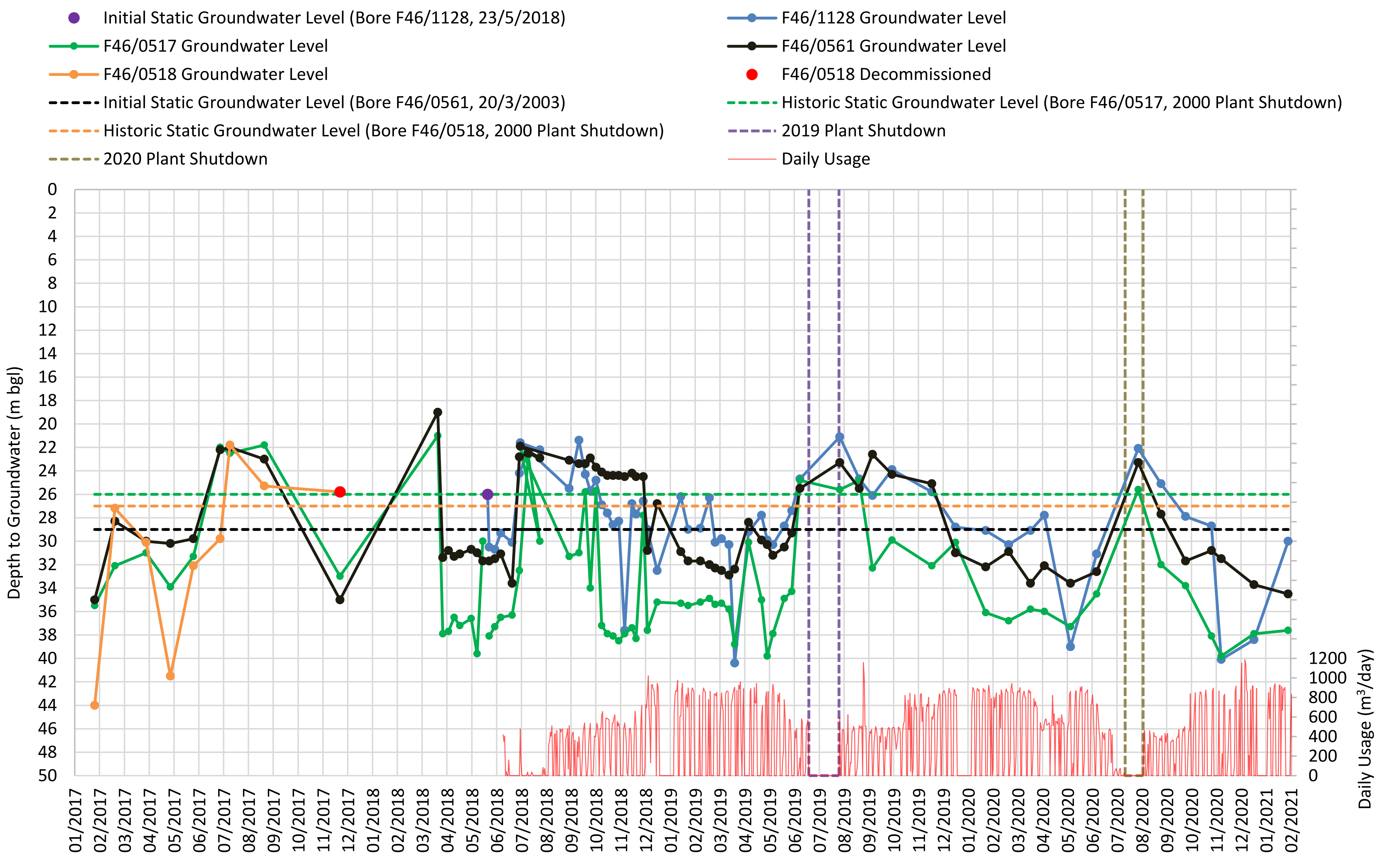
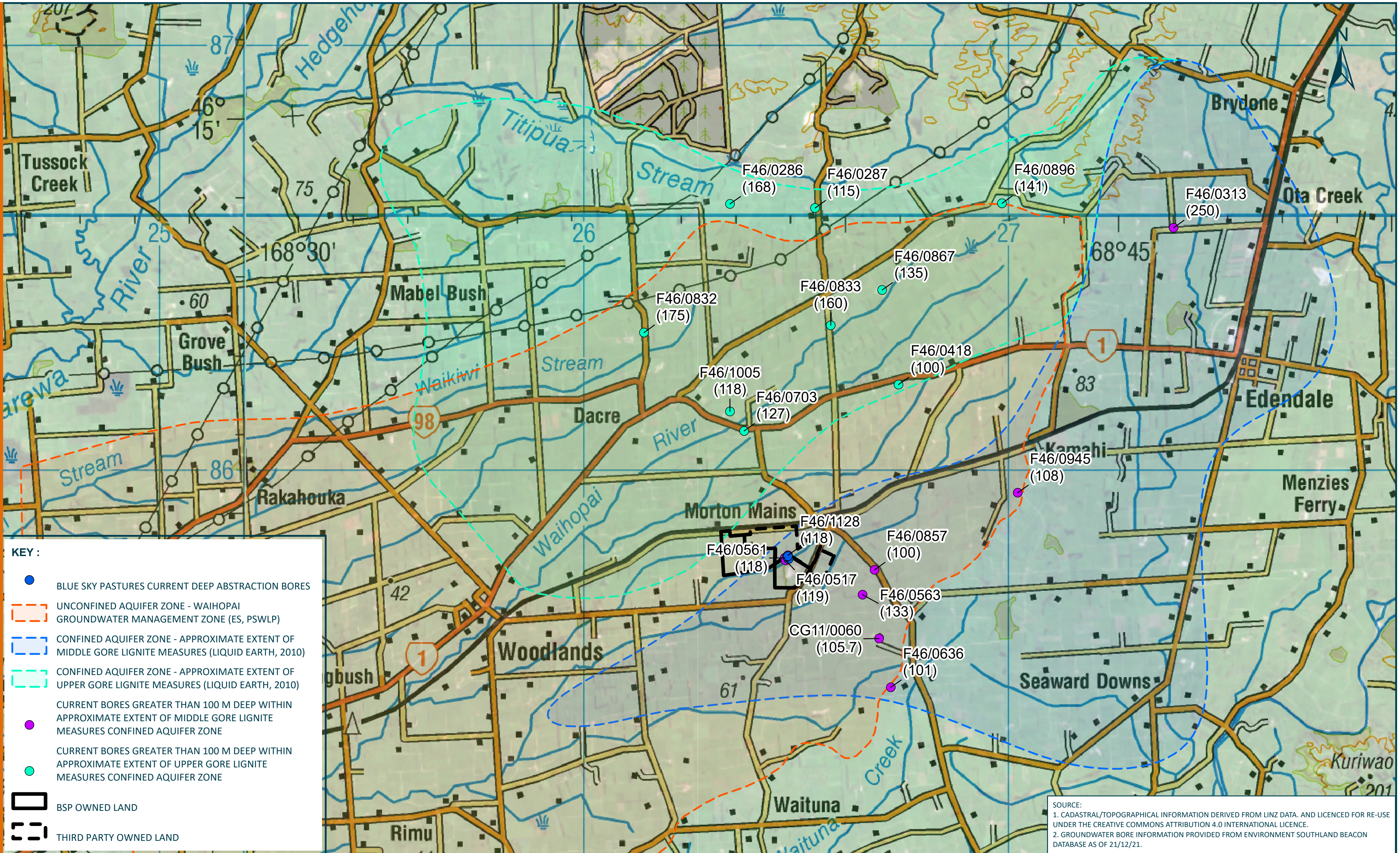



**Figure 3B: Groundwater Levels (January 2017 through February 2021) and Usage Data (June 2018 through February 2021)**




SOURCE:
1. CADASTRAL/TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA. AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. GROUNDWATER BORE INFORMATION PROVIDED FROM ENVIRONMENT SOUTHLAND BEACON DATABASE AS OF 21/12/21.

pdp

0 0.8 1.5 3
Kilometers
SCALE : 1:120,000 (A4)



| NO. | REVISION | DATE | BY |
|---|---|---|---|
| A | ISSUED FOR REVIEW | JAN 22 | CF |

CLIENT

BLUESKY PASTURES

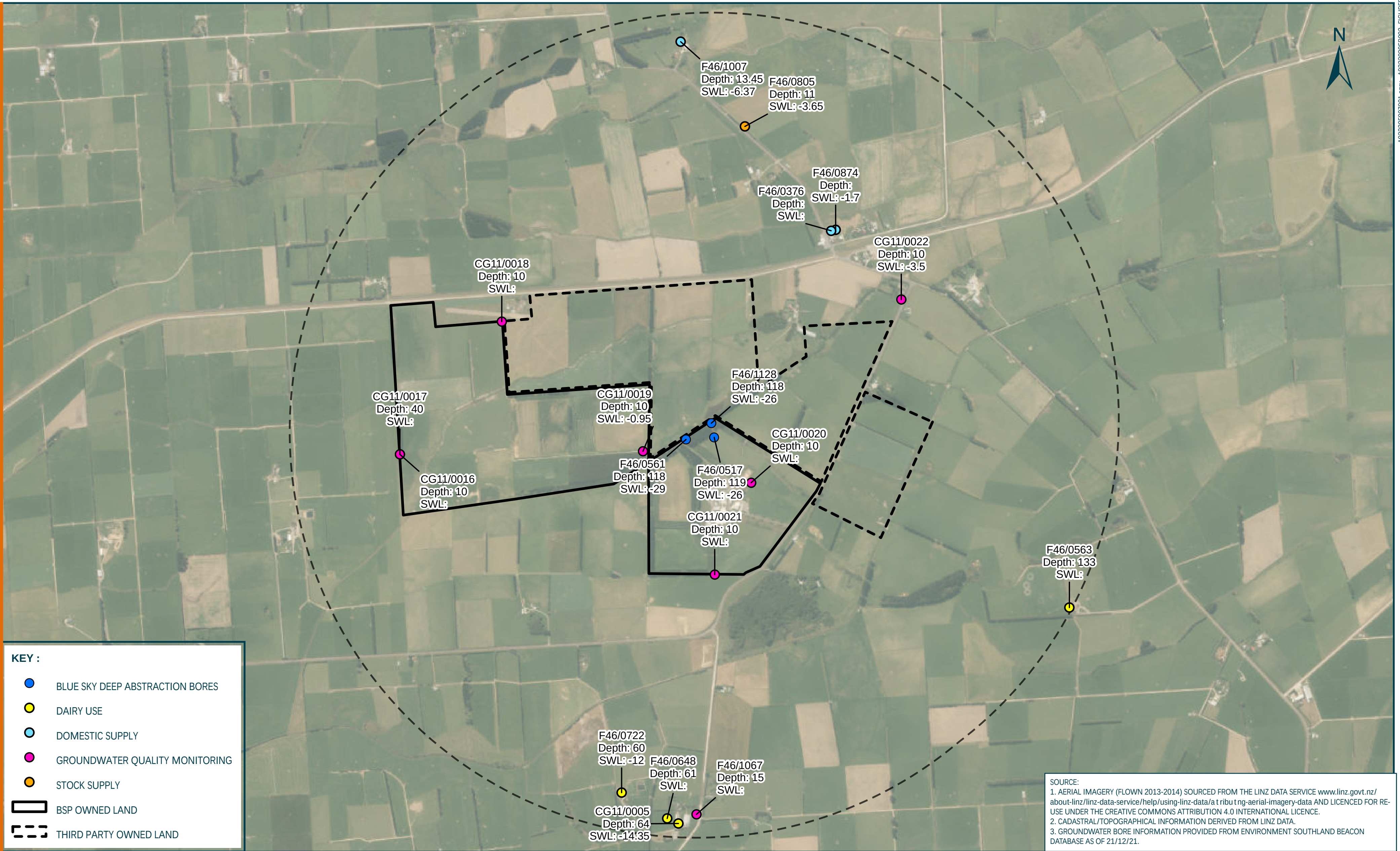
FIGURE

# FIGURE 4: AQUIFERS

PROJECT

BLUE SKY PASTURES RESOURCE CONSENT APPLICATION

A03220500Z001.aprx - A03220500_FIGURE4_AQUIFERS




0 175 350 700
METRES
SCALE : 1:25,000 (A4)



| NO. | REVISION | DATE | BY |
|---|---|---|---|
| A | ISSUED FOR REVIEW | JAN 22 | CF |

CLIENT

BLUESKY PASTURES

FIGURE

# FIGURE 5: NEIGHBOURING BORES WITHIN 2 KILOMETRES

PROJECT

BLUE SKY PASTURES RESOURCE CONSENT APPLICATION

A03220500201.aprx - A03220500R002_FIGURE5_NEIGHBOURINGBORES

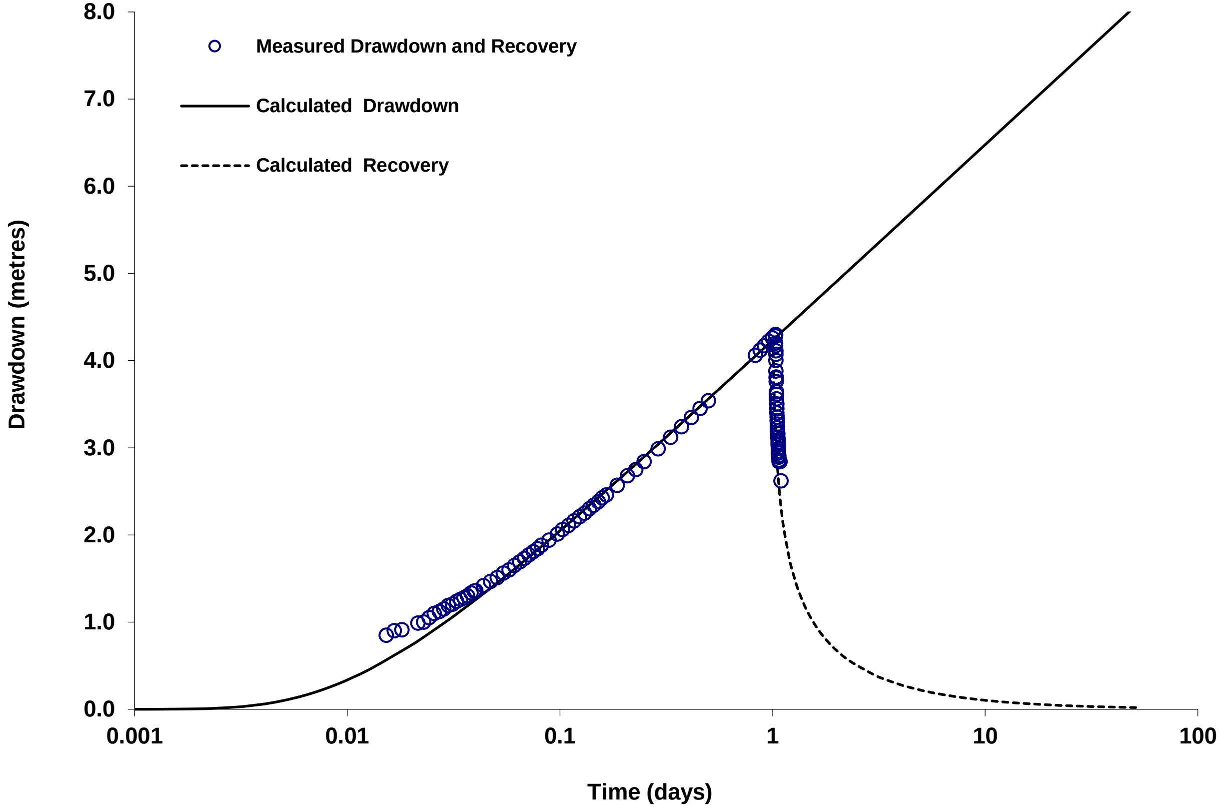



**Figure 6: Theis Reassessment of Aquifer Test Data**

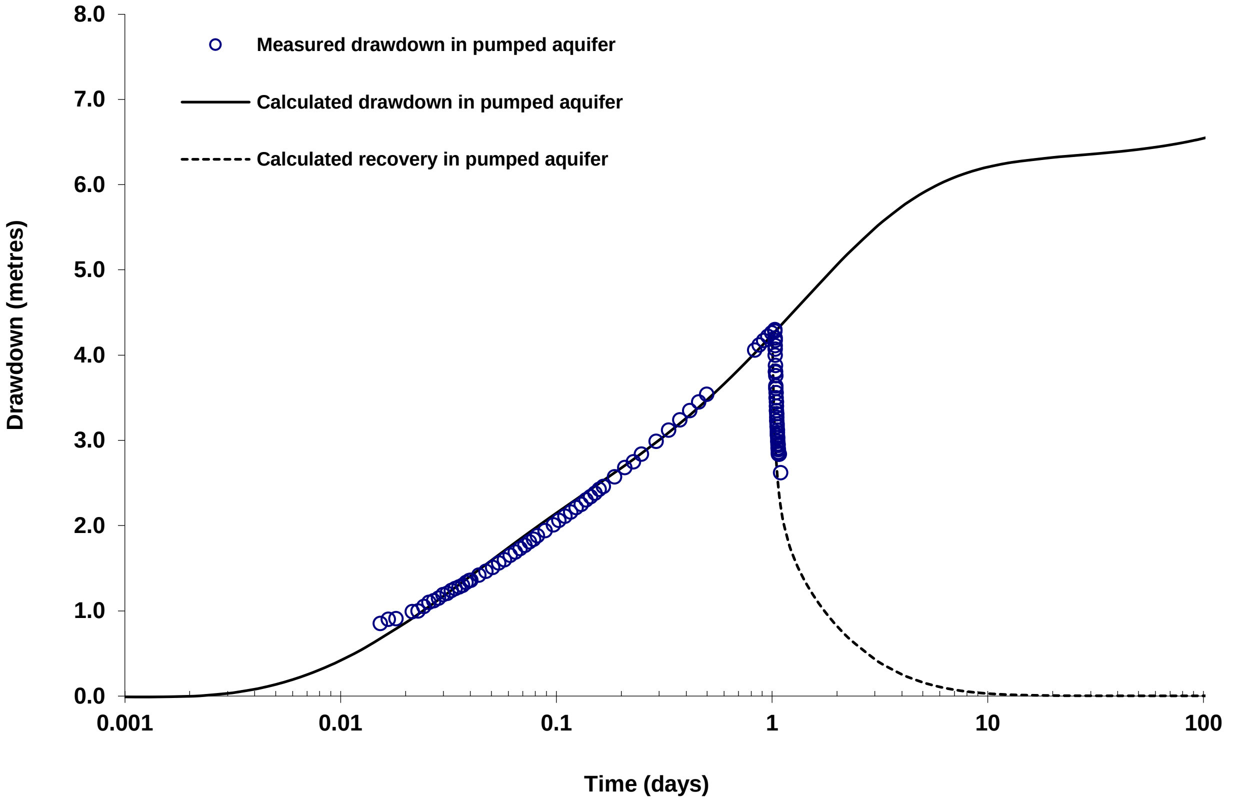



**Figure 7: Leakage Assessment of Aquifer Test Data**

# Appendix B: Existing Consent

environment SOUTHLAND

Cnr North Road and Price Street
(Private Bag 90116)
Invercargill

Telephone (03) 215 6197
Fax No. (03) 215 8081
Southland Freephone No. 0800 76 88 45

# Water Permit

**Pursuant to Section 104B** of the Resource Management Act 1991, a resource consent is hereby granted by the Southland Regional Council (the "Council") to **Blue Sky Meats (NZ) Limited** (the "consent holder") of **Morton Mains, R D 1, Invercargill** from **May 23, 2003.**

**Please read this Consent carefully, and ensure that any staff or contractors carrying out activities under this Consent on your behalf are aware of all the conditions of the Consent.**

## Details of Permit

| | | |
|---|---|---|
| Purpose for which permit is granted: | | To take groundwater for a meat processing plant and a rendering and blood drying plant |
| Location | - site locality | Morton Mains |
| | - map reference | F46/0517: NZTM2000 1264805E, 4857902N<br>F46/0561: NZTM2000 1264667E, 4857892N<br>F46/1128: NZTM2000 1264792E, 4857972N |
| | - catchment | Waihopai |
| | - groundwater zone | Waihopai |
| Legal description of land at the site: | | Lot 1 DP 595 Block VII Lothian HD |
| Expiry date: | | 31 December 2022 |

## History of Changes and Transfers

- Conditions varied on 11 May 2021

## Schedule of Conditions

**Consent Period**

1. This resource consent shall:

   (i) commence upon expiry, surrender or lapse of Resource Consent 94300; and

(ii) shall expire on 31 December 2022.

## General

2. This consent authorises the abstraction of water from up to three bores F46/0517, F46/0561 and F46/1128 at the locations specified above.

3. The rate of abstraction shall not exceed:
   (a) 1,200,000 litres per day; and
   (b) 7,000,000 litres per week.

4. The consent holder shall install a backflow prevention device or take other appropriate measures to ensure water and/or contaminants cannot return to the water source.

## Monitoring

5. The consent holder shall:

   (a) provide and maintain access to the heads of each bore to enable measurement of water level in each bore;
   (b) monitor groundwater levels at each bore once each calendar month; and
   (c) when monitoring groundwater levels, record whether or not the bore has been in use during the previous 24 hours and, if it has, the rate of abstraction from the bore during the previous 24 hour period.

6. The consent holder shall measure, to the satisfaction of the Director of Environmental Management, and record the daily rate of abstraction from the bores.

7. The consent holder shall provide the monitoring information required by Conditions 5 and 6, for the previous period 1 July to 30 June, to the Council's Environmental Compliance Manager by 31 August each year.

## Administration Conditions

8. The consent holder shall pay an administration and monitoring charge to the Southland Regional Council collected in accordance with Section 36 of the Resource Management Act, payable in advance on the first day of July each year.

9. The consent holder may apply to the Council for the change or cancellation of any of the conditions of this consent, other than Condition 1, in accordance with Section 127 of the Resource Management Act, during the period May to September each year.

10. Council may, in accordance with section 128 and 129 of the Act, serve notice, during the period May to September each year, of its intention to review conditions for the purpose of:

    (i) dealing with any adverse effects on the environment which may arise from the exercise of this consent;
    (ii) requiring monitoring of the rate of, or the effects of, the abstraction;
    (iii) requiring efficiency of water use; and/or
    (iv) complying with the requirements of a regional plan.

Reissued 11 May 2021 following variation to conditions 2 and 3.

for the **Southland Regional Council**

Lacey Bragg
**Team Leader Consents**

# Appendix C: Drillers Logs and Aquifer Test

Map 1.

# MCNEILL DRILLING CO. LTD

732

## WATER BORE/WELL SUMMARY FORM

| | |
|---|---|
| CLIENTS NAME: Blue Sky Meats | BORE SIZE: 6" |
| FULL ADDRESS: | START DATE: 13/3/03 |
| RAPID NO: | FINISH DATE: 20/3/03 |
| GRID REFERENCE: F46 E 2174470 N 5419870 | |
| DRILLER: G. Beer | MACHINE: Schramm |
| MEASURED FROM: | DRILL METHOD: W/D |
| TOTAL DEPTH BORE: 137m | |
| TOP LEADER: | |
| SWL: 29m | |
| SCREEN: SLOT: | LENGTH: 3m |
| TYPE: | SIZE: |
| P SLOTTED: TOP: | BASE: |
| SCREEN/LEADER/SUMP: 3m Screen | SUMP SIZE: |
| TOTAL CASING USED: 118·8m x 6" | |
| AIRLIFTED/PUMPED AT: 6,400 g.p.h | |
| DRAWDOWN FROM SWL: 8m | |
| AIR/PUMP INTAKE: | |
| BACTERIAL WATER TEST: | |
| CHEMICAL WATER TEST: | |

EXTRA NOTES:

BORE LOG:

00.000 — 10½, clay, bound gravels 10½–12½m coal 12½–17½ mud -stone 17½–18½ carbonaceous mud 18½–42 mudstone 42–43 gravels and silt stone 43–44½ coal and c/mud, 44½–46 gravel sand stone & coal 46–48 silt & gravel 48–49½ c/mud & coal 49½–55 carbonaceous mud 55–58, c/mud coal & wood 58, c/m 59 59–64½, mudstone 64½ m/s & coal 66 66–68½, c/mud & coal 68½–84½ m/s. 84½ – 85½ c/mud & coal 85½–87 coal & m/s. 87–92 silt stone 92–99 m/s 99–100 c/mud & m/s. 100–101 c/mud 101–118½ m/s & gravels. 118½–121 c/mud 121–137 c/m & coal.

24/7/03

Blue Sky Meats Bore No 1

FROM : MCNEILL DRILLING G.STEWART PHONE NO. : 64 3 4489420 Mar. 05 2003 10:04AM

Ross Wrongly Bore No 2 Sept 1986

0-000 - 1-000 (1) clay
1-000 - 5 500 (4-5) clay bound gravels
5-500 - 6 500 (1) Blue mudstone
6-500 - 7-300 (0-8) Dark Brown mudstone
7-300 - 8-700 (1-4) muddy lignite
8-700 - 13-000 (4-3) Dark Brown mudstone Traces carbon
13-000 - 17-700 (4-7) grey sandy mudstone
17-700 - 18-500 (0-8) muddy lignite
18-500 - 27-000 (8-5) grey mudstone
27-000 - 31-000 (4) Dark Brown mudstone with lignite [illegible]
31-000 - 37-000 (6-0) grey sandy mudstone very fine
37-000 - 40-800 (3-8) Dark brown ~~[illegible]~~ carbonaceous mudstone with wood and traces of gravels
40-800 - 48-500 (7-7) grey sandy mudstone Traces carbon
48-500 - 51-000 (2-5) Brown mudstone Traces carbon.
51-000 - 60-000 (9) lignite with muddy layers and Timber
60-000 - 63-300 (3-3) light grey mudstone
63-300 - 70-600 (7-3) Brown mudstone Traces carbon
70-600 - 76-000 (5-4) very fine sandy mudstone
76-000 - 78-400 (2-4) grey mudstone
78-400 - 93-800 (14-4) Brown fine sandy mudstone with layers of carbon
93-800 - 95-700 (1-9) grey mudstone with ~~layers~~ layers of carbon
95-700 - 100-000 (4-3) Dark brown mudstone with layers of carbon 5%
100-000 - 108-000 (8) grey mudstone Traces carbon
108-000 - 115 500 (7-5) grey very fine sandy mudstone
115-500 - 121-000 (5-5) small gravels
121-000 - 122-000 (1) grey mudstone
122-000 - 124-500 (2-5) Black muddy lignite
124-500 - 129-000 (4-5) light brown mudstone

Map 2.

MD 37254

mcneill DRILLING ■ DISTRIBUTION ■ PUMPING SINCE 1918

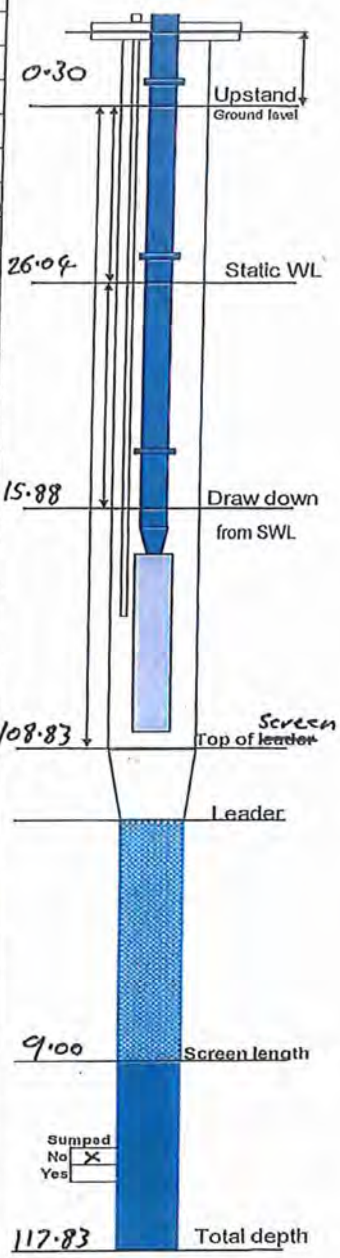
| | | | |
|---|---|---|---|
| Client Name: | Blue sky meats<br>yards Bore | Home No. | 03 2313421 |
| | | Cell No. | |
| Address | Blue Sky meats<br>woodlands | Consent No. | 2018/1290 |
| Grid Reference | E-1264795 | N-4857973 | |

| | | | | | |
|---|---|---|---|---|---|
| Driller | Neil Simmons | | | | |
| Machine/Rig: | DR24 | Fleet No. 184 | | | |
| Drill Method: | Duel rotary | | | | |
| Bore diameter mm | 150mm | | | | |
| Start date: | 16-5-18 | Finish Date: 23-5-18 | | | |
| Development Hours: | 3 | Development Method: air Surge | | | |
| Screen Slot: | 0.50 mm | ID 152 mm | OD 168 mm | | |
| PVC slotted | Top m | Bottom m | | | |
| Total casing used: | 109.13 m | Total Depth: 117.83 m | | | |
| Sump length: | — m | Sump Diameter: — mm | | | |
| Test Pumping | Air lifted | Pumped ✓ | Rate: 7 LPS | | |
| Test Pump period | 40 Hrs | Pump Intake: 79.8 m | | | |
| Bacterial Water test | Yes | ✓ | No | | |
| Chemical Water test | Yes | ✓ | No | | |
| Casing top sealed | Yes | ✓ | No | | |
| Impervious seal at ground | Yes | ✓ | No | | |
| Over Drilled | Yes | | No | ✓ | m |
| Photo of bore diameter | Yes | | No | ✓ | |
| Photo of bore tag | Yes | | No | ✓ | |

Comments:

Bore Drilled 200mm and Installed 150mm with Gravel pack
Gravel pack 4mm-7mm washed pea Gravel
Screen welded to casing
pumped Bore at 17Lps for 1.5hrs Draw Down from SWL 33.68m

log
0 – 0.3 Soil
0.3 – 4.4 Clay yellow Some Gravel
4.4 – 6.5 Clay Grey
6.5 – 10.5 lignite
10.5 – 45.4 Grey mudstone Some lignite
45.4 – 69 lignite and Brown mudstone layers
69 – 75.2 Grey Sand and mudstone
75.2 – 77 mudstone Brown carbonaceous
77 – 85 Grey mudstone and lignite
85 – 92 mudstone carbonaceous
p.t.o



**BORE LOG:** Blue Sky meats yards Bore

| | |
|---|---|
| 92 – 99.5 | Grey Sand and mudStone |
| 99.5 – 102 | Brown mudStone few Gravels |
| 102 – 108 | Hard Grey mudStone / SiltStone few Gravels |
| 108 – 115 | Grey Sand quartz Gravels 2 – 10mm |
| 115 – 118 | quartz Gravels 2 – 15mm |

OLD BORES.

WENSLEY Ross *BLUE SKY* 4" BORE
MOrton Mains

~~24-09-86~~

TEST BORE

| | |
|---|---|
| Total Depth BOre | 158.500 |
| SWL | 15.000 |
| Total Casing 4" | 121.000 |

Pumped at 1450 GPH with pump at 34.000

6" BORE in same spot 15-10-87

~~NO~~/BORE

| | | |
|---|---|---|
| Total Depth Bore | 118.900 | G/L |
| Top Leader | 113.830 | G/L |
| SWL | 13.500 | G/L |
| Screen 150 & 100 Slot | 3.340 | |
| Screen/Leader | 5.100 | |
| Total Casing Used | 153.400 | |
| Pump at 75 GPM | 20.400 D/Down | |
| Casing blown at | 118.000 | |

64/C

OLD BORES.

WENSLEY Ross
Blue Sky

6" BORE
21-11-90

**No 2 BORE**

| | | |
|---|---|---|
| **Total** Depth Bore | 118.575 | G/L |
| Top Leader | 110.750 | G/L |
| SWL | 23.700 | G/L |
| Screen 60 Slot Top | 6.000 | |
| 80 Slot Bottom | 7.825 | |
| Total Casing Used | 113.000 | |

Pumped at over 90[illegible]GPM

64/C

# Blue Sky Meats (NZ) Limited

# Further Information - Water Permit Application B094-006

July 2002

*This report has been prepared solely for the benefit of Blue Sky Meats (NZ) Limited. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.*

*This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval or to fulfil a legal requirement.*

| Quality Assurance Statement | |
|---|---|
| **Blue Sky Meats (NZ) Limited**<br><br>**Further Information - Water Permit Application B094-006** | **Prepared by:**<br>Craig Evans<br>**Reviewed by:**<br>Jens Rekker |
| Project Manager:<br>Craig Evans | **Approved for issue by:**<br><br>*July 2002 – 801/005117* |

**MWH New Zealand Ltd**
31 Stafford Street
P O Box 4
Dunedin
Tel: 64-3-477 0885
Fax: 64-3-477 0616

**Blue Sky Meats (NZ) Limited**
**Further Information - Water Permit Application B094-006**

# Contents

# 1. Background

MWH was approached by Den Ouden Cooper Associates Limited to assist Blue Sky Meats (NZ) Limited to address a request for further information that was received from Environment Southland in relation to the application to take groundwater (B094-006) from two bores at the Morton Mains factory site.

In their technical comment (dated 10 June 2002) Environment Southland requested further information regarding well performance and abstraction rate in order to determine the cause of observed declines in groundwater levels within the GLMA-3 aquifer. Further information was also sought on the hydraulic properties of the aquifer and it was recommended that a 24-hour pumping test was undertaken. A stepped-rate pumping test was also recommended for the assessment of well efficiencies and potential well yield.

MWH was engaged by Blue Sky Meats to perform the aquifer testing and report on the results.

# 2. Bores

Both bores were drilled by McNeill Drilling around 1987 and have been completed with submersible pumps that are understood to be set at 65 metres depth.

| | Bore 1 | Bore 2 |
|---|---|---|
| Total depth (m) | 118.9 | 118.57 |
| Top of Screen (m) | 115.9 | 115.57 |
| Static water-level on 3 July | 48.2m | 24.2m |

In a letter from the drillers dated 29 November 1993, the interval between 8 metres and 110 metres is described as "mudstones, sandstones, coal layers etc". This interval is considered to be impermeable.

The static water level encountered in Bore 1 on 3 July (48.2m) was much lower than expected. The water level is normally similar to that of Bore 2, as would be expected for two nearby bores tapping the same aquifer. Since Bore 1 had not been pumped for a week prior to the test, and since there was also no evidence of any drawdown in Bore 2, it is considered that the measurement must be anomalous.

Blue Sky Meats submitted water-level monitoring data with its application. This information has been plotted by Environment Southland and in his technical comment, Brydon Hughes of Environment Southland has commented on apparent declines in Bore 1 from mid-1999 to March 2001, and in Bore 2 from September 2000 to March 2001. The hydrograph depicts water-levels that vary around 43 and 46 metres depth respectively. Since the static level of the aquifer is around 21 – 27 metres, it is evident that the hydrograph represents pumping levels rather than natural aquifer conditions.

Static water levels during the 2000-year plant shut-down were 26.1 and 26.9 metres for Bore 1 and 2 respectively. By comparison, the levels during the 2002-year plant shut-down were 21.2 and 22.4 metres respectively. Therefore the most recent information shows that the head of the aquifer has not declined, rather, relative to the same period in 2000, the natural water-levels have increased by about 4.5 metres.

We do not have the information to explain why the pumped water-levels presented in the hydrograph by Environment Southland around the early part of 2001 were up to 3 metres lower. Natural static water-levels indicate that the aquifer has not declined at all. So therefore it is assumed that either the 2001 period was characterised by lower than normal recharge levels, or the bore measurements were made at different times of day late in the pumping period when the drawdown was greater.

## 3. Aquifer Pump Testing

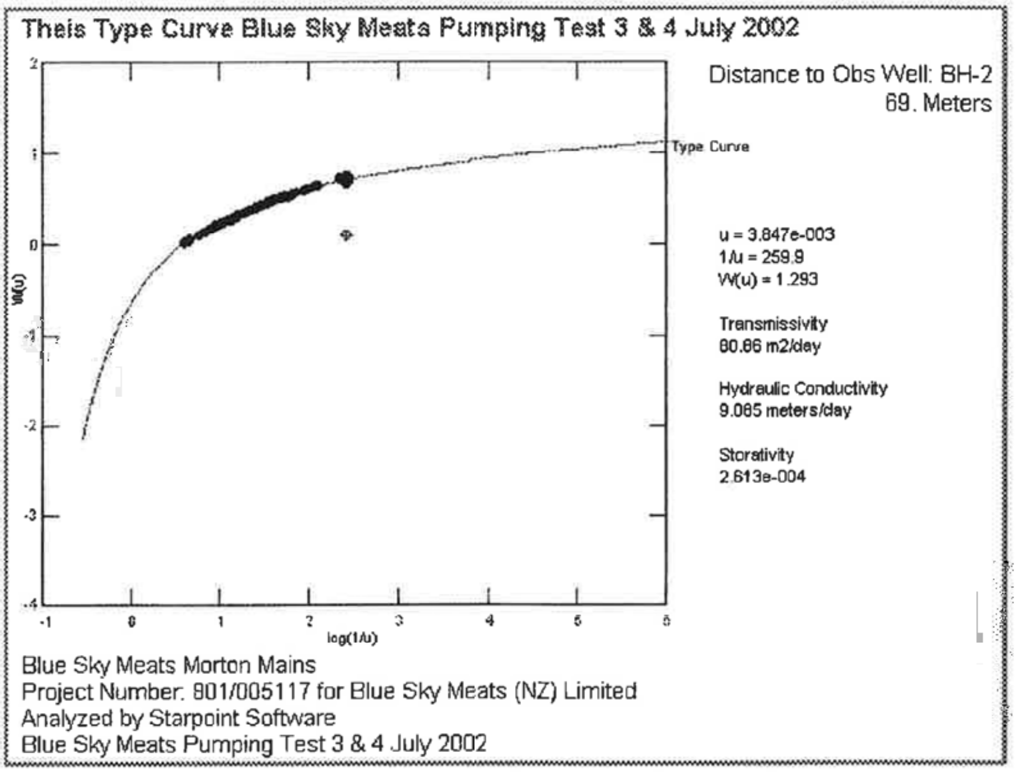
MWH undertook a constant rate pumping test on 3 & 4 July 2002 during plant shut-down. The No.1 bore, near the creek, was pumped and the No.2 bore was shut-off and used for observation purposes.

We were surprised to encounter a static water level of 48.2 metres in the No.1 bore. The bore was not pumped for a week prior to the test. A subsequent measurement in Bore 1 taken on 16 July encountered a static water-level of 21.2 metres. Once pumping started, the water-level drew below the 50-metre limit of the probe and subsequent measurements could not be made. It is also noted that by 11:06am during the recovery test the water level in Bore 1 had recovered to 26.42 metres. It is assumed that the initial water-level measurements in Bore 1 were anomalous.

A 24-hour duration constant rate test was successfully undertaken, followed by a recovery test. The observations are given in Appendix 1. Based on measurements in the observation well (at 69 metres radius), the aquifer exhibited the classic response of a confined aquifer when pumped, as shown in Figure 1. The aquifer parameters were determined as follows:

| | |
|---|---|
| Transmissivity (T) | 80 – 100 $m^2$/day |
| Storativity (S) | 0.00026 |
| Hydraulic Conductivity (K) | 10 – 12.5 m/day |

After the completion of the constant rate and recovery tests to establish the properties of the aquifer, a stepped-rate test was undertaken of the No.2 bore.



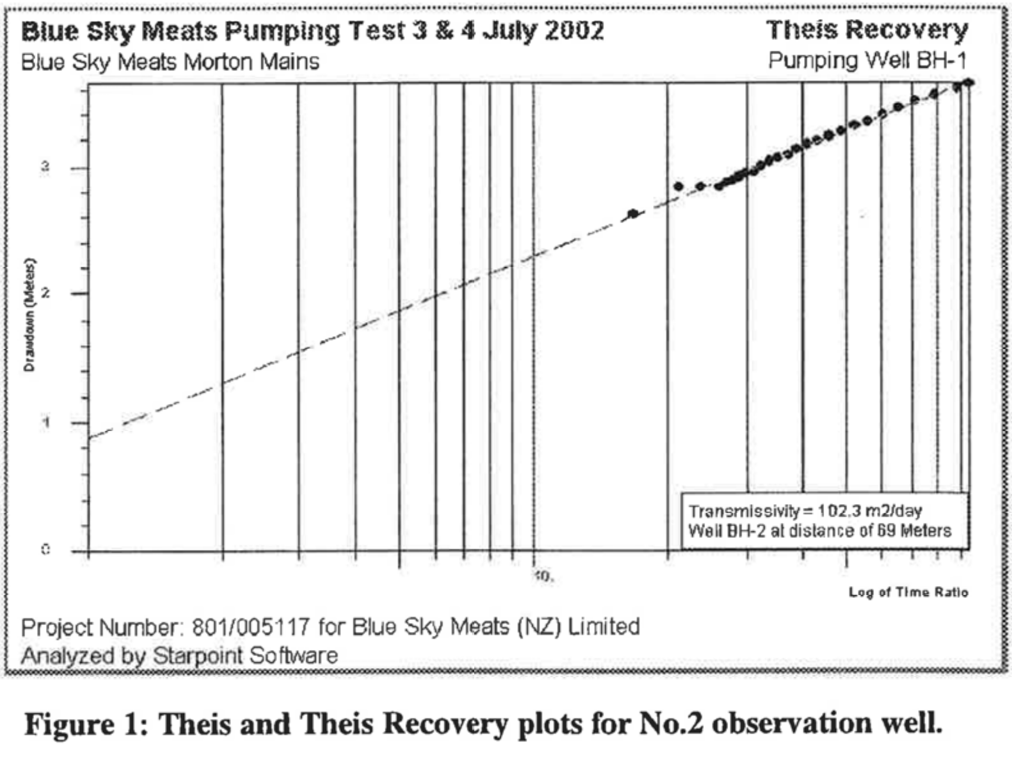




**Figure 1: Theis and Theis Recovery plots for No.2 observation well.**

# 4. Assessment of Effects

The application is to take up to 1000 cubic metres of water per day from the two bores. When allowed to discharge at their default pump rates, the No.1 well discharged at 786 $m^3$/day and the No.2 well discharged at 1385 $m^3$/day. Since both bores tap the same aquifer a short distance apart, the assessment assumes that the abstraction is from a single well only.

Assuming that 20-metres of drawdown is available, then the sustainable daily well yield when $T = 80$ $m^2$/day and $S = 0.00026$ is 1080 $m^3$/day.

The Theis equation describes drawdown that approaches steady-state asymptotically, but never actually reaches a single steady-state value. Therefore some amount of change in drawdown per time must be specified to indicate the well has reached steady state. The value entered here is the amount of drawdown that occurs in five minutes of pumping to define steady-state. By default, this value is 0.001 meters. In other words, when the change in drawdown as described by the Theis equation is less than 0.001 meters in five minutes, it is assumed that steady-state has been reached.

For this aquifer, with a pump rate of 1000 $m^3$/day, steady-state is reached after 4980 minutes of continuous pumping. The radius of influence under steady-state conditions is 4000 metres. This means that pumping from Blue Sky Meats will effect water-levels in the GLMA-3 aquifer over a 4000-metre radius, due to the low level of storage in the aquifer. It is understood that other bores may be situated within sufficient distance of Blue Sky Meats to potentially be effected by the abstraction. Interference effects on neighbouring wells are dependent upon the pump rate of both wells. At this stage we do not have this information in order to make a full calculation of the interference effect. Figure 2 illustrates that any effect on the specific capacity of a neighbouring well becomes increasingly minor beyond a radius of about 1500-metres.

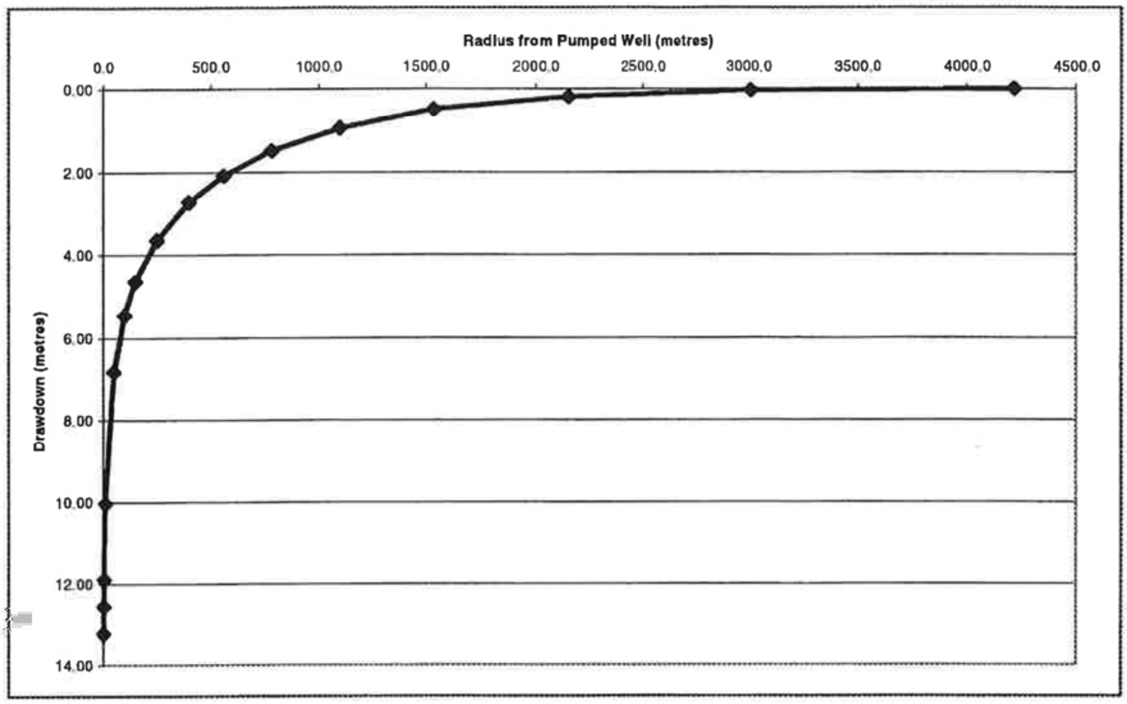



**Figure 2: Distance drawdown curve calculated for Blue Sky Meats under steady-state conditions.**

## 5. Well Efficiency

There is anecdotal evidence that the wells are not performing at a desirable level of efficiency.

The anomalous static water-level measurement for Bore 1 makes it difficult to determine how much drawdown occurred in the bore. Based on water-level measurements taken 12-days after the test (on 16 July), the water level in Bore 1 is expected to be about 1.3-metres higher than for Bore 2. This also correlates well with the recovery test information that shows that Bore 1 was indeed recovering in a similar fashion as Bore 2, and well above the static water-level recorded at the start of the constant rate test. Correcting the water-level in Bore 1 makes it possible to perform some rough-order well efficiency calculations. The water-level in Bore 1 must have been drawn down to below 50-metres in order to exceed the length of the probe, but must have remained above 65-metres in order for the pump to continue operating (the pump level). The actual drawdown is therefore assumed to be 27.1 – 42 metres.

For Q = 786 $m^3$/day, T = 80 $m^2$/day and S = 0.00026;

| | |
|---|---|
| Specific capacity for a 100% efficient well: | 59.36 $m^3$/day/m |
| Specific capacity observed: | 18.7 – 29 $m^3$/day/m |
| Well efficiency: | 31 – 48% |

This rough-order calculation implies that Bore 1 is operating at a very poor level of efficiency. This may also explain why the two bores have very different yields, even though they are at almost identical depths with identical pumps.

The efficiency of Bore 2 is calculated from the stepped-rate pumping test. This test shows that 68% of the head loss is attributable to laminar flow. It does not mean that the well efficiency is 68%, which is a relatively good efficiency for a well. Based on the mean pump rate for the step test (940 $m^3$/day):

| | |
|---|---|
| Specific capacity for a 100% efficient well: | 59.36 $m^3$/day/m |
| Specific capacity observed: | 43.46 $m^3$/day/m |
| Well efficiency: | 73% |

The well efficiency for Bore 2 is good. Bore 1 is a candidate for well maintenance or replacement with a new bore.

# 6. Summary

The aquifer tests confirm that the GLMA-3 aquifer is confined and exhibits a classic Theis response to pumping. The aquifer does not appear to be declining and this is further qualitative evidence that the aquifer is able to sustain the water abstraction. The drawdown characteristics for long-term pumping have been calculated and the activity will have a minor effect on the environment provided there are no other users of the same aquifer within about a 4-kilometre radius. Effects on water users beyond about 1500 metres radius (if there are any) are likely to be minor, subject to evaluating their pump rates.

The bores at Blue Sky Meats are capable of meeting the 1000 $m^3$/day of water sought by the consent application. Bore 1 is operating at a poor level of efficiency and is an ideal candidate for maintenance or replacement. It is understood that Blue Sky Meats do have plans to drill a new bore in the near future.

# Appendix – Test Data

```
Blue Sky Meats Pumping Test
Site Name:        Blue Sky Meats
Location:         Morton Mains
Test Date:        3 & 4 July 2002
Client:           Blue Sky Meats (NZ) Limited

Well Discharge Rate:          786.1 Meters3/Day

Well Label:       BH-1  BH-2
Distance to Obs Well:         7.5e-002 Meters  69. Meters
Aquifer Top to Screen Top:          5.9 Meters 5.57 Meters
Aquifer Top to Screen Bottom:             9.3 Meters  11.57 Meters
Aquifer Thickness:            8.9 Meters
```

| Trial | Time (Minutes) | Obs Well 1 (Meters) | Obs Well 2 (Meters) |
|---|---|---|---|
| 1 | 0 | 0 | |
| 2 | 22 | 0.85 | |
| 3 | 24 | 0.9 | |
| 4 | 26 | 0.91 | |
| 5 | 31 | 0.99 | |
| 6 | 33 | 1 | |
| 7 | 35 | 1.05 | |
| 8 | 37 | 1.1 | |
| 9 | 39 | 1.12 | |
| 10 | 41 | 1.15 | |
| 11 | 43 | 1.19 | |
| 12 | 45 | 1.205 | |
| 13 | 47 | 1.24 | |
| 14 | 49 | 1.26 | |
| 15 | 51 | 1.28 | |
| 16 | 53 | 1.3 | |
| 17 | 55 | 1.334 | |
| 18 | 57 | 1.355 | |
| 19 | 58 | 1.36 | |
| 20 | 63 | 1.42 | |
| 21 | 68 | 1.465 | |
| 22 | 73 | 1.51 | |
| 23 | 78 | 1.56 | |
| 24 | 83 | 1.6 | |
| 25 | 88 | 1.65 | |
| 26 | 93 | 1.69 | |
| 27 | 98 | 1.73 | |
| 28 | 103 | 1.77 | |
| 29 | 108 | 1.808 | |
| 30 | 113 | 1.84 | |
| 31 | 118 | 1.88 | |
| 32 | 128 | 1.94 | |
| 33 | 140 | 2.01 | |
| 34 | 148 | 2.06 | |
| 35 | 158 | 2.11 | |
| 36 | 168 | 2.16 | |
| 37 | 178 | 2.21 | |
| 38 | 188 | 2.25 | |
| 39 | 198 | 2.3 | |

| | | |
|---|---|---|
| 40 | 208 | 2.34 |
| 41 | 218 | 2.38 |
| 42 | 228 | 2.425 |
| 43 | 238 | 2.46 |
| 44 | 268 | 2.57 |
| 45 | 299 | 2.68 |
| 46 | 328 | 2.75 |
| 47 | 358 | 2.84 |
| 48 | 418 | 2.988 |
| 49 | 478 | 3.12 |
| 50 | 538 | 3.24 |
| 51 | 598 | 3.348 |
| 52 | 658 | 3.45 |
| 53 | 718 | 3.54 |
| 54 | 1198 | 4.06 |
| 55 | 1258 | 4.12 |
| 56 | 1318 | 4.17 |
| 57 | 1378 | 4.22 |
| 58 | 1438 | 4.26 |
| *59 | 1486 | 4.3 |
| 60 | 1487 | 4.29 |
| 61 | 1488 | 4.28 |
| 62 | 1489 | 4.2 |
| 63 | 1490 | 4.17 |
| 64 | 1491 | 4.11 |
| 65 | 1492 | 4.07 |
| 66 | 1493 | 4 |
| 67 | 1495 | 3.88 |
| 68 | 1497 | 3.81 |
| 69 | 1498 | 3.8 |
| 70 | 1499 | 3.76 |
| 71 | 1440 | 3.71 |
| 72 | 1441 | 3.68 |
| 73 | 1502 | 3.64 |
| 74 | 1503 | 3.61 |
| 75 | 1505 | 3.56 |
| 76 | 1507 | 3.5 |
| 77 | 1509 | 3.45 |
| 78 | 1511 | 3.4 |
| 79 | 1513 | 3.35 |
| 80 | 1515 | 3.31 |
| 81 | 1517 | 3.27 |
| 82 | 1519 | 3.23 |
| 83 | 1521 | 3.19 |
| 84 | 1523 | 3.16 |
| 85 | 1525 | 3.12 |
| 86 | 1527 | 3.09 |
| 87 | 1529 | 3.06 |
| 88 | 1531 | 3.03 |
| 89 | 1533 | 2.99 |
| 90 | 1535 | 2.96 |
| 91 | 1537 | 2.94 |
| 92 | 1539 | 2.91 |
| 93 | 1541 | 2.89 |
| 94 | 1543 | 2.86 |
| 95 | 1545 | 2.84 |
| 96 | 1551 | 2.84 |
| 97 | 1559 | 2.84 |
| 98 | 1580 | 2.62 |

# Appendix D: Pumping Test Analysis

The original bores (F46/0517 and F46/0518) were drilled in 1987 with a 24-hour aquifer test (Appendix C) conducted in 2002 (pumping F46/0518 at about 9 L/s with level monitoring at F46/0517). According to den Ouden Cooper Associates Ltd (2002)[2], the results from the constant rate pumping test suggested that the target deep aquifer exhibits a classic confined aquifer response to pumping. This was attributed to the deep aquifer being overlain by thick sequences of low permeability strata up to the unconfined aquifer zone.

Aquifer parameters were originally estimated from the analysis of groundwater level data (drawdown and recovery separately) with the Theis (1935) solution from the observation bore (F46/0517) data and estimated at about 80 to 100 $m^2$/d for transmissivity and 2.6 x $10^{-4}$ for storativity (Appendix C).

*Theis Reassessment of Aquifer Test Data:*

Reanalysis by PDP shows that the later-time drawdown response and recovery data appear to be able to be reasonably fit simultaneously with the Theis (1935) solution with the aquifer transmissivity set slightly lower (at about 64 $m^2$/d) and aquifer storativity set slightly higher (4.0 x $10^{-4}$) as shown on Figure 6 (Appendix A). The Theis assessment shown on Figure 6 indicates that the immediate zone around the bores may be more permeable than strata affected beyond the early stages of the test.

*Leakage Assessment of Aquifer Test Data:*

Maximum vertical leakage through the low permeability strata overlying the confined aquifer can be further estimated in accordance with the Ward and Lough (2011) solution using the results from the original testing data. The Ward and Lough solution allows for the addition of leakage through the overlying aquitard and drawdown within the shallow unconfined aquifer zone along with stream depletion effects to be considered if necessary. The Boulton solution (Boulton, 1973) could also be used in a similar manner, although does not allow for the presence of a stream. The original constant rate pump testing involved pumping from F46/0518 (within about 5 m of a channelised section of a first-order tributary to the Waihopai River) and groundwater level monitoring at F46/0517. The leakage assessment considers the geometry of the original aquifer testing and stream location above and applies a conservatively very-high streambed conductance (1,000 m/d) with a low unconfined aquifer transmissivity of about 1 $m^2$/d (considering the upper range hydraulic conductivity of claybound gravels expected at about 0.1 m/d according to Kruseman & de Ridder (2000) over an approximate 10 m thickness).

[2] Bore tests included in Appendix IV (prepared by MWH Ltd)

Groundwater quality sampling at the site commenced in November 2020 at the newly constructed shallow groundwater quality monitoring bore (CG11/0019, 10 m deep, within about 300 m of the current production bores). The sampling required a low-flow pumping rate at about 0.002 L/s, which resulted in a stable drawdown effect of about 0.03 m in bore CG11/0019. If this is converted to a specific capacity (0.066 L/s/m) and applied to empirical relationships between specific capacities and permeabilities in aquifers established by Bal, A., 1996, the unconfined aquifer in the vicinity of the production bores could have a relatively low transmissivity at around 22 $m^2$/d, however there is some uncertainty with this as the empirical relationship noted above is applied to specific capacities for supply bores and not usually applied to low-flow pumping rates used for groundwater quality sampling. However, it does indicate that the strata is not high yielding with a high transmissivity.

Storativity of the unconfined aquifer is assumed at 0.1 with the deeper aquifer parameters initially set at 64 $m^2$/d transmissivity and 4.0 x $10^{-4}$ storativity. The aquitard (approximately between the 10 m thick unconfined claybound gravels and the 115 m deep top screened depth) is expected to have an effective bulk thickness of about 105 m. The maximum possible value for the vertical hydraulic conductivity of the aquitard strata assessed through this reanalysis was estimated at about 0.012 m/d based on this thickness, which appears to be well in line with a mid-range conductivity estimate for layered clay according to Bear (1972) or a lower-mid-range conductivity for silt according to Freeze & Cherry (1979). This maximum possible vertical hydraulic conductivity of the aquitard strata above corresponds to a relatively low maximum aquitard conductance at about 1.14 x $10^{-4}$ $d^{-1}$ (across the bulk 105 m aquitard thickness), although the actual value could be much lower (less than 1 x $10^{-5}$ $d^{-1}$ considering the range of potential hydraulic conductivity values as described above). A longer term aquifer test would be required to further constrain this value.

A reasonable fit to the data can be achieved with the maximum potential aquitard conductance value above as shown on Figure 7 (Appendix A). The re-assessment of potential leakage requires an aquifer transmissivity and storativity similar to previous estimates from the Theis reassessment described above at 60 $m^2$/d and 3.6 x $10^{-4}$.

*Summary of Aquifer Parameters:*

The aquifer parameters derived from the original analysis in 2002 did not consider the maximum potential leakage effects from the overlying aquitard and corresponding potential drawdown within the unconfined aquifer zone and stream depletion effects. The following adopted range of parameters considers the original estimates of transmissivity and storativity for the confined aquifer and the reassessment of the aquifer test data described above for the further drawdown interference and stream depletion assessments:

- Confined Aquifer Transmissivity = 60 to 100 $m^2$/day
- Confined Aquifer Storativity = 2.6 to 4.0 x $10^{-4}$
- Aquitard conductance = < 1 x $10^{-5}$ $day^{-1}$ to 1.14 x $10^{-4}$ $day^{-1}$
- Unconfined Aquifer Specific yield = 0.1
- Unconfined Aquifer Transmissivity = 1 $m^2$/day to 22 $m^2$/day
- Streambed conductance = 1,000 m/day (set conservatively high for stream depletion calculations)

Overall, the reassessment of the original pumping test data above suggests that the deep gravelly aquifer strata screened by the current bores can be considered confined with a relatively low maximum potential aquitard conductance for the bulk of the overlying strata, acknowledging that this could be much lower implying greater confinement.

*Suitability of Aquifer Test:*

Aquifer test requirements under Appendix L.1 of the pSWLP state that for abstractions greater than 750 $m^3$/day from a confined aquifer, a step-drawdown test of at least three, one hour steps is required, with the maximum pumping rate being equal to or greater than the maximum proposed abstraction rate. Additionally, a constant rate pumping test is required at the maximum proposed abstraction rate and for at least 24 hours in duration with monitoring of drawdown and recovery in the pumped bore and at least two observation bores.

Based on these planning requirements, the 24 hours aquifer test undertaken is largely in line with the ES aquifer test requirements and their purpose. Step-drawdown testing has not been undertaken in all bores (the den Ouden Cooper Associates Ltd (2002) report refers to previous step-testing of bore F46/0517), the main purpose of a step-drawdown test is to confirm that the proposed yield is sustainable. The usage data and groundwater level data (Appendix A, Figures 3A and 3B) show that the abstraction has been occurring at long-term volumes of around 400 $m^3$/day on average since June 2018. Static groundwater levels during the 2019 and 2020 plant shutdowns appear to recover above the historic static groundwater levels during the 2000 plant shutdown. This suggests that the abstraction has been occurring without causing a long term groundwater level decline in the confined aquifer. Usage and monitoring of the bores also demonstrate that they can provide the required combined yield of about 17.4 L/s for the proposed maximum daily abstraction of 1,500 $m^3$ while the long term usage is expected to be similar with the weekly abstraction not exceeding 7,000 $m^3$.

The proximity, similar construction, and similar geologic logs of the current and original bores provides a strong case that the same confined aquifer zone has been utilised in the immediate vicinity of the original bores since usage of the current bores commenced. While the pumping rate in the original aquifer test is slightly less that the proposed maximum daily abstraction, it appears to be well in line with average long term usage. The aquifer test data also appear to be well fit and aquifer parameters are well constrained by the original assessment. The reassessment of the aquifer test data also indicates the original test provides a reliable basis for conservative upper estimates of parameters such as leakage for the purpose of assessing additional potential effects such as drawdown within overlying strata and stream depletion.

The aquifer testing undertaken to date is considered to meet the purpose of the Appendix L.1 pSWLP requirements and is therefore considered sufficient for assessing effects such as potential drawdown interference and stream depletion effects.

It is noted that the information supplied in this section was provided for the March 2021 change of conditions application and was accepted for the assessments of that application.

# Appendix E: Assessment of Stream Depletion Effects

According to the ES database, there are no regionally significant wetlands or sensitive waterbodies that could be expected to be impacted as the closest regionally significant wetland (Spurhead Swamp) is about 8.2 km northeast in a different surface water sub-catchment of the Waihopai River (within the upstream headwaters of the Waihopai River mainstem catchment).

Policy 29 (Stream depletion effects) of the RWP and Table L.2 (Classification and management for stream depletion effects) of the pSWLP provide criteria for the degree of hydraulic connection with a nearby surface water way. Both plans define the connection depending on the effect of short-term and long-term abstraction from the subject bore. The short-term assessment period is 7 days of pumping at the maximum proposed pumping rate for both plans, however the long-term assessment criteria are different. The RWP is based on 150 days of pumping at the average rate to deliver the seasonal volume while the pSWLP criteria is based on pumping at the maximum rate for either the maximum period allowed by the seasonal volume or a continuous period of 90 days.

*Proposed Southland Water and Land Plan:*

The deep confined nature of the pumped aquifer means that the hydraulic connection to surface water bodies is expected to be restricted. Rule 54(e) of the pSWLP does not indicate a stream depletion assessment is required for confined aquifers. However, for completeness, a conservative estimate of stream depletion has been completed.

Appendix L.2 of the pSWLP states that stream depletion should be calculated both over a 7-day period at the maximum rate, and over a continuous period of 90 days at the maximum rate, or shorter period if limited by the annual volume. Applying the Ward and Lough (2011) solution using the most conservative aquifer/aquitard parameters outlined in Section 7.2.3 estimated from the original pump test data allows for forward estimates of stream depletion effects on the channelised section of the first-order tributary to the Waihopai River (within about 5 m of the current abstraction bores F46/0561 and F46/1128).

With a constant pumping rate set at 1,000 $m^3$/d (considering the proposed 7,000 $m^3$ weekly limit at about 11.6 L/s as a constant rate) the stream depletion as a result of potential vertical leakage through the aquitard is estimated to peak at about 0.5 L/s (about 4.5% of the pumping rate) after 90 days at the maximum proposed consented long term abstraction. This is at the maximum aquitard conductance estimated above, when in actual fact the aquitard conductance may be significantly lower resulting in even less potential for stream depletion. For example, with an aquitard conductance one-magnitude lower (lower range hydraulic conductivity values for the low permeability strata), estimated stream depletion effects peak at about 0.15 L/s. In addition, the streambed conductance has been estimated to be much higher than expected, also resulting in a conservative assessment.

Short term stream depletion effects associated with the proposed 1,500 $m^3$/d maximum daily abstraction (about 17.4 L/s for 4.7 days until the 7,000 $m^3$ weekly abstraction is used up) are estimated to be significantly less (less than 0.15 L/s with the conservative aquitard conductance value) than the longer term effects described above as would be expected.

As noted above, analyses by NIWA (NZ River Maps) suggest that the Waihopai River tributary adjacent to the applicant's bore has a simulated 1 in 5 year low flow of about 2.99 L/s (median flow simulated at about 19.86 L/s), so in a worst-case scenario the proposed take is not expected to induce a stream depletion effect that would cease or significantly affect flow or extent of the surface waterway during low-flow conditions. Overall, the re-assessment of maximum potential vertical leakage through the aquitard coupled with the forward estimate of stream depletion effects helps establish that the proposed take would result in less than minor effects on surface water bodies.

According to the pSWLP Appendix L.2, the estimated stream depletion effect is low, and the proposed take should therefore be managed solely as a groundwater take with the full abstraction applied to groundwater allocation.

It should also be noted that no actual change in the consented stream depletion effect is expected as a result of this consent application, as only a change in the short term rate is sought. In addition, it is noted that most of the water is expected to be returned to land following use in the plant, so there may be no potential for stream depletion.

*Regional Water Plan:*

The RWP states that the stream depletion effect should be calculated both over a 7-day period at the maximum abstraction rate, and also after pumping over 150 days at the average daily rate (in this case the proposed maximum weekly rate of 7,000 $m^3$ or 11.6 L/s as a constant rate). Using the same approach as used above, the modelled stream depletion with maximum potential vertical leakage through the aquitard is estimated to peak around 0.6 L/s after pumping for 150 days at the rate of 11.6 L/s with a conservative estimate of aquitard conductance.

The above assessments would similarly categorise the take in the low stream depletion category under the RWP as would be expected in this hydrogeologic setting. As such, under the RWP, there is considered no need to place any minimum flow restrictions on the consent.

As described above, no actual change in the consented stream depletion effect is expected as a result of this consent application, as only a change in the short term rate is sought, and with the return of water to the land, there may be no potential for stream depletion.

PATTLE DELAMORE PARTNERS LTD

# Assessment of Environmental Effects Technical Report – New Wastewater Treatment Plant for Blue Sky Meats, Morton Mains

Blue Sky Meats (N.Z.) Limited

# Assessment of Environmental Effects Technical Report - New Wastewater Treatment Plant for Blue Sky Meats, Morton Mains

Prepared for

Blue Sky Meats (N.Z.) Ltd

December 2018

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# Quality Control Sheet

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**Limitations:**

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Blue Sky Meats (N.Z.) Limited and others (not directly contracted by PDP for the work), including Environment Southland. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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## Appendices

# 1.0 Introduction

Blue Sky Meats (N.Z.) Ltd (Blue Sky Meats) own and operate a lamb & sheep processing and an ancillary meat rendering plant at Morton Mains, Southland.

Pattle Delamore Partners Ltd (PDP) has been engaged by Blue Sky Meats to undertake detailed design of a new wastewater treatment plant (WWTP) for the Morton Mains plant. The contract for construction of the new WWTP will be tendered during December 2018 and early-2019.

New resource consents, certificates of compliance, or variations to existing resource consents held by Blue Sky Meats, are required from Environment Southland and Southland District Council (SDC) for discharge and land use activities associated with the new WWTP.

The purpose of this Assessment of Environmental Effects (AEE) technical report is to support resource consent applications to Environment Southland and Southland District Council associated with discharge and land use activities.

## 1.1 Background

Blue Sky Meats processes up to 5,000 lambs and sheep per day at their Morton Mains plant. The site also undertakes rendering for meat, blood & bone meal and tallow.

Wastewater from the primary slaughterhouse is presently screened before being transferred to a holding pond and combined with untreated wastewater from the rendering plant. Wastewater from the holding pond is transferred into an irrigation storage lagoon which is aerated for storage purposes, however is not necessarily biologically treated. From the aerated irrigation storage lagoon wastewater is irrigated onto pastoral farm land operated as a "zero grazed" system (cut and carry only) under Environment Southland Resource Consent No. 201191.

Managing the nitrogen load presently applied to the irrigation area is constraining the site's rendering plant operation. An improved wastewater treatment system is required to allow the plant to operate at full capacity, and to reduce nitrogen loading to the irrigation disposal system.

Construction of the new WWTP will involve modifying and building on existing infrastructure to develop a full biological nitrogen removal treatment system. This will include a covered anaerobic treatment lagoon and activated sludge plant operated as a sequencing batch reactor (SBR).

Relevant drawings showing general arrangements of the proposed new WWTP are attached to this report as Appendix A. The general layout of the Blue Sky Meats Site, and of the proposed new WWTP system is shown in Drawings D001 and D002, Appendix A.

# 2.0 Description of the Environment

## 2.1 Site Description

The site is located at 729 Woodlands-Morton Mains Rd, Morton Mains, Southland within the land parcel legally described as Lot 1 DP595 owned by Blue Sky Meats (N.Z.) Limited.

The site is presently zoned Rural under the Southland District Plan.

The proposed WWTP will be located adjacent to the existing aerated irrigation storage pond as shown on Drawing D001, Appendix A. The proposed WWTP site is presently stockyards associated with the processing plant and grazing land.

The Blue Sky Meats site is bounded by Woodlands-Morton Mains Road to the south east (approximately 200 m from the proposed WWTP site) and farmland on all other sides. The nearest sensitive receptor (dwelling) to the Blue Sky Meats site is approximately 500 m to the south east. The processing plant and the proposed location of the new WWTP are generally hidden from view from neighbouring properties and from Woodlands-Morton Mains Road by existing mature trees.

The proposed WWTP site slopes in a general north east direction towards the drain shown on Drawing D001, Appendix A. Stormwater runoff from the wider Blue Sky Meats site is also directed to this agricultural drain (PDP site inspection, August 2018), which eventually flows to an unnamed tributary of the Waihopai River.

## 2.2 Site Geology and Geotechnical Investigation

The GNS Science New Zealand Geology Web Map describes the geology of the site as weathered gravel, sand, silt and mud of alluvial and colluvial origin.

As part of the detailed design phase, four geotechnical test pits were excavated in the location of the proposed WWTP in August 2018. The test pits were excavated to a maximum depth of 3.7 m below ground level (bgl), and encountered ground conditions generally consistent with the GNS geological description. The near surface soil profile encountered in the four test pits is summarised in Table 1.

**Table 1: Near Surface Soil Profile**

| Depth (m bgl) | Geological Description |
|---|---|
| 0 – 0.2 m | Topsoil, Dark brown, loosely packed and friable, dry, slightly plastic. |
| 0.2 – 1.3 to 2.4 m | Silty Clay, light brown, firm, moist, plastic, bedded, alluvial silt/clay. |
| 1.3 to 2.4 – 3.1 to 3.7 m | Gravel in a matrix of light grey to light brown becoming orange brown below 2.5 m silt and clay, dense, slightly plastic, wet. Gravels are sub rounded to rounded, Alluvial gravels. |

*Notes:*

1. *Geotechnical information sourced from email from Gerald Strayton (PDP Technical Director – Geotechnics) to Josh Lotter (PDP Environmental Engineer) dated 28 August 2018.*

In one test pit the gravel layer was not present and a silty sand, white streaked yellow, medium dense and bedded was present to the base of the excavation at 3.7 m bgl.

No fill material was encountered in the four test pits excavated.

## 2.3 Surface Water

The site is located within the Waihopai River catchment. The Waihopai River drains a north east to south west aligned catchment of approximately 250 km$^2$ between the Edendale terrace (lower Mataura Valley), and Invercargill. Only the lower catchment is urbanised where the Waihopai River discharges to the New River Estuary at Invercargill. The primary catchment land use is agricultural land, with the catchment classified under the Land Air Water Aotearoa (LAWA) online database as predominantly ‘lowland pastoral farmland’.

Stormwater from the Blue Sky Meats site is presently discharged via the existing surface drain to the north east of the site shown on Drawing D001, Appendix A as a permitted activity. This drain flows on a general north west alignment before turning to the south west and flowing into an upper tributary of the Waihopai River to the south of Woodlands Morton Mains Road.

Water quality sampling is carried out in the lower Waihopai River upstream of Queens Drive, Invercargill where the river enters the urban area. Beacon Environment Southland online GIS and LAWA’s online database report the following water quality states and trends for the Waihopai River at Queens Drive summarised in Table 2.

**Table 2: Water Quality Summary Waihopai River at Queens Drive**

| Water Quality Indicator | 5 Year Median Value | State Relative to Like Sites | Trend (10 year) |
|---|---|---|---|
| Bacteria – E. *coli* | 330 MPN/100 mL | Worst 25% of like sites | Very likely improving |
| Clarity - Turbidity | 3.4 NTU | Worst 50% of like sites | Not assessed |
| Nitrogen – Total Nitrogen | 2.8 $g/m^3$ | Worst 25% of like sites | Very likely improving |
| Nitrogen – Ammonia Nitrogen | 0.0165 $g/m^3$ | Worst 25% of like sites | Very likely improving |
| Phosphorus – Dissolved Reactive Phosphorus | 0.009 $g/m^3$ | Best 50% of like sites | Very likely improving |
| Phosphorus – Total Phosphorus | 0.028 $g/m^3$ | Worst 50% of like sites | Very likely improving |

*Notes:*

1. *All data sourced from LAWA, 20 November 2018 (https://www.lawa.org.nz/explore-data/southland-region/river-quality/waihopai-stream/waihopai-river-us-queens-drive/).*

Further to Table 2, Environment Southland report that the Macroinvertebrate Community Index (MCI) for the Queens Drive monitoring site is 'Poor' (Beacon GIS, LAWA,).

## 2.4 Groundwater

Three out of four test pits described in Section 2.2 encountered groundwater seepage into the excavation at approximately 2 to 2.5 m bgl (August).

The Blue Sky Meats site is located within the Waihopai groundwater management zone under both the Southland Regional Water Plan (RWP) and the Proposed Southland Water and Land Plan (pSWLP). Environment Southland's Groundwater Zone Information Sheet includes general groundwater quality information for the Waihopai zone. Groundwater quality in this zone is influenced by nutrient enrichment, however generally remains within the limits set by the Drinking-water Standards for New Zealand 2005 (Revised 2008)[1].

The Waihopai groundwater catchment consists of a relatively thin (<30 m) layer of gravels overlying tertiary sediments (low permeability soils). Recharge to the Waihopai groundwater zone is exclusively from rainfall recharge estimated at 521 mm/year[1].

[1] Environment Southland's Groundwater Zone Information Sheet for the Waihopai zone

Numerous partially incised streams exist across the Waihopai groundwater zone, which forms the rolling topography. The major component of groundwater flow occurs to local rivers and streams. Surface water quality characteristics are therefore expected to reflect groundwater quality.

#### 2.4.1 Nearby Groundwater Bores

Four well records exist at the Blue Sky Meats site associated with onsite water supply bores F46/0517, F46/0518, F46/0561, F46/1128. Details for wells F46/0561 and F46/1128 are available on Environment Southland's Beacon Online GIS. These wells were drilled to depths of 121.8 and 118 m bgl respectively, and are screened near the base. The initial water level readings in these wells were 29 and 26.4 m bgl respectively. As such, these bores are not expected to be influenced by changes in shallow groundwater levels.

There are no other production bores within 1.0 km of the site listed on Environment Southland's Beacon Online GIS. The nearest production bores to the proposed WWTP site, which also draw water from shallow groundwater, are domestic supply wells F46/0376 and F46/0874. These bores are located at Morton Mains approximately 1.2 km from the proposed WWTP site. An initial water level of 1.7 m bgl was recorded in F46/0874.

## 3.0 Proposed Works

### 3.1 WWTP System Description

The proposed WWTP is a biological treatment plant utilising both a covered anaerobic treatment lagoon and aerated treatment lagoon operated as a sequencing batch reactor.

The biological treatment plant is proposed to comprise of the following processes:

1. Screened wastewater from the primary slaughterhouse and untreated wastewater from the rendering plant will be discharged to the existing holding pond, which will be converted to a flow equalisation basin.

2. From the flow equalisation basin wastewater will be pumped into a new High Density Polyethylene (HDPE) lined and covered anaerobic lagoon with an active volume of 5,000 $m^3$ (active storage volume) allowing for biogas management through biogas flaring and a contingency biofilter. These components are shown on D005.

3. Partially treated wastewater from the covered anaerobic lagoon will flow via a gravity transfer into a 6,000 $m^3$ (active storage volume) HDPE lined aerobic lagoon operated as a sequencing batch reactor (SBR) and optimised for biological nitrogen removal (BNR). 230 kW of aeration in the SBR lagoon will allow for reduction of nitrogen to allow sustainable

land treatment. Further provision is made to increase aeration to 300 kW.

4. Treated wastewater will be discharged via a decant system to the existing irrigation storage lagoon, which may contain some level of mechanical aeration to ensure dissolved oxygen levels are maintained prior to land treatment.

The proposed system is shown in D005, Appendix A. Design of the WWTP has been overseen by suitably qualified and experienced Chartered Professional Engineers (Daniel Garden, PDP, Chartered Professional Engineer 1018789, and Azam Khan, PDP, Chartered Professional Engineer 194400).

## 3.2 Construction Works

Once consents are granted, Blue Sky Meats propose to carry out the works during early and mid-2019.

The primary components of the construction works (with respect to resource management) will involve:

- Bulk earthworks to form the wastewater lagoons through cut to fill (approximately 5,000 $m^3$).
- Construction of HDPE liners and HDPE cover on the anaerobic lagoon.
- Installation of a biogas management system including biogas flare unit and contingency biofilter.
- Groundwater dewatering and leak detection systems, as well as stormwater management systems.
- Installation of above and below ground pipelines, pumps, manholes, mechanical pipework, electrical and control systems including control building and other systems associated with operating the WWTP.

## 3.3 Leak Detection System

It is proposed to install a leak detection underdrainage system below the invert of the lagoons as shown on Drawing D007 and D114, Appendix A. The leak detection system will discharge to a manhole with a closed valve on the outlet.

Blue Sky Meats personnel will periodically inspect the manhole to check for leakage of wastewater. The leak detection system may from time to time intercept groundwater. If this occurs, Blue Sky Meats personnel will confirm that the water present is groundwater in accordance with the site Operation and Maintenance Manual (O&M manual; to be prepared by the Contractor as part of the contract works) and discharge the standing water to the stormwater system.

## 3.4 Groundwater Management

The seasonal high groundwater level at the construction site may be slightly above the proposed new lagoon invert level (Section 2.2 and Section 2.4). There is a risk that groundwater may be present to this level during construction, and could therefore impact on construction of the new wastewater lagoons.

Seasonal high groundwater is not expected to impact on operation of the WWTP when the lagoons are full.

An existing 160 mm outer diameter groundwater dewatering drain exists in the location of the proposed lagoons. Further 160 mm outer diameter land drains are proposed to be installed at the perimeter of the proposed new wastewater lagoons as shown in Drawing D007, Appendix A.

The proposed dewatering system will discharge to the surface drain to the north east of the existing irrigation lagoon. It is expected that the groundwater dewatering system will only intercept groundwater periodically.

If groundwater is encountered during construction, the contractor may increase the dewatering flowrate by pumping water out of the groundwater dewatering system. This water will be discharged in accordance with the site erosion and sediment control plan (Section 4.2.1) and the Environment Southland Builders Pocket Guide (Practical Advice on Managing Worksites and the Environment, 3rd Edition).

## 3.5 Stormwater Management

The primary new impervious area associated with the proposed WWTP is the new anaerobic lagoon. Stormwater runoff from the surrounding WWTP site will discharge to the surrounding pervious areas. Roof runoff from the MCC building (Drawing D002, Appendix A) will be discharged to the existing site stormwater system.

Rainfall on the anaerobic lagoon cover will be directed to a sump at the centre of the lagoon via preformed channels as shown on D007, Appendix A. From there, the stormwater will be pumped to MH1, and discharged to the surface drain to the north east of the site.

The stormwater from the anaerobic lagoon cover sump is expected to be pumped at a discharge flowrate of approximately 4.5 L/s. Based on a Rational Method estimate for the pre-developed wastewater lagoon area, this flowrate is less than the 2 year Average Recurrence Interval (ARI) 1 hour rainfall event runoff.

The discharge to the existing stormwater drain will be via a stabilised outlet.

Stormwater runoff from the HDPE cover is expected to contain low levels of stormwater contaminants, similar to roof runoff. The HDPE cover will be fully sealed, and therefore no wastewater, wastewater aerosols or sludge will be entrained in stormwater runoff from the HDPE cover.

## 3.6 Biogas Management

Biogas is a by-product of anaerobic digestion of wastewater containing organic matter. Biogas consists predominantly of methane (50-60%) and carbon dioxide (40-50%) but also contains very low levels of trace gases such as hydrogen, nitrogen and odour generating hydrogen sulphide. Other than hydrogen sulphide, small amounts of other odour generating compounds are also present.

The proposed covered anaerobic lagoon will have an air-tight gas collection system, which will discharge to a biogas flare to allow combustion of biogas and contingency biofilter treatment system to eliminate the potential environmental and nuisance effects associated with biogas.

### 3.6.1 Biogas Collection

On average, the biogas production rate from the anaerobic lagoon is estimated to be in the order of 4,500 N $m^3$/d. This is based on the design carbonaceous Biochemical Oxygen Demand ($cBOD_5$) loading from the processing plant. A peaking factor of 2 provides a conservative estimate for biogas generation during peak production conditions at Blue Sky Meats, corresponding to a peak biogas production rate from the proposed anaerobic lagoon in the order of 9,000 $m^3$/d.

Windsor Engineering Limited has prepared a preliminary design for the Blue Sky Meats biogas flare system on the basis of the biogas production rates calculated by PDP.

Provision is made in design for at least 1,000 $m^3$ storage of biogas under the HDPE floating cover at atmospheric pressure.

### 3.6.2 Biogas Treatment

Burning biogas through the flare system will significantly reduce greenhouse gas emissions from the site. Sulphurous compounds and other gases will be neutralized by the flaring process. The capture and combustion of gases from covered anaerobic lagoon is considered best practice.

Gas flaring will be utilised as the primary treatment system for the biogas. The captured gas is distributed through a collection pipe to the flare, via a fan, to be burnt off. The captured gas is not required to be pressurised or stored in the process.

The flare will operate on a pressure switch; when the pressure reaches the set point, the control valves will open and the flare will operate until pressure reduces below the lower pressure threshold. To minimise any ingress of oxygen from outside the pressure under the cover will not be allowed to reduce below atmospheric pressure.

The flare tip will be shielded to ensure that complete combustion occurs and to provide a wind shield to the naked flame. The flare unit will be maintained with continually cycling electrical auto-ignition unit (no pilot flame requirement).

Odour generating gases will be destroyed during combustion and therefore no objectionable odour will be discharged after the flare unit.

The contingency biofilter will provide for biogas biofiltration in the event the flare or the extraction blower is malfunctioning. A temperature sensor will be installed at the flare tip to identify if the flare is not operating. This will trigger an alarm (electronic notification to the plant operator) and biogas will be diverted to the contingency biofilter.

The design empty bed residence time (EBRT) for the biofilter is 500 seconds, which is a conservative design parameter. The biofilter media will be fine bark/compost overlying a drainage bed. This will be irrigated during extended periods of low rainfall to maintain suitable moisture content. The biofilter will be seeded with material from the existing rendering plant biofilter, and periodic manual diversion of biogas to the biofilter will maintain the required microbiological population in the biofilter media.

While the biofilter will reduce a limited amount of the methane in the biogas, it will reduce odorous hydrogen sulphide levels so that odour discharge will not cause nuisance effects, even during flare malfunction.

During biofilter operation, the odorous gases will be treated to the extent that any objectionable odour will be reduced to low levels at the biofilter.

All condensates (liquids condensing from the biogas stream) from the biogas prior to the flaring unit and the leachate from the biofilter underdrain will be collected and directed into the WWTP influent wastewater stream.

### 3.6.3 Anticipated Emissions from Flare and Biofilter

Anticipated air discharge volumes and constituents are outlined in Table 3.

**Table 3: Anticipated Air Discharge Requirements**

| **Parameter** | **Flaring** | **Biofilter** |
|---|---|---|
| Peak flow rate (N $m^3$/d) | 9,000 | 9,000 |
| Average flow rate (N $m^3$/d) | 4,500 | 4,500 |
| Duration (days per year) – Nominal Estimate Only | 360 | 5 |
| **Estimate of Bulk Air Discharge Constituents** | | |
| Carbon dioxide (and water vapour) | 100% | 40%-50% |
| Methane | 0% | 50%-60% |

*Notes:*

1. *The biofilter is to be operated under contingency only and the discharges through the biofilter is given as maximum values under worst case.*
2. *Both the flare unit and biofilter are sized to handle 9,000 $m^3$/d of biogas.*

The biofilter emission characteristics will be similar to the biogas constituent, with the exception of hydrogen sulphide and other odour generating gases, which will be significantly reduced by the biofilter prior to discharge.

Carbon monoxide (CO) emissions may be expected as the flare temperature may not necessarily be above 850 °C at all times. Studies based on open landfill flares[2] suggest that carbon monoxide concentration in efficiently operated biogas flares is approximately 3 g/m$^3$ in exhaust gases.

## 3.7 Monitoring, Operation and Maintenance

Once operational, the treatment system will require regular monitoring and maintenance. A separate Operation and Maintenance Manual (O&M manual) will be prepared for the system. This O&M manual will include, but not be limited to:

- Health and safety considerations and requirements;
- A description of wastewater treatment system;
- System layout diagrams and drawings;
- Discharge details and criteria;
- Solids management and gas management system details;
- Stormwater and groundwater management system details;
- Process control;
- Operational limits;
- General operation and maintenance details;
- Pipework, pump and valve details;
- Asset resilience and maintenance procedures;
- Equipment schedules;
- Maintenance schedules;
- Contingency measures for pump failures, blockages, chemical spills and System Performance Problems.

### 3.7.1 Wastewater Solids Management

Microbial solids are a by-product of all wastewater treatment systems. Solids that accumulate in the wastewater treatment system will require periodic removal.

[2] DEP (2010). *Engineering Evaluation/Fact Sheet R13-2592B*, West Virginia Department of Environmental Protection, Division of Air Quality.

For the covered anaerobic lagoon solids accumulation will require a long term management plan (10 year plan or longer). If excavation and removal of anaerobic lagoon solids is required, any associated permits or consents will be sought as required.

Activated sludge from the SBR will be periodically pumped out and mixed with the treated wastewater stream to be irrigated to land under Environment Southland Resource Consent No. 201191. The resulting discharge will be consistent with the existing resource consent conditions.

# 4.0 Assessment of Environmental Effects

## 4.1 Positive Impacts

The proposed wastewater treatment plant will have significant environmental benefit by reducing the leachable nitrogen loading to the existing irrigation system. It will also reduce odour associated with the existing land treatment system.

## 4.2 Construction and Earthworks

The construction works have the potential to cause short-term adverse environmental effects. The following sections assess actual and potential effects on the environment associated with the proposed construction works.

### 4.2.1 Runoff

Prior to construction the contractor will prepare and give effect to an erosion and sediment control plan (ESCP) in accordance with the Environment Southland Builders Pocket Guide (Practical Advice on Managing Worksites and the Environment, 3rd Edition). The ESCP will include but not be limited to:

- silt fencing around any excavation areas which may generate sediment;
- mitigation of tracking of soil from trucks such as a wheel wash system;
- temporary runoff collection and decanting structures for containment of sediment laden stormwater runoff;
- covering of exposed earth surfaces as soon as is practicable to avoid erosion;
- monitoring of erosion and sediment control devices.

These measures are considered appropriate for the scale of the works and will ensure that sediment laden runoff is contained and or treated prior to discharge.

#### 4.2.2 Vibration

Vibrating rollers and other standard vibro-compaction machinery may be utilised in the works. It is not expected that the short term use of this machinery will have any effect beyond the Blue Sky Meats site.

#### 4.2.3 Construction Noise

Construction noise and hours of work associated with the proposed new WWTP will comply with Southland District Plan limits (Rule NSE.12).

#### 4.2.4 Dust

There is potential for minor dust generation during the construction as the earthworks activity will be limited to excavation of in-situ material and deposition and compaction of material within the proximity of the cut area. Once the earthworks are completed there will be no potential for dust to occur, as all exposed areas will be either under synthetic liner or grassed.

The contractor will have a water cart and water supply available on-site for dust suppression as required. All exposed earth surfaces will be covered as soon as practicable to minimise dust generation potential.

#### 4.2.5 Traffic

There will be some increased vehicle movements to the site during construction of the treatment facility, however once operational, traffic movements associated with ongoing management will be unaffected.

### 4.3 Discharges to Air and Odour

The collected biogas will destroyed by combustion (thermal oxidation) with the use of a flare system specifically designed for purpose. Thermal oxidation or destruction is considered one of the most effective techniques for odour control because it removes not only hydrogen sulphide but also methyl mercaptan and practically any other objectionable odorous gas that could be present in the biogas. Flaring essentially eliminates all odours.

The discharge of contaminants into the air from the proposed biogas flare system will be combustion by-products, namely carbon dioxide, small amounts of oxides of nitrogen and sulphide and water. There is generally no objectionable odour associated with the combustion of biogas.

A biofilter will also be constructed at the site as a contingency system. Biofilters are a widely accepted method for odour control and all odorous gases are expected to be removed to levels that are deemed no longer objectionable at the site boundaries.

The proposed biogas collection and flaring system has been designed to ensure that the discharge will not result in an objectionable odour effect at or beyond the boundary of the subject property.

From the SBR lagoon, the discharges to air will be carbon dioxide and this presents no odour risk.

Spray drift resulting from the aerator operation in the SBR lagoon will be negligible. The spray zone will be limited to just above the water surface around the aerators in the SBR. The aerators will be located in the middle of the SBR with no potential for aerosols forming to the extent beyond the initial spray zone and the spray drift to occur beyond the edge of the SBR.

Once the WWTP is constructed the irrigation storage lagoon will hold biologically treated wastewater with low $BOD_5$. It is therefore unlikely that anaerobic conditions would develop, and no perceivable odour discharge is expected from the irrigation storage lagoon.

## 4.4 Noise

The aerated lagoon will produce minor noise through the use of the aerators. Noise levels at the outer batter of slope are expected to be less than 45 dBA.

## 4.5 Effects on Groundwater

### 4.5.1 Groundwater Quantity

The proposed dewatering system will draw the localised groundwater level down by a maximum of approximately 1 - 1.5 m (based on the estimated high groundwater level outlined in Section 2.4). The zone of influence of the groundwater dewatering system is expected to be limited to the immediate area of the WWTP, in the order of 20 m beyond the perimeter of the dewatering drains.

No effects are expected on other groundwater users, as the drawdown effect will be localised, and nearby production bores generally draw water from deeper aquifers (Section 2.4).

### 4.5.2 Groundwater Quality

The proposed wastewater lagoons will be lined with a 1.5 mm thickness HDPE liner. The liner material will be subject to a manufacturer's guarantee of 20 years minimum design life applicable to water holding applications and use for wastewater containment.

A leak detection system will be installed and monitored to provide first warning of any leakage which may occur in accordance with the site O&M manual.

This containment system is at least equivalent to the industry standard level of groundwater protection for a WWTP of this type and groundwater environment.

## 4.6 Effects on Surface Water

### 4.6.1 Groundwater Dewatering

As outlined in Section 2.4, the water quality in the Waihopai River system is expected to reflect shallow groundwater quality, and as such it is not expected that the discharge of groundwater from the proposed groundwater dewatering system will affect surface water quality.

The estimated dewatering flowrate of approximately 1 – 6 L/s (based on nominal aquifer parameters determined from a visual assessment of the site soils) is expected to augment base flows in the surface water system and may provide some ecological enhancement.

### 4.6.2 Stormwater Discharge

Stormwater discharged to surface water from the aerated lagoon cover is expected to have similar water quality characteristics as roof water runoff, and will contain low levels of typical stormwater contaminants.

Stormwater runoff from gravel, slabs and other surrounding areas of the WWTP is expected to have similar characteristics to runoff from the wider Blue Sky Meats site. There will be no direct pathways for wastewater contamination to occur in routine stormwater discharges. All air valves will be fitted with tubing to direct leakage back into the WWTP.

Any hazardous substances stored at the WWTP site will be contained or kept indoors in accordance with Blue Sky Meats protocol.

Stormwater will be discharged via pumping at a flowrate of approximately 4.5 L/s. This flowrate is expected to be less than the 2 year Average Recurrence Interval (ARI) 1 hour rainfall event runoff for the existing site area.

### 4.6.3 Wastewater Storage

The crest of the proposed SBR and Anaerobic Lagoon embankments will be approximately 2.5 to 3.0 m above the surrounding ground level (Drawing D002, Appendix A). The WWTP site is located adjacent to an existing farm drain; however is removed from the main floodplain of the Waihopai River and its tributaries. The drain invert is approximately 2-3 m below the ground level in the location of the proposed WWTP. Flooding of this drain, should it occur, is unlikely to reach the WWTP site. It is not expected that floodwater would overtop the lagoon embankments even in severe flood conditions.

The proposed lagoons will not divert any existing floodway or overland flow path.

## 4.7 Cultural and Archaeological Values

There are no anticipated issues associated with cultural and archaeological values. However, should any archaeological remains be uncovered during the minor excavation works proposed, all work will cease in the vicinity of the discovery and the New Zealand Historic Places Trust (NZHPT) will be contacted so that the appropriate action can be taken before any work continues.

## 5.0 Mitigation Measures

Adverse effects on the receiving environment associated with the proposal are being minimised and/or eliminated by the following mitigation measures:

i. Use of wastewater treatment technology that will reduce solids, organic and nitrogen loadings discharged to land via irrigation;

ii. Reduction of greenhouse gas emissions by controlled collection and combustion of biogas;

iii. Ensuring a contained physical extent for the wastewater treatment plant, including a site which avoids any negative visual, noise and aesthetic impacts and having the levels generally present prior to development of the wastewater treatment plant;

iv. Significantly reducing the potential for groundwater contamination with the use of a HDPE liner;

v. Minimising and/or controlling any discharges of silt and stormwater run-off during construction;

vi. Eliminating the potential for objectionable odour by collecting all gases generated from the anaerobic treatment facility and controlled thermal destruction of all gases.

vii. Mitigation of potential fugitive dust occurring during construction by applying water or covering exposed earth surfaces.

viii. Restriction of work hours and maintaining acceptable levels of construction noise.

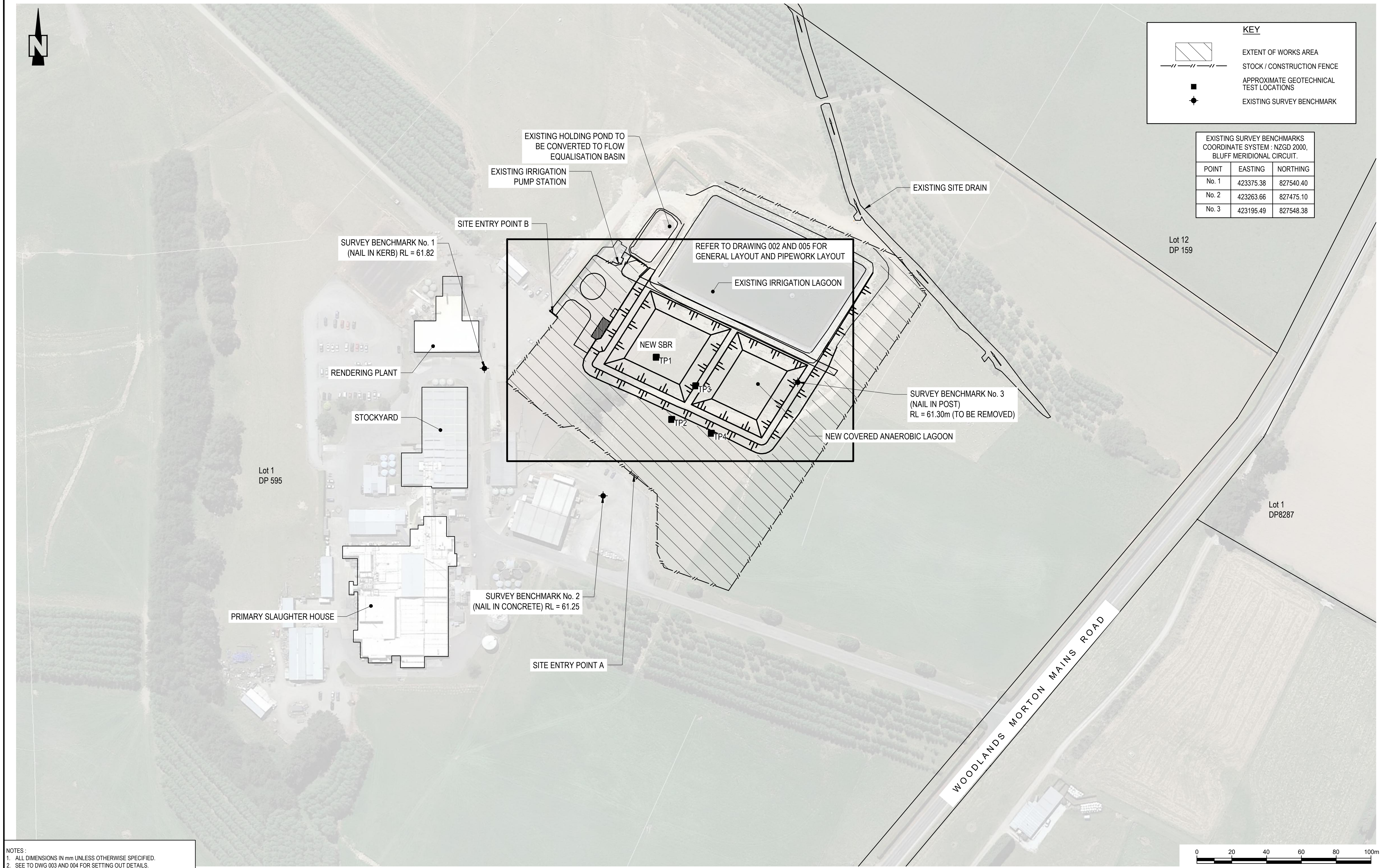
## 6.0 Concluding Statement

The proposed WWTP will have significant environmental benefit through reducing the leachable nitrogen loading (and other contaminant loadings) discharged to the existing irrigation field.

Potential negative environmental effects associated with the proposal, particularly during the construction phase, will be mitigated and managed as outlined in this report.

**Appendix A**

PDP WWTP Design Drawings




EXISTING SURVEY BENCHMARKS
COORDINATE SYSTEM : NZGD 2000,
BLUFF MERIDIONAL CIRCUIT.

| POINT | EASTING | NORTHING |
|---|---|---|
| No. 1 | 423375.38 | 827540.40 |
| No. 2 | 423263.66 | 827475.10 |
| No. 3 | 423195.49 | 827548.38 |

NOTES :
1. ALL DIMENSIONS IN mm UNLESS OTHERWISE SPECIFIED.
2. SEE TO DWG 003 AND 004 FOR SETTING OUT DETAILS.
3. COORDINATE SYSTEM: NZGD 2000, BLUFF MERIDIONAL CIRCUIT. LEVEL DATUM: MEAN SEA LEVEL DUNEDIN-BLUFF VERTICAL DATUM 1960
4. THE IDENTITY AND LOCATION OF ANY SERVICES SHOWN ON THIS DRAWING CANNOT BE GUARANTEED TO BE COMPLETE OR ACCURATE.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL SERVICES PRIOR TO UNDERTAKING ANY EXCAVATION.

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1. SURVEY DATA SUPPLIED BY BONISCH CONSULTANTS LTD. 181102 6700 RevB, SURVEYED ON 08/08/2018 AND 26/10/2018
2. AERIAL IMAGERY (FLOWN 01/13/2018) DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE)

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| NO. | REVISION | DATE | APP. |
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| B | FOR REVIEW | NOV 18 | |
| A | PRELIMINARY | OCT 18 | |

| | BY | CHECKED | DATE |
|---|---|---|---|
| DESIGNED | J.L. | D.G. | OCT 18 |
| DRAWN | J.G.G. | D.R. | OCT 18 |
| APPROVED ISSUE FOR : | TENDER | | DEC 18 |
| APPROVED : | | | |

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CLIENT: BlueSkyMeats

PROJECT: NEW WASTEWATER TREATMENT PLANT

TITLE: SITE PLAN

PROJECT NO. : A03220201 | SCALE 1:2,000 (A3) | SHEET : OF : | DRAWING NO. : 001 | REV : 0

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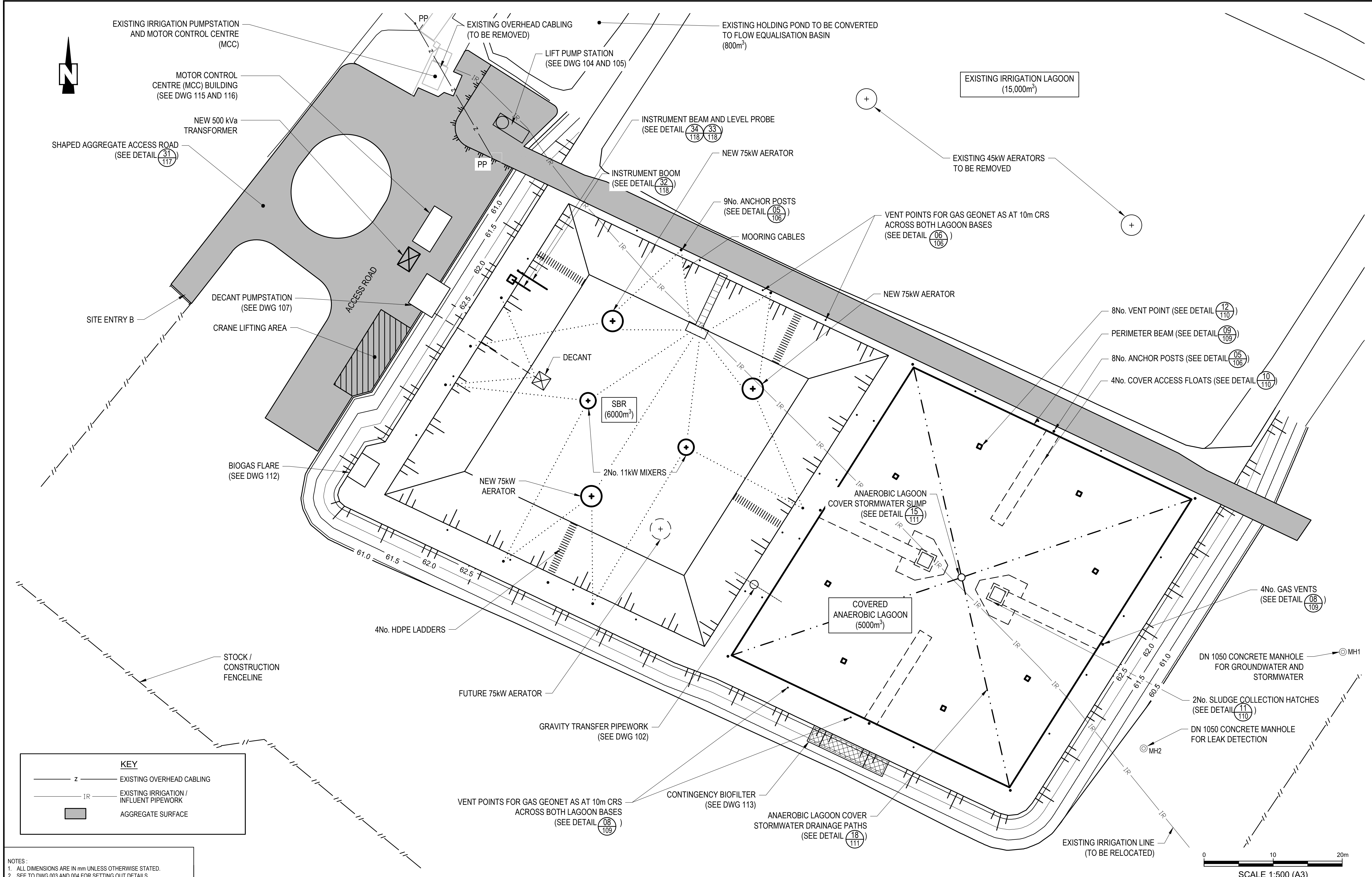


NOTES :
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. SEE TO DWG 003 AND 004 FOR SETTING OUT DETAILS.
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2. AERIAL IMAGERY (FLOWN 01/13/2018) DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE)

FILED: A03220201D002.dwg

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| A | PRELIMINARY | OCT 18 | |

| | BY | CHECKED | DATE |
|---|---|---|---|
| DESIGNED | J.L. | D.G. | OCT 18 |
| DRAWN | J.G.G. | D.R. | OCT 18 |
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CLIENT: BlueSkyMeats

PROJECT: NEW WASTEWATER TREATMENT PLANT

TITLE: GENERAL SITE LAYOUT

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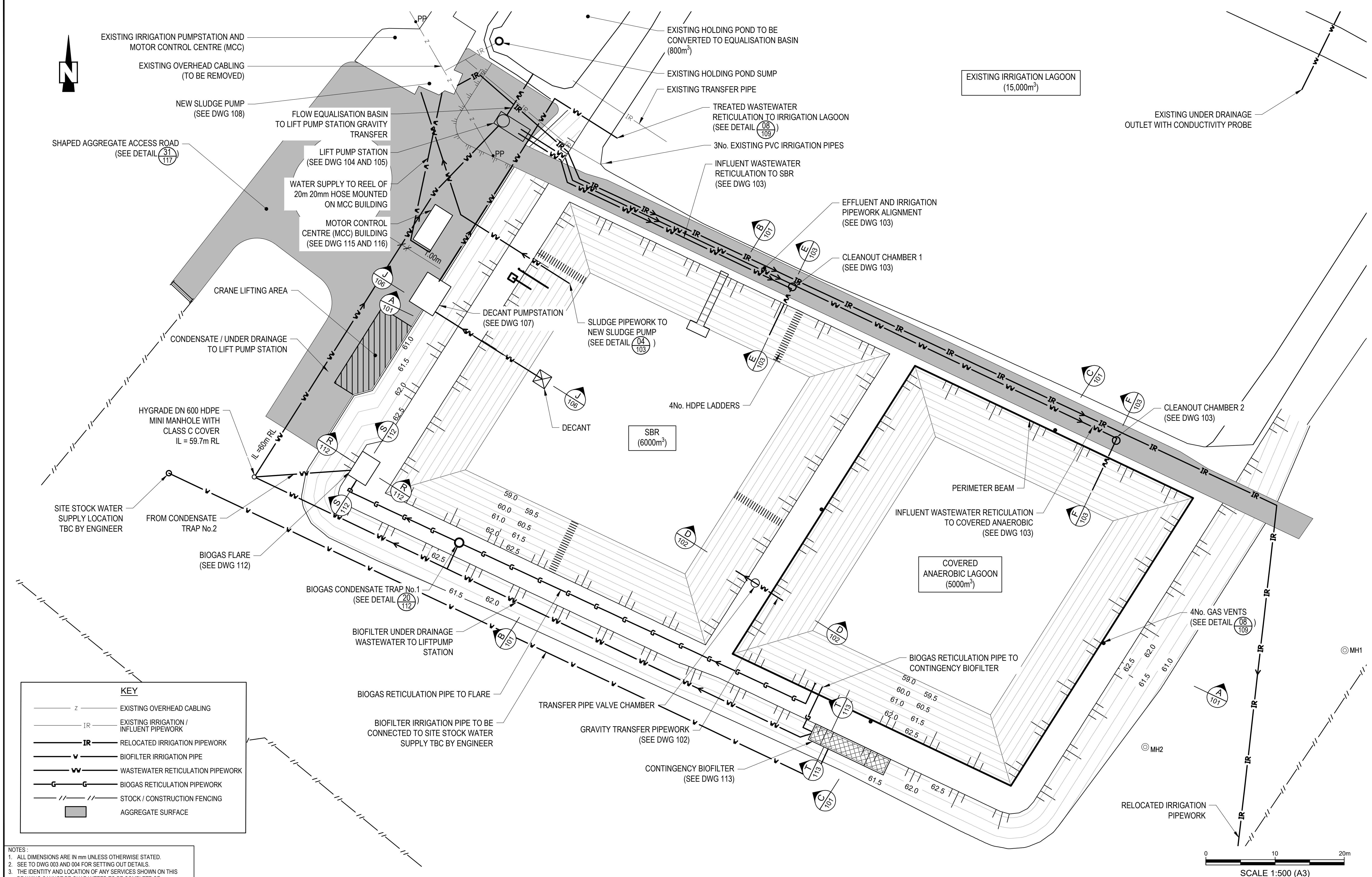


NOTES :
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. SEE TO DWG 003 AND 004 FOR SETTING OUT DETAILS.
3. THE IDENTITY AND LOCATION OF ANY SERVICES SHOWN ON THIS DRAWING CANNOT BE GUARANTEED TO BE COMPLETE OR ACCURATE.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL SERVICES PRIOR TO UNDERTAKING ANY EXCAVATION.

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| A | FOR REVIEW | NOV 18 | |

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|---|---|---|---|
| DESIGNED | J.L. | D.G. | OCT 18 |
| DRAWN | J.G.G. | D.R. | OCT 18 |
| APPROVED ISSUE FOR : | TENDER | | DEC 18 |
| APPROVED : | | | |

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CLIENT: BlueSkyMeats

PROJECT: NEW WASTEWATER TREATMENT PLANT

TITLE: PIPEWORK LAYOUT

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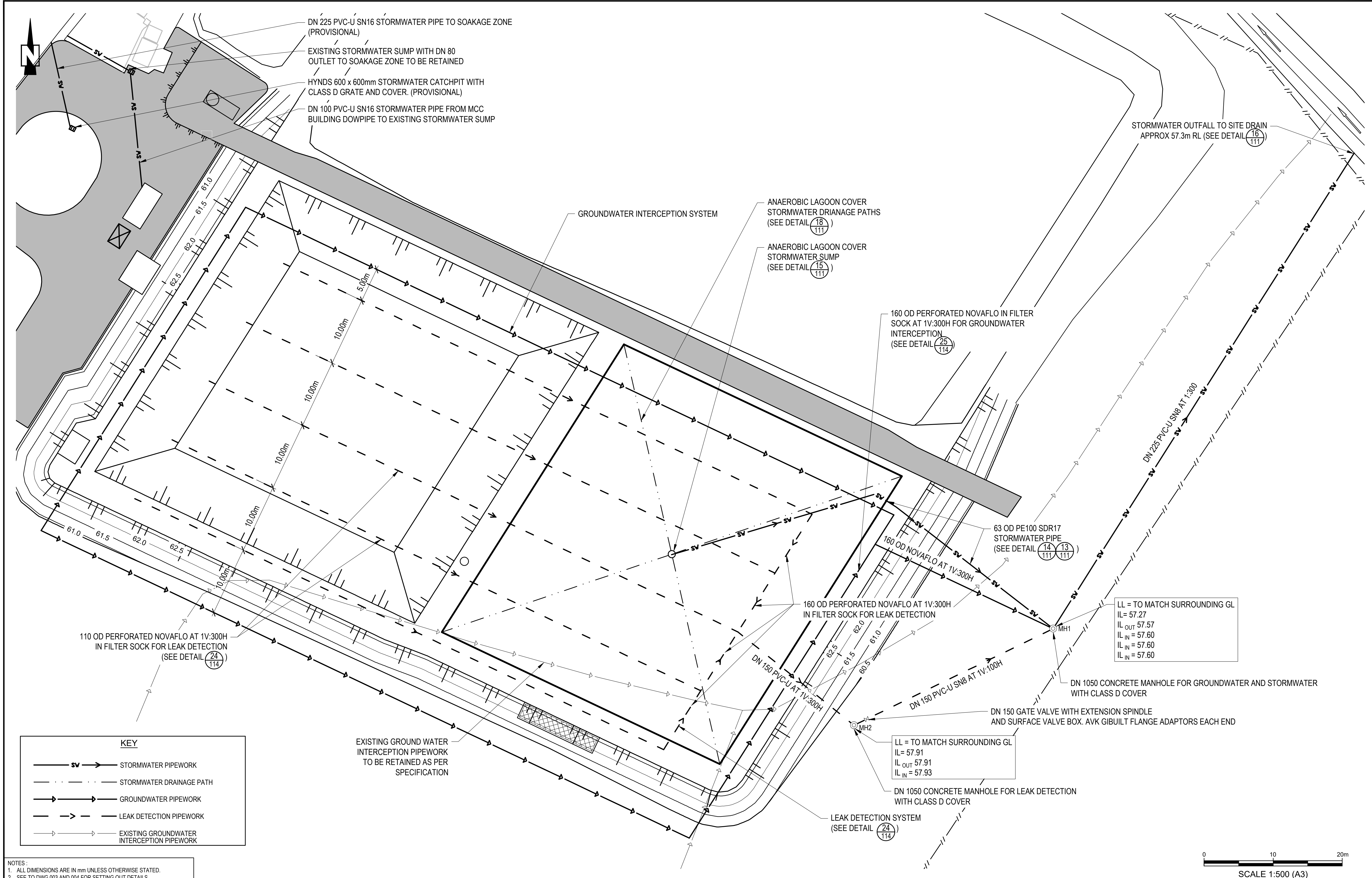


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PROJECT: NEW WASTEWATER TREATMENT PLANT

TITLE: STORMWATER AND GROUNDWATER LAYOUT

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# APPENDIX G

Blue Sky Pastures Energy Transition Accelerator Study Report – Transition Opportunity Assessment for the Morton Mains site - Beca

# Blue Sky Pastures Energy Transition Accelerator (ETA) Study Report

Transition opportunity assessment for the Morton Mains site

Prepared for Blue Sky Meats (NZ) Ltd
Prepared by Beca Limited

**15 July 2021**

## Revision History

| Revision Nº | Prepared By | Description | Date |
|---|---|---|---|
| A | Emma Rees | Draft for Client Review | 4/6/2021 |
| B | Emma Rees | Final Issue | 15/7/2021 |
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| | | | |
| | | | |

## Document Acceptance

| Action | Name | Signed | Date |
|---|---|---|---|
| Prepared by | Emma Rees | [signature] | 15/7/2021 |
| Reviewed by | Sean Milnes | [signature] | 15/7/2021 |
| Approved by | Nigel Wilson | [signature] | 15/7/2021 |
| on behalf of | Beca Limited | | |

# Contents

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# Executive Summary

The Energy Transition Accelerator (ETA) programme aims to support New Zealand's largest businesses to make technically and economically viable decisions and investments that support their energy transition pathway to a low carbon future.

## Key Findings

### The Business Context

On its journey to reduce its environmental impact, BSP has done significant work in recent years to improve wastewater management on site. Focus is now shifting to atmospheric emissions as BSP seeks to become a fully environmentally aware processor.

Total carbon dioxide equivalent emissions from the Morton Mains processing site are 6,442 $tCO_{2e}$/annum, made up of:

- Coal consumption – 5,400 $tCO_{2e}$/annum
- Electricity – 803 $tCO_{2e}$/annum
- Vehicle fuels and LPG for domestic hot water – 238 $tCO_{2e}$/annum
- Biogas flare – 0.8 $tCO_{2e}$/annum.

There are two key external drivers that BSP will have to consider as it looks to decarbonise:

- BSP currently operates two coal-fired boilers, with their air discharge consents due for renewal in 2022. The government's preferred approach for existing fossil fuel-fired low and medium temperature process heat assets is to phase out coal in existing sites by 2037. It will use re-consenting processes to do this. As well as helping to achieve their sustainability goals, BSP will likely need to a decarbonising plan to support reconsenting in 2022.
- The BSP site is located approximately equidistant to the electricity network substations at Edendale and Kennington. This position at the end of the electricity supply networks means that the power supply to the site is limited. Significant additional electrical load (such as for an electric boiler) will require that a new high voltage supply line and sub-station be installed.

### Overall Potential Emissions Reductions

BSP has a pathway to reduce total $CO_2$-e emissions in the order of 94% to around 400 $tCO_2$-e/annum through steps listed below. The residual emissions are from the bio-gas flare and electricity used on site.

- Recovering waste heat, especially from the rendering plant and refrigeration equipment
- Demand reduction steps:
  - installing standby heat exchangers to enable maintenance to reduce scale build-up
  - upgrading hose nozzles to reduce flow
  - improved pipe insulation
- Upgrading knife sterilisers to sensor-activated units
- Replacing the main processing boiler with a heat pump driven off the reject heat from the soon-to-be-installed refrigeration plant. A heat pump will fall within the current electrical supply capacity
- Replacing the rendering boiler with a technology likely from the list below:
  - Bio-mass boiler
  - Electric boiler (this would require a significant upgrade to the electricity supply network)
  - Tallow-fired boiler.

### Financial Implications

Excluding the replacement of the rendering boiler, the abatement projects are expected to have a capital cost in the order of $2.8 million. Operating costs are expected to reduce by approximately $300,000 per annum (assuming a carbon price of $36/t$CO_2$e), or $140,000 with the carbon price set to $0.

Three fuel options are presented for replacing the rendering boiler – wood chip, electricity, tallow. These options will require a significant further capital investment ($2-6 million) and impact on operating costs ($600,000 to $3 million per annum). Further work is recommended to investigate energy supply options for this project.

### Transition Pathway

The proposed transition pathway is summarised below. The selected projects have a significant impact on carbon emissions, and favourable economics at this high level of analysis. It is worth noting that the heat pump project is expected to have power costs lower than the coal cost for the existing boiler – the relatively high marginal abatement cost (MAC) of $53 per tonne of carbon dioxide equivalent is largely due to the assumed maintenance cost of the equipment. This cost estimate can be further refined during development of that project.

The remaining emissions are form the bio-gas flare, or are imported to the site from electricity generation and distribution.

TE TARI TIAKI PŪNGAO EECA

## Potential projects for long-term low carbon transition pathway

| Actions | Year (currently scheduled) | Year (achievable) | Percent reduction | Remaining Emissions | Option Capex ($) | Annual Opex Impact ($/y) | MAC ($/$t_{CO2e}$) |
|---|---|---|---|---|---|---|---|
| **Baseline Emissions** | 2021 | N/A | 0.0% | 0.0% 100.0% | N/A | N/A | N/A |
| **Enabling Projects** | | | | | | | |
| *Refrigeration System Upgrade inc Heat Recovery* | 2021 | 2021 | | | | | |
| **Demand Reduction/Heat Recovery** | | | | | | | |
| *Hot Water Ringmain Insulation* | 2022 | 2021 | 0.4% | 0.4% 99.6% | $ 61,000 | -$ 835 | $ 24 |
| *Standby Heat Exchangers in Processing* | 2022 | 2022 | 1.4% | 1.4% 98.2% | $ 17,000 | -$ 13,884 | -$ 19 |
| *Washdown Hose Nozzles* | 2022 | 2021 | 0.0% | 0.0% 98.2% | $ 1,600 | $ - | $ - |
| *Rendering Water Supply Upgrade* | 2023 | 2022 | 6.4% | 6.4% 91.9% | $ 1,440,000 | -$ 27,199 | $ 33 |
| *Heat Recovery from Refrigeration* | 2023 | 2022 | 0.4% | 0.4% 91.5% | $ 60,000 | -$ 1,731 | $ 34 |
| **Alternative Technologies** | | | | | | | |
| *Upgrade Sterilisers* | 2022 | 2022 | 5.7% | 5.7% 85.7% | $ 424,000 | -$ 38,344 | -$ 0 |
| **Fuel Switching** | | | | | | | |
| *Replace Main Boiler with Heat Pump* | 2023 | 2023 | 26.8% | 26.8% 58.9% | $ 830,000 | -$ 60,005 | $ 3 |
| *Electric Forklifts* | Underway | | 2.0% | 2.0% 57.0% | - | | |
| *Biodiesel/electric Fleet Vehicles* | As vehicles are available | | 1.7% | 1.7% 55.3% | - | | |
| *Replace Rendering Boiler Options:* | | | | | | | |
| *Wood Chip* | 2035 | 2035 | 49.5% | 49.5% 5.8% | $ 5,640,000 | $ 677,129 | $ 150 |
| *Electricity* | 2035 | 2035 | 36.8% | 36.8% 18.5% | $ 1,710,800 | $ 3,010,810 | $ 544 |
| *Tallow* | 2035 | 2035 | 48.3% | 48.3% 7.0% | $ 2,594,000 | $ 808,790 | $ 136 |

% of total emissions abated by the project

% of total emsisions remaining

## Opportunity Assessment Recommendations and Opportunities

The key recommendations and next steps are as follows:

| **Recommended Next Steps** | | |
|---|---|---|
| Activity | | Timeframe |
| 1 | BSP to develop their sustainability focus and establish clear corporate objectives to decarbonise. | 3-6 months |
| 2 | Further develop the business case for replacing the main boiler with a heat pump. | 3 months |
| 3 | Leverage additional EECA programmes to expedite activity:<br>• EECA's Business Programme support<br>• EECA's Energy Graduate programme to scope and deliver projects and programmes. | 6-12 months |
| 4 | Start working towards the easy wins:<br>• Insulate bare pipes in the hot water network<br>• Start trialling fixed flow hose nozzles<br>• Review and reset the flow controls on the sterilisers. | 2-3 months |
| 5 | Start planning for:<br>• Recovering heat from rendering by improving the water supply and eliminating the cooling tower<br>• Testing and then installing standby heat exchangers in the processing plant. | 6-12 months |
| 6 | Commence the next stage of development of the heat pump project, targeting installation in 2023. | 6 months |
| 7 | Develop thinking around the options to replace the rendering boiler | 12-36 months |

# 1 Introduction to the Energy Transition Accelerator (ETA) Programme

## 1.1 Introduction to the Programme

The Energy Transition Accelerator (ETA) programme was launched by Te Tari Tiaki Pūngao, the Energy Efficiency and Conservation Authority (EECA) to help New Zealand's largest energy-related emitters to make technically and economically viable decisions and investments that support their energy transition pathway to a low carbon future.

The ETA programme is intended to help organisations and specifically large energy users develop the tools and practices required to support long-term thinking and allow decision makers to make the fully informed decisions related to energy and climate change. The ETA Opportunities Assessment is intended to identify options for reducing energy-related carbon emissions through the optimisation of existing assets, evaluation of alternative energy savings technologies and replacement of end of life fossil fuelled infrastructure with low carbon alternatives.

The ETA outcomes are intended to reach beyond just carbon reductions and include benefits such as reduced energy related costs, improved market and environmental resilience, improved productivity and brand perception.

## 1.2 Proposed Approach

The focus of this ETA is on energy related emissions reduction. The general approach taken has been to:

- Examine process flows, energy usage and GHG emissions of the current operation
- Review energy demand and investigate options to minimise energy demands
- Consider optimisation of energy supply and fuel switching opportunities
- Evaluate options considering their life cycle cost, emissions reduction potential, and implementation aspects
- Select a pathway starting with reductions options that can be quickly implemented and reduce GHG emissions, and moving on to options with more precursor activities and lesser reduction of emissions
- Prepare outline scope of works for any further investigations to evaluate options that require further development.

## 1.3 Sources of Information Used

As well as information supplied by BSP, the following key sources of information have been relied upon for the preparation of this report:

Intergovernmental Panel on Climate Change. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 2: Stationary Combustion.*

Meat and Livestock Australia Ltd. (2002). *Eco-Efficiency Manual for Meat Processing.* Queensland: Meat and Livestock Australia.

Ministry for the Environment. (2020). *Measuring Emissions: A Guide for Organisations. 2020 Summary of Emission Factors.* Wellington: Ministry for the Environment.

Ministry for the Environment. (2021). *Consultation document: Phasing out Fossil Fuels in Process Heat, National Direction on Industrial Greenhouse Gas Emissions.* Wellington: Ministry for the Environment.

Smith, M., Aber, J., & Rynk, R. (2017). Heat Recovery from Composting: A Comprehensive Review of System Design, Recovery Rate, and Utilisation. *Compost Science & Utilisation, 25:sup1,* , S11-S22.

# 2 Context of the Company

## 2.1 Company Overview

Blue Sky Meats (NZ) Ltd (BSP) is a publicly traded company in the meat processing industry. The main processing plant is located at Morton Mains, Invercargill. BSP has been operating here since the 1980's. Over the last 30 years, the site has been through various developments, including the introduction of a rendering plant more recently.

The focus of this study is the whole Morton Mains site, including processing and rendering.

## 2.2 Transition Risks

BSP currently operates two coal-fired boilers. The Ministry for the Environment (MfE) have released a consultation document *Phasing out fossil fuels in process heat: National direction on industrial greenhouse gas emissions* (Ministry for the Environment, 2021) with focus on implementing regulatory backstops to accelerate the decarbonisation of process heat

- The government's preferred approach for implementing these 'regulatory backstops' is a combination of a National Environmental Standard (NES) supported by a National Policy Statement (NPS).
- The NES and NPS would come into effect via consenting processes for air discharge.
- The NES would specify the maximum consent duration applied to permits e.g. 5-10 years (open to consultation).

The consultation is broken down into four key areas:

1. New fossil fuel-fired assets
2. Existing fossil fuel-fired assets
3. Greenhouse gas (GHG) emissions plans
4. Non-industrial emissions

The government's preferred approach for existing fossil fuel-fired assets is to phase out coal in existing sites by 2037 for low and medium temperature process heat requirements through re-consenting processes. Also require regional councils to review consent conditions for significant GHG emitters with long-term permits. This requirement would be targeted at larger emitters (operating capacity of 20 MW or above or GHG emissions of 5,000 $tCO_2$-e/year) with longer permits (expiry date of 2035 or longer) and regional councils would be required to review these consents by 2025.

In the context of BSP operating two coal-fired boilers with a combined GHG emission from coal of 5,400 $tCO_2$-e/year, there are risks with transition timing for reconsenting with the regional council. Existing coal-fired assets are proposed to be phased out by 2037 which will need to be considered in the Energy Transition Pathway.

# 3 Process Description

## 3.1 Process Overview

BSP is primarily a lamb abattoir, while also processing bobby calves. Sheep and calves are delivered to site by truck and offloaded into yards. From there they are processed into carcasses.

Carcasses are boned and packed into cartons which are then chilled or frozen. BSP processes edible offals for sale. Skins are collected and salted on-site and on-sold. BSP has cold storage onsite, with most product being sold frozen and approximately 5% of product sold chilled.

Inedible material is transferred in bins by forklift to the onsite rendering plant. The material is mechanically ground down and water is added to make a slurry. The slurry is heated to extract the tallow which is then separated off. The remaining material is pressed, milled and screened. The blood collected is also dried and mixed with the dried meal, which is sold as fertiliser.

Refer to Appendix A for process flow diagrams and mass and energy balances for the processing plant and rendering plant.

BSP processes in the order of:

- 27,000 Lamb Equivalent Units (LEU) per week at peak.

A simplified block flow diagram is shown in Figure 3-1.

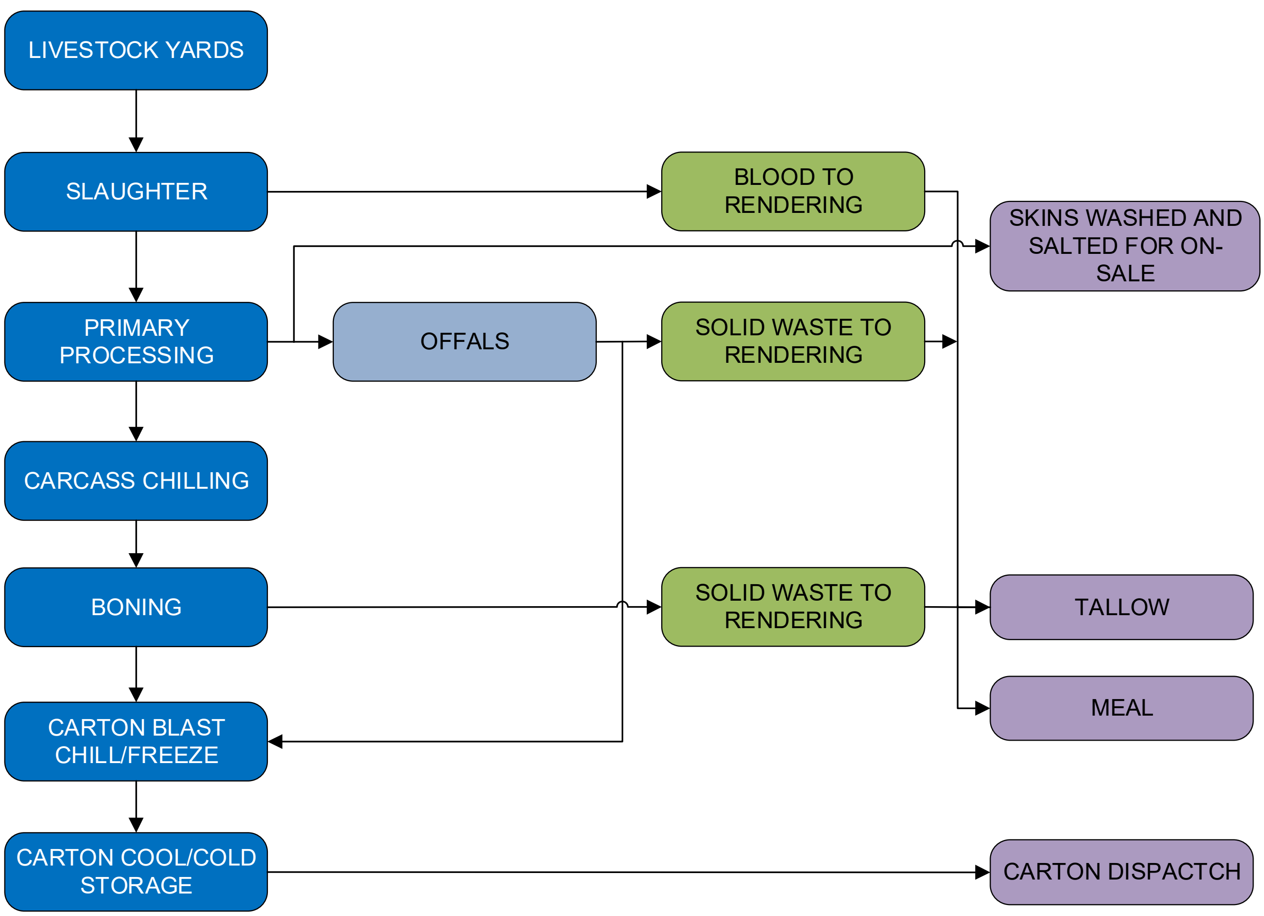



Figure 3-1: Production flow through Blue Sky Pastures plant

A site layout is shown in Figure 3-2.

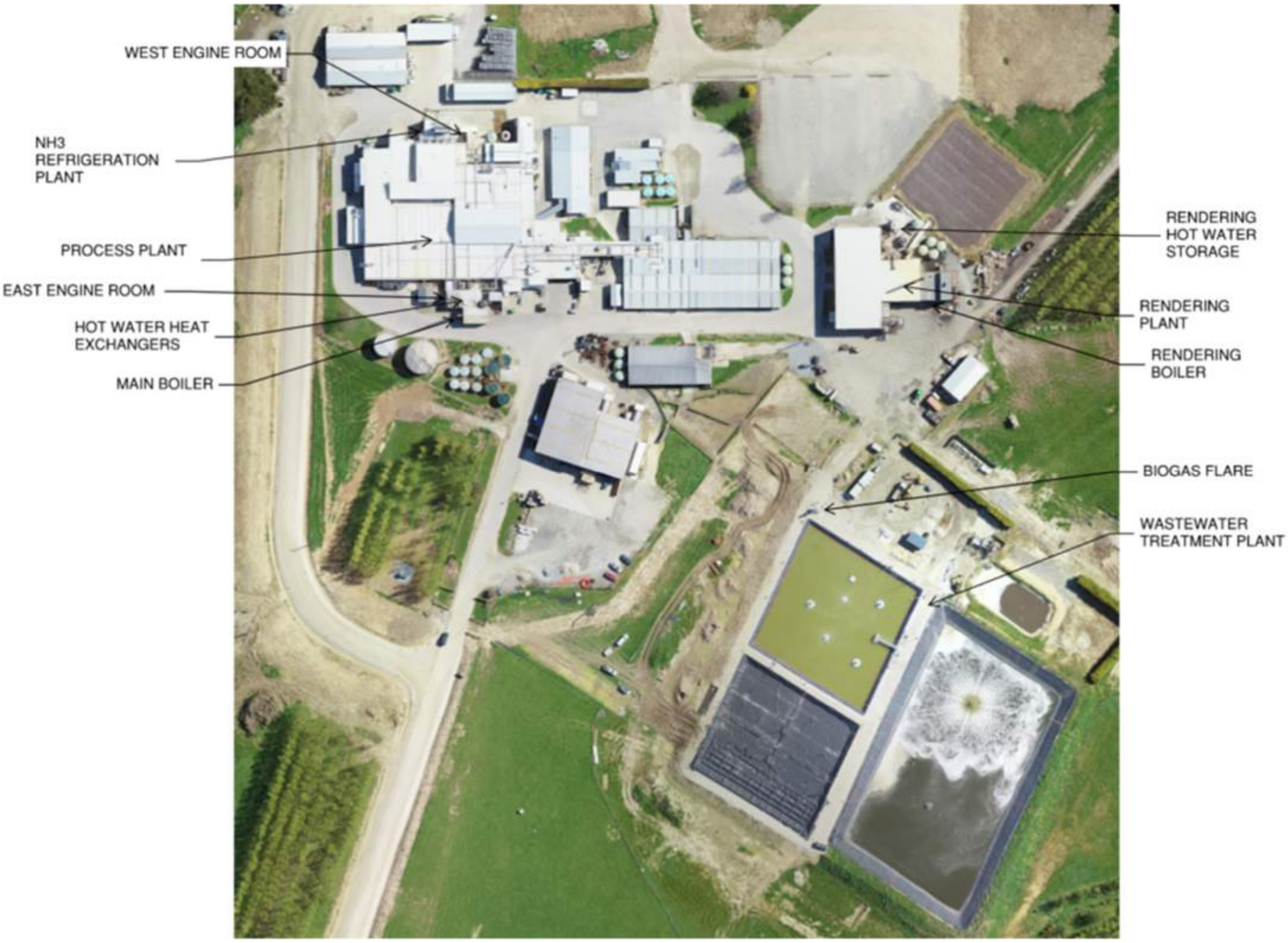



Figure 3-2: Aerial view of the Blue Sky Pastures site

## 3.2 Main Energy Users

The main energy users on the site are:

- Coal boiler for steam supply to rendering
- Coal boiler for hot water
- Electricity for refrigeration
- Diesel, LPG and electricity for on-site transfer of renderables
- LPG for hot water to amenities.

See Appendix A for mass and energy balances for key energy consumption onsite.

The energy balances show approximately 80% of the energy in the rendering plant is unaccounted due to lack of metering. Some of this energy will be in the wastewater, consumptive steam use, energy in the products, and general energy losses.

The is a significant opportunity recover heat from the rendering cooker condenser by upgrading the rendering water supply line, returning heat recovered to the processing plant as hot water, and operating the cooling tower less. Other than this, it is unlikely there are major energy gains to be made in the rendering plant due to the “losses” being necessary (heat in the tallow) or of low quality.

The current process of high temperature cooking means the meal is not thermally dried, rather is pressed to remove moisture and milled. Over-drying of meal is therefore not an emissions risk.

Blood drying only happens for a short time during the day, so the total energy for that duty is expected to be low. Installation of steam metering on the blood dryer would improve visibility of the process to assess whether over-drying is occurring.

The processing plant energy balance is based on average water consumption. Two weeks' of consumption was recorded and showed that peak flows are much higher than average, in line with what would be expected with a daily washdown programme. The limited metering on site means that accurate measurements of hot water consumption is difficult. We recommend that metering increase to have a better understanding of hot water consumption.

A simplified process block diagram showing energy consumption and hot water flows at the site is provided in Figure 3-3.

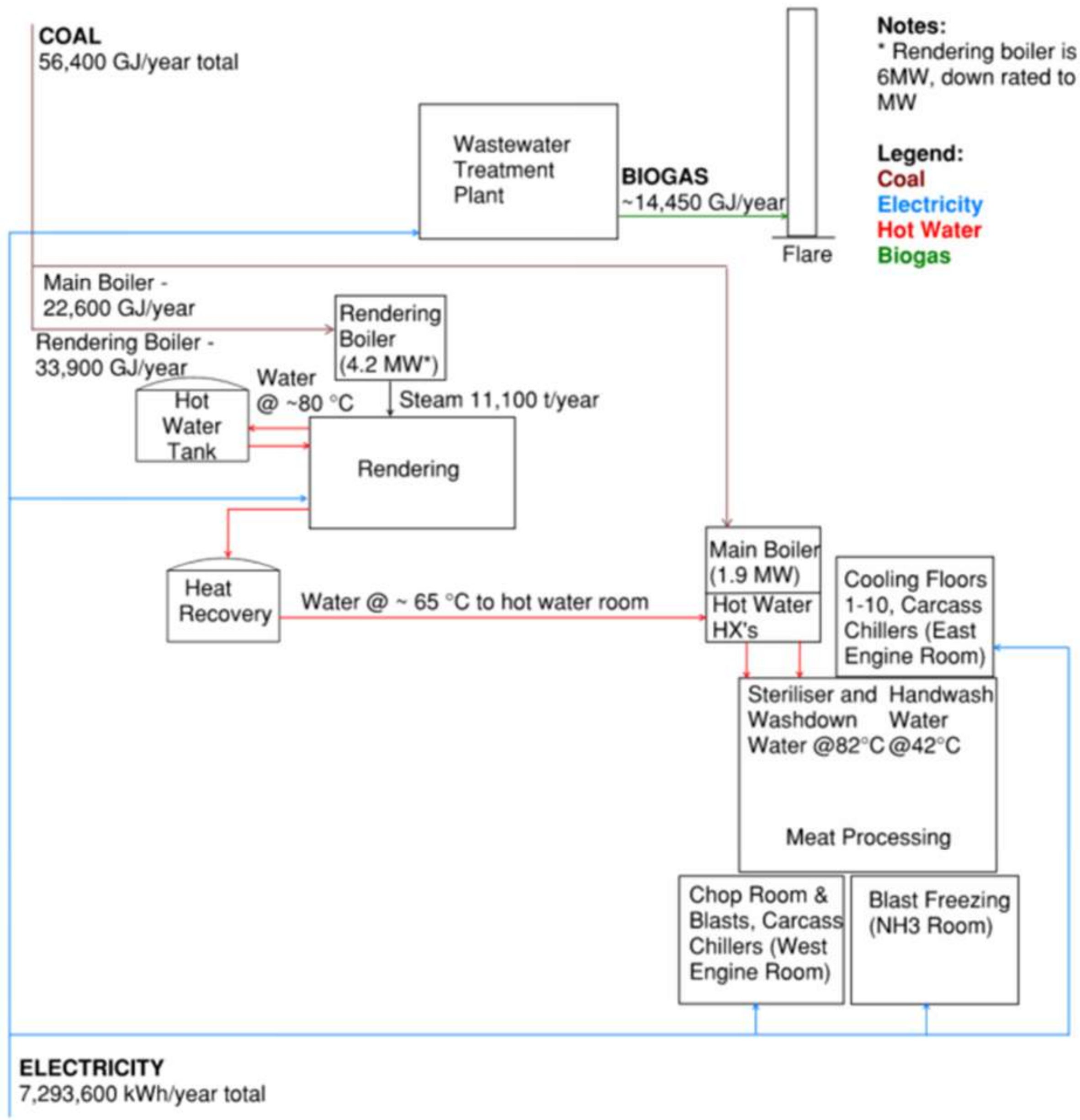



Figure 3-3: Annual Energy Flow Diagram

### 3.2.1 Coal

A 6 MW coal-fired boiler in the rendering plant supply steam to heat the slurry cookers, as well as heat for drying the meal. Currently, this boiler is down-rated to 4.2 MW to allow unsupervised boiler operation, as well as the boiler initially being oversized for the rendering demand.

At an integrated meat processor much of the hot water, approximately 70%, is provided from the rendering plant. After cooking, heat from the rendered material is rejected, and this provides hot water for other purposes. At BSP, however, limitations on the water supply to the rendering plant results in limited hot water available for return to the processing plant. Instead, waste heat is rejected using a cooling tower.

BSP also captures reject heat from the blood condenser providing hot water for use in the rendering plant.

An additional 1.9 MW coal-fired boiler is used to provide most of the plant hot water demand due to limitations on the hot water received from the rendering plant. Water is provided at 90°C for sterilisation and mixed to 65°C in the plant for washing. Water for hand washing and apron washes are also provided from the hot water boiler.

The split of coal consumption on site is not well measured, and assumptions were made on the amount of coal consumed by the rendering boiler and hot water boiler. This basis is tabulated in section 4.

In total, 56,400 GJ/year (3,760 t/year) (approximately $303,000 equivalent to 5,400 t$CO_2$-e/year) of coal was consumed on site last year.

### 3.2.2 Electricity

Refrigeration is the main consumer of electrical energy. It is used for ventilation and air-conditioning, carcass chilling, and finished goods chilling and freezing. BSP has three engine rooms:

- Blast Freezer Engine Room – recently replaced in 2018, includes blast freezers and zero store
- West Engine Room – to be replaced imminently, includes chilling for some of the processing plant chillers and chop room
- East Engine Room – to be replaced imminently, includes chilling for the boning room and carcass chillers.

It should be noted that the West and East Engine Rooms will be replaced with a new centralised ammonia refrigeration system. The design and tendering process for this refrigeration replacement was ongoing during this study. It is likely that replacement of the existing Freon system with a more efficient ammonia system will reduce electricity demand.

Beyond refrigeration, electricity is also used for:

- Pumps
- Air compressors
- Conveyors
- Sundry Equipment
- Aeration and mixing in wastewater treatment plant.

The site has 2 electrical incomers supplying electricity as tabulated in section 4 below.

In total, 7,294,000 kWh/year (approximately $1.1 million, equivalent to 803 t$CO_2$-e/year) of electricity was consumed on site last year.

### 3.2.3 Fuel

Transport fuel is used for:

- General loading and unloading by forklifts (diesel and gas)
- On-site transfer by forklift of renderables to rendering plant

- Petrol and diesel consumption by fleet vehicles (11 vehicles) with 285,000 km travelled last year.

A small amount of LPG is used for amenities hot water for staff showers.

Last year's total consumption included:

- Approximately 82 GJ of LPG (approximately $4,000 and 5 t$CO_2$-e/year)
- Approximately 1900 GJ of diesel for forklift operation (approximately $40,000 and 126 t$CO_2$-e/year)
- Approximately 1400 GJ of petrol and diesel for fleet vehicles (approximately $53,000, and 107 t$CO_2$-e/year).

# 4 Energy Consumption and Greenhouse Gas Emissions

## 4.1 Emission Factors

Greenhouse Gas (GHG) emissions, carbon emissions and carbon footprint are terms often used interchangeably. This report at all times is referring to, and all figures are presented in, carbon dioxide equivalent ($CO_2e$). Carbon dioxide equivalent accounts for the relative global warming potential of different gases in a single equivalent number.

Emission factors are taken from the New Zealand Ministry for the Environment *Measuring Emissions: A Guide for Organisations* 2019 Summary of Emissions Factors and the *IPCC Guidelines for National Greenhouse Gas Inventories* 2006 (Volume 2: Energy, Chapter 2: Stationary Combustion). The report and calculations assume that the emission factors used are static for all future years. Therefore, the analysis and marginal abatement cost does not include any changes in the carbon intensity of the electricity or fuel sources.

## 4.2 Coal

The main consumers of coal and the proportion of the site coal consumption are shown in Table 4-1. Note that the percentage breakdown is indicative only.

Table 4-1: Breakdown of the site coal consumption per annum.

| Coal User | Plant Area Break Down (%) | Coal Consumption (GJ/year) | Emissions Factor (kg/kg / kg/GJ) | Carbon Emissions ($tCO_2e$/year |
|---|---|---|---|---|
| Rendering boiler | 60% | 33,900 | 1.43 / 95.3 | 3,200 |
| Main boiler | 40% | 22,600 | 1.43 / 95.3 | 2,200 |
| Total | | 56,400 | 1.43 / 95.3 | 5,400 |

## 4.3 Electricity

The site has two electrical incomers, feeding a ring main which provides resilience in the power supply to the site. The electricity to the site is not separately metered by plant area and consumption by plant area has not been assumed in this study. Total electricity consumption based on 2020/21 financial year values is shown in Table 4-2.

Table 4-2: Site electricity consumptions per annum.

| Electricity User | Electricity Consumption (GJ/year) | Emissions Factor (kg/kWh / kg/GJ) | Carbon Emissions ($tCO_2$-e/year) |
|---|---|---|---|
| Total | 7,293,600 | 0.111 / 30.6 | 803 |

## 4.4 Vehicle Emissions

The main source of vehicle emissions considered in this study are onsite forklifts used for general loading and unloading, and transfer of renderables from the processing plant to the rendering plant. The BSP vehicle fleet has also been considered at a high level.

The forklift fleet consists of gas, diesel, and electric. A small amount of LPG is also used for amenities water heating, which is considered in the total gas consumption shown here. Emissions from electric forklift operation have been already accounted for in total site electricity consumption, thus are excluded here. Vehicle fleet fuel consumption consists of petrol and diesel, where an average energy content and emissions factor have been used for a petrol/diesel fleet fuel. A breakdown of the emissions for the vehicle emissions is shown in Table 4-3.

Table 4-3: Breakdown of forklift and fleet vehicle fuel consumption per annum.

| Fuel User | Fuel Consumption (GJ/year) | Emissions Factor (kg/unit) | Carbon Emissions ($tCO_2$-e/year) |
|---|---|---|---|
| Vehicle Fleet | 1,400 | 2.57** | 107 |
| Diesel Forklifts | 2,000 | 2.69 | 126 |
| Gas* Forklifts and Amenities | 80 | 3.02 | 5 |
| **Total** | **3,500** | | **238** |

* Gas includes LPG forklifts as well as LPG used for amenities water heating.

** Due to undefined ratios, we have applied the average of the emissions factors of petrol and diesel vehicle fuel.

## 4.5 Other Emissions

The onsite wastewater treatment plant includes anaerobic treatment which produces biogas. Currently, this biogas is flared at an average rate of 1,885 $m^3$/day (based on 30 days data, assuming typical production).

$CO_2$ emissions from the combustion of biogas are considered biogenic so are not counted in the total carbon emissions. The carbon equivalent emissions from $CH_4$ and $N_2O$ emissions are shown in Table 4-4.

Table 4-4: Site biogas flaring per annum.

| User | Biogas Consumption (GJ/year) | Carbon Emissions ($tCO_2$-e/year) |
|---|---|---|
| **Biogas Flare** | **14,450** | **0.8***  |

* Carbon equivalent emissions do not include $CO_2$ in the biogas, nor the $CO_2$ resulting from combustion of the gas as this $CO_2$ is considered biogenic. Total emissions only consider the impact of $CH_4$ and $N_2O$ emissions from the flare.

## 4.6 Total Emissions

Total emissions for the site are 6,421 $tCO_2$-e/annum. The breakdown of this is shown in Figure 4-1.

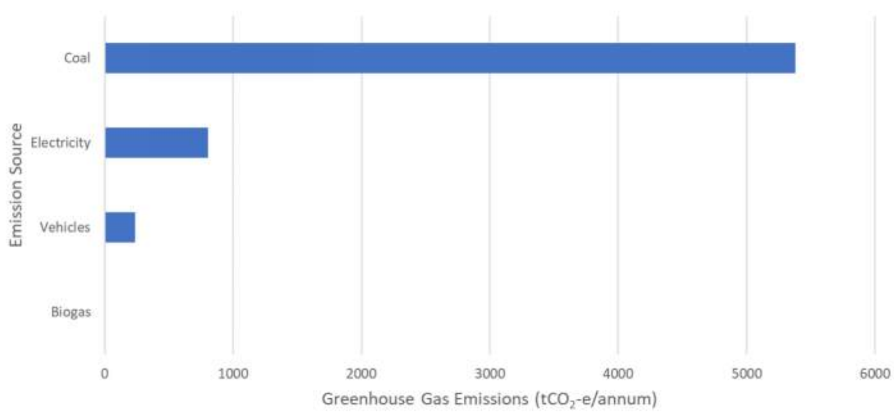



Figure 4-1: Breakdown of total site emissions.

# 5 Asset Base

## 5.1 Main Emissions-Related Assets

- Main Boiler – Hot Water supply for processing plant
- Rendering Boiler – Steam supply to rendering plant
- Diesel and Gas Forklifts – Leased
- Freon refrigeration plant – Refrigeration for processing plant, provides heat which can be utilised by heat pumps when upgraded.

The larger energy consuming equipment on site is summarised in Table 5-1.

Table 5-1: Summary of main emissions-related assets.

| Asset | Manufacturer | Date of Manufacture | Remaining Life | Rating |
|---|---|---|---|---|
| Main Boiler | Anderson | 1982 | 10+ years | 1.9 MW |
| Rendering Boiler | Anderson Vekos | 27/4/82 | 10+ years | 4.2 MW (down-rated from 6MW)* |
| Cooker | Keith | 1975 (Refurbished 2017) | 6-8 years | 4 t/h |
| Blood Dryer | Rendertech | 2008 | 20 years | 11kW, 990kpa |
| Wastewater Aerators | Older aerators – unknown<br>New aerators - AquaSystems | Old – Unknown<br>New – 2019 | 30 years | Old – 90 kW total<br>New – 150 kW total |
| Wastewater Mixers | AquaSystems | 2019 | 30 years | 22 kW total |
| Biogas Flare | Windsor | 2019 | 30 years | 500 $m^3/h$ |
| $NH_3$ Refrigeration Plant | Mycom | 2018 | 30 years | 2 x 220kW compressors |
| Freon Refrigeration Plant | Copeland,<br>Halls | 1980s | Nil | - |
| Sterilisers | Custom BSP | Earliest 1987 | - | - |
| Shrink Tunnels | Cryovac x2 | 2006<br>2016 | 15 years | 12.8 kW<br>9 kW |

* Rendering Boiler is down rated from 6 MW to 4.2 MW due to rendering demand, and boiler operational requirements.

## 5.2 Asset Replacement Schedule

The key assets considered here are the two boilers, and there are two factors BSP is working through to understand their replacement timeline:

- Ability to obtain air discharge consents for the boilers
- Age and wear-and-tear of the boilers leading to the end of their economic life.

The air discharge consents for the site are due to expire next year (31st December 2022). Early discussions with the issuing authority indicate that by virtue of undertaking this ETA and developing a decarbonising roadmap the Council may issue a new consent. This is likely to be provisional on BSP implementing the roadmap projects.

The boilers are both relatively old, however we have not been informed of any near-term issues with them being certified for use. It is reasonable to expect that the boilers can remain in service as a replacement plan progresses prior to the Government's indicated 2037 ban on coal-fired boilers.

## 5.3 Electricity Supply Network

BSP is located at the end of the network from both the Edendale and Kennington substations. This means that supply is constrained.

PowerNet manages the lines network supplying electricity to BSP. They have advised that the site is approaching its network capacity limit. Good practice in electricity supply is to have "n-1" redundancy so that if one incomer fails then the site needs can be adequately met by the remaining supplies. BSP no longer has this level of redundancy and so is required to segregate their equipment into high priority (continues to be powered in the event of a line failure) and low priority (shuts down in the event of a failure).

PowerNet has advised that there is capacity for BSP's near-term objectives (subject to balancing priority loads across the transformers), including a refrigeration plant upgrade planned to come online mid-2022. There is also capacity to install a heat pump to replace the main plant boiler (refer to section 6.4.1 below for project details). It is likely that the site would approach the limits on the supply at this point.

Further electrical demand on site would then require a supply upgrade. We approached PowerNet to enquire as to the upgrades for an additional 5MW for an electric boiler. Their proposal is to:

- Install a new 33kV line from Kennington to BSP
- Upgrade the conductor from the Invercargill Grid Exit Point to the Kennington substation
- Build a new 10MW substation at BSP to supply the new and existing load.

They have estimated the capital cost of these works as $14-19 million, with line charges increasing to a new total in the order of $1.8-2.3 million dollars per annum from their current level of approximately $270,000. It is likely that the network owner would accept a capital contribution to help fund the upgrades and offset some of the additional line charges. PowerNet's proposal is provided in Appendix D.

Further work is required to develop these concepts and understand the detailed economics.

# 6 Emissions Reduction Options

## 6.1 Methodology

Emission reduction options have been identified and evaluated using the following methodology.


### 6.1.1 Option Identification

Emission reduction options have been identified by:

- BSP's own analysis prior to commencing the project
- By Beca, BSP and EECA during site visits, project workshops, and analysis of the process.

### 6.1.2 Initial Evaluation

A preliminary evaluation was completed considering:

- Dependencies – precursors that might be required before the idea can be implemented
- Implementation – the key steps to implement the idea, particularly whether the idea can be sensibly implemented in the existing plant or should be considered in the site redevelopment
- Effectiveness – the extent to which the opportunity will reduce site emissions.

### 6.1.3 Shortlisting and Prioritising

A range of emission reduction projects were identified and prioritised in a workshop with EECA, BSP and Beca. The projects are listed below.

The type of project is described by:

- Heat Demand Reduction – These are projects which reduce the overall demand for heat, perhaps by improving efficiency or by eliminating processes
- Alternative Technologies/Methods – These are projects that apply different technologies or processes to achieve the same outcome
- Fuel Switching – Projects to change the type of fuel used in processes to low-carbon alternatives

Some of the projects could fit within several of these categories. Primary categories have been assigned, however the selection of category has not affected their treatment.

Projects which are identified as "Not Assessed" were agreed in the workshop to be of lower priority, with preference that effort be directed to analyse other projects. These projects may have been thought to have low abatement potential, high complexity/cost, or to be straightforward to implement without further analysis – two projects have not received further analysis but have been included in the pathway. The fact that they haven't been further analysed here should not be taken to mean that they are not worth further study in the future.

There is a big opportunity for BSP to reduce energy consumption by recovering heat from the rendering plant and reducing the amount of hot water it uses. We have not itemised water reduction opportunities beyond the use of spray sterilisers and washdown hose nozzles, as the overall use of water on site is complex. To this end, when analysing projects which will be implemented for fuel switching opportunities, we have assumed that heat recovery from rendering will occur, effectively reducing demand.

The opportunities are summarised in Table 6-1. Refer to Appendix E for more detailed description of the methodology used. The projects that were not assessed further, as indicated in Table 6-1, are described in Appendix F.

Table 6-1: List of abatement projects identified.

| # | Description | Type* | Reduction ($tCO_2$-e/annum) | CAPEX | Selected for Pathway (Y/N) |
|---|---|---|---|---|---|
| 1 | Replace main boiler with heat pump | F | 1726 | $840,000 | Y |
| 2 | Upgrade sterilisers | A | 1110# | $424,000 | N |
| 3 | **Alternative boiler fuels** | F | | | |
| | A – Main Boiler | | | | |
| | A1 Electric | | 1630 | $1,590,000 | N |
| | A2 Biomass | | 1230 | $1,890,000 | N |
| | B – Rendering Boiler | | | | |
| | B1 Electric | | 2370 | $1,711,000 | Y |
| | B2 Biomass | | 3188 | $5,640,000 | Y |
| | B3 Biogas/Biomass Dual-Fired | | 3205 | $8,373,000 | N |
| | B4 Tallow | | 3114 | $2,594,000 | Y |
| 4 | Biogas recovery for heat or electricity generation | F | Not Assessed | | N |
| 5 | Increase biogas generation | F | Not Assessed | | N |
| 6 | Air compressors heat recovery | H | Not Assessed | | N |
| 7 | Refrigeration system heat recovery | H | 49 | $60,000 | Y |
| 8 | Shrink tunnels | A | 4 | $413,000 | N |
| 9 | Washdown hose nozzles | H | Not Assessed | $1,600 | Y |
| 10 | Hot water ring main insulation | H | 77 | $61,000 | Y |
| 11 | Heat recovery from steriliser water | H | Not Assessed | | N |
| 12 | Stand-by heat exchangers for processing | H | 265 | $17,000 | Y |
| 13 | Water softening | A | Not Assessed | | N |
| 15 | Electrification of amenities water | F | Not Assessed | | Y |
| 16 | Upgrade rendering water supply line | A | 1230 | $1,440,000 | Y |
| 17 | Stand-by heat exchangers for Rendering | H | Not Assessed | $14,000 | N |
| 18 | Rendering hot well upgrade | A | Not Assessed | | N |
| 19 | Electric/biofuel vehicles | F | Not Assessed | | Y |
| 20 | Optimise blast freezer operation | A | Not Assessed | | N |

| # | Description | Type* | Reduction ($tCO_2$-e/annum) | CAPEX | Selected for Pathway (Y/N) |
|---|---|---|---|---|---|
| 21 | Composting paunch | A | Not Assessed | | N |
| 22 | Water system review (including softening) | A | Not Assessed | | N |

* Type refers to categories of project as below:

H – Heat Demand Reduction; A – Alternative Technologies/Methods; F – Fuel Switching

# If hot water is generated by electric plant then the abatement is 14 $tCO_2e$ per annum.

## 6.2 Heat Demand Reduction Options

### 6.2.1 Project 7 – Refrigeration System Heat Recovery

The refrigeration system onsite can be considered as two independent systems – the new $NH_3$ plant for blast freezers, and the refrigeration plant for the chillers and cooling floors. Currently for the blast refrigeration plant, heat is rejected from the refrigerant via evaporative condensers. The chiller/ cooling floor refrigeration plant replacement is imminent (to be replaced during the 2022 shut down) and should be designed with heat recovery incorporated.

#### Recovery form the Ammonia Blast System

The blast refrigeration plant has recently been upgraded, and heat recovery is not feasible without additional design changes due to the use of evaporative condensers. Heat recovery from de-superheating could be achieved with the installation of a by-pass and desuperheater prior to the evaporative condenser, recovering approximately 22 kW, or 435 GJ/year.

This heat recovery has not been considered for the process water pre-heating as the focus is on the imminent chiller refrigeration upgrade as the heat recovery potential is much greater (approximately 1 MW). In addition the $NH_3$ plant is located some distance from the proposed heat pump location. However, this heat could be utilised for providing hot water to amenities, which are located adjacent to the $NH_3$ plant onsite. Amenities hot water usage is currently unknown. Therefore, further investigation would be required to size and design an appropriate amenities hot water system to utilise the recovered heat.

This project has only been assessed at a high level, and the scope is limited to the heat recoverable from the ammonia refrigeration plant and does not extend to the use of this heat within the amenities hot water system. Additional metering and investigation into the current amenities hot water system is required before suggestions can be made on the most appropriate hot water system to utilise the benefits of the heat recovered from this project. This project ties in with Project 15.

The project life has been assumed at 18 years to take into account the age of the existing refrigeration plant and EECA's standard advice for equipment life of 20 years, as the heat recovery is only possible for the life of the refrigeration plant. The high-level cost estimate used for both the new refrigeration plant heat recovery, and retrofitting heat recovery to the ammonia refrigeration plant is the same, as the same equipment has been assumed (heat exchanger, return pump and pipework).

| Summary Card – $NH_3$ Refrigeration System Heat Recovery – Amenities Water Pre-heating | |
|---|---|
| Application | Heat recovery from blast refrigeration plant to provide heat source for amenities hot water. |
| Description of Opportunity | Design new desuperheater to harvest some heat from the $NH_3$ refrigeration plant to provide pre-heating for amenities hot water. A hot water cylinder |

| | |
|---|---|
| | would be required to keep the water hot and provide storage. |
| Energy Used | Additional electrical energy for transfer pump |
| Energy Saving Expected | 22 kW demand reduction on hot water system, 435 GJ/year energy saved |
| Co-benefits Reported | • Reduction in electricity demand if amenities hot water is electrified.<br>• Reduction in gas consumption for hot water heating |
| Cost Indicators | • CAPEX: $60,000**<br>• Project Life: 18 years<br>• MAC: $34/t$CO_2$-e<br>• NPV: -$15,000 |

** The CAPEX for this project is for the inclusion of an additional heat exchanger, piping, and an additional pump that would allow the installation of a de-superheater prior to the evaporative condenser and enable heat recovery from the refrigeration system. The amenities hot water system upgrades are not included in the cost of this project.

#### Recovery from the Planned Chiller Plant Upgrade

Heat recovery to provide for process hot water pre-heating has been included as part of the Main Boiler replacement discussion – refer to Project 1 in section 6.4 below. The assumption has been that the new chiller refrigeration plant will be designed to enable recovery of the reject heat.

The basis for the heat rejected from the refrigeration plant has been frequency analysis of the operation of the existing freon refrigeration plant, assuming the refrigeration loads will be similar for the new ammonia plant.

This project has been considered in the MAC analysis for Project 1, rather than as a stand-alone project. It has been assumed that this heat recovery will occur within other projects which are included in the MAC such as a heat pump for process water heating. Further analysis is required if this project is to be considered in isolation, which has not been included in this ETA.

| **Summary Card – New Refrigeration System Heat Recovery – Process Water Pre-Heating** | |
|---|---|
| Application | Heat recovery from chiller refrigeration plant to provide heat source for main process hot water. |
| Description of Opportunity | Design new chiller refrigeration plant to integrate condenser heat as a heat source for pre-heating water for process heat, including additional piping and pump for heat transfer. |
| Energy Used | Additional electrical energy for transfer pump |
| Energy Saving Expected | 1,240 kW* demand reduction on hot water system |
| Co-benefits Reported | • Possible reduction in water consumption due to lower usage of cooling tower in refrigeration system |
| Cost Indicators | CAPEX: $60,000**<br>Project Lifetime: 20 years |

* Energy available for pre-heating boiler feed water or heat-pump inlet, thus reduction on current demand

** The CAPEX for this project is for the inclusion of an additional heat exchanger, piping, and an additional pump that would allow the bypassing of a cooling tower and enable heat recovery from the refrigeration system. The refrigeration upgrade is not included in these costs.

### 6.2.2 Project 9 – Washdown Hose Nozzles

Currently, hose nozzles on site are adjustable. Swapping to a fixed hose nozzle will remove unnecessary variability in flow. This will control hot water used during wash down and is expected to reduce overall hot water demand.

It is suggested that a variety of nozzle sizes are trialled on site to achieve the appropriate spray velocity for most effective washdown. Table 6-2 shows the comparison of different nozzle sizes. The existing nozzle sizes on site are unknown and vary around site. The base case for comparison is a 19 mm opening, or the typical internal diameter of the washdown hoses. It is assumed that the flow velocity in this base case is typical for all nozzle sizes in order to estimate comparative water savings. Energy savings have been estimated based on the existing coal boiler. The replacement of the boiler with a heat pump would reduce the energy savings.

Table 6-2: Hot water savings with various hose nozzle sizes

| Nozzle Size | Flow (L/s) | Water Saving ($m^3$/year) | Energy Saving* (GJ/year) |
|---|---|---|---|
| 19 mm | 0.5 | None – Base case | None – Base case |
| 15 mm | 0.3 | 4,200 | 1,650 |
| 11 mm | 0.2 | 7,400 | 2,900 |
| 8 mm | 0.1 | 9,200 | 3,600 |

* Energy savings calculated based on existing coal boiler

Size and shape of the nozzle should be determined through the onsite trials. The reduction in hot water consumed during wash down cannot be easily estimated until a nozzle size has been selected. **Therefore, the energy savings have not been assessed at this time.**

| Summary Card – Washdown Hose Nozzles | |
|---|---|
| Application | Reduce hot water consumption by changing to fixed hose nozzles. |
| Description of Opportunity | Trial fixed hose nozzles and swap adjustable nozzles for appropriate fixed nozzles. |
| Energy Used | None |
| Energy Saving Expected | Reduction in hot water demand, quantity not assessed |
| Co-benefits Reported | • More effective washdown procedures due to more suitable water velocities<br>• Time savings from more effective washdown |
| Cost Indicators | • Total CAPEX: $1,600<br>• MAC to be determined once hot water demand reduction has been quantified |

### 6.2.3 Project 10 – Hot Water Ring Main Insultation

Insulation of the hot water ring main reduces heat losses through the system. More effective lagging of the pipes will result in higher temperature water returning to the hot water heating system, thus reducing load on the main boiler.

Currently, the hot water ring main is lagged where it is open to air but is not lagged in the ceiling space. There exists opportunity to lag the remaining pipe and renew existing lagging if necessary.

| Summary Card - Hot Water Ring Main Insulation | |
|---|---|
| Application | Reduction of heat losses from hot water piping. |
| Description of Opportunity | Lagging of ring main in ceiling space and renew existing lagging if required. |
| Energy Used | None |
| Energy Saving Expected | Reduced coal consumption - 810 GJ per annum |
| Co-benefits Reported | • Reduced safety risks of injury from hot pipes |
| Cost Indicators | • CAPEX: $61,000<br>• Project Lifetime: 20 years<br>• MAC: $24/tCO_2-e<br>• NPV: -$12,000 |

### 6.2.4 Project 12 – Stand-by Heat Exchangers for Processing

Hot water from the boiler is used to heat returning water from the processing plant ring mains, bore water, and other water streams (such as rendering water return and air compressor heat recovery).

The existing heat exchangers operate as duty only. They are typically serviced during the annual plant shut-down and any additional servicing requires the heat exchanger to be taken off-line. Hard water from the bores results in regular fouling of the heat exchangers reducing heat transfer efficiency and increasing load on the Main Boiler.

Therefore, installing standby heat exchangers to allow duty/standby operation would allow for more regular maintenance and reducing demand on the boiler as well as improving reliability of operation. The extent of fouling, and the changes to maintenance schedules cannot be well defined, therefore the energy saving has been assessed based on broad assumptions (a 15% loss in heat transfer, and therefore the same increase in boiler work).

This project has operational benefits, as well as energy savings, and therefore should be considered despite the energy saving being not well defined at the current time. The quick payback and negative MAC indicate benefits for BSP to complete this project immediately.

| Summary Card – Standby Heat Exchangers for Processing | |
|---|---|
| Application | Improve the reliability of heat transfer from boiler water to hot water. |
| Description of Opportunity | Install standby heat exchangers for hot water production for processing plant to allow more regular servicing of existing heat exchangers and increased reliability of heat transfer. |
| Energy Used | None |
| Energy Saving Expected | 15% reduction on Main Boiler Demand (2800 GJ/year) |
| Co-benefits Reported | • Reduced demand on Main Boiler<br>• Improved operational reliability |
| Cost Indicators | • CAPEX: $17,000<br>• Project lifetime: 20<br>• MAC: -$19.10/ tCO_2-e<br>• NPV: $187,000 |

## 6.3 Alternative Technologies/Methods

### 6.3.1 Project 2 – Upgrade Sterilisers

Currently, the majority of sterilisers on site are spray sterilisers which use less water than dunk sterilisers. However, the sterilisers operate continuously during the day, and flow rates have been measured to greatly exceed recommended flows.

It is recommended that all flows should be checked and reduced where appropriate to maintain 82 °C at point of use (typically 2.5 – 3.5 L/min). Turning off the sterilisers automatically at breaks and end of shift would reduce unnecessary water use.

Additionally, reviewing the option of ring main extension down to each steriliser to have photo-eye operation will further reduce water demand, or review of replacing ring main hot water sterilisers with stand-alone electric water heater integrated sterilisers.

Sterilisation by UV has not been deeply investigated in this study. The use of UV is typically dependent on approval from markets, and so is difficult to implement where a site is exporting. Furthermore, for UV sterilisation to be effective the knife has to be clean, necessitating a washing step which eliminates the benefit of moving to a UV system or restricting their use to a small number of suitable tasks.

A summary of both ring-main and electric water heating options is shown in Table 6-3.

Table 6-3: Summary of steriliser replacement options

| Steriliser Type | CAPEX | Advantages | Disadvantages |
|---|---|---|---|
| Electric Water Heating | $512,000 | • Lower emission energy source<br>• Hot water demand reduction on boiler<br>• No additional piping required | • Additional electrical load on already restricted supply<br>• Higher price per unit, higher overall CAPEX |
| Ring-Main Hot Water | $424,000 | • Uses existing hot water supply network<br>• No additional electrical loads<br>• Lower price per unit and lower overall CAPEX | • Additional piping required to extend ring main to point of use<br>• Higher emission energy source (boiler) |

Due to the highly constrained power supply to site, and the lower CAPEX, the ring-main supplied photo-eye sterilisers have been recommended. This has been carried through to the MAC analysis.

It has been assumed that all 28 sterilisers will be replaced. This should be assessed further prior to the project being completed to confirm the operational needs, as some areas may be better suited to continuous flow sterilisers.

There is a benefit to BSP to upgrade spray sterilisers immediately, however that benefit will reduce with a move to hot water generation by heat pump. It is expected to save in the order of $14,000 pa of electricity cost if hot water is provided by heat pump. Further optioneering should be undertaken to understand if the reduced hot water demand would reduce the capital cost of the heat pump sufficiently to justify the investment in new sterilisers.

| Summary Card – Upgrade Sterilisers | |
|---|---|
| Application | Sterilisation of knives. |
| Description of Opportunity | Consideration of spray sterilisers with photo-eye off a ring main return dropper |
| Energy Used | Fuel consumption for hot water production (Fuel TBC depending on Main Boiler fuel switch) |
| Energy Saving Expected | • Reduction in hot water demand – 9,320 GJ per annum.<br>• Current total steriliser hot water demand estimated 133 L/minute<br>• Total steriliser hot water demand estimated with steriliser replacement estimated 5.3 L/minute<br>• Estimated annual water saving – 24,000 m³/year |
| Co-benefits Reported | • Reduced water consumption and wastewater generation<br>• Only operate when line is running<br>• Greatly reduced steam release into the environment<br>• Low thermal mass so much lower temperature equipment. Increased safety<br>• Fully automatic, yielding consistent results across all equipment operators |
| Cost Indicators | • CAPEX: $424,000<br>• Years to break even: 12 (while coal-fired. Does not break even when heat is from a heat pump)<br>• Project Lifetime: 20<br>• MAC: $-0.3/t$CO_2$-e<br>• NPV: 369,000 |

### 6.3.2 Project 8 – Shrink Tunnels

There are two shrink tunnels on site currently with 12.8 kW and 9 kW respectively.

Replacing these with upgraded models such as Moda Shrink Tunnels which consume 50% less energy than conventional hot water shrink tunnels would reduce energy consumption.

The low energy saving results in a minor emission reduction, and a very high MAC. However, the added benefits of reduced loading on the constrained power supply mean this project should be considered when the existing shrink tunnels are approaching end of life (in approximately 15 years) and would require replacement.

| Summary Card – Shrink Tunnels | |
|---|---|
| Application | Energy efficient shrink tunnels. |
| Description of Opportunity | Replace existing shrink tunnels with new Moda Shrink tunnels or similar. |
| Energy Used | Electricity as per current operation |
| Energy Saving Expected | 50% of current shrink tunnel electricity consumption (approximately 34,000 kWh/year) |
| Co-benefits Reported | • Reduction of load on constrained power supply to site |
| Cost Indicators | CAPEX: $413,000<br>Project lifetime: 20 |

| | |
|---|---|
| | MAC: \$6057/t$CO_2$-e<br>NPV: -\$451,000 |

### 6.3.3 Project 16 – Upgrade Rendering Water Supply Line

The Rendering Plant operation is currently limited by water supply. The existing cold-water supply line is undersized, and there is inadequate cold water storage at the rendering plant. This means the heat recovery system on the cooker condenser must operate on closed loop (utilising the cooling tower to reject heat to atmosphere). Currently, approximately 2 MW of heat is being rejected to atmosphere through a closed-loop cooling loop utilising a cooling tower. The closed loop is necessary due to a restricted supply of water to the rendering plant. This represents a significant lost opportunity to offset heating requirements in the processing plant.

Upgrading the water supply line will allow sufficient water flow to rendering and heat recovered from rendering to be returned to the processing plant via hot water. Additional hot water storage will allow the misalignment of operating schedules between Rendering Plant and Processing Plant to be bridged and hot water will be available when required by Processing.

The heat recovered can be used to pre-heat the Rendering Boiler feed, reducing coal consumption. Also, hot water provided to processing can reduce demand on Main Boiler, further reducing coal consumption, or provide hot water for a heat pump to lift.

It is recommended this project be implemented immediately, as it will result in significant demand reduction on the Main Boiler and associated coal costs and emissions.

| **Summary Card – Upgrade Rendering Supply Line** | |
|---|---|
| Application | Cold water supply to rendering plant to allow hot water to be returned to processing plant. |
| Description of Opportunity | Increase diameter of water supply pipe (from 50 mm to 100mm) to rendering plant which will allow sufficient water for rendering plant, and therefore allow less closed-loop cooling, preheating boiler feed water, and allow more hot water to be returned to Processing. |
| Energy Used | Additional electrical energy consumption for return pump (5 kW, 99 GJ/year). This is small compared to energy savings |
| Energy Saving Expected | 12,320 GJ per annum |
| Co-benefits Reported | • Reduced load on main boiler<br>• Reduced load on rendering boiler<br>• Reduced electricity demand and water consumption for cooling tower operation |
| Cost Indicators | • CAPEX: \$1,440,000<br>• Project lifetime: 20<br>• MAC: \$64/t$CO_2$-e<br>• NPV: -\$415,000 |

### 6.3.4 Project 20 – Optimise Blast Freezer Operation

This project examines opportunities to optimise blast freezer operation to ensure that the blasts are not running needlessly.

Over the weekends when processing has stopped, the refrigeration load on the blast freezers reduces, but this is not currently reflected in the blast freezer operation and the freezers are typically at a much lower temperature than required by start of processing on a Monday.

Therefore, there is an opportunity to tune the refrigeration plant to reduce unnecessary load and save on electricity. The extent of electricity savings cannot be determined at this time, and it is recommended BSP conduct trials for optimal refrigeration operation.

| **Summary Card – Optimise Blast freezer Operation** | |
|---|---|
| Application | Optimising blast refrigeration operation |
| Description of Opportunity | Optimising blast refrigeration operation |
| Energy Used | None |
| Energy Saving Expected | Reduction in electricity consumption TBC based on further investigation. Typically 15%. |
| Co-benefits Reported | • Reduction in electrical load, easing power constraints |
| Cost Indicators | Not Assessed |

## 6.4 Fuel Switching Analysis

### 6.4.1 Project 1 – Replace Main Boiler with Heat Pump

This project is intended to entirely replace the existing Main Boiler to produce 82°C water for the plant.

This project ties closely with Project 7 – Refrigeration System Heat Recovery. The heat pump will be designed to utilise the heat rejected from the new chiller refrigeration plant to act as a heat source. The 1,300 kW of heat rejected from the refrigeratation plant requires a 0.5 MW heat pump to lift 15 °C cold water to 90 °C. Further heat recovery from the rendering plant reduces the power consumption of the heat pump to 81 kW. It is assumed that the rendering water supply upgrade project (see 6.3.4 – Project 16) will be completed such that the hot water demand is reduced prior to the heat pump being sized.

A critical pathway to improve the feasibility of the heat pump operation is Project 16 – Upgrade Rendering Water Supply. Other heat recovery options are not considered in the pathway at this current time, but if they are introduced in the future, this will reduce the load on the heat pump and therefore reduce electricity consumption.

A further driver for the replacement of the Main Boiler is the air discharge resource consent is nearing expiry and there are risks around the reconsenting, especially in the longer term. Therefore, a move away from a coal boiler in the future is likely.

Based on preliminary investigations, the heat pump has been sized at 335 $kW_{th}$ for current hot water demand, and has taken into account the heat recovery implementation from rendering. This reduces the load on the hot water system by approximately 1.5 MW. The heat recoverable from the refrigeration plant has been estimated to size the heat pump from operating power data from the existing freon plant. This should be revisited based on the design of the new plant when this information becomes available.

It should be noted that the economics of this project are very sensitive to the base load of the refrigeration plant and the operating tempertaure of the condenser. It is recommened that a more detailed study be pursued when details of the new refrigeration system become clearer.

| **Summary Card – Replace Main Boiler with Heat Pump** | |
|---|---|
| Application | Hot water supply at 82 °C |

| | |
|---|---|
| Description of Opportunity | Move from coal-fired boilers to heat pumps for water heating. |
| Energy Used | Electricity - 350,400 kWh/year |
| Energy Saving Expected | Main boiler can be decommissioned saving 18,508 GJ per annum of coal consumption |
| Co-benefits Reported | • Rendering heat recovery reducing demand at processing<br>• Reduced air emissions by removing main boiler completely |
| Cost Indicators | • CAPEX: $830,000<br>Project lifetime: 20<br>• MAC: $3/t$CO_2$-e<br>• LCOE: $-7.54/GJ<br>• Years to payback: 8 (assuming savings based on coal consumption)<br>• NPV: $453,000 |

### 6.4.2 Project 3 – Alternative Boiler Fuels

We have considered alternative fuel boilers for the Main Boiler and the Rendering Boiler. Fuels investigated are summarised in Table 6-4. OPEX refers to fuel costs only for this comparison. The CAPEX and OPEX values should be considered for comparative purposes only. Emissions reduction are based on changes from current operation (coal-fired boilers).

- The recommended option for Main Boiler replacement would be a heat pump (see 6.4.1 – Project 1), therefore this should be considered in future.
- Due to the risks associated with biomass supply (long-term contracted supply), it is recommended that this be investigated further prior to selection of an alternative fuel for the rendering boiler. Fuel supply should be contracted prior to committing to a solution, and the risks of the supply being disrupted should be considered.
- An electric boiler will incur significant costs associated with the level of infrastructure upgrades to supply an additional 4.5 MW of power, however energy supply would then be relatively secure and reliable.
- Tallow is a good option to consider in future if the tallow prices drop, or government moves to make tallow a nationally significant resource (limiting exports) in the movement towards a zero-carbon future for New Zealand. Again, tallow manufactured on site will provide certainty of fuel supply.

The rendering boiler has been sized based on the current demand. Based on timing of the project, if the heat pump project for Main Boiler replacement has not taken place by the time the rendering boiler replacement is occurring, this project could be considered differently to increase the capacity to service both rendering and processing off one single boiler. This would need to be investigated further at the time of implementation. However, this is not the recommended timing as indicated on the emissions reduction pathway indicated in Section 7.2.

Table 6-4: Summary of alternative fuel options considered

| Boiler | Fuel | Cost Indicators | Advantages | Disadvantages |
|---|---|---|---|---|
| Main Boiler (350 kW) | Biomass | • CAPEX: $1,890,000<br>• OPEX: $119,000 / year<br>• Annual Emissions Reduction: 1230 t$CO_2$-e/year<br>• MAC: $77/t$CO_2$-e | • Existing fuel handling systems could be utilised.<br>• Local wood fuel suppliers in the vicinity. | • Risks with fuel supply. A supply contract would be required before committing to this project. |

| Boiler | Fuel | Cost Indicators | Advantages | Disadvantages |
|---|---|---|---|---|
| | | • LCOE: $28/GJ<br>• NPV: -$1,502,000 | | • Higher cost for wood chip, more operational difficulties for lower quality fuel (hog fuel)<br>• Lower energy density would require greater fuel volumes, hence additional fuel deliveries, or increasing fuel storage onsite.<br>• Resource consent for emissions would need to be considered<br>• Lower emissions reduction than electricity |
| | Electricity | • CAPEX: $1,590,000<br>• OPEX: $258,000 / year<br>• Annual Emissions Reduction: 1631 $tCO_2$-e/year<br>• MAC: $82/tCO_2$-e<br>• LCOE: $40/GJ<br>• NPV: -$2,143,000 | • No fuel handling system required<br>• No boiler operator required<br>• Greater emissions reduction than wood chip<br>• Lower CAPEX than wood chip | • Increased electricity load will possibly require investment in network infrastructure to increase electricity supply to site.<br>• Higher OPEX than wood chip<br>• Lower electrical efficiency than heat pump. If electricity is selected, heat pump would be preferred over electric boiler. |
| Rendering Boiler<br>(4.5 MW) | Biomass (wood chip) | • CAPEX: $5,640,000<br>• OPEX: $606,000 / year<br>• Annual Emissions Reduction: 3188 $tCO_2$-e/year<br>• MAC: $150/tCO_2$-e<br>• LCOE: $26/GJ<br>• NPV: -$8,543,000 | • As above | • As above |
| | Electricity | • CAPEX: $1,711,000<br>• OPEX: $3,168,000 / year | • As above | • Increased electricity load will require significant |

| Boiler | Fuel | Cost Indicators | Advantages | Disadvantages |
|---|---|---|---|---|
| | | • Annual Emissions Reduction: 2370 $tCO_2$-e/year<br>• MAC: \$544/$tCO_2$-e<br>• LCOE: \$77/GJ<br>• NPV: -\$25,000,000 | | investment in network infrastructure to increase electricity supply to site making this option unfeasible at the existing plant location<br>• Much higher OPEX than wood chip<br>• Lower emissions reduction than wood chip |
| | Biogas/Biomass Dual Fired | • CAPEX: \$8,373,000<br>• OPEX: \$349,000/ year<br>• Annual Emissions Reduction: 3205 $tCO_2$-e/year<br>• MAC: \$168/$tCO_2$-e<br>• LCOE: \$30/GJ<br>• NPV: -\$9,705,000 | • Utilising biogas which is normally wasted<br>• Biogas is biogenic carbon source, so emissions are lower than biomass-only system | • Biogas operational issues such as gas scrubbing and disposal of scrubbing water and biogas storage would require additional investigation<br>• Wood chip supply risks as described above. Would need confirmed supply contract in place prior to considering further<br>• Bespoke boiler design required at high expense<br>• Insufficient biogas generation, so most of the energy would be from wood chip. |
| | Tallow | • CAPEX: \$2,594,000<br>• OPEX: \$915,000 / year<br>• Annual Emissions Reduction: 3114 $tCO_2$-e/year<br>• MAC: \$136/$tCO_2$-e<br>• LCOE: \$23/GJ<br>• NPV: -\$7,445,000 | • Fuel is produced onsite so no transport costs or associated emissions<br>• Automated feed system so no boiler operator required | • Tallow value is currently high, making this economically unfavourable. A shift in tallow prices could change this.<br>• Additional fuel handling equipment |

| Boiler | Fuel | Cost Indicators | Advantages | Disadvantages |
|---|---|---|---|---|
| | | | | required (heated tallow tanks, feed pump). |

Additional options were considered, but not pursued for the following reasons:

- **Rendering Boiler Conversion to Wood Chip** – Prior to confirmation of the feasibility of converting the existing coal-fired rendering boiler to handle wood chip, investment is required in the boiler investigations. The age of the rendering boiler, and the risk associated with up-front investment in the order of $50,000 has led to the recommendation to not consider the conversion of the existing boiler.
- **Tallow for Main Boiler** – The additional ancillary equipment required for a tallow boiler and the high fuel cost makes other fuel options more suitable for the main boiler due to the smaller scale required.
- **Biogas for Main Boiler** – Although the biogas production on site is sufficient to meet the demand of the Main Boiler, the operational complications with biogas combustion, such as the need for scrubbing to remove sulphur and the subsequent disposal of the sulphur-containing water, and biogas storage indicates that other fuel options are more feasible. Biogas was not considered further at this stage.
- **Biogas for Rendering Boiler** - The current biogas production provides insufficient energy to produce steam in its own right. Therefore, either co-fired boilers or a gas-fired boiler and an additional heat pump would be required to produce the steam required for rendering. This should be considered further at a time when the carbon costs associated with coal are such that the additional heat pump and gas-fired boiler required to produce steam are economically favourable.

| Summary Card – Alternative Boiler Fuels | |
|---|---|
| Application | Supply steam to rendering plant |
| Description of Opportunity | Eliminate coal use by replacing with alternative boiler fuels:<br>• Biomass (wood chip)<br>• Biogas<br>• Tallow |
| Energy Used | Small additional electrical energy for gas feed blower or tallow feed pump possible but would reduce fuel required for solid fuel handling on site.<br>Energy source is TBC based on further investigations for the best fuel option for the rendering boiler. The energy required (regardless of source) would be 33,300 GJ/year. |
| Energy Saving Expected | 580 GJ/year from boiler feed pre-heating |
| Co-benefits Reported | • Utilisation of biogas currently flared (if biogas/biomass dual-fired option selected<br>• Energy savings from pre-heating of boiler feed water which will be integrated into this project |
| Cost Indicators | TBC depending on selected option |

### 6.4.3 Project 4 – Biogas Recovery for Heat or Electricity Generation

Currently, biogas produced onsite is flared. An alternative opportunity is to recover the biogas and use for heat or electricity generation. As discussed in Section 6.4.2 – Project 3 – Alternative Boiler Fuels, utilising biogas for heat generation is not a recommended pathway at this time due to the limited biogas generation and the high costs associated with a dual-fired boiler option.

The biogas generated onsite is insufficient to meet the rendering heat demand. The biogas production is estimated at 1,890 $m^3$/day or 0.5 MW energy potential, compared to the 4.5 MW rendering boiler. Therefore, a dual-fired option would be required to meet demand, which is a high-cost option. The CAPEX for a woodchip/biogas dual-fired boiler is $2.7 - $6.7 million greater than the other options proposed. Increasing biogas production could be achieved through redesign of the wastewater treatment plant and increasing load on the wastewater plant. However, the increases to biogas production would need to be further investigated to assess feasibility and likely benefit.

Using biogas for electricity generation via a biogas-fired engine could be an option to reduce constraints on power supply to site.

The scale of electricity that could be produced by the biogas produced on site is small; 150 kW or 4,100 GJ/year. Electricity generation is not the most efficient use of biogas, with only approximately 1/3 of the biogas energy converted to electrical energy. Consideration of a combined heat and power (CHP) unit would allow some additional heat recovery and improve energy efficiency.

Due to the small scale of generation and relatively high capital costs associated with such equipment, **this project has not been assessed further at this time.** However, if the power constraints remain unsolved in future, onsite electricity generation should be reassessed.

| **Summary Card – Biogas Recovery for Electricity Generation** | |
|---|---|
| Application | Fuel for electricity generation |
| Description of Opportunity | Utilise biogas produced onsite to fuel a biogas engine for electricity generation |
| Energy Used | Biogas, currently being flared so representing lost energy potential |
| Energy Saving Expected | Electricity savings - 4,100 GJ/year of electricity from the grid replaced with onsite generation |
| Co-benefits Reported | • Reduced demand from power network infrastructure |
| Cost Indicators | Not Assessed |

### 6.4.4 Project 15 – Electrification of Amenities Water

Currently, the hot water for amenities, such as showing, is supplied by bottled LPG hot water system, topped up by the hot weather ring main from the processing plant. The constraints on available power onsite and the small amounts of gas consumed mean this project is not high priority for switching to electric. However, it should be considered in future if power supply to site is upgraded. **This project was not assessed further.**

### 6.4.5 Project 19 – Electric / Biofuel Vehicles

The technology for electrification of vehicles is not yet readily available at an affordable price point. However, replacement of fleet vehicles with electric vehicles should be reassessed as vehicles come to end of life and technology advancements reduce the price of electric vehicles.

Consideration should be made in future to leasing electric forklifts as opposed to diesel forklifts if available, which would reduce the associated emissions. The current constraints on power supply to site make this project unfavourable at the current time but should be considered if power supply to site is upgraded.

**This project was not assessed further.**

## 6.5 Marginal Abatement Cost (MAC) Curves

Marginal abatement cost (MAC) curves show the cost to abate one further unit of carbon emission (t $CO_2$e). Abatement projects have been ranked from lowest abatement cost to highest, and are shown from left to right on the graph. Projects with a "cost" below zero have a positive net present value – they are financially beneficial to implement, so therefore have a negative cost to for the abatement. The width of the project describes the amount of carbon emission abated by the project.

The x-axis units of $/t $CO_2$e are derived by determining the discounted net present value of the project and dividing by the sum of the abated emissions over the assumed life of the project. An assumed weighted average cost of capital (WACC) is used as the discount rate in the NPV calculation. Note that no discount is applied to future abatements.

The WACC is assumed to be 7% in this study.

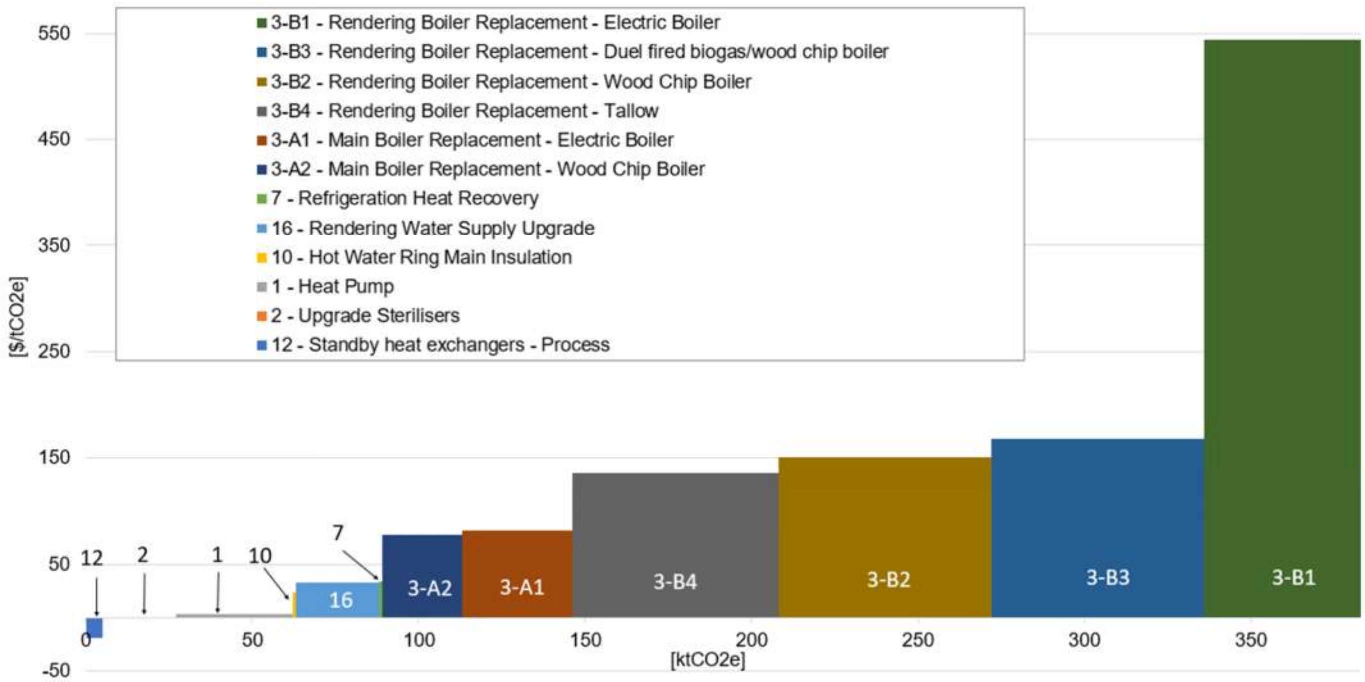
For the sake of clarity, when determining the NPV of a project the cost of carbon under the ETS is excluded (set to $0).

## 6.6 Interpreting the MAC Curve

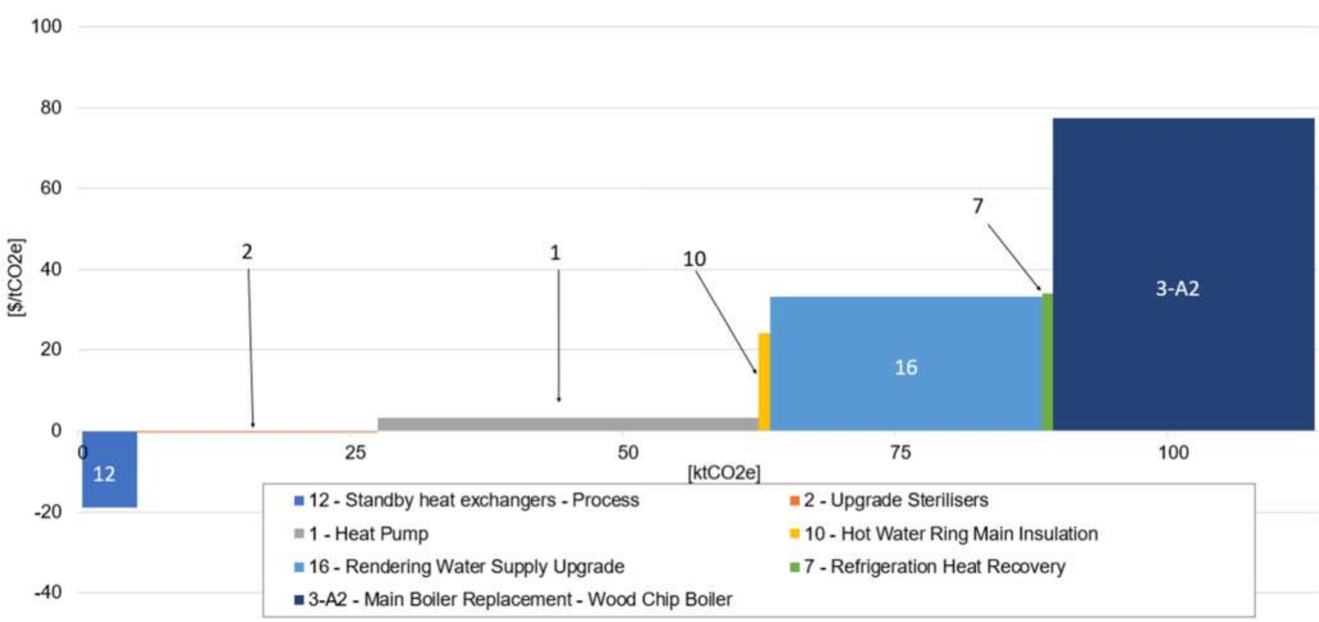
When considering the MAC curve it is worth noting:

- The MAC curve is a snapshot in time and makes no comment on when a project may be delivered. When calculating the NPV of the project it is assumed to start at year zero
- The marginal cost of abatement is influenced by the discount rate in the NPV calculation. For projects that don't payback (i.e. positive MAC, negative NPV) a higher discount rate makes these projects appear "less bad," with a lower cost of abatement
- Likewise, projects with a negative MAC will appear to be "less good" with a higher discount rate
- The question of discounting emission abatement into the future is a complex one. The *Center for Climate and Energy Solutions* has determined that there can be enormous shifts in the calculated benefit of a project if uncertainty in future discount rate is considered.
  While the idea of discounting future carbon abatement seems reasonable it is not clear what discount factor should be applied to future carbon abatements. Indeed, even considering the timeframe over which the abatement is considered is problematic – should the timeframe consider the life of the abatement project and also the much longer life of the gas in the atmosphere?
  The approach in the ETA studies is to not discount abatement over time and sum the expected abatement for the life of the project.

For those projects considered viable for implementation, the following chart compares the marginal abatement cost of the project with the total lifetime carbon abatement of the projects.




The curve for the seven projects with the lowest MAC value is shown below.



# 7 Energy Transition Pathway

## 7.1 Pathway Projects

The proposed pathway relies on heat recovery from rendering. The proposed pathway is also heavily determined by the outcome of investigations into power supply improvements to the site. Several of the recommended projects would function together to deliver the abatement.

- The rendering water supply upgrade to allow heat recovery from rendering should be completed regardless of other abatement opportunities. This will significantly reduce the demand on the main boiler and has been included within all boiler replacement projects.
- The proposed change to heat pump to replace the Main Boiler includes:
  - Heat recovery from the rendering plant, made possible by upgrading the water supply to the rendering plant
  - Heat recovery from the new (yet to be installed) refrigeration plant. This plant should be designed with heat recovery in mind as it is critical to the success of the heat pump
- Selection of a preferred option to replace the rendering boiler requires further work. BSP needs to weigh the risks and opportunities around securing supply of biomass against a high cost but reliable electricity supply and the opportunity cost of moving to tallow-firing.

There are several other remand reduction opportunities, discussed above in Section 6, than can be pursued

- Sterilisers may be replaced to photo-eye operation to reduce the hot water demand. This could be more economic if the reduced hot water demand can be seen to materially reduce the cost of a heat pump
- Complete the insulation of the hot water ring main
- Undertake tests to confirm the reducing efficiency of the heat exchangers in the processing plant. Install stand-by heat exchangers if the evidence supports it. This will enable the heat exchangers to be maintained more frequently, thereby reducing scale build up
- Install fixed-flow wash down hose nozzles to control water consumption.

### 7.1.1 Alternative Pathways

The proposed pathway should be monitored to ensure the logic remains coherent. Several projects in particular should be considered for early implementation if conditions change.

- Electrification of amenities water if power supply constraints can be eased
- Tallow for boiler fuel should continue to be monitored. The future value of tallow as a product and as a fuel may switch depending on the economic environment.

## 7.2 Transition Pathway

The proposed transition pathway is below. The remaining emissions are associated with carbon emitted during the generation of electricity. As more renewables are added to the grid, this should further reduce.

**Proposed BSP Transition Pathway**

**Client Milestones**

- Air Discharge Consent renewal
- Forecast boiler end of life (main boier and rendering)
- Coal boiler ban

| Transition Actions | CAPEX ($) | OPEX Impact ($/y) Carbon price set to $0 | MAC ($/$t_{CO2e}$) COAL | Annual Emissions Reduction tCO2e COAL | Annual Emissions Reduction tCO2e HP |
|---|---|---|---|---|---|
| **Enabling Projects** | | | | | |
| Refrigeration System Upgrade inc Heat Recovery | | | | | |
| **Demand Reduction/Heat Recovery** | | | | | |
| Hot Water Ringmain Insulation | $ 61,000 | -$ 835 | $ 24 | 77 | 26 |
| Standby Heat Exchangers in Processing | $ 17,000 | -$ 13,884 | -$ 19 | 265 | 88 |
| Washdown Hose Nozzles | $ 1,600 | | | | |
| Rendering Water Supply Upgrade | $ 1,440,000 | -$ 27,199 | $ 33 | 1,230 | 410 |
| Heat Recovery from Refrigeration | $ 60,000 | -$ 1,731 | $ 34 | 49 | 25 |
| **Alternative Technologies** | | | | | |
| Upgrade Sterilisers | $ 424,000 | -$ 38,344 | -$ 0 | 1,110 | 370 |
| **Fuel Switching** | | | | | |
| Replace Main Boiler with Heat Pump | $ 830,000 | -$ 60,005 | $ 3 | | 1,726 |
| Electric Forklifts | - | | | | 126 |
| Biodiesel/electric Fleet Vehicles | - | | | | 107 |
| Replace Rendering Boiler Options: | | | | | |
| Wood Chip | $ 5,640,000 | $ 677,129 | $ 150 | | 3,188 |
| Electricity | $ 1,710,800 | $ 3,010,810 | $ 544 | | 2,370 |
| Tallow | $ 2,594,000 | $ 808,790 | $ 136 | | 3,114 |
| **Approximate Total (assuming wood chip rendering boiler)** | 8,473,600 | 535,132 | | | 6,065 |
| **Baseline Current Emissions** | | | | | 6,442 |
| **Long-term Transition Tools** | | | | | |

| Transition Actions | 2021 Q1 | 2021 Q2 | 2021 Q3 | 2021 Q4 | 2022 Q1 | 2022 Q2 | 2022 Q3 | 2022 Q4 | 2023 Q1 | 2023 Q2 | 2023 Q3 | 2023 Q4 | 2024 Q1 | 2024 Q2 | 2024 Q3 | 2024 Q4 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Refrigeration System Upgrade inc Heat Recovery | | D | P | C | C | C | | | | | | | | | | | | | | | | | | | | | | | |
| Hot Water Ringmain Insulation | | | | D | P | C | | | | | | | | | | | | | | | | | | | | | | | |
| Standby Heat Exchangers in Processing | | | | D | P | C | | | | | | | | | | | | | | | | | | | | | | | |
| Washdown Hose Nozzles | | | | P | C | | | | | | | | | | | | | | | | | | | | | | | | |
| Rendering Water Supply Upgrade | | | | | D | D | P | P | C | C | | | | | | | | | | | | | | | | | | | |
| Heat Recovery from Refrigeration | | | | | | | F | P | P | C | | | | | | | | | | | | | | | | | | | |
| Upgrade Sterilisers | | | | F | P | C | | | | | | | | | | | | | | | | | | | | | | | |
| Replace Main Boiler with Heat Pump | | | | | F | D | P | P | C | C | | | | | | | | | | | | | | | | | | | |
| Electric Forklifts | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biodiesel/electric Fleet Vehicles | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wood Chip | | | | | | | | | | | | | | | | | | | | | F | P C | | | | | | | |
| Electricity | | | | | | | | | | | | | | | | | | | | | F | P C | | | | | | | |
| Tallow | | | | | | | | | | | | | | | | | | | | | F | P C | | | | | | | |

**Legend:**

| | | | | | |
|---|---|---|---|---|---|
| | Pre-Capex Approval Studies | | Implementation | | Project operational |
| PF | Pre-feasibility | D | Design | | |
| F | Feasibility | P | Procurement | ↓ | Important dependencies |
| T | Trial | C | Construct | | |

# 8 Building Blocks for an Energy Transition Pathway

The technical potential identified by this study demonstrates that BSP can make significant emissions reductions over the next decade or so. Complementary technical and cost information will be required to make a better assessment of feasibility and economic viability of the options presented here, and the required technical studies are itemised in the section below.

However, technical studies alone are not sufficient to fully inform the long-term strategic decisions which must be made. BSP management will likely make these decisions on the basis of broader considerations than pure economic and short-term factors. EECA seeks to provide support for all aspects of the energy transition decision-making process. The proposed energy transition pathway is intended to help organisations to develop the tools and practices required to support long-term thinking, and allow decision makers to make fully-informed decisions related to energy and climate change. The related recommendations for BSP relate to the following three areas.

## 8.1 Bolstering Energy Management Capability

- Implement an improved energy management system.
  - An energy management system will increase capability to support continuous improvement and decision-making within the organisation.
  - Developing a broad network of electricity meters, water and steam flow meters, and water temperature probes will enable BSP to properly monitor assess the efficiency and operating cost of equipment by understanding the energy flows.
  - EECA has a diagnostic tool to support this process. Beca can also assist.
- Understand best-practice digital technology and energy management.
  - Technology offers the opportunity to reimagine data gathering and measurement tools which will improve efficiency and reduce costs.
  - Digital technology, IIOT sensors and AI can now help people understand their operations in whole new ways.
- Leverage EECA Business Programme support.
  - Enables you to access the necessary skilled resources and de-risk energy management and carbon abatement projects. This could include EECA funding of initiatives that many not otherwise be prioritised.
  - Planning: Feasibility studies and industrial design advice
  - Optimisation: Audits, energy system optimisation, monitoring and targeting
  - Technology: technology demonstration fund.
- Increase BSP's dedicated energy management staff to specify and implement abatement projects.
  - This could include EECA's Energy Graduate programme to access a low-cost resource to support project delivery.
- Engage with EECA regarding the Government Investment in Decarbonising Industry (GIDI) Fund.
  - Develop an increased understanding of the GIDI fund

Apply to access the GIDI fund during the September 2021 round.

## 8.2 Increasing the Strategic Weight of Energy and Climate-Related Business Cases

- Further develop BSP's Environmental Protection commitment that "Sustainability is at the core of our business." Establish business goals for emissions reduction
  - Set a science-based target
  - In line with the Climate Change Reduction (Zero Carbon) Act 2019

  - Join the Climate Leaders Coalition
- Commence greenhouse gas emissions accounting
  - To measure progress towards achieve goals
  - Publish the results and link them to manager KPIs
- Understand BSP's climate-related risks and opportunities
  - Commission an assessment of BSP's energy and climate-related risks and opportunities along its value chain.

# 9 Summary of Recommendations

The following recommendations are made.

## 9.1 Establish Explicit Climate Change and Decarbonising Objectives

BSP to establish clear corporate objectives to decarbonise and reduce their impact on climate change;

- Establish business goals for emissions reduction to be supported by a focus on measurement and metering of consumption and greenhouse gas emission reporting.

## 9.2 Implement the Following Projects

Immediate benefit could be had from:

- Improving the water supply to rendering so that heat can be recovered and used to pre-heat heat to the processing plant
- Insulating the bare areas of the hot water ring main piping
- Selecting and installing fixed flow washdown hose nozzles
- Reviewing and resetting the hot water flow control to the sterilisers. Start investigating upgrading sterilisers to photo-eye operation
- The installation of stand-by heat exchangers at the processing plant to that efficiency losses from scale build-up can be managed

Start to plan for:

- Replacing the main process boiler with a heat pump
  - Specify the refrigeration system with heat rejection to a heat pump in mind – provide tie-in points, heat exchangers, space for piping, valves and instrumentation as well as the heat pump itself
  - Further develop the project for submission to the GIDI funding round in September
- Moving to electrify the fleet of forklifts and other vehicles
- The limits and constraints of the electrical supply to site. Have further discussion with PowerNet to better define the economics of any upgrade.

Monitor and weigh the options for:

- Replacing the rendering boiler
  - Biomass fuel?
  - Electric boiler?
  - Tallow-fired?

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# A

## Appendix A – Existing Site PFDs and Energy Balance

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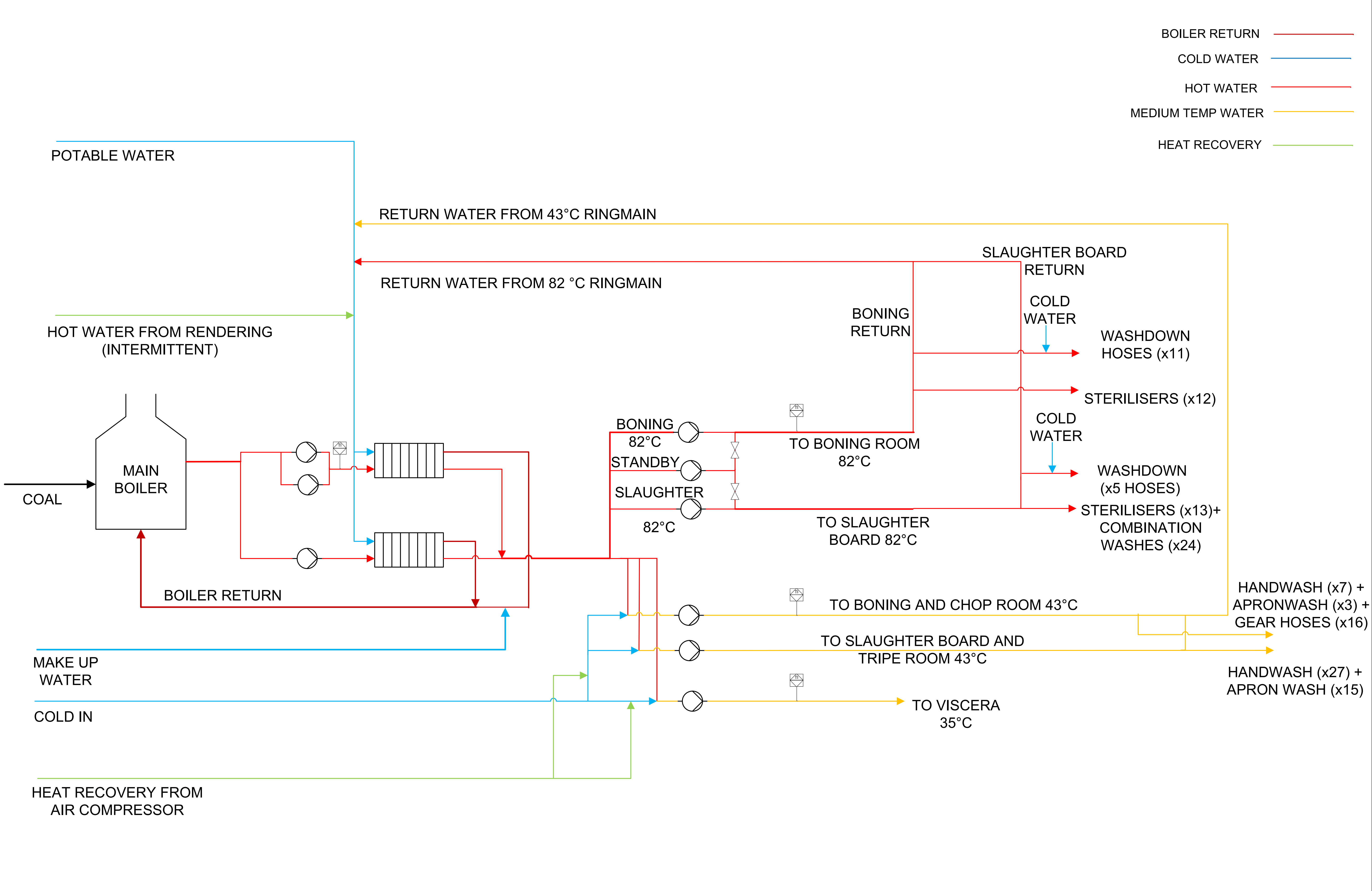


| No. | Revision | By | Chk | Appd | Date |
|---|---|---|---|---|---|
| C | UPDATED FOR FINAL ISSUE | EKR | SM | NW | 18/06/21 |
| B | UPDATED FROM OPERATOR COMMENTS | EKR | SM | NW | 23/04/21 |
| A | FOR INFORMATION | EKR | SM | NW | 29/03/21 |

Drawing Originator: Beca

Original Scale (A1) NTS
Reduced Scale (A3) NTS

| | | |
|---|---|---|
| Design | ER | 1/6/21 |
| Drawn | ER | 1/6/21 |
| Dsg Check* | SM | 1/6/21 |
| Dwg Check* | SM | 1/6/21 |

Approved For Construction*
Date

Client:

Project: BLUE SKY PASTURES EECA ETA

Title: HOT WATER PFD

Discipline: PROCESS

Drawing No. 2221845-PA-SK002

Rev. C

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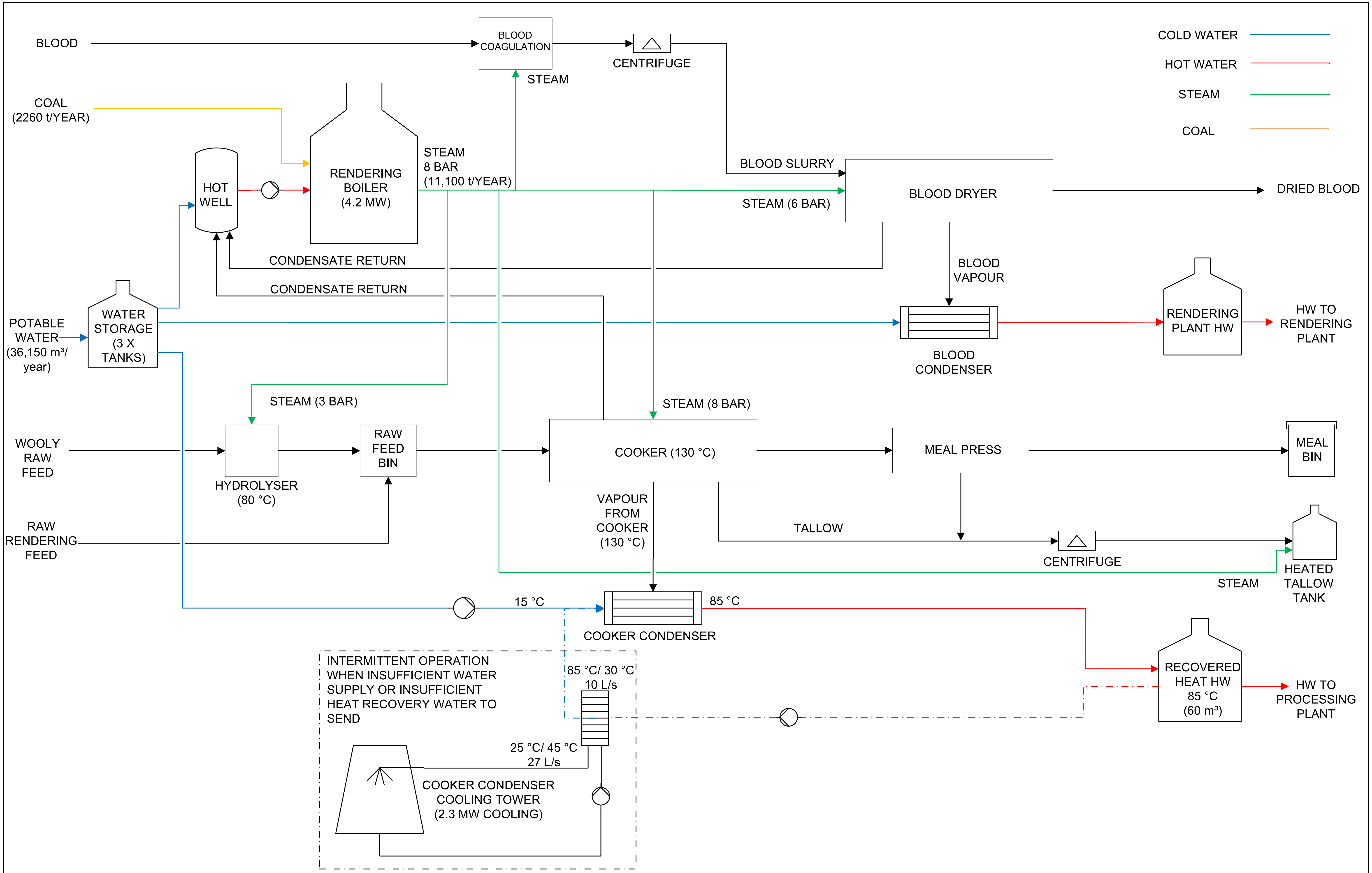


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| B | UPDATED FROM OPERATOR COMMENTS | EKR | SM | NW | 23/04/21 |
| A | FOR INFORMATION | EKR | SM | NW | 29/03/21 |

Drawing Originator: Beca

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| Original Scale (A1) NTS | Design | ER | 1/6/21 |
| | Drawn | ER | 1/6/21 |
| Reduced Scale (A3) NTS | Dsg Check* | SM | 1/6/21 |
| | Dwg Check* | SM | 1/6/21 |

Approved For Construction*

Date

Client:

Project: BLUE SKY PASTURES EECA ETA

Title: RENDERING PLANT HEAT PFD

Discipline: PROCESS

Drawing No. 2221845-PA-SK003

Rev. C

This document was created using Microsoft Visio

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Sensitivity: General

Beca

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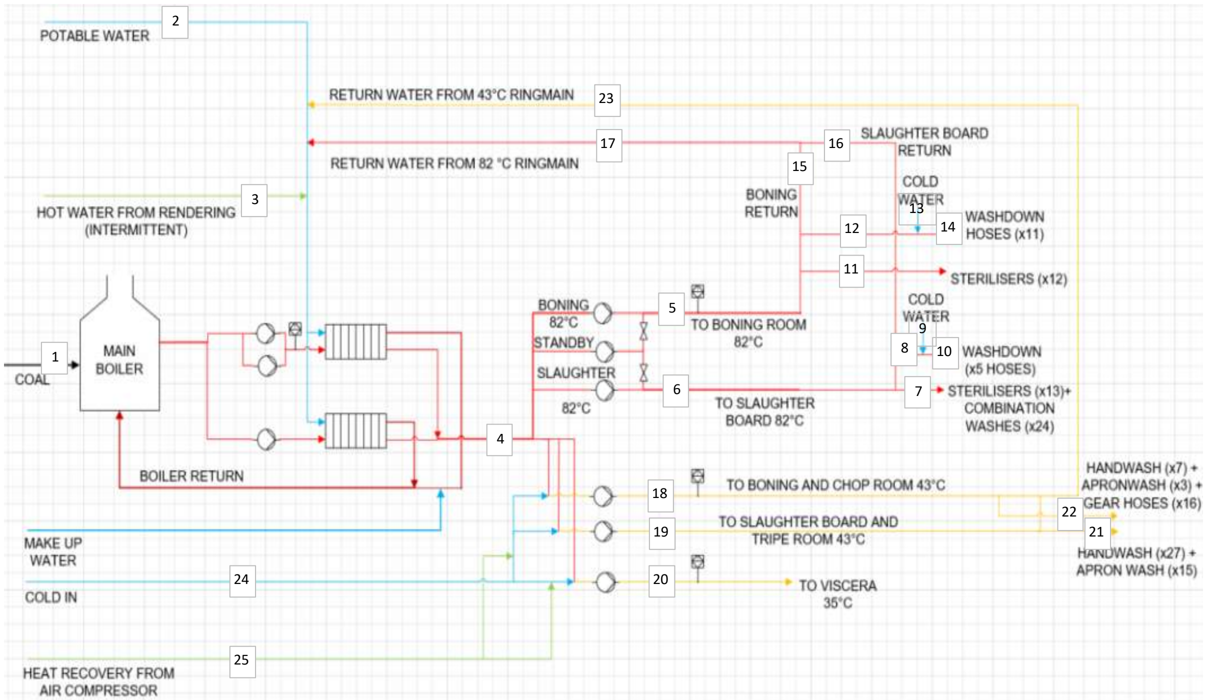
|---|---|---|---|
| JOB NAME: | EECA Study: Blue Sky Meats EECA ETA | JOB NO: | 2221845 |
| SUBJECT: | Processing energy balance | | |
| BY: | Emma Rees (ER) | DATE: | 15/07/2021 |
| VERIFIED BY: | Sean Milnes (SM) | VERIFICATION DATE: | 15/07/2021 |
| DOC. NO. | - | REV: | A |

METHODOLOGY:

Note: For stream numbers refer to PFD

Streams




| |
|---|
| Input |
| Linked |
| Calculation |
| Assumption |

| Stream Number | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Description | | Main Boiler Coal Feed | Potable Water In | Heat Recovery from Rendering | Hot Water |
| Volumetric Flow | m³/h | | 5.9 | 0.6 | 11.3 |
| Density | kg/m³ | | 998 | 998 | 998 |
| Mass Flow | t/h | 0.30 | 5.9 | 0.6 | 11.3 |
| Temperature | °C | | 15 | 65 | 95 |
| Heat Capacity | kJ/kg.°C | | 4.2 | 4.2 | 4.2 |
| Energy | kW | 1252 | 103 | 44 | 1252 |

| Energy Balance | | Water balance - consumption based on assumed flow rates from points of consumption | *Water balance check - actual consumption not hose estimates* |
|---|---|---|---|
| Energy In | kW | 2374 | *2374* |
| Energy Out | kW | 2593 | *1400* |
| Energy Discrepan | kW | -219 | *974* |
| Energy Descrepar | % | -9% | *41%* |
| Unaccounted energy | | Energy out based on assumed patterns of use, could be reflective of a peak, but the remaining values are based on average demand. | Using average flow rates - difference in ring main flows actual consumption |

**Assumptions**

40% total coal to main boiler

Assuming lignite

Carrying through from rendering energy balance, assume 10% of rendering heat recovery to processing plant

Assuming heat recovery from rendering is 65C based on discussion with operator.

82°C water actually 95.5 °C Based on instantaneous temperatures taken from site visit

Assuming 82 at point of use, and 82 on return

43°C water - note measured as 37°C when on site, kept at 43 for analysis

Viscera water 35°C for analysis. Note actually 25°C Based on instantaneous temperatures taken from site visit for analysis for conservatism

Assuming 230 oeprational days, 20 hours operation

Flow rates based on 95%ile hourly flow rates for 2 weeks data

Averaged 95%ile hourly flows from https://becagroup.sharepoint.com/:x:/s/project-54513/EREcaHOWwh9Oh-802WY1LU8BvmUt2yqKo-FfqE54eUbcJA?e=HKJJ4f

Assuming washdown hoses are 65°C, despite notes that the hose temperature can be changed on the processing floor

Assume viscera flow continuous (3 L/s)

Washdown hoses based on number of hoses in area and assumed flowrate per hose

Sterilisers flow based on measurements taken from site - 4.75 L/minute, and number of sterilisers provided for each area

Assuming 82C water is mixed with 15C to make 42 and 37

Unknown heat recovery from the air compressors - assume it meets viscera demand

Assume coal based on energy to produce hot water - matches within 20% with the 40% of coal purchased value

Sensitivity: General

| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82°C Ringmain to Boning Room | 82 °C Ringmain to Slaughterboard (SB) | SB Sterilisers and Combination Washes | Hot Water to SB Washdown Hoses | Cold Water to SB Washdown Hoses | SB Washdown Hoses | Boning Sterilisers | Hot Water to Boning Washdown Hoses | Cold Water to Boning Washdown Hoses | Boning Washdown Hoses | Boning 82°C Ring Main Return | SB 82°C Ring Main Return | Combined 82°C Ringmain Return | Boning and Chop Ringmain 43°C | Slaughter Ringmain 43 °C | Viscera 35 °C | SB Handwash and Apron Wash | Boning Handwash, Apron Wash and Gear Hoses | Combined 43°C Ringmain Return | Cold Water In |
| 4.1 | 6.1 | 9.5 | 3.0 | 0.4 | 3.4 | 4.3 | 2.9 | 4.6 | 7.459279778 | 1.0 | 3.2 | 4.2 | 0.6 | 4.6 | 10.8 | 4.0 | 0.6 | 0.69 | 4.1 |
| 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 |
| 4.1 | 6.0 | 9.4 | 3.0 | 0.4 | 3.4 | 4.3 | 2.9 | 4.5 | 7.4 | 1.0 | 3.2 | 4.1 | 0.6 | 4.6 | 10.8 | 4.0 | 0.6 | 0.7 | 4.1 |
| 95 | 95 | 82 | 82 | 15 | 65 | 82 | 82 | 15 | 41.1 | 82 | 82 | 82 | 43 | 43 | 35 | 43 | 43 | 43 | 15 |
| 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 |
| 459 | 670 | 904 | 289 | 6 | 257 | 408 | 277 | 80 | 357 | 91 | 306 | 397 | 29 | 233 | 440 | 198 | 29 | 34 | 72 |
| | | | | | *Temp Check* | | | | | | *Flow Check* | *Flow Check* | | | | | | | |
| | | | | | *74.8* | | | | | | *-6.4* | *-3.0* | | | | | | | |

Actual temp is higher - could be the mixing valves

Actual consumption is less - hoses?

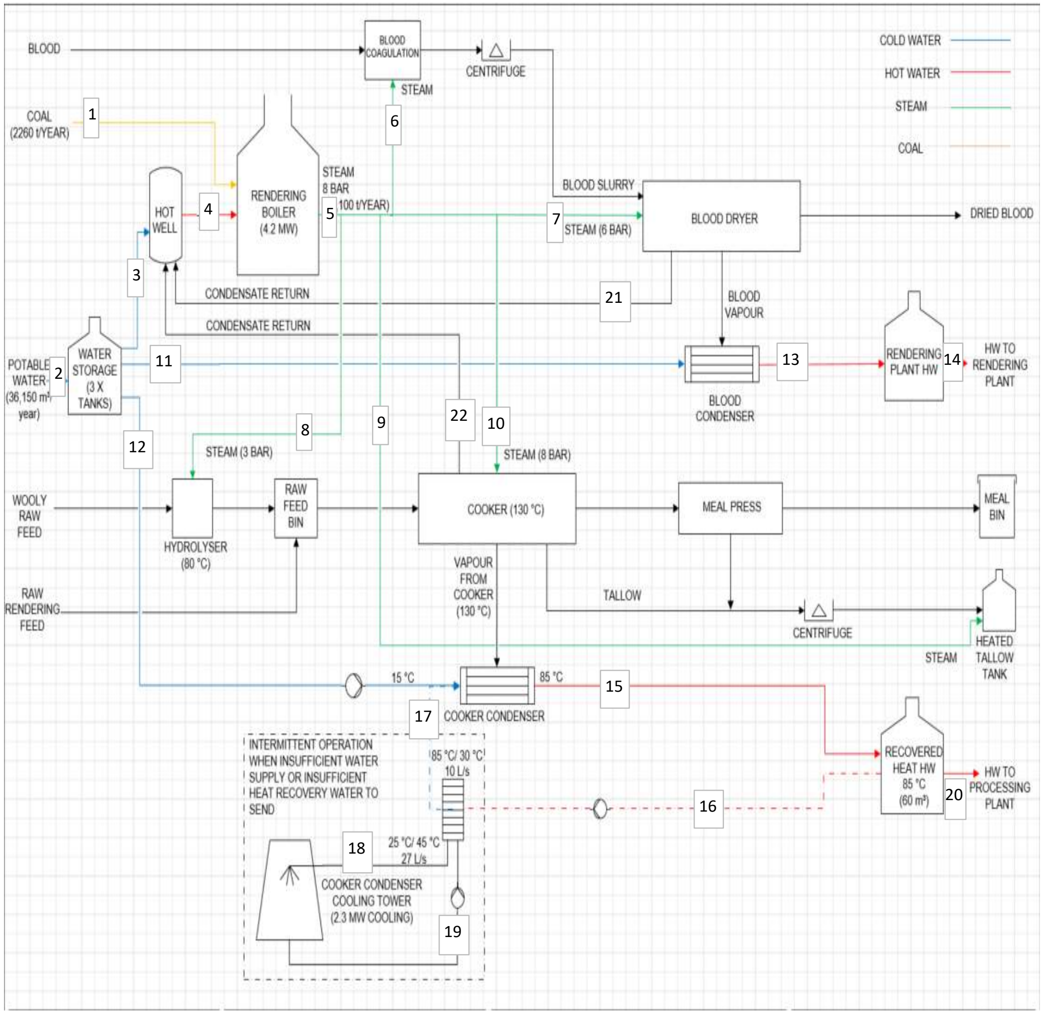
Hoses have been calculated as on all the time, compared to average flow rates which would account for times that hoses ar

25

| Heat Recovery from Air Compressor |
|---|
| 10.8 |
| 998 |
| 10.8 |
| 65 |
| 4.2 |
| 817 |

'e not operatin

| | | | |
|---|---|---|---|
| JOB NAME: | EECA Study: Blue Sky Meats EECA ETA | JOB NO: | 2221845 |
| SUBJECT: | Mass and Energy Balances - Rendering | | |
| BY: | Emma Rees (ER) | DATE: | 15/07/2021 |
| VERIFIED BY: | Sean Milnes (SM) | VERIFICATION DATE: | 15/07/2021 |
| DOC. NO. | - | REV: | A |



| |
|---|
| Input |
| Linked |
| Calculation |
| Assumption |

| Description | Units | Coal | Potable Water to Storage | Boiler Feed Topup | Boiler Feed | Total Steam | Blood Coagulator Steam | Blood Dryer Steam | Hydrolyser Steam | Heated Tallow Tank Steam | Cooker Steam | Blood Condenser Cooling Water | Cooker Condenser Cooling Water | Blood Condenser Heat Recovery | Hot Water to Rendering |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Volumetric Flow | m³/year | | 36146 | 2231 | 11156 | 2389289 | 137426 | 187496 | 277464 | 129205 | 1845789 | 7229 | 26685 | 7229 | 7229 |
| Mass Flow | t/year | 2257.2 | 36074 | 2227 | 11134 | 11134 | 640 | 688 | 602 | 602 | 8601 | 7215 | 26632 | 7215 | 7215 |
| Temperature | °C | | 15 | 15 | 86.43286513 | 175 | 175 | 165 | 144 | 175 | 175 | 15 | 15 | 85 | 85 |
| Pressure | bar g | | 1 | 1 | 1 | 8 | 8 | 6 | 3 | 8 | 8 | 1 | 1 | 1 | 1 |
| Energy | GJ/year | 33858 | 2273 | 140 | 4042 | 30841 | 1774 | 1899 | 1650 | 1668 | 23826 | 455 | 1678 | 2576 | 2576 |
| Density | kg/m³ | | 998 | 998 | 998 | 4.66 | 4.66 | 3.67 | 2.17 | 4.66 | 4.66 | 998 | 998 | 998 | 998 |
| Enthalpy | kJ/kg | 15 | | | | 2770 | 2770 | 2760 | 2740 | 2770 | 2770 | | | | |

| Energy Balance | | Rendering Boiler | Cooker Closed Loop HX | Cooker Cooling Tower | Rendering plant |
|---|---|---|---|---|---|
| Energy In | GJ/year | 37900 | 15352 | 12231 | 36130 |
| Energy Out | GJ/year | 30841 | 15251 | 6795 | 6387 |
| Energy Losses | GJ/year | 7058 | 101 | 5436 | 29743 |
| Energy Losses | % | 19% | 1% | 44% | 82% |
| Unaccounted energy | | | | | Energy in products, wastewater, consumptive steam use |
| Notes | | | Heat losses should be greater | Energy losses are to atmosphere | Should consider blood drying - the steam consumption has been assumed. Based on 1st principals, coagulator is a greater steam |

*Check coagulator steam use- based on literature*

| | | |
|---|---|---|
| *Blood processec* | *2846* | *t blood/year* |
| *Steam used* | *640406* | *kg steam/year* |
| | *640* | *t steam/year* |
| *Difference* | 0% | *Discrepancy* |

*Check blood dryer steam use based on blood drying*

| | | |
|---|---|---|
| Blood volume | 2846 | t/year |
| Dry solids | 10% | %DS |
| Solids | 285 | t DS/year |
| Coagulated Solids | 55% | %DS |
| Coagulated mass into dryer | 517.5 | t / year |
| Post-drying ds | 90% | %DS |
| Mass out of dryer | 316.25 | t/year |
| Water driven off | 201.25 | t/year |
| Latent heat | 2256 | kJ/kg |
| Sensible heat | 46.2 | kJ/kg |
| Energy to evaporate | 463317750 | kJ/year |
| Enthalpy of 6 bar st | 2760 | kJ/kg |
| Steam consumption | 168 | t steam/year |
| Discrepancy | 520 | t/year |
| | 76% | |

**Assumptions**

Cooker is main steam consumer. Assume 60% total steam
Calculated from literature coagulation steam consuymption, and assumed relative steam values based on pressure, line size and operating hours for remainders
Balanced the above steam consumption to balance the 80% condensate recovery
Assumed remaining steam split between other users
Assuming constant water density
Assuming saturated steam
Steam density, enthalpy and temperature from steam tables
Assume 20% water to the rendering plant to blood condenser, 60% water to cooker condenser
Assume hot water to rendering plant is used within the process, so not considered an energy outlet
Assume current operation only 10% of recovered heat is sent to processing
Assume cooling tower flow rate is 2.7 x closed loop flow (provided by operator, 27 L/s vs 10 L/s)
Assume cooling tower energy losses is the energy released to atmosphere through cooling.
Assume 200-250kg steam/t blood coagulated https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=2918
Assume 2.5 kg blood/sheep
Assume blood 55% solids post-coagulation to dryer
Assume blood is 7-12%DS (pre-coagulation)
Assume 90%DS after dryer (90-92%DS
Estimated blood sensible heat changes assuming 89°C from coagulation
Assume blood dryer steam is 8% of cooker steam based on steam line diameter, operating hours, and steam pressure

| 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|
| Cooker Condenser Heat Recovery | Closed Loop Cooling Hot Side | Closed Loop Cooling Return | Cooling Tower Feed | Cooling Tower Return | Hot Water to Rendering Plant | Blood Dryer Condensate Return | Cooker Condenser Condensate Return |
| 26685 | **24017** | **24017** | **64846** | **64846** | **2669** | **689** | **8619** |
| 26632 | **23969** | 23969 | 64716 | 64716 | 2663 | 688 | 8601 |
| 85 | 85 | 30 | 45 | 25 | 85 | 100 | 100 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **9508** | **8557** | **3020** | **12231** | **6795** | **951** | **289** | **3613** |
| 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 |

TE TARI TIAKI PŪNGAO EECA
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

# B

## Appendix B – Project Calculation Sheets

Sensitivity: General

Beca

# Project Economic Analysis

Project 1 - Heat Pump

## Option

**Option**

## Description

This project assumes rendering supply upgrade to allow a demand reduction on the main boiler before sizing the heat pump. The project is to replace the 1.9 MW Main Boiler and replace with a 335 kW heat pump to provide hot water for processing. This utilises heat recovered from the new ammonia refrigeration plant that is yet to be installed, assuming the new refrigeration plant will be designed with heat recovery in mind. The refrigeration plant project is outside the scope of this assessment. Network upgrades will be required to provide sufficient electricity to site to power the heat pump. These are included as an additional capital expense. This project has been assessed at the current electricity price of $0.15/kWh (including an averaged fixed charge).

## Calculations

| | | | | |
|---|---|---|---|---|
| Boiler Efficiency | 0.8 | | Assumed | Input |
| Heat Pump Efficiency | 0.95 | | Assumed | Linked Cell |
| Heat Pump shaft power | 80.95 | kW | From supplier heat pump selection | Calculation |
| Heat pump hot water flow rate | 11.5 | m³/h | From heat pump sizing - hot water demand | Output |

## Heat Pump Main Boiler Abatement

**Water Heating on a Volumetric Basis**

| Parameter | Using Coal | Heat Pump | Abatement | Units | Notes |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | is heated with hot water from the boiler via heat exchangers |
| Specific Enthalpy of Water at 65 °C | | 271.7 | | kJ/kg | |
| Specific Enthalpy of Water at 90 °C | 376.6 | 376.6 | | kJ/kg | |
| Equivalent Energy Consumed to Produce 1 m³ of Water | 391715 | 26675 | 365040 | kJ/m³ | Based on total energy consumed and hot water produced for coal, 80.95 kW heat pump (from supplier heat pump sizing) assuming rendering piping upgrade |
| Typical Daily Hot Water Demand | 276.1 | 276.1 | 0 | m³/day | 95%ile 82°C consumption based on 2020 site water data. Assuming no reduction from current operation |
| Plant OEE | 100% | 100% | | % | |
| Quantity of 90°C water produced annually | 47249 | 47249 | | m³/year | Total 2020 flow from flow data |
| Energy Generation | 14806 | 4946 | 9860 | GJ/year | Energy of hot water generated. Coal boiler takes cold water but heat pump relies on harvesting energy from rendering. |
| Annual Energy Consumption | 18508 | 1260 | 17248 | GJ/year | |
| | 5145232 | 350375 | | kWh/year | |
| Carbon Dioxide Emissions | 1764 | 39 | 1726 | tCO2-e/year | Total abatement for heat pump sized with reduced heat load |
| Annual Energy Cost | $ 99,228 | $ 52,556 | $ 46,672 | $/year | $0.15/kWh - current electricity cost |
| | $ 99,228 | $ 21,022 | $ 78,205 | $/year | $0.06/kWh - increased load reduced rate |

## CAPEX

Total Capital Cost Estimate $ 830,000.00

*Budget level cost estimates - these cost estimates include a nominal portion of the electricity supply network upgrades that are required for the heat pump and refrigeration plant*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -109183 | NZ$ | |
| Years to Project Payback | 15 | - | |
| Energy generation over 20 years | 98930 | GJ | |
| Levelised Cost of Energy - LCOE | 1.8 | NZ$/GJ | |
| MAC after 20 years - Discounted | 5.2 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 3.2 | NZ$/tCO2e | |
| Abated after 20 years | 34517 | tCO2e | |

## Discussion

This project represents a viable option to replace the main boiler. Note that this project assumes that the upgrade of the rendering plant water supply has taken place, reducing the demand on the heat pump, thus it has been sized for the reduced duty.

Sensitivity: General

Beca

## Economic Calculations

**Inputs**

| | | |
|---|---|---|
| Project title: | | Heat Pump |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 1604.1 | 1527.7 | 1454.9 | 1385.6 | 1319.7 | 1256.8 | 1197.0 | 1140.0 | 1085.7 | 1034.0 | 984.8 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 1604.1 | 3131.7 | 4586.7 | 5972.3 | 7292.0 | 8548.8 | 9745.8 | 10885.7 | 11971.4 | 13005.4 | 13990.2 |
| Energy Generation (GJ/year) | | 0 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 |
| Discounted Energy Generation (GJ/year) | | 0 | 4597.4 | 4378.5 | 4170.0 | 3971.4 | 3782.3 | 3602.2 | 3430.6 | 3267.3 | 3111.7 | 2963.5 | 2822.4 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 4597.4 | 8975.9 | 13145.8 | 17117.2 | 20899.5 | 24501.7 | 27932.4 | 31199.7 | 34311.4 | 37274.9 | 40097.3 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 |

**Capital Expenditure**

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 470,000 | 0% | $ 470,000 | $ - | $ - | $ - | $ - | - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 360,000 | 0% | $ 360,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $830,000 | | $830,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 697,200 | 697,200 | 585,648 | 491,944 | 413,233 | 347,116 | 291,577 | 244,925 | 205,737 | 172,819 | 145,168 | 121,941 |
| CAPEX Item 1 | 16.00% | 75,200 | 63,168 | 53,061 | 44,571 | 37,440 | 31,450 | 26,418 | 22,191 | 18,640 | 15,658 | 13,153 | 11,048 |
| CAPEX Item 2 | 16.00% | 57,600 | 48,384 | 40,643 | 34,140 | 28,677 | 24,089 | 20,235 | 16,997 | 14,278 | 11,993 | 10,074 | 8,462 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 697,200 | 585,648 | 491,944 | 413,233 | 347,116 | 291,577 | 244,925 | 205,737 | 172,819 | 145,168 | 121,941 | 102,431 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$132,800 | -$51,547 | -$33,699 | -$18,706 | -$6,112 | $4,466 | $13,352 | $20,817 | $27,087 | $32,354 | $36,778 | $40,494 |
| Tax | | -$43,824 | -$17,011 | -$11,121 | -$6,173 | -$2,017 | $1,474 | $4,406 | $6,870 | $8,939 | $10,677 | $12,137 | $13,363 |
| Net Operating Profit After Tax - NOPAT | | -$88,976 | -$34,537 | -$22,578 | -$12,533 | -$4,095 | $2,992 | $8,946 | $13,947 | $18,148 | $21,677 | $24,641 | $27,131 |
| Depreciation | | $132,800 | $111,552 | $93,704 | $78,711 | $66,117 | $55,539 | $46,652 | $39,188 | $32,918 | $27,651 | $23,227 | $19,511 |
| Capital Expenditure | | $830,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$786,176 | $77,015 | $71,125 | $66,178 | $62,022 | $58,531 | $55,599 | $53,135 | $51,066 | $49,328 | $47,868 | $46,642 |
| Discounted Cash Flow | | -$767,229 | $71,580 | $62,958 | $55,789 | $49,796 | $44,755 | $40,489 | $36,852 | $33,731 | $31,031 | $28,679 | $26,613 |
| IRR | | | -90.2% | -64.63% | -45.40% | -32.56% | -23.84% | -17.69% | -13.22% | -9.86% | -7.27% | -5.23% | -3.60% |
| NPV | | | -$695,649 | -$632,691 | -$576,902 | -$527,106 | -$482,350 | -$441,862 | -$405,010 | -$371,279 | -$340,248 | -$311,569 | -$284,956 |

**Summary**

| Parameter | | Values | Units | Notes |
|---|---|---|---|---|
| IRR after 20 years | | 3.0% | NZ$ | |
| NPV after 20 years | | -$ 109,183 | NZ$ | |
| Years to Project Payback | | 15.00 | - | |
| Energy generation over 20 years | | 98930 | GJ | |
| Levelised Cost of Energy - LCOE | | 1.8 | NZ$/GJ | |
| MAC after 20 years - Discounted | | $5 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | | $3 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | | 34517 | $t_{CO2e}$ | |

Sensitivity: General

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 | 1,726 |
| 937.9 | 893.2 | 850.7 | 810.2 | 771.6 | 734.8 | 699.8 | 666.5 | 634.8 |
| 14928.0 | 15821.2 | 16671.9 | 17482.1 | 18253.7 | 18988.5 | 19688.3 | 20354.9 | 20989.6 |
| 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 | 4946.5 |
| 2688.0 | 2560.0 | 2438.1 | 2322.0 | 2211.4 | 2106.1 | 2005.8 | 1910.3 | 1819.3 |
| 42785.3 | 45345.3 | 47783.4 | 50105.4 | 52316.8 | 54422.9 | 56428.8 | 58339.1 | 60158.4 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 | $159,561 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 | $ 47,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 | $ 52,556 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 | $99,556 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 102,431 | 86,042 | 72,275 | 60,711 | 50,997 | 42,838 | 35,984 | 30,226 | 25,390 |
| 9,280 | 7,796 | 6,548 | 5,501 | 4,620 | 3,881 | 3,260 | 2,739 | 2,300 |
| 7,108 | 5,971 | 5,016 | 4,213 | 3,539 | 2,973 | 2,497 | 2,098 | 1,762 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 86,042 | 72,275 | 60,711 | 50,997 | 42,838 | 35,984 | 30,226 | 25,390 | 21,328 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $43,616 | $46,238 | $48,441 | $50,291 | $51,845 | $53,151 | $54,247 | $55,169 | $55,942 |
| $14,393 | $15,259 | $15,985 | $16,596 | $17,109 | $17,540 | $17,902 | $18,206 | $18,461 |
| $29,223 | $30,980 | $32,455 | $33,695 | $34,736 | $35,611 | $36,346 | $36,963 | $37,481 |
| $16,389 | $13,767 | $11,564 | $9,714 | $8,160 | $6,854 | $5,757 | $4,836 | $4,062 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| $45,612 | $44,746 | $44,019 | $43,409 | $42,896 | $42,465 | $42,103 | $41,799 | $41,544 |
| $24,786 | $23,158 | $21,697 | $20,377 | $19,178 | $18,081 | $17,073 | $16,143 | $15,280 |
| -2.27% | -1.17% | -0.25% | 0.52% | 1.18% | 1.75% | 2.24% | 2.67% | 3.04% |
| -$260,170 | -$237,012 | -$215,315 | -$194,938 | -$175,760 | -$157,679 | -$140,606 | -$124,464 | -$109,183 |

Sensitivity: General

Beca

# Project Economic Analysis

Project 2 - Upgrade Sterilisers

| Option | Description |
|---|---|
| Option | This project is to replace all 28 sterilisers in the processing plant with photo-eye operation. This requires extension of the hot water ring main to the steriliser to ensure hot water is available on demand at the correct temperature. |

| Legend |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |

## Calculations

| | | | |
|---|---|---|---|
| Base hot water use for sterilisers | 4.75 | L/minute | Based on site measurements as per email received 19/03/21 |
| Number of sterilisers | 28 | | Total site count provided 19/4/21 |
| Total steriliser flow | 133 | L/minute | |
| | | | |
| Hot reduction with new sterilisers | 96% | | Based on EKS-2000B Economiser twin knife steriliser unit brochure |
| Total steriliser flow (reduced) | 5.32 | L/minute | |
| | | | |
| Hot Water Saving | 127.7 | L/minute | Check assumption |
| | | | |
| Operating days | 230 | days/year | |
| Shift length (2 shifts) | 13.5 | hours/day | Average of 2 9 hour shifts and 1 9 hour shift through year |
| Operating hours/year | 3105 | hours/year | |
| | | | |
| Annual water saving | 23787 | m³/year | |
| | | | |
| Boiler efficiency | 80% | | |
| Energy to produce 1 m³ water | 391715 | kJ/m³ | Taken from heat pump project |
| Annual energy saving | 9318 | GJ/year | |
| Coal saving | 11647 | GJ/year | |
| Fuel cost saving | $ 62,444 | $/year | If electric: |
| Emission saving | 1110 | tCO2-e/year | 14 tCO2-e/year |

## CAPEX

Total Capital Cost Estimate $ 424,000.00

*Budget level cost estimates*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | 0.05 | NZ$ | |
| NPV after 20 years | 6891 | NZ$ | |
| Years to Project Payback | 12 | - | |
| Energy generation over 20 years | 0 | GJ | |
| Levelised Cost of Energy - LCOE | #DIV/0! | NZ$/GJ | |
| MAC after 20 years - Discounted | -0.5 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | -0.3 | NZ$/tCO2e | |
| Abated after 20 years | 22207 | tCO2e | |

## Discussion

This project significantly reduces hot water demand and should be considered. Demand reduction will also have additional benefits if a boiler replacement project is selected, and additional assessment should be completed to confirm final hot water demand. Further investigation is needed to determine if the replacement of all sterilisers is the best operational strategy, or if some sterilisers should remain operating as per current operation.

Sensitivity: General

Beca

## Economic Calculations

| Inputs | | |
|---|---|---|
| Project title: | | Upgrade Sterilisers |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 1032.0 | 982.9 | 936.0 | 891.5 | 849.0 | 808.6 | 770.1 | 733.4 | 698.5 | 665.2 | 633.6 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 1032.0 | 2014.8 | 2950.9 | 3842.4 | 4691.4 | 5500.0 | 6270.1 | 7003.5 | 7702.0 | 8367.2 | 9000.8 |
| Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 |

**Capital Expenditure**

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 241,000 | 0% | $ 241,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 183,000 | 0% | $ 183,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $ 424,000 | | $424,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 356,160 | 356,160 | 299,174 | 251,306 | 211,097 | 177,322 | 148,950 | 125,118 | 105,099 | 88,283 | 74,158 | 62,293 |
| CAPEX Item 1 | 16.00% | 38,560 | 32,390 | 27,208 | 22,855 | 19,198 | 16,126 | 13,546 | 11,379 | 9,558 | 8,029 | 6,744 | 5,665 |
| CAPEX Item 2 | 16.00% | 29,280 | 24,595 | 20,660 | 17,354 | 14,578 | 12,245 | 10,286 | 8,640 | 7,258 | 6,097 | 5,121 | 4,302 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 356,160 | 299,174 | 251,306 | 211,097 | 177,322 | 148,950 | 125,118 | 105,099 | 88,283 | 74,158 | 62,293 | 52,326 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$67,840 | -$18,642 | -$9,524 | -$1,865 | $4,568 | $9,972 | $14,512 | $18,325 | $21,528 | $24,218 | $26,478 | $28,377 |
| Tax | | -$22,387 | -$6,152 | -$3,143 | -$616 | $1,507 | $3,291 | $4,789 | $6,047 | $7,104 | $7,992 | $8,738 | $9,364 |
| Net Operating Profit After Tax - NOPAT | | -$45,453 | -$12,490 | -$6,381 | -$1,250 | $3,061 | $6,681 | $9,723 | $12,278 | $14,424 | $16,226 | $17,741 | $19,013 |
| Depreciation | | $67,840 | $56,986 | $47,868 | $40,209 | $33,776 | $28,371 | $23,832 | $20,019 | $16,816 | $14,125 | $11,865 | $9,967 |
| Capital Expenditure | | $424,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$401,613 | $44,496 | $41,487 | $38,959 | $36,836 | $35,053 | $33,555 | $32,297 | $31,240 | $30,352 | $29,606 | $28,979 |
| Discounted Cash Flow | | -$391,934 | $41,355 | $36,723 | $32,843 | $29,575 | $26,803 | $24,436 | $22,399 | $20,635 | $19,093 | $17,737 | $16,535 |
| IRR | | | -88.9% | -61.85% | -42.12% | -29.18% | -20.49% | -14.44% | -10.07% | -6.82% | -4.33% | -2.39% | -0.85% |
| NPV | | | -$350,579 | -$313,856 | -$281,012 | -$251,437 | -$224,634 | -$200,199 | -$177,799 | -$157,165 | -$138,071 | -$120,334 | -$103,799 |

**Summary**

| Parameter | | Values | Units | Notes |
|---|---|---|---|---|
| IRR after 20 years | | 5.2% | NZ$ | |
| NPV after 20 years | | $ 6,891 | NZ$ | |
| Years to Project Payback | | 12.00 | - | |
| Energy generation over 20 years | | 0 | GJ | |
| Levelised Cost of Energy - LCOE | | #DIV/0! | NZ$/GJ | |
| MAC after 20 years - Discounted | | -$1 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | | $0 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | | 22207 | $t_{CO2e}$ | |

Sensitivity: General

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 | 1,110 |
| 603.4 | 574.7 | 547.3 | 521.2 | 496.4 | 472.8 | 450.3 | 428.8 | 408.4 |
| 9604.2 | 10178.8 | 10726.1 | 11247.3 | 11743.7 | 12216.5 | 12666.8 | 13095.6 | 13504.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 | $ 62,444 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 | $62,444 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 | $ 24,100 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 | $24,100 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 52,326 | 43,954 | 36,921 | 31,014 | 26,052 | 21,883 | 18,382 | 15,441 | 12,970 |
| 4,759 | 3,997 | 3,358 | 2,821 | 2,369 | 1,990 | 1,672 | 1,404 | 1,180 |
| 3,613 | 3,035 | 2,550 | 2,142 | 1,799 | 1,511 | 1,269 | 1,066 | 896 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 43,954 | 36,921 | 31,014 | 26,052 | 21,883 | 18,382 | 15,441 | 12,970 | 10,895 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $29,972 | $31,311 | $32,436 | $33,382 | $34,175 | $34,842 | $35,403 | $35,873 | $36,268 |
| $9,891 | $10,333 | $10,704 | $11,016 | $11,278 | $11,498 | $11,683 | $11,838 | $11,969 |
| $20,081 | $20,978 | $21,732 | $22,366 | $22,898 | $23,344 | $23,720 | $24,035 | $24,300 |
| $8,372 | $7,033 | $5,907 | $4,962 | $4,168 | $3,501 | $2,941 | $2,471 | $2,075 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| $28,453 | $28,011 | $27,640 | $27,328 | $27,066 | $26,846 | $26,661 | $26,506 | $26,375 |
| $15,462 | $14,497 | $13,624 | $12,828 | $12,100 | $11,430 | $10,811 | $10,236 | $9,701 |
| 0.40% | 1.42% | 2.27% | 2.98% | 3.58% | 4.09% | 4.52% | 4.90% | 5.23% |
| -$88,337 | -$73,840 | -$60,216 | -$47,388 | -$35,288 | -$23,857 | -$13,046 | -$2,810 | $6,891 |

Sensitivity: General

## Project Economic Analysis

Project 3-A1 Main boiler - electric boiler replacement - note includes rendering pipe upgrade project too

| Option | Description |
|---|---|
| Option | This project assumes rendering supply upgrade to allow a demand reduction on the main boiler before sizing the electric boiler. The project is to replace the 1.9 MW Main Boiler and replace with a 350 kW electric boiler to provide hot water for processing. This utilises heat recovered from the rendering plant and the project costs required to achieve heat recovery from rendering. Network upgrades will be required to provide sufficient electricity to site to power the heat pump. These are included as an additional capital expense. This project has been assessed at the current electricity price of $0.15/kWh (including an averaged fixed charge). |

Input
Linked Cell
Calculation
Output

### Calculations

| | | |
|---|---|---|
| Boiler Efficiency | 0.8 | Assumed |
| Electric Boiler Efficiency | 0.95 | Assumed |

### Carbon abatement from rendering boiler feed pre-heating

Heat pump project includes rendering boiler feed pre-heating

| | | | |
|---|---|---|---|
| Rendering coal savings | 582 | GJ/year | Energy saved pre-heating boiler feed water from 15°C to 65 °C using rendering heat recovery |
| | 39 | t/year | |
| Emission reduction | 55 | tCO2-e/year | |
| Coal cost savings | $ 3,120 | $/year | Input as an operating cost - negative cost = saving |

### Electric Main Boiler Abatement - including inputs for rendering boiler feed pre-heating

**Water Heating on a Volumetric Basis**

| Parameter | Using Coal | Electric Boiler | Abatement | Units | Notes |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | Current operation takes water at ambient and it is heated with hot water from the boiler via heat exchangers |
| Specific Enthalpy of Water at 65 °C | | 271.7 | | kJ/kg | |
| Specific Enthalpy of Water at 90 °C | 376.6 | 376.6 | | kJ/kg | |
| Equivalent Energy Consumed to Produce 1 m³ of Water | 391715 | 130863 | 260852 | kJ/m³ | Based on total energy consumed and hot water produced for coal, electric boiler |
| Typical Daily Hot Water Demand | 276.1 | 276.1 | 0 | m³/day | site water data. Assuming no reduction from |
| Plant OEE | 100% | 100% | | % | |
| Quantity of 90°C water produced annually | 47249 | 47249 | | m³/year | Total 2020 flow from flow data |
| Energy Generation | 14806 | 4364 | 10442 | GJ/year | energy reduction of rendering boiler |
| Annual Energy Consumption | 18508 | 6183 | 12325 | GJ/year | impact energy consumed (excluding |
| | | 1718901 | | kWh/year | |
| Carbon Dioxide Emissions | 1764 | 189 | 1631 | tCO2-e/year | rendering boiler due to feed pre-heating |
| Annual Energy Cost | $ 99,228 | $ 257,835 | -$ 155,487 | $/year | $0.15/kWh - current electricity cost |
| | $ 99,228 | $ 103,134 | -$ 786 | $/year | $0.06/kWh - increased load reduced rate |

## CAPEX

Total Capital Cost Estimate $ 1,590,000.00

*Budget level cost estimates - these cost estimates include a nominal portion of the electricity supply network upgrades that are required for the electric boiler and refrigeration plant*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -2758288 | NZ$ | |
| Energy generation over 20 years | 87289 | GJ | |
| Levelised Cost of Energy - LCOE | 52.0 | NZ$/GJ | |
| MAC after 20 years - Discounted | 139.1 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 84.6 | NZ$/tCO2e | |
| Abated after 20 years | 32613 | tCO2e | |

## Discussion

The cost of the network upgrades make this project appear infeasible at this time. It is recommended that if this project were to be considered further on the basis that network infrastructure upgrades are possible, a heat pump would be a better solution due to increased electrical efficiency.

Sensitivity: General

## Economic Calculations

**Inputs**

| | | |
|---|---|---|
| Project title: | | Main Boiler Replacement - Electric Boiler |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 1515.6 | 1443.4 | 1374.7 | 1309.2 | 1246.9 | 1187.5 | 1131.0 | 1077.1 | 1025.8 | 977.0 | 930.4 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 1515.6 | 2959.0 | 4333.7 | 5642.9 | 6889.8 | 8077.3 | 9208.3 | 10285.4 | 11311.2 | 12288.1 | 13218.6 |
| Energy Generation (GJ/year) | | 0 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 |
| Discounted Energy Generation (GJ/year) | | 0 | 4056.4 | 3863.3 | 3679.3 | 3504.1 | 3337.2 | 3178.3 | 3027.0 | 2882.8 | 2745.6 | 2614.8 | 2490.3 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 4056.4 | 7919.7 | 11599.0 | 15103.1 | 18440.4 | 21618.7 | 24645.7 | 27528.5 | 30274.1 | 32888.9 | 35379.2 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 |
| Revenue/Savings Item 2 | | $ - | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 |

**Capital Expenditure**

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 924,000 | 0% | $ 924,000 | $ - | $ - | $ - | $ - | - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 666,000 | 0% | $ 666,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $1,590,000 | | $1,590,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 1,335,600 | 1,335,600 | 1,121,904 | 942,399 | 791,615 | 664,957 | 558,564 | 469,194 | 394,123 | 331,063 | 278,093 | 233,598 |
| CAPEX Item 1 | 16.00% | 147,840 | 124,186 | 104,316 | 87,625 | 73,605 | 61,828 | 51,936 | 43,626 | 36,646 | 30,783 | 25,857 | 21,720 |
| CAPEX Item 2 | 16.00% | 106,560 | 89,510 | 75,189 | 63,159 | 53,053 | 44,565 | 37,434 | 31,445 | 26,414 | 22,187 | 18,637 | 15,655 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 1,335,600 | 1,121,904 | 942,399 | 791,615 | 664,957 | 558,564 | 469,194 | 394,123 | 331,063 | 278,093 | 233,598 | 196,222 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$254,400 | -$401,250 | -$367,058 | -$338,337 | -$314,212 | -$293,947 | -$276,924 | -$262,625 | -$250,613 | -$240,524 | -$232,048 | -$224,929 |
| Tax | | -$83,952 | -$132,412 | -$121,129 | -$111,651 | -$103,690 | -$97,002 | -$91,385 | -$86,666 | -$82,702 | -$79,373 | -$76,576 | -$74,227 |
| Net Operating Profit After Tax - NOPAT | | -$170,448 | -$268,837 | -$245,929 | -$226,686 | -$210,522 | -$196,944 | -$185,539 | -$175,958 | -$167,911 | -$161,151 | -$155,472 | -$150,703 |
| Depreciation | | $254,400 | $213,696 | $179,505 | $150,784 | $126,658 | $106,393 | $89,370 | $75,071 | $63,060 | $52,970 | $44,495 | $37,376 |
| Capital Expenditure | | $1,590,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$1,506,048 | -$55,141 | -$66,424 | -$75,902 | -$83,864 | -$90,551 | -$96,169 | -$100,887 | -$104,851 | -$108,181 | -$110,978 | -$113,327 |
| Discounted Cash Flow | | -$1,469,752 | -$51,250 | -$58,797 | -$63,987 | -$67,332 | -$69,239 | -$70,033 | -$69,971 | -$69,257 | -$68,054 | -$66,489 | -$64,663 |
| IRR | | | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$1,521,002 | -$1,579,799 | -$1,643,786 | -$1,711,118 | -$1,780,357 | -$1,850,391 | -$1,920,361 | -$1,989,619 | -$2,057,672 | -$2,124,161 | -$2,188,824 |

**Summary**

| Parameter | | Values | Units | Notes |
|---|---|---|---|---|
| IRR after 20 years | | #NUM! | NZ$ | |
| NPV after 20 years | | -$ 2,674,087 | NZ$ | |
| Energy generation over 20 years | | 87289 | GJ | |
| Levelised Cost of Energy - LCOE | | 50 | NZ$/GJ | |
| MAC after 20 years - Discounted | | $135 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | | $82 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | | 32613 | $t_{CO2e}$ | |

Sensitivity: General

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 | 1,631 |
| 886.1 | 843.9 | 803.7 | 765.5 | 729.0 | 694.3 | 661.2 | 629.8 | 599.8 |
| 14104.7 | 14948.6 | 15752.4 | 16517.9 | 17246.9 | 17941.2 | 18602.4 | 19232.2 | 19832.0 |
| 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 |
| 2371.7 | 2258.8 | 2151.2 | 2048.8 | 1951.2 | 1858.3 | 1769.8 | 1685.5 | 1605.3 |
| 37750.9 | 40009.7 | 42160.9 | 44209.7 | 46160.9 | 48019.2 | 49789.0 | 51474.5 | 53079.8 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 |
| $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 | $ 92,400 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 | $ 257,835 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 | $350,235 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 196,222 | 164,827 | 138,455 | 116,302 | 97,694 | 82,063 | 68,933 | 57,903 | 48,639 |
| 18,245 | 15,326 | 12,874 | 10,814 | 9,084 | 7,630 | 6,409 | 5,384 | 4,522 |
| 13,151 | 11,047 | 9,279 | 7,794 | 6,547 | 5,500 | 4,620 | 3,881 | 3,260 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 164,827 | 138,455 | 116,302 | 97,694 | 82,063 | 68,933 | 57,903 | 48,639 | 40,857 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| -$218,949 | -$213,926 | -$209,706 | -$206,162 | -$203,185 | -$200,684 | -$198,583 | -$196,818 | -$195,336 |
| -$72,253 | -$70,596 | -$69,203 | -$68,033 | -$67,051 | -$66,226 | -$65,532 | -$64,950 | -$64,461 |
| -$146,696 | -$143,330 | -$140,503 | -$138,128 | -$136,134 | -$134,458 | -$133,050 | -$131,868 | -$130,875 |
| $31,396 | $26,372 | $22,153 | $18,608 | $15,631 | $13,130 | $11,029 | $9,265 | $7,782 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$115,300 | -$116,958 | -$118,350 | -$119,520 | -$120,503 | -$121,328 | -$122,021 | -$122,604 | -$123,093 |
| -$62,656 | -$60,531 | -$58,334 | -$56,106 | -$53,873 | -$51,659 | -$49,480 | -$47,349 | -$45,274 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$2,251,480 | -$2,312,011 | -$2,370,345 | -$2,426,451 | -$2,480,324 | -$2,531,983 | -$2,581,464 | -$2,628,813 | -$2,674,087 |

Sensitivity: General

Beca

## Project Economic Analysis

Project 3-A2- Main boiler - wood chip boiler replacement - note includes rendering pipe upgrade project too

| Option | Description |
|---|---|
| Option | This project assumes rendering supply upgrade to allow a demand reduction on the main boiler before sizing the wood chip boiler. The project is to replace the 1.9 MW Main Boiler and replace with a 350 kW wood chip boiler to provide hot water for processing. This utilises heat recovered from the rendering plant and the project costs required to achieve heat recovery from rendering. |

Input
Linked Cell
Calculation
Output

### Calculations

| | | |
|---|---|---|
| Boiler Efficiency | 0.8 | Assumed |

### Carbon abatement from rendering boiler feed pre-heating

Main boiler replacement project includes rendering boiler feed pre-heating

| | | | |
|---|---|---|---|
| Rendering coal savings | 582 | GJ/year | Energy saved pre-heating boiler feed water from 15°C to 65 °C using rendering heat recovery |
| | 39 | t/year | |
| Emission reduction | 55 | tCO2-e/year | |
| Coal cost savings | $ 3,120 | $/year | Input as an operating cost - negative cost = saving |

### Wood Chip Main Boiler Abatement - including inputs for rendering boiler feed pre-heating

**Water Heating on a Volumetric Basis**

| Parameter | Using Coal | Using Wood Chip | Abatement | Units | Notes |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | Current operation takes water at ambient and it is heated with hot water from the boiler via heat exchangers |
| Specific Enthalpy of Water at 65 °C | | 271.7 | | kJ/kg | |
| Specific Enthalpy of Water at 90 °C | 376.6 | 376.6 | | kJ/kg | |
| Equivalent Energy Consumed to Produce 1 m³ of Water | 391715 | 130863 | 260852 | kJ/m³ | Based on total energy consumed and hot water produced for coal, wood chip boiler assuming rendering piping upgrade |
| Typical Daily Hot Water Demand | 276.1 | 276.1 | 0 | m³/day | 95%ile 82°C consumption based on 2020 site water data. Assuming no reduction from current operation |
| Plant OEE | 100% | 100% | | % | |
| Quantity of 90°C water produced annually | 47249 | 47249 | | m³/year | Total 2020 flow from flow data |
| Energy Generation | 14806 | 4364 | 10442 | GJ/year | Energy of hot water generated. Coal boiler takes cold water but heat pump relies on harvesting energy from rendering, includes energy reduction of rendering boiler savings |
| Annual Energy Consumption | 18508 | 6183 | 12325 | GJ/year | Rendering boiler feed pre-heating does not impact energy consumed (excluding pumping costs at this stage) |
| Carbon Dioxide Emissions | 1764 | 589 | 1230 | tCO2-e/year | Total abatement includes reduction from rendering boiler due to feed pre-heating |
| Annual Energy Cost | $ 99,228 | $ 108,822 | -$ 6,474 | $/year | |

**Carbon abatement from the rendering heat recovery aspect**

| | | |
|---|---|---|
| Energy consumed to make hot water (post heat rec | 4946 | GJ/year |
| Energy saving | 9860 | GJ/year |
| CO2-e emissions associated with energy saving | 940 | t CO2/y |

## CAPEX

| | |
|---|---|
| Total Capital Cost Estimate | $ 1,890,000.00 |

*Budget level cost estimates*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -1902855 | NZ$ | |
| Energy generation over 20 years | 87289 | GJ | |
| Levelised Cost of Energy - LCOE | 35.8 | NZ$/GJ | |
| MAC after 20 years - Discounted | 127.2 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 77.3 | NZ$/tCO2e | |
| Abated after 20 years | 24609 | tCO2e | |

## Discussion

The costs seem prohibitive to uptake of this project at the current time.
Biomass boiler costs, supply and installation costs may decrease in coming years as they become more popular in the public and industrial sector.
Additional risks associated with this project include fuel supply. Investigation into a fuel supply contract should be completed before this project is taken any further. There is a possibility that fuel prices will decline in future as a biomass fuel supply chain grows to support biomass use for process heat.
Blue Sky should also consider the possibility of gaining resource consent for the emissions generated by a biomass boiler installation before committing to this project.

Sensitivity: General

## Economic Calculations

**Inputs**

| | | |
|---|---|---|
| Project title: | | Main Boiler Replacement - Wood Chip Boiler |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 1143.6 | 1089.2 | 1037.3 | 987.9 | 940.9 | 896.1 | 853.4 | 812.8 | 774.1 | 737.2 | 702.1 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 1143.6 | 2232.8 | 3270.1 | 4258.0 | 5198.9 | 6094.9 | 6948.3 | 7761.1 | 8535.1 | 9272.3 | 9974.4 |
| Energy Generation (GJ/year) | | 0 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 |
| Discounted Energy Generation (GJ/year) | | 0 | 4056.4 | 3863.3 | 3679.3 | 3504.1 | 3337.2 | 3178.3 | 3027.0 | 2882.8 | 2745.6 | 2614.8 | 2490.3 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 4056.4 | 7919.7 | 11599.0 | 15103.1 | 18440.4 | 21618.7 | 24645.7 | 27528.5 | 30274.1 | 32888.9 | 35379.2 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 |
| Revenue/Savings Item 2 | | $ - | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 |

**Capital Expenditure**

| | | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 1,099,000 | 0% | | $ 1,099,000 | $ - | $ - | $ - | $ - | - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 791,000 | 0% | | $ 791,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $ 1,890,000 | | | $1,890,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 |
| OPEX description 2 | | - | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 1,587,600 | 1,587,600 | 1,333,584 | 1,120,211 | 940,977 | 790,421 | 663,953 | 557,721 | 468,485 | 393,528 | 330,563 | 277,673 |
| CAPEX Item 1 | 16.00% | 175,840 | 147,706 | 124,073 | 104,221 | 87,546 | 73,538 | 61,772 | 51,889 | 43,586 | 36,613 | 30,755 | 25,834 |
| CAPEX Item 2 | 16.00% | 126,560 | 106,310 | 89,301 | 75,013 | 63,011 | 52,929 | 44,460 | 37,347 | 31,371 | 26,352 | 22,135 | 18,594 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 1,587,600 | 1,333,584 | 1,120,211 | 940,977 | 790,421 | 663,953 | 557,721 | 468,485 | 393,528 | 330,563 | 277,673 | 233,245 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$302,400 | -$320,390 | -$279,748 | -$245,608 | -$216,931 | -$192,842 | -$172,607 | -$155,610 | -$141,332 | -$129,339 | -$119,264 | -$110,802 |
| Tax | | -$99,792 | -$105,729 | -$92,317 | -$81,051 | -$71,587 | -$63,638 | -$56,960 | -$51,351 | -$46,640 | -$42,682 | -$39,357 | -$36,565 |
| Net Operating Profit After Tax - NOPAT | | -$202,608 | -$214,662 | -$187,431 | -$164,557 | -$145,344 | -$129,204 | -$115,647 | -$104,258 | -$94,692 | -$86,657 | -$79,907 | -$74,237 |
| Depreciation | | $302,400 | $254,016 | $213,373 | $179,234 | $150,556 | $126,467 | $106,233 | $89,235 | $74,958 | $62,964 | $52,890 | $44,428 |
| Capital Expenditure | | $1,890,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$1,790,208 | $39,354 | $25,942 | $14,676 | $5,213 | -$2,737 | -$9,414 | -$15,023 | -$19,735 | -$23,693 | -$27,017 | -$29,810 |
| Discounted Cash Flow | | -$1,747,064 | $36,577 | $22,963 | $12,372 | $4,185 | -$2,093 | -$6,856 | -$10,419 | -$13,035 | -$14,904 | -$16,186 | -$17,009 |
| IRR | | | -97.8% | -86.81% | -76.61% | -71.04% | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$1,710,487 | -$1,687,523 | -$1,675,151 | -$1,670,966 | -$1,673,058 | -$1,679,914 | -$1,690,333 | -$1,703,369 | -$1,718,273 | -$1,734,459 | -$1,751,468 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | #NUM! | NZ$ | |
| NPV after 20 years | -$ 1,902,855 | NZ$ | |
| Energy generation over 20 years | 87289 | GJ | |
| Levelised Cost of Energy - LCOE | 36 | NZ$/GJ | |
| MAC after 20 years - Discounted | $127 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $77 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 24609 | $t_{CO2e}$ | |

Sensitivity: General

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 |
| 668.7 | 636.8 | 606.5 | 577.6 | 550.1 | 523.9 | 499.0 | 475.2 | 452.6 |
| 10643.1 | 11279.9 | 11886.4 | 12464.0 | 13014.1 | 13538.0 | 14037.0 | 14512.2 | 14964.7 |
| 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 |
| 2371.7 | 2258.8 | 2151.2 | 2048.8 | 1951.2 | 1858.3 | 1769.8 | 1685.5 | 1605.3 |
| 37750.9 | 40009.7 | 42160.9 | 44209.7 | 46160.9 | 48019.2 | 49789.0 | 51474.5 | 53079.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 | $ 159,561 |
| $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 | $162,682 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 | $ 109,900 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 | $ 108,822 |
| $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 | $ 10,333 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 | $229,056 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 233,245 | 195,926 | 164,578 | 138,246 | 116,126 | 97,546 | 81,939 | 68,828 | 57,816 |
| 21,700 | 18,228 | 15,312 | 12,862 | 10,804 | 9,075 | 7,623 | 6,404 | 5,379 |
| 15,619 | 13,120 | 11,021 | 9,257 | 7,776 | 6,532 | 5,487 | 4,609 | 3,872 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 195,926 | 164,578 | 138,246 | 116,126 | 97,546 | 81,939 | 68,828 | 57,816 | 48,565 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| -$103,694 | -$97,722 | -$92,707 | -$88,494 | -$84,955 | -$81,982 | -$79,484 | -$77,387 | -$75,625 |
| -$34,219 | -$32,248 | -$30,593 | -$29,203 | -$28,035 | -$27,054 | -$26,230 | -$25,538 | -$24,956 |
| -$69,475 | -$65,474 | -$62,114 | -$59,291 | -$56,920 | -$54,928 | -$53,255 | -$51,849 | -$50,669 |
| $37,319 | $31,348 | $26,332 | $22,119 | $18,580 | $15,607 | $13,110 | $11,013 | $9,251 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$32,155 | -$34,126 | -$35,781 | -$37,171 | -$38,339 | -$39,320 | -$40,144 | -$40,837 | -$41,418 |
| -$17,474 | -$17,662 | -$17,636 | -$17,449 | -$17,140 | -$16,742 | -$16,279 | -$15,771 | -$15,234 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$1,768,942 | -$1,786,604 | -$1,804,240 | -$1,821,689 | -$1,838,830 | -$1,855,572 | -$1,871,850 | -$1,887,621 | -$1,902,855 |

Sensitivity: General

# Project Economic Analysis

Project 3-B1 - Upgrade Rendering Boiler - Electric Boiler

## Option

**Option**

## Description

This project is one fuel switching option for the Rendering boiler to replace with a new 4.5 MW electric boiler. This project is based on the current steam demand from the rendering plant, assuming significant reductions in steam demand are not feasible. Electricity network infrastructure upgrades would be required to allow for the additional demand, which have been included as an additional capital expense. This project has been assessed at the current electricity price of $0.15/kWh (including an averaged fixed charge).

| Legend |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |

## Calculations

| | | | |
|---|---|---|---|
| Make-up water ambient | 20% | | Based on operator discussion |
| Coal Boiler Efficiency | 80% | | Assumed |
| Electric Boiler Efficiency | 95% | | Assumed - consider some losses, better than solid fuel/ combustion |
| Daily Steam Production | 48 | t/day | Based on actual coal consumption - assuming 60% total coal to rendering |
| Operating days | 230 | days/year | Allowing for shutdown - same as benchmarking assumptions |

**Steam Production on a Mass Basis**

| Parameter | Using Coal | Using Electricity | Abatement | Units | Notes |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | Current operation takes 20% make up water at 15°C and hot well at 100°C, production of 10 bar steam. |
| Specific Enthalpy of Water at 70°C | | 271.7 | | kJ/kg | New boiler would include feed preheating from rendering boiler make up - 70°C to be conservative |
| Specific Enthalpy of Water at 100 °C | 418.7 | 418.7 | | kJ/kg | |
| Specific Enthalpy of Steam | 2780.2 | 2780.2 | | kJ/kg | |
| Equivalent Energy Consumed to Produ | 3041 | 2517 | 524 | kJ/kg | Energy required difference based on boiler feed preheating + more efficient electric boiler |
| Typical Daily Steam Demand | 48409 | 48409 | 0 | kg/day | Calculated based on assumed 24h/day operation |
| Plant OEE | 100% | 100% | | % | |
| Quantity of Steam Produced Annually | 11134085.3 | 11134085 | | kg/year | Assuming 230 days |
| Energy Generation | 27086 | 26620 | 466 | GJ/year | Energy of steam generated. |
| Annual Energy Consumption | 33858 | 28022 | 5836 | GJ/year | |
| | | 7789994 | | kWh/year | |
| Carbon Dioxide Emissions | 3228 | 858 | 2370 | tCO2-e/year | |
| Annual Energy Cost | $ 181,522 | $ 1,168,499 | -$ 986,977 | $/year | $0.15/kWh |
| Annual Energy Cost | $ 181,522 | $ 467,400 | -$ 285,878 | $/year | $0.06/kWh |

## CAPEX

Total Capital Cost Estimate $ 1,710,800.00

*Budget level cost estimates - these cost estimates include a cost estimate for electricity supply network upgrades that are required for the additional electrical loads*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -25934721 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 80 | NZ$/GJ | |
| MAC after 20 years - Discounted | 900 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 547 | NZ$/tCO2e | |
| Abated after 20 years | 47402 | tCO2e | |

## Discussion

This project cost is prohibitive at this stage, mostly due to the significant power infrastructure upgrades that would be required to provide the additional power to site for the boiler. An electric boiler could be considered in future if other parties can cost share the network infrastructure upgrades.

Sensitivity: General

Beca

## Economic Calculations

**Inputs**

| | | |
|---|---|---|
| Project title: | Rendering Boiler Replacement - Electric Boiler | |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 2202.8 | 2097.9 | 1998.0 | 1902.9 | 1812.3 | 1726.0 | 1643.8 | 1565.5 | 1491.0 | 1420.0 | 1352.3 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 2202.8 | 4300.8 | 6298.8 | 8201.7 | 10013.9 | 11739.9 | 13383.7 | 14949.2 | 16440.1 | 17860.1 | 19212.4 |
| Energy Generation (GJ/year) | | 0 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 23563.7 | 22441.6 | 21372.9 | 20355.2 | 19385.9 | 18462.7 | 17583.6 | 16746.3 | 15948.8 | 15189.3 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 48305.5 | 70747.1 | 92120.0 | 112475.2 | 131861.1 | 150323.8 | 167907.4 | 184653.6 | 200602.4 | 215791.8 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

**Capital Expenditure**

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 995,000 | 0% | $ 995,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 715,800 | 0% | $ 715,800 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $1,710,800 | | $1,710,800 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 |
| ETS | - | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | - | | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 |
| OPEX description 1 | - | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | - | | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 |
| OPEX description 3 | - | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | - | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 1,437,072 | 1,437,072 | 1,207,140 | 1,013,998 | 851,758 | 715,477 | 601,001 | 504,841 | 424,066 | 356,216 | 299,221 | 251,346 |
| CAPEX Item 1 | 16.00% | 159,200 | 133,728 | 112,332 | 94,358 | 79,261 | 66,579 | 55,927 | 46,978 | 39,462 | 33,148 | 27,844 | 23,389 |
| CAPEX Item 2 | 16.00% | 114,528 | 96,204 | 80,811 | 67,881 | 57,020 | 47,897 | 40,233 | 33,796 | 28,389 | 23,847 | 20,031 | 16,826 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 1,437,072 | 1,207,140 | 1,013,998 | 851,758 | 715,477 | 601,001 | 504,841 | 424,066 | 356,216 | 299,221 | 251,346 | 211,130 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$273,728 | -$3,240,742 | -$3,203,953 | -$3,173,050 | -$3,147,092 | -$3,125,287 | -$3,106,971 | -$3,091,585 | -$3,078,661 | -$3,067,805 | -$3,058,686 | -$3,051,026 |
| Tax | | -$90,330 | -$1,069,445 | -$1,057,304 | -$1,047,107 | -$1,038,540 | -$1,031,345 | -$1,025,300 | -$1,020,223 | -$1,015,958 | -$1,012,376 | -$1,009,366 | -$1,006,838 |
| Net Operating Profit After Tax - NOPAT | | -$183,398 | -$2,171,297 | -$2,146,648 | -$2,125,944 | -$2,108,551 | -$2,093,942 | -$2,081,670 | -$2,071,362 | -$2,062,703 | -$2,055,429 | -$2,049,319 | -$2,044,187 |
| Depreciation | | $273,728 | $229,932 | $193,142 | $162,240 | $136,281 | $114,476 | $96,160 | $80,774 | $67,851 | $56,994 | $47,875 | $40,215 |
| Capital Expenditure | | $1,710,800 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$1,620,470 | -$1,941,366 | -$1,953,506 | -$1,963,704 | -$1,972,270 | -$1,979,466 | -$1,985,510 | -$1,990,587 | -$1,994,852 | -$1,998,435 | -$2,001,444 | -$2,003,972 |
| Discounted Cash Flow | | -$1,581,417 | -$1,804,361 | -$1,729,185 | -$1,655,440 | -$1,583,487 | -$1,513,585 | -$1,445,911 | -$1,380,580 | -$1,317,655 | -$1,257,163 | -$1,199,101 | -$1,143,443 |
| IRR | | | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$3,385,777 | -$5,114,962 | -$6,770,402 | -$8,353,890 | -$9,867,475 | -$11,313,386 | -$12,693,966 | -$14,011,621 | -$15,268,784 | -$16,467,885 | -$17,611,329 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | #NUM! | NZ$ | |
| NPV after 20 years | -$ 25,766,320 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 80 | NZ$/GJ | |
| MAC after 20 years - Discounted | $894 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $544 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 47402 | $t_{CO2e}$ | |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 | 2,370 |
| 1287.9 | 1226.6 | 1168.2 | 1112.6 | 1059.6 | 1009.1 | 961.1 | 915.3 | 871.7 |
| 20500.4 | 21727.0 | 22895.2 | 24007.8 | 25067.4 | 26076.5 | 27037.6 | 27952.9 | 28824.6 |
| 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| 14466.0 | 13777.2 | 13121.1 | 12496.3 | 11901.2 | 11334.5 | 10794.8 | 10280.7 | 9791.2 |
| 230257.8 | 244035.0 | 257156.1 | 269652.4 | 281553.7 | 292888.2 | 303683.0 | 313963.7 | 323754.9 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 | $ 99,500 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 | $ 1,168,499 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 | $ 2,000,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 | $3,267,999 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 211,130 | 177,349 | 148,974 | 125,138 | 105,116 | 88,297 | 74,170 | 62,303 | 52,334 |
| 19,647 | 16,503 | 13,863 | 11,645 | 9,782 | 8,217 | 6,902 | 5,798 | 4,870 |
| 14,134 | 11,873 | 9,973 | 8,377 | 7,037 | 5,911 | 4,965 | 4,171 | 3,503 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 177,349 | 148,974 | 125,138 | 105,116 | 88,297 | 74,170 | 62,303 | 52,334 | 43,961 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| -$3,044,591 | -$3,039,186 | -$3,034,646 | -$3,030,832 | -$3,027,629 | -$3,024,938 | -$3,022,678 | -$3,020,779 | -$3,019,184 |
| -$1,004,715 | -$1,002,931 | -$1,001,433 | -$1,000,175 | -$999,118 | -$998,230 | -$997,484 | -$996,857 | -$996,331 |
| -$2,039,876 | -$2,036,255 | -$2,033,213 | -$2,030,658 | -$2,028,511 | -$2,026,708 | -$2,025,194 | -$2,023,922 | -$2,022,853 |
| $33,781 | $28,376 | $23,836 | $20,022 | $16,819 | $14,128 | $11,867 | $9,968 | $8,373 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$2,006,095 | -$2,007,879 | -$2,009,377 | -$2,010,636 | -$2,011,693 | -$2,012,581 | -$2,013,327 | -$2,013,953 | -$2,014,480 |
| -$1,090,148 | -$1,039,159 | -$990,414 | -$943,842 | -$899,370 | -$856,921 | -$816,417 | -$777,782 | -$740,939 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$18,701,476 | -$19,740,635 | -$20,731,049 | -$21,674,891 | -$22,574,260 | -$23,431,181 | -$24,247,598 | -$25,025,381 | -$25,766,320 |

Sensitivity: General

Beca

# Project Economic Analysis

Project 3-B2 - Upgrade Rendering Boiler - Wood Chip

| Option | Description |
|---|---|
| Option | This project is one fuel switching option for the Rendering boiler to replace with a new 4.5 MW biomass boiler. Pricing has been based on wood chip, but consideration should also be given to alternatives such as hog fuel due to fuel supply constraints. This project is based on the current steam demand from the rendering plant, assuming significant reductions in steam demand are not feasible. |

## Calculations

| | | | | |
|---|---|---|---|---|
| Make-up water ambient | 20% | | Based on operator discussion | Input |
| Boiler Efficiency | 80% | | Assumed | Linked Cell |
| Operating days | 230 | days/year | Allowing for shutdown | Calculation |
| | | | | Output |

**Annual Steam Production Estimate - Based on Site Coal Consumption**

| | | | |
|---|---|---|---|
| Annual Coal Consumption | 56429 | GJ/year | From coal invoices for previous 12 months - assuming lignite |
| Rendering Annual Coal Consumption | 33858 | GJ/year | Assumed 60% of site total - hot water demand matches well to 40% coal consumption so considered valid assumption |
| Energy to make steam | 45143.52 | GJ/year | 80% boiler efficiency |
| Total steam production | 11134085 | kg/year | Assumed no make-up water preheat as per current operation - boiler efficiency included in energy to make steam |
| | 11134 | t/year | |
| Daily steam | 48 | t/day | |

**Steam Production on a Mass Basis**

| **Parameter** | **Using Coal** | **Using Wood Chip** | **Abatement** | **Units** | **Notes** |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | Current operation takes 20% make up water at 15°C and hot well at 100°C, production of 10 bar steam. |
| Specific Enthalpy of Water at 65°C | | 271.7 | | kJ/kg | New boiler would include feed preheating from rendering boiler make up - 65°C to be conservative |
| Specific Enthalpy of Water at 100 °C | 418.7 | 418.7 | | kJ/kg | |
| Specific Enthalpy of Steam | 2780.2 | 2780.2 | | kJ/kg | |
| Equivalent Energy Consumed to Prod | 3041 | 2989 | 52 | kJ/kg | Energy required difference based on boiler feed preheating |
| Typical Daily Steam Demand | 48409 | 48409 | 0 | kg/day | Calculated based on steam demand from coal consumption (assuming 60% total coal) |
| Plant OEE | 100% | 100% | | % | |
| Quantity of Steam Produced Annually | 11134085 | 11134085 | | kg/year | Assuming 230 days/ year operation |
| Energy Generation | 27086 | 26620 | 466 | GJ/year | Energy of steam generated. Coal boiler takes cold water but Wood Chip boiler relies on preheating boiler feed |
| Annual Energy Consumption | 33858 | 33276 | 582 | GJ/year | |
| Carbon Dioxide Emissions | 3228 | 40 | 3188 | tCO2-e/year | |
| Annual Energy Cost | $ 181,522 | $ 585,651 | -$ 404,129 | $/year | |

## CAPEX

Total Capital Cost Estimate $ 5,640,000.00

Budget level cost estimate - assumes that existing fuel storage and boiler house will be able to be utilised

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -9581954 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 30 | NZ$/GJ | |
| MAC after 20 years - Discounted | 247 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 150 | NZ$/tCO2e | |
| Abated after 20 years | 63757 | tCO2e | |

## Discussion

The costs seem prohibitive to uptake of this project at the current time.
Biomass boiler costs, supply and installation costs may decrease in coming years as they become more popular in the public and industrial sector.
Additional risks associated with this project include fuel supply. Investigation into a fuel supply contract should be completed before this project is taken any further. There is a possibility that fuel prices will decline in future as a biomass fuel supply chain grows to support biomass use for process heat.
Blue Sky should also consider the possibility of gaining resource consent for the emissions generated by a biomass boiler installation before committing to this project.

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -10749261 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 33 | NZ$/GJ | |
| MAC after 20 years - Discounted | 276 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 168 | NZ$/tCO2e | |
| Abated after 20 years | 64094 | tCO2e | |

## Discussion

The cost of a dual fired boiler is prohibitive at this stage.
Due to the low amounts of biogas being produced onsite compared to the required heat demand, a significant amount of biomass (wood chip) would be required. Alternative fuels could be considered, such as hog fuel which would be cheaper. However, the boiler needs to be design to handle the variability of hog fuel to get effective boiler performance.
Additional risks associated with this project include fuel supply. Investigation into a fuel supply contract should be completed before this project is taken any further. There is a possibility that fuel prices will decline in future as a biomass fuel supply chain grows to support biomass use for process heat.
Blue Sky should also consider the possibility of gaining resource consent for the emissions generated by a biomass boiler installation before committing to this project.

Sensitivity: General

Beca

## Economic Calculations

| Inputs | | |
|---|---|---|
| Project title: | Rendering Boiler Replacement - Wood Chip Boiler | |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 | 0.543 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 | 1.426 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 2962.9 | 2821.8 | 2687.4 | 2559.4 | 2437.6 | 2321.5 | 2210.9 | 2105.7 | 2005.4 | 1909.9 | 1818.9 | 1732.3 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 2962.9 | 5784.6 | 8472.0 | 11031.5 | 13469.0 | 15790.5 | 18001.4 | 20107.1 | 22112.5 | 24022.4 | 25841.3 | 27573.6 |
| Energy Generation (GJ/year) | | 0 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 23563.7 | 22441.6 | 21372.9 | 20355.2 | 19385.9 | 18462.7 | 17583.6 | 16746.3 | 15948.8 | 15189.3 | 14466.0 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 48305.5 | 70747.1 | 92120.0 | 112475.2 | 131861.1 | 150323.8 | 167907.4 | 184653.6 | 200602.4 | 215791.8 | 230257.8 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

**Capital Expenditure**

| | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | $ 3,280,000 | 0% | $ 3,280,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | $ 2,360,000 | 0% | $ 2,360,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | $5,640,000 | | $5,640,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 |
| OPEX description 2 | | - | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 4,737,600 | 4,737,600 | 3,979,584 | 3,342,851 | 2,807,994 | 2,358,715 | 1,981,321 | 1,664,310 | 1,398,020 | 1,174,337 | 986,443 | 828,612 | 696,034 |
| CAPEX Item 1 | 16.00% | 524,800 | 440,832 | 370,299 | 311,051 | 261,283 | 219,478 | 184,361 | 154,863 | 130,085 | 109,272 | 91,788 | 77,102 | 64,766 |
| CAPEX Item 2 | 16.00% | 377,600 | 317,184 | 266,435 | 223,805 | 187,996 | 157,917 | 132,650 | 111,426 | 93,598 | 78,622 | 66,043 | 55,476 | 46,600 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 4,737,600 | 3,979,584 | 3,342,851 | 2,807,994 | 2,358,715 | 1,981,321 | 1,664,310 | 1,398,020 | 1,174,337 | 986,443 | 828,612 | 696,034 | 584,669 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$902,400 | -$1,435,145 | -$1,313,862 | -$1,211,985 | -$1,126,408 | -$1,054,523 | -$994,140 | -$943,418 | -$900,812 | -$865,022 | -$834,959 | -$809,706 | -$788,494 |
| Tax | | -$297,792 | -$473,598 | -$433,574 | -$399,955 | -$371,715 | -$347,993 | -$328,066 | -$311,328 | -$297,268 | -$285,457 | -$275,537 | -$267,203 | -$260,203 |
| Net Operating Profit After Tax - NOPAT | | -$604,608 | -$961,547 | -$880,288 | -$812,030 | -$754,693 | -$706,530 | -$666,074 | -$632,090 | -$603,544 | -$579,565 | -$559,423 | -$542,503 | -$528,291 |
| Depreciation | | $902,400 | $758,016 | $636,733 | $534,856 | $449,279 | $377,394 | $317,011 | $266,290 | $223,683 | $187,894 | $157,831 | $132,578 | $111,365 |
| Capital Expenditure | | $5,640,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$5,342,208 | -$203,531 | -$243,554 | -$277,174 | -$305,414 | -$329,136 | -$349,062 | -$365,801 | -$379,861 | -$391,671 | -$401,592 | -$409,925 | -$416,926 |
| Discounted Cash Flow | | -$5,213,461 | -$189,167 | -$215,587 | -$233,663 | -$245,209 | -$251,672 | -$254,198 | -$253,702 | -$250,908 | -$246,390 | -$240,601 | -$233,899 | -$226,565 |
| IRR | | | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$5,402,629 | -$5,618,215 | -$5,851,878 | -$6,097,088 | -$6,348,759 | -$6,602,957 | -$6,856,660 | -$7,107,568 | -$7,353,958 | -$7,594,559 | -$7,828,458 | -$8,055,023 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | #NUM! | NZ$ | |
| NPV after 20 years | -$ 9,581,954 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 30 | NZ$/GJ | |
| MAC after 20 years - Discounted | $247 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $150 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 63757 | $t_{CO2e}$ | |

Sensitivity: General

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 | 3,188 |
| 1649.8 | 1571.3 | 1496.4 | 1425.2 | 1357.3 | 1292.7 | 1231.1 | 1172.5 |
| 29223.4 | 30794.7 | 32291.2 | 33716.3 | 35073.7 | 36366.4 | 37597.5 | 38770.0 |
| 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| 13777.2 | 13121.1 | 12496.3 | 11901.2 | 11334.5 | 10794.8 | 10280.7 | 9791.2 |
| 244035.0 | 257156.1 | 269652.4 | 281553.7 | 292888.2 | 303683.0 | 313963.7 | 323754.9 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 | $ 328,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 | $ 585,651 |
| $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 | $934,317 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| 584,669 | 491,122 | 412,542 | 346,535 | 291,090 | 244,515 | 205,393 | 172,530 |
| 54,403 | 45,699 | 38,387 | 32,245 | 27,086 | 22,752 | 19,112 | 16,054 |
| 39,144 | 32,881 | 27,620 | 23,201 | 19,489 | 16,370 | 13,751 | 11,551 |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - |
| 491,122 | 412,542 | 346,535 | 291,090 | 244,515 | 205,393 | 172,530 | 144,925 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| -$770,676 | -$755,708 | -$743,135 | -$732,574 | -$723,703 | -$716,251 | -$709,991 | -$704,733 |
| -$254,323 | -$249,384 | -$245,235 | -$241,749 | -$238,822 | -$236,363 | -$234,297 | -$232,562 |
| -$516,353 | -$506,324 | -$497,901 | -$490,825 | -$484,881 | -$479,888 | -$475,694 | -$472,171 |
| $93,547 | $78,579 | $66,007 | $55,446 | $46,574 | $39,122 | $32,863 | $27,605 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$422,806 | -$427,745 | -$431,894 | -$435,379 | -$438,307 | -$440,766 | -$442,831 | -$444,567 |
| -$218,819 | -$210,834 | -$202,742 | -$194,645 | -$186,623 | -$178,733 | -$171,020 | -$163,514 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$8,273,842 | -$8,484,676 | -$8,687,417 | -$8,882,063 | -$9,068,686 | -$9,247,419 | -$9,418,439 | -$9,581,954 |

Sensitivity: General

Beca

## Project Economic Analysis

Project 3-B3 - Upgrade Rendering Boiler - Dual Fired Biogas/Biomass Boiler

| Option | Description |
|---|---|
| Option | This project is one fuel switching option for the Rendering boiler to replace with a new 4.5 MW dual-fired biomass/biogas boiler. This project is based on the current steam demand from the rendering plant, assuming significant reductions in steam demand are not feasible. The biogas production from the plant is insufficient to meet the heat demand, therefore dual firing with wood chip has been considered here. It has been assumed that the biogas will be cleaned using a water scrubber. |

## Calculations

| | | | | |
|---|---|---|---|---|
| Make-up water ambient | 20% | | Based on operator discussion | Input |
| Coal/Wood Chip Boiler Efficiency | 80% | | Assumed | Linked Cell |
| Biogas Boiler Efficiency | 90% | | Assumed - Better than solid fuel combustion | Calculation |
| Overall boiler efficiency | 85% | | Assumed to be between wood chip and biogas | Output |
| Daily Steam Production | 48 | t/day | Based on actual coal consumption - assuming 60% total coal to rendering | |
| Operating days | 230 | days/year | Allowing for shutdown | |

**Biogas**

| **Parameter** | **Value** | **Unit** | **Comment** |
|---|---|---|---|
| Average daily production | 1885 | m³/day | Average gas flared - 1 month data<br>Energy Balances and Data analysis Blue Sky Meats ETA.xlsx |
| Methane Content | 60% | | Assumed |
| Methane Energy Density | 35 | MJ/m³ | |
| Average Biogas potential | 39595 | MJ/day | |
| Average biogas potential | 0.46 | MW | |
| Days of gas generation | 320.00 | days/year | |
| Annual Biogas potential | 12670335 | MJ/year | Assumed with average daily production 320 days/year - no gas generated during 6 week shut |
| | 12670 | GJ/year | Assume that biogas energy can be deducted from total to give woodchip |

**Steam Production on a Mass Basis**

| **Parameter** | **Using Coal** | **Using Biogas/Wood** | **Abatement** | **Units** | **Notes** |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | Current operation takes 20% make up water at 15°C and hot well at 100°C, production of 10 bar steam. |
| Specific Enthalpy of Water at 70°C | | 271.7 | | kJ/kg | New boiler would include feed preheating from rendering boiler make up - 70C to be conservative |
| Specific Enthalpy of Water at 100 °C | 418.7 | 418.7 | | kJ/kg | |
| Specific Enthalpy of Steam | 2780.2 | 2780.2 | | kJ/kg | |
| Equivalent Energy Consumed to Produce 1kg of | 3041 | 2813 | 228 | kJ/kg | Energy required difference based on boiler feed preheating + more efficient electric boiler |
| Typical Daily Steam Demand | 48409 | 48409 | 0 | kg/day | Calculated based on assumed 24h/day operation |
| Plant OEE | 100% | 100% | | % | |
| Quantity of Steam Produced Annually | 11134085.3 | 11134085 | | kg/year | Assuming 230 days |
| Energy Generation | 28779 | 26620 | 2159 | GJ/year | Energy of steam generated. |
| Annual Energy Consumption | 33858 | 31318 | 2539 | GJ/year | |
| Carbon Dioxide Emissions | 3228 | 23 | 3205 | tCO2-e/year | Assuming all biogas utilised and remaining is woodchip |
| Annual Energy Cost | $ 181,522 | $ 328,203 | -$ 146,681 | $/year | remaining energy portion purchased as wood chip |

## CAPEX

Total Capital Cost Estimate $ 8,373,000.00

*Budget level cost estimates - assumed the existing boiler house and fuel storage will be able to be used*

## Economic Summary

| **Parameter** | **Values** | **Units** | **Notes** |
|---|---|---|---|
| NPV after 20 years | -10749261 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 33 | NZ$/GJ | |
| MAC after 20 years - Discounted | 276 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 168 | NZ$/tCO2e | |
| Abated after 20 years | 64094 | tCO2e | |

## Discussion

The cost of a dual fired boiler is prohibitive at this stage.
Due to the low amounts of biogas being produced onsite compared to the required heat demand, a significant amount of biomass (wood chip) would be required. Alternative fuels could be considered, such as hog fuel which would be cheaper. However, the boiler needs to be design to handle the variability of hog fuel to get effective boiler performance.
Additional risks associated with this project include fuel supply. Investigation into a fuel supply contract should be completed before this project is taken any further. There is a possibility that fuel prices will decline in future as a biomass fuel supply chain grows to support biomass use for process heat.
Blue Sky should also consider the possibility of gaining resource consent for the emissions generated by a biomass boiler installation before committing to this project.

Sensitivity: General

## Economic Calculations

**Inputs**

| | |
|---|---|
| Project title: | Rendering Boiler Replacement - Duel fired biogas/wood chip boiler |
| Economic life (years) | 20 |
| Inflation (% per year) | 3.0% |
| WACC (% per year) | 5.0% |
| Tax Rate (% per year) | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 2978.5 | 2836.7 | 2701.6 | 2573.0 | 2450.4 | 2333.8 | 2222.6 | 2116.8 | 2016.0 | 1920.0 | 1828.6 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 2978.5 | 5815.2 | 8516.9 | 11089.8 | 13540.3 | 15874.0 | 18096.7 | 20213.4 | 22229.4 | 24149.4 | 25978.0 |
| Energy Generation (GJ/year) | | 0 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 23563.7 | 22441.6 | 21372.9 | 20355.2 | 19385.9 | 18462.7 | 17583.6 | 16746.3 | 15948.8 | 15189.3 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 48305.5 | 70747.1 | 92120.0 | 112475.2 | 131861.1 | 150323.8 | 167907.4 | 184653.6 | 200602.4 | 215791.8 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

**Capital Expenditure**

| | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | $ 4,870,000 | 0% | $ 4,870,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | $ 3,503,000 | 0% | $ 3,503,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | $8,373,000 | | $8,373,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 |
| OPEX description 2 | | - | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 7,033,320 | 7,033,320 | 5,907,989 | 4,962,711 | 4,168,677 | 3,501,689 | 2,941,418 | 2,470,791 | 2,075,465 | 1,743,390 | 1,464,448 | 1,230,136 |
| CAPEX Item 1 | 16.00% | 779,200 | 654,528 | 549,804 | 461,835 | 387,941 | 325,871 | 273,731 | 229,934 | 193,145 | 162,242 | 136,283 | 114,478 |
| CAPEX Item 2 | 16.00% | 560,480 | 470,803 | 395,475 | 332,199 | 279,047 | 234,399 | 196,896 | 165,392 | 138,929 | 116,701 | 98,029 | 82,344 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 7,033,320 | 5,907,989 | 4,962,711 | 4,168,677 | 3,501,689 | 2,941,418 | 2,470,791 | 2,075,465 | 1,743,390 | 1,464,448 | 1,230,136 | 1,033,315 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$1,339,680 | -$1,704,012 | -$1,523,959 | -$1,372,714 | -$1,245,669 | -$1,138,951 | -$1,049,308 | -$974,007 | -$910,755 | -$857,623 | -$812,992 | -$775,502 |
| Tax | | -$442,094 | -$562,324 | -$502,906 | -$452,996 | -$411,071 | -$375,854 | -$346,272 | -$321,422 | -$300,549 | -$283,016 | -$268,287 | -$255,916 |
| Net Operating Profit After Tax - NOPAT | | -$897,586 | -$1,141,688 | -$1,021,052 | -$919,719 | -$834,598 | -$763,097 | -$703,036 | -$652,585 | -$610,206 | -$574,607 | -$544,705 | -$519,587 |
| Depreciation | | $1,339,680 | $1,125,331 | $945,278 | $794,034 | $666,988 | $560,270 | $470,627 | $395,327 | $332,074 | $278,942 | $234,312 | $196,822 |
| Capital Expenditure | | $8,373,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$7,930,906 | -$16,357 | -$75,774 | -$125,685 | -$167,610 | -$202,827 | -$232,409 | -$257,258 | -$278,131 | -$295,665 | -$310,393 | -$322,765 |
| Discounted Cash Flow | | -$7,739,771 | -$15,202 | -$67,073 | -$105,955 | -$134,570 | -$155,090 | -$169,248 | -$178,422 | -$183,714 | -$185,995 | -$185,962 | -$184,166 |
| IRR | | | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$7,754,974 | -$7,822,047 | -$7,928,002 | -$8,062,571 | -$8,217,662 | -$8,386,909 | -$8,565,332 | -$8,749,045 | -$8,935,041 | -$9,121,003 | -$9,305,169 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | #NUM! | NZ$ | |
| NPV after 20 years | -$ 10,749,261 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 33 | NZ$/GJ | |
| MAC after 20 years - Discounted | $276 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $168 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 64094 | $t_{CO2e}$ | |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 | 3,205 |
| 1741.5 | 1658.6 | 1579.6 | 1504.4 | 1432.7 | 1364.5 | 1299.5 | 1237.6 | 1178.7 |
| 27719.5 | 29378.0 | 30957.6 | 32462.0 | 33894.7 | 35259.2 | 36558.7 | 37796.4 | 38975.1 |
| 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| 14466.0 | 13777.2 | 13121.1 | 12496.3 | 11901.2 | 11334.5 | 10794.8 | 10280.7 | 9791.2 |
| 230257.8 | 244035.0 | 257156.1 | 269652.4 | 281553.7 | 292888.2 | 303683.0 | 313963.7 | 323754.9 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 | $ 487,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 | $ 328,203 |
| $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 | $ 20,667 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 | $835,869 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 1,033,315 | 867,984 | 729,107 | 612,450 | 514,458 | 432,144 | 363,001 | 304,921 | 256,134 |
| 96,161 | 80,776 | 67,851 | 56,995 | 47,876 | 40,216 | 33,781 | 28,376 | 23,836 |
| 69,169 | 58,102 | 48,806 | 40,997 | 34,437 | 28,927 | 24,299 | 20,411 | 17,145 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 867,984 | 729,107 | 612,450 | 514,458 | 432,144 | 363,001 | 304,921 | 256,134 | 215,152 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| -$744,011 | -$717,558 | -$695,338 | -$676,673 | -$660,994 | -$647,824 | -$636,761 | -$627,468 | -$619,662 |
| -$245,524 | -$236,794 | -$229,461 | -$223,302 | -$218,128 | -$213,782 | -$210,131 | -$207,064 | -$204,488 |
| -$498,487 | -$480,764 | -$465,876 | -$453,371 | -$442,866 | -$434,042 | -$426,630 | -$420,404 | -$415,174 |
| $165,330 | $138,877 | $116,657 | $97,992 | $82,313 | $69,143 | $58,080 | $48,787 | $40,981 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$333,157 | -$341,886 | -$349,219 | -$355,379 | -$360,553 | -$364,899 | -$368,550 | -$371,616 | -$374,192 |
| -$181,043 | -$176,940 | -$172,129 | -$166,824 | -$161,193 | -$155,367 | -$149,449 | -$143,517 | -$137,630 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$9,486,212 | -$9,663,152 | -$9,835,281 | -$10,002,104 | -$10,163,297 | -$10,318,664 | -$10,468,114 | -$10,611,631 | -$10,749,261 |

Sensitivity: General

Beca

# Project Economic Analysis

Project 3-B4 - Rendering boiler replacement - Tallow

## Option

**Option**

## Description

This project is one fuel switching option for the Rendering boiler to replace with a new 4.5 MW tallow boiler utilising tallow produced onsite. This project is based on the current steam demand from the rendering plant, assuming significant reductions in steam demand are not feasible. The fuel cost for this project is based on the value of tallow if sold as a product.

## Calculations

| | | | | |
|---|---|---|---|---|
| Make-up water ambient | 20% | | Based on operator discussion | Input |
| Boiler Efficiency | 80% | | Assumed | Linked Cell |
| Operating days | 230 | days/year | Allowing for shutdown | Calculation |
| | | | | Output |

**Annual Steam Production Estimate - Based on Site Coal Consumption**

| | | | |
|---|---|---|---|
| Annual Coal Consumption | 56429 | GJ/year | From coal invoices for previous 12 months - assuming lignite |
| Rendering Annual Coal Consumption | 33858 | GJ/year | Assumed 60% of site total - hot water demand matches well to 40% coal consumption so considered valid assumption |
| Energy to make steam | 45143.52 | GJ/year | 80% boiler efficiency |
| Total steam production | 11134085 | kg/year | Assumed no make-up water preheat as per current operation - boiler efficiency included in energy to make steam |
| | 11134 | t/year | |
| Daily steam | 48 | t/day | |

**Steam Production on a Mass Basis**

| Parameter | Using Coal | Using Tallow | Abatement | Units | Notes |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | Current operation takes 20% make up water at 15°C and hot well at 100°C, production of 10 bar steam. |
| Specific Enthalpy of Water at 65°C | | 271.7 | | kJ/kg | New boiler would include feed preheating from rendering boiler make up - 65°C to be conservative |
| Specific Enthalpy of Water at 100 °C | 418.7 | 418.7 | | kJ/kg | |
| Specific Enthalpy of Steam | 2780.2 | 2780 | | kJ/kg | |
| Equivalent Energy Consumed to Produce 1kg of St | 3041 | 2989 | 52 | kJ/kg | Energy required difference based on boiler feed preheating |
| Typical Daily Steam Demand | 48409 | 48409 | 0 | kg/day | Calculated based on steam demand from coal consumption (assuming 60% total coal) |
| Plant OEE | 100% | 100% | | % | |
| Quantity of Steam Produced Annually | 11134085 | 11134085 | | kg/year | Assuming 230 days/ year operation |
| Energy Generation | 27086 | 26620 | 466 | GJ/year | Energy of steam generated. Coal boiler takes cold water but tallow boiler relies on preheating boiler feed |
| Annual Energy Consumption | 33858 | 33276 | 582 | GJ/year | |
| Carbon Dioxide Emissions | 3228 | 114 | 3114 | tCO2-e/year | |
| Annual Energy Cost | $ 181,522 | $ 915,079 | -$ 733,557 | $/year | Based on tallow value 2021 |

## CAPEX

Total Capital Cost Estimate $ 2,594,000.00

*Budget level cost estimates*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -8628130 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 26.7 | NZ$/GJ | |
| MAC after 20 years - Discounted | 227.8 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 138.5 | NZ$/tCO2e | |
| Abated after 20 years | 62279 | tCO2e | |

## Discussion

The lost revenue from tallow due to consuming it as a fuel makes this project seem infeasible at the current time. However, in future if tallow is to be considered as a nationally significant resource, the export of tallow may become restricted and reduce the value of tallow as a product. This would improve the economics of this project. Further consideration of resource consent for boiler emissions is required.

Sensitivity: General

Beca

## Economic Calculations

**Inputs**

| | | |
|---|---|---|
| Project title: | | Rendering Boiler Replacement - Tallow |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 2894.2 | 2756.4 | 2625.1 | 2500.1 | 2381.1 | 2267.7 | 2159.7 | 2056.9 | 1958.9 | 1865.6 | 1776.8 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 2894.2 | 5650.6 | 8275.7 | 10775.8 | 13156.9 | 15424.6 | 17584.3 | 19641.1 | 21600.1 | 23465.7 | 25242.5 |
| Energy Generation (GJ/year) | | 0 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 23563.7 | 22441.6 | 21372.9 | 20355.2 | 19385.9 | 18462.7 | 17583.6 | 16746.3 | 15948.8 | 15189.3 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 24741.8 | 48305.5 | 70747.1 | 92120.0 | 112475.2 | 131861.1 | 150323.8 | 167907.4 | 184653.6 | 200602.4 | 215791.8 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

**Capital Expenditure**

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 1,509,000 | 0% | $ 1,509,000 | $ - | $ - | $ - | $ - | - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 1,085,000 | 0% | $ 1,085,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $ 2,594,000 | | $2,594,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 2,178,960 | 2,178,960 | 1,830,326 | 1,537,474 | 1,291,478 | 1,084,842 | 911,267 | 765,464 | 642,990 | 540,112 | 453,694 | 381,103 |
| CAPEX Item 1 | 16.00% | 241,440 | 202,810 | 170,360 | 143,102 | 120,206 | 100,973 | 84,817 | 71,247 | 59,847 | 50,272 | 42,228 | 35,472 |
| CAPEX Item 2 | 16.00% | 173,600 | 145,824 | 122,492 | 102,893 | 86,430 | 72,602 | 60,985 | 51,228 | 43,031 | 36,146 | 30,363 | 25,505 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 2,178,960 | 1,830,326 | 1,537,474 | 1,291,478 | 1,084,842 | 911,267 | 765,464 | 642,990 | 540,112 | 453,694 | 381,103 | 320,126 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$415,040 | -$1,157,424 | -$1,101,643 | -$1,054,786 | -$1,015,427 | -$982,365 | -$954,593 | -$931,265 | -$911,669 | -$895,208 | -$881,381 | -$869,767 |
| Tax | | -$136,963 | -$381,950 | -$363,542 | -$348,079 | -$335,091 | -$324,180 | -$315,016 | -$307,317 | -$300,851 | -$295,419 | -$290,856 | -$287,023 |
| Net Operating Profit After Tax - NOPAT | | -$278,077 | -$775,474 | -$738,101 | -$706,707 | -$680,336 | -$658,185 | -$639,577 | -$623,947 | -$610,818 | -$599,790 | -$590,526 | -$582,744 |
| Depreciation | | $415,040 | $348,634 | $292,852 | $245,996 | $206,637 | $173,575 | $145,803 | $122,474 | $102,878 | $86,418 | $72,591 | $60,976 |
| Capital Expenditure | | $2,594,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$2,457,037 | -$426,840 | -$445,248 | -$460,711 | -$473,700 | -$484,610 | -$493,775 | -$501,473 | -$507,940 | -$513,372 | -$517,935 | -$521,767 |
| Discounted Cash Flow | | -$2,397,822 | -$396,718 | -$394,121 | -$388,388 | -$380,322 | -$370,554 | -$359,582 | -$347,799 | -$335,508 | -$322,949 | -$310,304 | -$297,714 |
| IRR | | | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$2,794,540 | -$3,188,661 | -$3,577,049 | -$3,957,371 | -$4,327,924 | -$4,687,507 | -$5,035,305 | -$5,370,813 | -$5,693,762 | -$6,004,066 | -$6,301,780 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | #NUM! | NZ$ | |
| NPV after 20 years | -$ 8,459,728 | NZ$ | |
| Energy generation over 20 years | 532410 | GJ | |
| Levelised Cost of Energy - LCOE | 26 | NZ$/GJ | |
| MAC after 20 years - Discounted | $223 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $136 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 62279 | $t_{CO2e}$ | |

Sensitivity: General

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 |
| 1692.2 | 1611.6 | 1534.9 | 1461.8 | 1392.2 | 1325.9 | 1262.7 | 1202.6 | 1145.3 |
| 26934.6 | 28546.3 | 30081.1 | 31542.9 | 32935.0 | 34260.9 | 35523.6 | 36726.2 | 37871.6 |
| 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 | 26620.5 |
| 14466.0 | 13777.2 | 13121.1 | 12496.3 | 11901.2 | 11334.5 | 10794.8 | 10280.7 | 9791.2 |
| 230257.8 | 244035.0 | 257156.1 | 269652.4 | 281553.7 | 292888.2 | 303683.0 | 313963.7 | 323754.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 | $ 257,189 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 | $257,189 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 | $ 150,900 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 | $ 915,079 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 | $1,065,979 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 320,126 | 268,906 | 225,881 | 189,740 | 159,382 | 133,881 | 112,460 | 94,466 | 79,352 |
| 29,796 | 25,029 | 21,024 | 17,660 | 14,835 | 12,461 | 10,467 | 8,793 | 7,386 |
| 21,424 | 17,996 | 15,117 | 12,698 | 10,666 | 8,960 | 7,526 | 6,322 | 5,311 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 268,906 | 225,881 | 189,740 | 159,382 | 133,881 | 112,460 | 94,466 | 79,352 | 66,655 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| -$860,011 | -$851,815 | -$844,931 | -$839,149 | -$834,291 | -$830,211 | -$826,784 | -$823,905 | -$821,487 |
| -$283,804 | -$281,099 | -$278,827 | -$276,919 | -$275,316 | -$273,970 | -$272,839 | -$271,889 | -$271,091 |
| -$576,207 | -$570,716 | -$566,104 | -$562,230 | -$558,975 | -$556,242 | -$553,945 | -$552,016 | -$550,396 |
| $51,220 | $43,025 | $36,141 | $30,358 | $25,501 | $21,421 | $17,994 | $15,115 | $12,696 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$524,987 | -$527,691 | -$529,963 | -$531,871 | -$533,474 | -$534,821 | -$535,952 | -$536,902 | -$537,700 |
| -$285,287 | -$273,102 | -$261,217 | -$249,673 | -$238,501 | -$227,717 | -$217,332 | -$207,350 | -$197,769 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$6,587,068 | -$6,860,169 | -$7,121,386 | -$7,371,059 | -$7,609,560 | -$7,837,277 | -$8,054,609 | -$8,261,959 | -$8,459,728 |

Sensitivity: General

# Project Economic Analysis

Project 7 - Ammonia Refrigeration Desuperheater Heat Recovery

| Option | Description |
|---|---|
| Option | This project includes retrofitting heat recovery from the existing ammonia refrigeration plant to act as a desuperheater. The recovered heat will be used for amenities hot water. |

| |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |
| Key Assumption |

## Calculations

**Heat Provided by NH3 Plant De-superheating**

| | | | |
|---|---|---|---|
| Heat Removed from Refrig Plant | 22 | kW | Based on 50% of full desuperheat of ammonia plant |
| Annual Operating days | 230 | days/year | Assumed to allow shut |
| Annual heat recovered | 437 | GJ/year | Assuming continuous refrigeration operation over operating days |
| | | | |
| Site LPG Consumption | 82 | GJ/year | Total based on $4000/year total cost |
| Amenities LPG Consumption | 54.7 | GJ/year | Assumed 2/3 to amenities, 1/3 to forklifts |
| Emissions reduction | 3.6 | tCO2-e/year | |
| Cost Saving | 2667.3 | $/year | |

Assumed the remaining heat recovery would off-set coal consumed in main boiler as amenities hot water is topped up by plant hot water

| | | | |
|---|---|---|---|
| Energy off-set from main boiler | 383 | GJ/year | |
| Boiler efficiency | 80% | | |
| Coal saved | 478 | GJ/year | Assuming boiler efficiency of 80% |
| Emissions reduction | 46 | tCO2-e/year | |
| Cost Saving | 2564 | $/year | |
| | | | |
| Total emissions reduction | 49.2 | tCO2-e/year | Assume additional pumping would have small impact and has been excluded. Excluding the amenities hot water system and any additional energy that would be required to complete the amenities hot water system |
| Total Cost Savings | $ 5,231 | $/year | Total coal and LPG savings |

## CAPEX

Total Capital Cost Estimate $ 60,000

Cost does not include amenities hot water system upgrades, just heat recovery at the refrig plant and piping to amenities

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 18 years | -0.05 | NZ$ | |
| NPV after 18 years | -30090 | NZ$ | |
| Years to Project Payback | 21 | - | |
| Energy generation over 18 years | 0 | GJ | |
| Levelised Cost of Energy - LCOE | #DIV/0! | NZ$/GJ | |
| MAC after 18 years - Discounted | 54 | NZ$/tCO2e | |
| MAC after 18 years - Un-discounted | 34 | NZ$/tCO2e | |
| Abated after 18 years | 886 | tCO2e | |

## Discussion

This project provides immediate benefit and should be included in the timeline. Further investigation and metering of the amenities hot water demand, and design of an appropriate hot water system for amenities (which has not been included in this project) is required to complete this. However, based on heat recovery alone, there is merit in completing these additional investigations.

## Economic Calculations

**Inputs**

| | |
|---|---|
| Project title: | Refrigeration Heat Recovery |
| Economic life (years) | 18.00 |
| Inflation (% per year) | 3.0% |
| WACC (% per year) | 5.0% |
| Tax Rate (% per year) | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 | 49 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 45.7 | 43.6 | 41.5 | 39.5 | 37.6 | 35.8 | 34.1 | 32.5 | 31.0 | 29.5 | 28.1 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 45.7 | 89.3 | 130.8 | 170.3 | 207.9 | 243.8 | 277.9 | 310.4 | 341.4 | 370.8 | 398.9 |
| Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 |

**Capital Expenditure**

| | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | $ 35,000 | 0% | $ 35,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | $ 25,000 | 0% | $ 25,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | $60,000 | | $60,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 50,400 | 50,400 | 42,336 | 35,562 | 29,872 | 25,093 | 21,078 | 17,705 | 14,873 | 12,493 | 10,494 | 8,815 |
| CAPEX Item 1 | 16.00% | 5,600 | 4,704 | 3,951 | 3,319 | 2,788 | 2,342 | 1,967 | 1,653 | 1,388 | 1,166 | 979 | 823 |
| CAPEX Item 2 | 16.00% | 4,000 | 3,360 | 2,822 | 2,371 | 1,991 | 1,673 | 1,405 | 1,180 | 992 | 833 | 700 | 588 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 50,400 | 42,336 | 35,562 | 29,872 | 25,093 | 21,078 | 17,705 | 14,873 | 12,493 | 10,494 | 8,815 | 7,405 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$9,600 | -$6,333 | -$5,043 | -$3,959 | -$3,049 | -$2,284 | -$1,642 | -$1,102 | -$649 | -$268 | $52 | $320 |
| Tax | | -$3,168 | -$2,090 | -$1,664 | -$1,307 | -$1,006 | -$754 | -$542 | -$364 | -$214 | -$88 | $17 | $106 |
| Net Operating Profit After Tax - NOPAT | | -$6,432 | -$4,243 | -$3,379 | -$2,653 | -$2,043 | -$1,530 | -$1,100 | -$738 | -$435 | -$180 | $35 | $215 |
| Depreciation | | $9,600 | $8,064 | $6,774 | $5,690 | $4,780 | $4,015 | $3,372 | $2,833 | $2,380 | $1,999 | $1,679 | $1,410 |
| Capital Expenditure | | $60,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$56,832 | $3,821 | $3,395 | $3,037 | $2,737 | $2,485 | $2,273 | $2,094 | $1,945 | $1,819 | $1,714 | $1,625 |
| Discounted Cash Flow | | -$55,462 | $3,551 | $3,005 | $2,560 | $2,197 | $1,900 | $1,655 | $1,453 | $1,285 | $1,144 | $1,027 | $927 |
| IRR | | | -93.3% | -71.97% | -54.43% | -42.14% | -33.49% | -27.25% | -22.59% | -19.01% | -16.20% | -13.95% | -12.10% |
| NPV | | | -$51,911 | -$48,906 | -$46,346 | -$44,148 | -$42,249 | -$40,594 | -$39,141 | -$37,856 | -$36,712 | -$35,685 | -$34,758 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 18 years | -5.0% | NZ$ | |
| NPV after 18 years | -$ 30,090 | NZ$ | |
| Years to Project Payback | 21 | - | |
| Energy generation over 18 years | 0 | GJ | |
| MAC after 18 years - Discounted | $54 | NZ$/$t_{CO2e}$ | |
| MAC after 18 years - Un-discounted | $34 | NZ$/$t_{CO2e}$ | |
| Abated after 18 years | 886 | $t_{CO2e}$ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 49 | 49 | 49 | 49 | 49 | 49 | 49 |
| 26.7 | 25.5 | 24.3 | 23.1 | 22.0 | 21.0 | 20.0 |
| 425.7 | 451.1 | 475.4 | 498.5 | 520.5 | 541.4 | 561.4 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 | $ 5,231 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 | $5,231 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 7,405 | 6,220 | 5,225 | 4,389 | 3,687 | 3,097 | 2,601 |
| 691 | 581 | 488 | 410 | 344 | 289 | 243 |
| 494 | 415 | 348 | 293 | 246 | 206 | 173 |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| 6,220 | 5,225 | 4,389 | 3,687 | 3,097 | 2,601 | 2,185 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| $546 | $736 | $895 | $1,029 | $1,141 | $1,235 | $1,315 |
| $180 | $243 | $295 | $339 | $376 | $408 | $434 |
| $366 | $493 | $600 | $689 | $764 | $828 | $881 |
| $1,185 | $995 | $836 | $702 | $590 | $495 | $416 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| $1,551 | $1,488 | $1,435 | $1,391 | $1,354 | $1,323 | $1,297 |
| $843 | $770 | $708 | $653 | $605 | $563 | $526 |
| -10.57% | -9.27% | -8.17% | -7.22% | -6.39% | -5.66% | -5.02% |
| -$33,915 | -$33,145 | -$32,438 | -$31,785 | -$31,179 | -$30,616 | -$30,090 |

Sensitivity: General

# Project Economic Analysis

Project 8 - Replacement of Shrink Tunnels

| Option | Description |
|---|---|
| Option | This project is to replace the two existing shrink tunnels with two more energy efficient models. |

| Legend |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |

## Calculations

| | | | |
|---|---|---|---|
| ***Existing Shrink Tunnels*** | | | |
| Total Shrink Tunnel Load | 21.8 | kW | Power consumption, provided information 16.4.21 |
| ***New Shrink Tunnels*** | | | |
| Energy Reduction | 50% | | Based on Moda Shrink Brochure |
| Effective New Energy Consumption | 10.9 | kW | |
| Energy saving | 10.9 | kW | |
| ***Operating hours*** | | | |
| Operating days | 230 | days/year | |
| Average operating hours | 13.5 | hours/day | Average of 1 and 2 9 hour shifts |
| Operating hours | 3105 | hours/year | Assuming shrink tunnels operate continuously during shifts |
| | 11178000 | s/year | |
| Energy Saving | 121.8 | GJ/year | Electricity saving |
| | 33872 | kWh/year | |
| Cost Saving | $ 5,081 | $/year | Based on $0.15/kWh |
| Emissions saving | 3.7 | tCO2-e/year | |

## CAPEX

Total Capital Cost Estimate $ 413,000.00

*Budget level cost estimates*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -451787 | NZ$ | |
| Energy generation over 20 years | 0 | GJ | |
| Levelised Cost of Energy - LCOE | #DIV/0! | NZ$/GJ | |
| MAC after 20 years - Discounted | 9961.2 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 6057.3 | NZ$/tCO2e | |
| Abated after 20 years | 75 | tCO2e | |

## Discussion

There is minimal energy savings from swapping the shrink tunnels. However, due to the limited electrical capacity on site, this project should be considered when the existing shrink tunnels need replacing.

Sensitivity: General

Beca

## Economic Calculations

**Inputs**

| | |
|---|---|
| Project title: | Upgrade Shrink Tunnels |
| Economic life (years) | 20 |
| Inflation (% per year) | 3.0% |
| WACC (% per year) | 5.0% |
| Tax Rate (% per year) | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 3.5 | 3.3 | 3.1 | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.3 | 2.2 | 2.1 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 3.5 | 6.8 | 9.9 | 12.9 | 15.8 | 18.5 | 21.1 | 23.5 | 25.9 | 28.1 | 30.2 |
| Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 |

**Capital Expenditure**

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 240,000 | 0% | $ 240,000 | $ - | $ - | $ - | $ - | | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 173,000 | 0% | $ 173,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $ 413,000 | | $413,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 346,920 | 346,920 | 291,413 | 244,787 | 205,621 | 172,722 | 145,086 | 121,872 | 102,373 | 85,993 | 72,234 | 60,677 |
| CAPEX Item 1 | 16.00% | 38,400 | 32,256 | 27,095 | 22,760 | 19,118 | 16,059 | 13,490 | 11,331 | 9,518 | 7,995 | 6,716 | 5,642 |
| CAPEX Item 2 | 16.00% | 27,680 | 23,251 | 19,531 | 16,406 | 13,781 | 11,576 | 9,724 | 8,168 | 6,861 | 5,763 | 4,841 | 4,067 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 346,920 | 291,413 | 244,787 | 205,621 | 172,722 | 145,086 | 121,872 | 102,373 | 85,993 | 72,234 | 60,677 | 50,968 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$66,080 | -$74,426 | -$65,545 | -$58,085 | -$51,819 | -$46,555 | -$42,133 | -$38,419 | -$35,299 | -$32,678 | -$30,477 | -$28,628 |
| Tax | | -$21,806 | -$24,561 | -$21,630 | -$19,168 | -$17,100 | -$15,363 | -$13,904 | -$12,678 | -$11,649 | -$10,784 | -$10,057 | -$9,447 |
| Net Operating Profit After Tax - NOPAT | | -$44,274 | -$49,866 | -$43,915 | -$38,917 | -$34,718 | -$31,192 | -$28,229 | -$25,741 | -$23,650 | -$21,894 | -$20,419 | -$19,180 |
| Depreciation | | $66,080 | $55,507 | $46,626 | $39,166 | $32,899 | $27,635 | $23,214 | $19,500 | $16,380 | $13,759 | $11,557 | $9,708 |
| Capital Expenditure | | $413,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$391,194 | $5,641 | $2,711 | $249 | -$1,819 | -$3,556 | -$5,015 | -$6,241 | -$7,271 | -$8,135 | -$8,862 | -$9,472 |
| Discounted Cash Flow | | -$381,766 | $5,243 | $2,399 | $210 | -$1,461 | -$2,719 | -$3,652 | -$4,329 | -$4,802 | -$5,118 | -$5,309 | -$5,405 |
| IRR | | | -98.6% | -90.92% | -88.16% | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| NPV | | | -$376,523 | -$374,123 | -$373,913 | -$375,374 | -$378,093 | -$381,745 | -$386,074 | -$390,876 | -$395,994 | -$401,304 | -$406,708 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | #NUM! | NZ$ | |
| NPV after 20 years | -$ 451,787 | NZ$ | |
| Energy generation over 20 years | 0 | GJ | |
| MAC after 20 years - Discounted | $9,961 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $6,057 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 75 | $t_{CO2e}$ | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.4 |
| 32.3 | 34.2 | 36.0 | 37.8 | 39.4 | 41.0 | 42.5 | 44.0 | 45.4 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 | $ 5,081 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 | $5,081 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 | $ 24,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 | $24,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 50,968 | 42,814 | 35,963 | 30,209 | 25,376 | 21,316 | 17,905 | 15,040 | 12,634 |
| 4,739 | 3,981 | 3,344 | 2,809 | 2,359 | 1,982 | 1,665 | 1,398 | 1,175 |
| 3,416 | 2,869 | 2,410 | 2,025 | 1,701 | 1,429 | 1,200 | 1,008 | 847 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 42,814 | 35,963 | 30,209 | 25,376 | 21,316 | 17,905 | 15,040 | 12,634 | 10,612 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| -$27,074 | -$25,769 | -$24,673 | -$23,753 | -$22,979 | -$22,330 | -$21,784 | -$21,326 | -$20,941 |
| -$8,934 | -$8,504 | -$8,142 | -$7,838 | -$7,583 | -$7,369 | -$7,189 | -$7,037 | -$6,910 |
| -$18,140 | -$17,266 | -$16,531 | -$15,914 | -$15,396 | -$14,961 | -$14,595 | -$14,288 | -$14,030 |
| $8,155 | $6,850 | $5,754 | $4,833 | $4,060 | $3,410 | $2,865 | $2,406 | $2,021 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| -$9,985 | -$10,415 | -$10,777 | -$11,081 | -$11,336 | -$11,550 | -$11,731 | -$11,882 | -$12,009 |
| -$5,426 | -$5,390 | -$5,312 | -$5,202 | -$5,068 | -$4,918 | -$4,757 | -$4,589 | -$4,417 |
| #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! | #NUM! |
| -$412,134 | -$417,525 | -$422,836 | -$428,038 | -$433,106 | -$438,024 | -$442,781 | -$447,370 | -$451,787 |

Sensitivity: General

Beca

# Project Economic Analysis

Project 10 - Insulation of Hot Water Ring Main

| Option | Description |
|---|---|
| Option | This project is to improve energy efficiency by lagging the hot water ring main in the processing plant. Currently, the ring main is lagged when open to air, but is not lagged in ceiling space. Improving the lagging will reduce heat losses. It is assumed all the ring main will be re-lagged, but has not included the down-comers to point of use. |

| |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |

## Calculations

| | | | |
|---|---|---|---|
| **Heat Loss Estimates** | | | |
| Pipe Length | 350 | m | Estimated from plant layout drawings |
| Pipe Diameter | 200 | mm | Assumed - based on site observations |
| | | | |
| Temperature of water in pipes | 82 | °C | Minimum required temperature, assumed constant throughout system |
| Air temperature | 20 | °C | Assumed, average ceiling space will be hotter than the processing floors |
| Temperature difference | 62 | | |
| | | | |
| **Losses with no lagging** | | | |
| Heat loss from fluid | 320 | W/m | 60°C temperature difference, 200mm pipe |
| Correction factor | 0.75 | | For ceiling conditions |
| Heat losses | 84 | kW | |
| | | | |
| Losses with complete 40mm lagging | | | |
| Heat loss from fluid | 60 | W/m | Extrapolated from graph for 40mm insulation thickness |
| Correction factor | 0.9 | | For inside conditions |
| Heat losses | 18.9 | kW | |
| | | | |
| Existing lagging | 51.45 | kW | Assume 50% effective |
| | | | |
| Operating days | 230 | days | Assumed |
| Operating Hours | 24 | h/d | Assuming 24 hours as the water in the pipes will remain |
| | | | |
| **Emissions Reduction** | | | |
| Boiler efficiency | 80% | | |
| Energy savings | 32.55 | kW | |
| | 646.8336 | GJ/year | Assume 230 days, 24 hours/day |
| Coal Saving | 808.542 | GJ/year | Based on existing coal-fired boiler |
| | 53.90 | t/year | |
| Emissions Reduction | 77.1 | t CO2e/year | |
| Cost Saving | $ 4,335 | $/year | |

## CAPEX

Total Capital Cost Estimate $ 61,000.00

*Budget level cost estimates*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| NPV after 20 years | -37156 | NZ$ | |
| Energy generation over 20 years | 0 | GJ | |
| Levelised Cost of Energy - LCOE | #DIV/0! | NZ$/GJ | |
| MAC after 20 years - Discounted | 39.6 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 24.1 | NZ$/tCO2e | |
| Abated after 20 years | 1542 | tCO2e | |

## Discussion

The energy saving from lagging are minimal based on the assumption that the pipes are currently partially lagged. Although the MAC is unfavourable, lagging pipes is good practise and should be considered as part of normal operation and maintenance.

Sensitivity: General

Beca

## Economic Calculations

**Inputs**

| | | |
|---|---|---|
| Project title: | | Hot Water Ring Main Insulation |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

**Discounting**

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 71.6 | 68.2 | 65.0 | 61.9 | 58.9 | 56.1 | 53.5 | 50.9 | 48.5 | 46.2 | 44.0 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 71.6 | 139.9 | 204.9 | 266.7 | 325.7 | 381.8 | 435.3 | 486.2 | 534.7 | 580.9 | 624.8 |
| Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 |

**Capital Expenditure**

| | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | $ 35,000 | 0% | $ 35,000 | $ - | $ - | $ - | $ - | - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | $ 26,000 | 0% | $ 26,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | $ 61,000 | | $61,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 51,240 | 51,240 | 43,042 | 36,155 | 30,370 | 25,511 | 21,429 | 18,001 | 15,120 | 12,701 | 10,669 | 8,962 |
| CAPEX Item 1 | 16.00% | 5,600 | 4,704 | 3,951 | 3,319 | 2,788 | 2,342 | 1,967 | 1,653 | 1,388 | 1,166 | 979 | 823 |
| CAPEX Item 2 | 16.00% | 4,160 | 3,494 | 2,935 | 2,466 | 2,071 | 1,740 | 1,461 | 1,228 | 1,031 | 866 | 728 | 611 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 51,240 | 43,042 | 36,155 | 30,370 | 25,511 | 21,429 | 18,001 | 15,120 | 12,701 | 10,669 | 8,962 | 7,528 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$9,760 | -$7,364 | -$6,052 | -$4,950 | -$4,024 | -$3,247 | -$2,594 | -$2,045 | -$1,584 | -$1,197 | -$872 | -$599 |
| Tax | | -$3,221 | -$2,430 | -$1,997 | -$1,633 | -$1,328 | -$1,071 | -$856 | -$675 | -$523 | -$395 | -$288 | -$198 |
| Net Operating Profit After Tax - NOPAT | | -$6,539 | -$4,934 | -$4,055 | -$3,316 | -$2,696 | -$2,175 | -$1,738 | -$1,370 | -$1,062 | -$802 | -$584 | -$401 |
| Depreciation | | $9,760 | $8,198 | $6,887 | $5,785 | $4,859 | $4,082 | $3,429 | $2,880 | $2,419 | $2,032 | $1,707 | $1,434 |
| Capital Expenditure | | $61,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$57,779 | $3,265 | $2,832 | $2,468 | $2,163 | $1,906 | $1,691 | $1,510 | $1,358 | $1,230 | $1,123 | $1,033 |
| Discounted Cash Flow | | -$56,387 | $3,034 | $2,507 | $2,081 | $1,737 | $1,458 | $1,231 | $1,047 | $897 | $774 | $673 | $589 |
| IRR | | | -94.3% | -74.86% | -58.19% | -46.28% | -37.81% | -31.63% | -27.00% | -23.43% | -20.61% | -18.33% | -16.46% |
| NPV | | | -$53,352 | -$50,846 | -$48,765 | -$47,028 | -$45,570 | -$44,339 | -$43,292 | -$42,395 | -$41,621 | -$40,949 | -$40,360 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | -7.9% | NZ$ | |
| NPV after 20 years | -$ 37,156 | NZ$ | |
| Years to Project Payback | 71.00 | - | |
| Energy generation over 20 years | 0 | GJ | |
| MAC after 20 years - Discounted | $40 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $24 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 1542 | $t_{CO2e}$ | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 |
| 41.9 | 39.9 | 38.0 | 36.2 | 34.5 | 32.8 | 31.3 | 29.8 | 28.4 |
| 666.7 | 706.6 | 744.6 | 780.8 | 815.3 | 848.1 | 879.3 | 909.1 | 937.4 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 | $ 4,335 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 | $4,335 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 | $ 3,500 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 | $3,500 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 7,528 | 6,324 | 5,312 | 4,462 | 3,748 | 3,148 | 2,645 | 2,221 | 1,866 |
| 691 | 581 | 488 | 410 | 344 | 289 | 243 | 204 | 171 |
| 513 | 431 | 362 | 304 | 256 | 215 | 180 | 151 | 127 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 6,324 | 5,312 | 4,462 | 3,748 | 3,148 | 2,645 | 2,221 | 1,866 | 1,567 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| -$370 | -$177 | -$15 | $121 | $235 | $331 | $412 | $479 | $536 |
| -$122 | -$58 | -$5 | $40 | $78 | $109 | $136 | $158 | $177 |
| -$248 | -$119 | -$10 | $81 | $158 | $222 | $276 | $321 | $359 |
| $1,204 | $1,012 | $850 | $714 | $600 | $504 | $423 | $355 | $299 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| $957 | $893 | $840 | $795 | $757 | $726 | $699 | $677 | $658 |
| $520 | $462 | $414 | $373 | $339 | $309 | $283 | $261 | $242 |
| -14.89% | -13.56% | -12.42% | -11.43% | -10.56% | -9.78% | -9.09% | -8.47% | -7.91% |
| -$39,840 | -$39,377 | -$38,964 | -$38,590 | -$38,252 | -$37,943 | -$37,659 | -$37,398 | -$37,156 |

**Project Economic Analysis**
Project 12 - Standby Heat Exchanger - Processing

| Option | Description |
|---|---|
| Option | Addition of 2 heat exchangers for hot water generation to allow duty/standby operation. This will allow more frequent maintenance on the heat exchangers, reducing fouling and improving overall heat transfer efficiency. It has been assumed the heat transfer losses are 20% on a fouled heat exchanger, and the addition of new heat exchangers will allow a 5% transfer loss to be maintained at all times. Calculations have assumed the existing coal boiler operation and therefore emissions and cost reductions are based on reduced coal consumption. |

| |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |

## Calculations

**Heat Exchanger Losses**

| | | | |
|---|---|---|---|
| Fouling | 20% | | Assumed losses in fouled HX |
| Un-fouled | 5% | | Assumed losses in HX with low amounts of fouling |
| Difference in boiler load | 15% | | |
| Current boiler energy production | 14806 | GJ/year | |
| Reduced boiler energy production | 12585 | GJ/year | Assuming 15% reduction due to less losses from fouling |
| Boiler efficiency | 80% | | |
| Coal savings | 2776 | GJ/year | |
| | 185 | t/year | |
| Cost savings | 14884 | $/year | |
| Emissions reduction | 265 | tCO2-e/year | |

## CAPEX

Total Capital Cost Estimate $ 17,000.00

*Budget level cost estimates*

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | 0.61 | NZ$ | |
| NPV after 20 years | 100884 | NZ$ | |
| Years to Project Payback | 2 | - | |
| Energy generation over 20 years | 0 | GJ | |
| Levelised Cost of Energy - LCOE | #DIV/0! | NZ$/GJ | |
| MAC after 20 years - Discounted | -31.3 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | -19.1 | NZ$/tCO2e | |
| Abated after 20 years | 5293 | tCO2e | |

## Discussion

This project should be considered immediately, with both economic and operational advantages.

## Economic Calculations

### Inputs

| | | |
|---|---|---|
| Project title: | Standby heat exchangers - Process | |
| Economic life (years) | | 20 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

### Discounting

| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

### Emissions Abatement & LCOE
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 246.0 | 234.3 | 223.1 | 212.5 | 202.4 | 192.7 | 183.6 | 174.8 | 166.5 | 158.6 | 151.0 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 246.0 | 480.3 | 703.4 | 915.9 | 1118.2 | 1311.0 | 1494.5 | 1669.4 | 1835.9 | 1994.4 | 2145.4 |
| Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

### Annual Revenues/Savings

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 |
| Revenue/Savings Item 2 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 |

### Capital Expenditure

| | | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | | $ 10,000 | 0% | $ 10,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | | $ 7,000 | 0% | $ 7,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | | $ 17,000 | | $17,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

### Annual Expenses

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |

### Depreciation

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 14,280 | 14,280 | 11,995 | 10,076 | 8,464 | 7,110 | 5,972 | 5,017 | 4,214 | 3,540 | 2,973 | 2,498 |
| CAPEX Item 1 | 16.00% | 1,600 | 1,344 | 1,129 | 948 | 797 | 669 | 562 | 472 | 397 | 333 | 280 | 235 |
| CAPEX Item 2 | 16.00% | 1,120 | 941 | 790 | 664 | 558 | 468 | 393 | 331 | 278 | 233 | 196 | 165 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 14,280 | 11,995 | 10,076 | 8,464 | 7,110 | 5,972 | 5,017 | 4,214 | 3,540 | 2,973 | 2,498 | 2,098 |

### Cash Flow

| Cash Flow Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$2,720 | $11,599 | $11,965 | $12,272 | $12,530 | $12,747 | $12,929 | $13,082 | $13,210 | $13,318 | $13,408 | $13,485 |
| Tax | | -$898 | $3,828 | $3,948 | $4,050 | $4,135 | $4,206 | $4,266 | $4,317 | $4,359 | $4,395 | $4,425 | $4,450 |
| Net Operating Profit After Tax - NOPAT | | -$1,822 | $7,772 | $8,016 | $8,222 | $8,395 | $8,540 | $8,662 | $8,765 | $8,851 | $8,923 | $8,984 | $9,035 |
| Depreciation | | $2,720 | $2,285 | $1,919 | $1,612 | $1,354 | $1,138 | $956 | $803 | $674 | $566 | $476 | $400 |
| Capital Expenditure | | $17,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$16,102 | $10,056 | $9,936 | $9,834 | $9,749 | $9,678 | $9,618 | $9,567 | $9,525 | $9,489 | $9,459 | $9,434 |
| Discounted Cash Flow | | -$15,714 | $9,347 | $8,795 | $8,291 | $7,827 | $7,400 | $7,004 | $6,635 | $6,291 | $5,969 | $5,667 | $5,383 |
| IRR | | | -37.5% | 15.76% | 38.69% | 49.34% | 54.70% | 57.58% | 59.18% | 60.11% | 60.65% | 60.98% | 61.18% |
| NPV | | | -$6,368 | $2,427 | $10,718 | $18,545 | $25,945 | $32,949 | $39,585 | $45,876 | $51,845 | $57,513 | $62,896 |

### Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | 61.5% | NZ$ | |
| NPV after 20 years | $ 100,884 | NZ$ | |
| Years to Project Payback | 2.00 | - | |
| Energy generation over 20 years | 0 | GJ | |
| MAC after 20 years - Discounted | -$31 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | -$19 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 5293 | $t_{CO2e}$ | |

Sensitivity: General

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 |
| 143.8 | 137.0 | 130.5 | 124.2 | 118.3 | 112.7 | 107.3 | 102.2 | 97.3 |
| 2289.3 | 2426.2 | 2556.7 | 2680.9 | 2799.2 | 2911.9 | 3019.3 | 3121.5 | 3218.8 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 | $ 14,884 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 | $14,884 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 | $ 1,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 2,098 | 1,762 | 1,480 | 1,243 | 1,045 | 877 | 737 | 619 | 520 |
| 197 | 166 | 139 | 117 | 98 | 83 | 69 | 58 | 49 |
| 138 | 116 | 98 | 82 | 69 | 58 | 49 | 41 | 34 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 1,762 | 1,480 | 1,243 | 1,045 | 877 | 737 | 619 | 520 | 437 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $13,548 | $13,602 | $13,647 | $13,685 | $13,717 | $13,744 | $13,766 | $13,785 | $13,801 |
| $4,471 | $4,489 | $4,504 | $4,516 | $4,527 | $4,535 | $4,543 | $4,549 | $4,554 |
| $9,077 | $9,113 | $9,144 | $9,169 | $9,190 | $9,208 | $9,223 | $9,236 | $9,247 |
| $336 | $282 | $237 | $199 | $167 | $140 | $118 | $99 | $83 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| $9,413 | $9,395 | $9,381 | $9,368 | $9,358 | $9,349 | $9,341 | $9,335 | $9,330 |
| $5,115 | $4,863 | $4,624 | $4,398 | $4,183 | $3,981 | $3,788 | $3,605 | $3,432 |
| 61.30% | 61.37% | 61.41% | 61.44% | 61.46% | 61.47% | 61.48% | 61.48% | 61.48% |
| $68,011 | $72,874 | $77,497 | $81,895 | $86,078 | $90,059 | $93,847 | $97,452 | $100,884 |

Sensitivity: General

# Project Economic Analysis
Project 16 - Rendering Water Supply Upgrade

## Option / Description

| Option | Description |
|---|---|
| Option | This project includes the upgrade of water supply line to rendering which will allow hot water to be returned to the processing plant, utilising heat recovery from the cooker condenser. This project also includes hot water storage at the processing plant to bridge the gaps in operation between rendering and processing, as well as the inclusion of a heat exchanger to allow rendering boiler make-up water to be pre-heated using recovered heat. It has been assumed that the hot water at the plant is 65°C, and that the boiler feed water can be pre-heated to 65°C. There is possibility these temperatures could be greater, but a conservative estimate more akin to current operation has been taken |

| Legend |
|---|
| Input |
| Linked Cell |
| Calculation |
| Output |
| Key Assumption |

## Calculations

| | | | |
|---|---|---|---|
| Boiler efficiency | 80% | | |
| **Heat Provided to Processing** | | | |
| Heat Removed from Cooker Condenser | 2305 | kW | Based on current cooling tower operation from information provided |
| Flow | 10 | L/s | Provided by blue sky |
| Temperature from cooker condenser | 85 | °C | Provided by blue sky |
| Assumed losses to processing - piping, s | 30% | | Assumed - to achieve 65°C at processing plant as per current operation - conservative |
| Heat to processing plant | 1613.5 | kW | |
| Temp drop after losses | 16.5 | °C | |
| Temp at plant | 68.5 | °C | |
| Max outlet temperature | 65.5 | °C | 3 °C approach - this is the temperature of make-up water for recovered heat case |
| Losses through HX | 5% | | At processing plant |
| Heat transferred to plant water | 1533 | kW | Energy saving at processing plant |
| Residual boiler duty | 367.2 | W | Hot Water Boiler 1.9MW, reduced duty to 0.4MW |

## Carbon abatement from rendering boiler feed pre-heating

| | | | |
|---|---|---|---|
| Rendering coal savings | 582 | GJ/year | Energy saved pre-heating boiler feed water from 15°C to 65 °C using rendering heat recovery |
| | 39 | t/year | |
| Emission reduction | 55 | tCO2-e/year | |
| Coal cost savings | $ 3,120 | $/year | |
| | 161806 | kWh/year | |

### Energy Savings and Carbon Abatement on Volumetric Basis

| Parameter | Baseline | With Heat Recovery | Abatement | Units | Notes |
|---|---|---|---|---|---|
| Specific Enthalpy of Water at 15°C | 62.6 | | | kJ/kg | |
| Specific Enthalpy of Water at 65 °C | | 271.7 | | kJ/kg | Water provided at 65°C from rendering |
| Specific Enthalpy of Water at 90 °C | 376.6 | 376.6 | | kJ/kg | |
| Equivalent Energy Consumed to Produce 1 m³ of Water | 391715 | 130863 | 260852 | kJ/m³ | Based on total energy consumed to make hot water, assuming boiler remains in both cases and inlet temperature is the difference |
| Typical Daily Hot Water Demand | 276.1 | 276.1 | | | |
| Plant OEE | 100% | 100% | | | |
| Quantity of 90°C water produced annuall | 47249 | 47249 | | m³/year | Total 2020 flow from flow data |
| Energy Generation | 14806 | 4364 | 10442 | GJ/year | Energy generation is reduced by amount of heat transferred to plant water, reduced energy generation based on rendering coal savings too |
| Annual Energy Consumption | 18508 | 6183 | 12325 | GJ/year | Rendering boiler pre-heating does not impact energy consumed here |
| Carbon Dioxide Emissions | 1764 | 589 | 1230 | tCO2-e/year | Assuming energy from coal in both cases, includes abatement from rendering boiler feed pre-heating |
| Annual Energy Cost | $ 99,228 | $ 23,399 | $ 78,949 | $/year | Includes cost savings from rendering coal |

## CAPEX
Total Capital Cost Estimate $ 1,440,000

Utilised the cost estimate from project 3, but excluded the heat pump equipment.

## Economic Summary

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | -0.05 | NZ$ | |
| NPV after 20 years | -736643 | NZ$ | |
| Years to Project Payback | 21 | - | |
| Energy generation over 20 years | 87289 | GJ | |
| Levelised Cost of Energy - LCOE | 14 | NZ$/GJ | |
| MAC after 20 years - Discounted | 49 | NZ$/tCO2e | |
| MAC after 20 years - Un-discounted | 30 | NZ$/tCO2e | |
| Abated after 20 years | 24609 | tCO2e | |

## Discussion

It is common place for meat works plants with onsite rendering to recover heat for processing. It is recommended that this project go ahead. This will allow an immediate 1.4MW reduction in load to the main process boiler and therefore should be considered immediately as a stand alone project, even if boiler replacement projects are not implemented for an extended period of time. This will have benefits of emissions reduction, but will also have co-benefits in re-consenting (lower fuel coal burning and reduced emissions from Main Boiler)

Sensitivity: General

Beca

## Economic Calculations

| Inputs | | |
|---|---|---|
| Project title: | | Rendering Water Supply Upgrade |
| Economic life (years) | | $ 20.00 |
| Inflation (% per year) | | 3.0% |
| WACC (% per year) | | 5.0% |
| Tax Rate (% per year) | | 33.0% |

| Discounting | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discounting Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Discount Factor | | 0.976 | 0.929 | 0.885 | 0.843 | 0.803 | 0.765 | 0.728 | 0.694 | 0.661 | 0.629 | 0.599 | 0.571 |
| Inflation Factor | | 1.000 | 1.030 | 1.061 | 1.093 | 1.126 | 1.159 | 1.194 | 1.230 | 1.267 | 1.305 | 1.344 | 1.384 |

**Emissions Abatement & LCOE**
**(reduction is entered as a positive value of equivalent tonnes of carbon dioxide)**

| Emissions Abatement Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions reduction ($t_{CO2e}$/year) | | 0 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 |
| Discounted emissions reduction ($t_{CO2e}$/year) | | 0 | 1143.6 | 1089.2 | 1037.3 | 987.9 | 940.9 | 896.1 | 853.4 | 812.8 | 774.1 | 737.2 | 702.1 |
| Summed NPV of discounted emissions ($t_{CO2e}$/year) | | 0 | 1143.6 | 2232.8 | 3270.1 | 4258.0 | 5198.9 | 6094.9 | 6948.3 | 7761.1 | 8535.1 | 9272.3 | 9974.4 |
| Energy Generation (GJ/year) | | 0 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 |
| Discounted Energy Generation (GJ/year) | | 0 | 4056.4 | 3863.3 | 3679.3 | 3504.1 | 3337.2 | 3178.3 | 3027.0 | 2882.8 | 2745.6 | 2614.8 | 2490.3 |
| Summed NPV of Discounted Energy Generation (GJ/year) | | 0 | 4056.4 | 7919.7 | 11599.0 | 15103.1 | 18440.4 | 21618.7 | 24645.7 | 27528.5 | 30274.1 | 32888.9 | 35379.2 |

**Annual Revenues/Savings**

| Revenue/Savings Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue/Savings Item 1 | | $ - | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 |
| Revenue/Savings Item 2 | | $ - | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 |
| Revenue/Savings Item 3 | | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total Revenue | | $0 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 |

**Capital Expenditure**

| | | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital Parameters | | Contingency | 100.0% | 0.0% | 0.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| CAPEX Item 1 | $ 840,000 | 0% | $ 840,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 2 | $ 600,000 | 0% | $ 600,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 3 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 4 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 5 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 6 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 7 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 8 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 9 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| CAPEX Item 10 | $ - | 0% | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total CAPEX** | $1,440,000 | | $1,440,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

**Annual Expenses**

| Annual Expense Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance | | | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 |
| ETS | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Electricity cost | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 1 | | - | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 |
| OPEX description 2 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 3 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| OPEX description 4 | | - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Total OPEX | | $0 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 |

**Depreciation**

| Depreciation Parameters | Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Book Value | DV Rate | 1,209,600 | 1,209,600 | 1,016,064 | 853,494 | 716,935 | 602,225 | 505,869 | 424,930 | 356,941 | 299,831 | 251,858 | 211,561 |
| CAPEX Item 1 | 16.00% | 134,400 | 112,896 | 94,833 | 79,659 | 66,914 | 56,208 | 47,214 | 39,660 | 33,315 | 27,984 | 23,507 | 19,746 |
| CAPEX Item 2 | 16.00% | 96,000 | 80,640 | 67,738 | 56,900 | 47,796 | 40,148 | 33,725 | 28,329 | 23,796 | 19,989 | 16,791 | 14,104 |
| CAPEX Item 3 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 4 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 5 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 6 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 7 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 8 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 9 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| CAPEX Item 10 | 16.00% | - | - | - | - | - | - | - | - | - | - | - | - |
| Closing Book Value | | 1,209,600 | 1,016,064 | 853,494 | 716,935 | 602,225 | 505,869 | 424,930 | 356,941 | 299,831 | 251,858 | 211,561 | 177,711 |

**Cash Flow**

| Cash Flow Parameters | **Year** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Net profit before tax - NPBT | | -$230,400 | -$166,337 | -$135,372 | -$109,360 | -$87,511 | -$69,157 | -$53,741 | -$40,790 | -$29,912 | -$20,774 | -$13,099 | -$6,651 |
| Tax | | -$76,032 | -$54,891 | -$44,673 | -$36,089 | -$28,879 | -$22,822 | -$17,734 | -$13,461 | -$9,871 | -$6,856 | -$4,323 | -$2,195 |
| Net Operating Profit After Tax - NOPAT | | -$154,368 | -$111,446 | -$90,699 | -$73,272 | -$58,632 | -$46,336 | -$36,006 | -$27,329 | -$20,041 | -$13,919 | -$8,776 | -$4,456 |
| Depreciation | | $230,400 | $193,536 | $162,570 | $136,559 | $114,710 | $96,356 | $80,939 | $67,989 | $57,111 | $47,973 | $40,297 | $33,850 |
| Capital Expenditure | | $1,440,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Cash Flow | | -$1,363,968 | $82,090 | $71,871 | $63,287 | $56,077 | $50,021 | $44,933 | $40,659 | $37,070 | $34,054 | $31,521 | $29,393 |
| Discounted Cash Flow | | -$1,331,096 | $76,297 | $63,618 | $53,353 | $45,023 | $38,248 | $32,722 | $28,199 | $24,485 | $21,423 | $18,885 | $16,772 |
| IRR | | | -94.0% | -73.84% | -56.85% | -44.79% | -36.24% | -30.03% | -25.38% | -21.79% | -18.96% | -16.68% | -14.81% |
| NPV | | | -$1,254,800 | -$1,191,182 | -$1,137,829 | -$1,092,806 | -$1,054,558 | -$1,021,837 | -$993,637 | -$969,152 | -$947,729 | -$928,844 | -$912,073 |

**Summary**

| Parameter | Values | Units | Notes |
|---|---|---|---|
| IRR after 20 years | -6.3% | NZ$ | |
| NPV after 20 years | -$ 816,094 | NZ$ | |
| Years to Project Payback | 21 | - | |
| Energy generation over 20 years | 87289 | GJ | |
| Levelised Cost of Energy - LCOE | 15 | NZ$/GJ | |
| MAC after 20 years - Discounted | $55 | NZ$/$t_{CO2e}$ | |
| MAC after 20 years - Un-discounted | $33 | NZ$/$t_{CO2e}$ | |
| Abated after 20 years | 24609 | $t_{CO2e}$ | |

Sensitivity: General

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0.543 | 0.518 | 0.493 | 0.469 | 0.447 | 0.426 | 0.406 | 0.386 | 0.368 |
| 1.426 | 1.469 | 1.513 | 1.558 | 1.605 | 1.653 | 1.702 | 1.754 | 1.806 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 | 1,230 |
| 668.7 | 636.8 | 606.5 | 577.6 | 550.1 | 523.9 | 499.0 | 475.2 | 452.6 |
| 10643.1 | 11279.9 | 11886.4 | 12464.0 | 13014.1 | 13538.0 | 14037.0 | 14512.2 | 14964.7 |
| 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 | 4364.4 |
| 2371.7 | 2258.8 | 2151.2 | 2048.8 | 1951.2 | 1858.3 | 1769.8 | 1685.5 | 1605.3 |
| 37750.9 | 40009.7 | 42160.9 | 44209.7 | 46160.9 | 48019.2 | 49789.0 | 51474.5 | 53079.8 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 | $ 99,228 |
| $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 | $ 3,120 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 | $102,348 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 | $ 42,000 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 | $ 33,150 |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 | $75,150 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| 177,711 | 149,277 | 125,393 | 105,330 | 88,477 | 74,321 | 62,429 | 52,441 | 44,050 |
| 16,586 | 13,933 | 11,703 | 9,831 | 8,258 | 6,937 | 5,827 | 4,894 | 4,111 |
| 11,847 | 9,952 | 8,360 | 7,022 | 5,898 | 4,955 | 4,162 | 3,496 | 2,937 |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| - | - | - | - | - | - | - | - | - |
| 149,277 | 125,393 | 105,330 | 88,477 | 74,321 | 62,429 | 52,441 | 44,050 | 37,002 |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|
| -$1,235 | $3,314 | $7,136 | $10,346 | $13,042 | $15,307 | $17,210 | $18,808 | $20,151 |
| -$408 | $1,094 | $2,355 | $3,414 | $4,304 | $5,051 | $5,679 | $6,207 | $6,650 |
| -$828 | $2,221 | $4,781 | $6,932 | $8,738 | $10,256 | $11,531 | $12,601 | $13,501 |
| $28,434 | $23,884 | $20,063 | $16,853 | $14,156 | $11,891 | $9,989 | $8,391 | $7,048 |
| $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| $27,606 | $26,105 | $24,844 | $23,784 | $22,895 | $22,147 | $21,519 | $20,992 | $20,549 |
| $15,002 | $13,510 | $12,245 | $11,165 | $10,236 | $9,430 | $8,726 | $8,107 | $7,558 |
| -13.25% | -11.92% | -10.79% | -9.80% | -8.94% | -8.18% | -7.50% | -6.89% | -6.34% |
| -$897,071 | -$883,561 | -$871,315 | -$860,150 | -$849,915 | -$840,485 | -$831,759 | -$823,652 | -$816,094 |

# C

## Appendix C – Project Cost Estimates

| | | | |
|---|---|---|---|
| **Project:** | Boiler Options for GIDI | **Details:** | Concept Capital Cost Estimate |
| **Building:** | Blue Sky Meats | | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| | **BLUE SKY MEATS (N.Z.) Limited** | | | | |
| | **Boiler Options for GIDI** | | | | |
| | **Concept Capital Cost Estimates** | | | | **(NZD)** |
| 1 | Accuracy (-30%+50%) | | | | |
| 2 | It should be noted that the cost estimates provided as part of the Services are not a statement of absolute cost, rather they will have an accuracy range commensurate with various factors such as the extent of relevant information provided, the certainty of data and the level of detail available at the time of preparation. | | | | |
| 3 | The high level cost estimates presented in this section are typically developed based on extrapolation of recent similar project pricing, new and historical quotes for some equipment items, industry unit rates and Beca's general experience. The estimates are based on incomplete design and other information and are not warranted or guaranteed by Beca. The accuracy of these estimates is not expected to be better than approximately -30% to +50% for the scope of work described in this document and are not suitable for final Capex approval. Further design should be undertaken if a more reliable estimate is required. | | | | |
| | **NOTE: These estimates are not to be used for any budget / funding purposes as the costs are not project capital costs but only costs associated with each item/project as a differentiator between the various options. Once Options have been chosen, then a concept design will have to be done in order for a proper cost estimte to be done.** | | | | |
| | | | | | |
| | **Project 3 - Rendering Water Supply Upgrade and Heat Pump** | | | | |
| | DIRECT COSTS | | | | |
| 4 | 120kW heat transfer - Plate heat exchangers | No | 1 | 1,500 | 1,500 |
| 5 | Heat exchanger supply pumps - assume 10kW motors | No | 2 | 5,000 | 10,000 |
| | *Refer Johnson Controls quotation 1344562 dated 10/05/2021* | | | | |
| 6 | 335kW Heat pump - Supplier to provide pricing | LS | 1 | 341,000 | 341,000 |
| 7 | Heat pump room | m2 | 20 | 4,000 | 80,000 |
| 8 | Insulated 75 m³ Hot water storage tanks | No | 2 | 130,000 | 260,000 |
| 9 | 100mm SS pipe - Rendering supply piping | m | 200 | 420 | 84,000 |
| 10 | 100mm SS pipe, lagged - Heat recovery return piping | m | 300 | 520 | 156,000 |
| 11 | 5kW Water return pump | LS | 1 | 3,500 | 3,500 |
| 12 | 100mm SS piping, lagged - Boiler feed preheating piping | m | 25 | 520 | 13,000 |
| 13 | 25mm SS piping, lagged | m | 25 | 140 | 3,500 |
| 14 | Civil and Building works (Plinths etc.) | Sum | 1 | 50,000 | 50,000 |
| 15 | Mechanical Installation | Sum | 1 | 230,000 | 230,000 |
| 16 | Allowance for electrical and controls | Sum | 1 | 50,000 | 50,000 |
| 17 | Allowance for commissioning | Sum | 1 | 25,000 | 25,000 |
| | **Subtotal - Direct Costs** | | | | **1,310,000** |
| | INDIRECT COSTS | | | | |
| | | | | | |

| | | | |
|---|---|---|---|
| **Project:** | Boiler Options for GIDI | **Details:** | Concept Capital Cost Estimate |
| **Building:** | Blue Sky Meats | | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 18 | Contractors Preliminary & General | % | 1,310,000 | 0.15 | 196,500 |
| 19 | Freight | % | 341,000 | 0.04 | 13,640 |
| 20 | Professional Fees | % | 1,518,000 | 0.15 | 227,700 |
| 21 | Contingency | % | 1,746,000 | 0.30 | 523,800 |
| | **TOTAL** | | | | **2,270,000** |
| | | | | | |
| | **Project 5 - Rendering Boiler Replacement - Wood Chip** | | | | |
| | DIRECT COSTS | | | | |
| 22 | 4.5MW Wood Chip Boiler | LS | 1 | 2,650,000 | 2,650,000 |
| 23 | Fuel reception canopy including slab and three sided walls | LS | 1 | 380,000 | 380,000 |
| 24 | Piping upgrades | LS | 1 | 100,000 | 100,000 |
| 25 | Civil and Building works (Plinths etc.) | Sum | 1 | 50,000 | 50,000 |
| 26 | Mechanical Installation | Sum | 1 | 60,000 | 60,000 |
| 27 | Allowance for electrical and controls | Sum | 1 | 40,000 | 40,000 |
| | **Subtotal - Direct Costs** | | | | **3,280,000** |
| | INDIRECT COSTS | | | | |
| 28 | Contractors Preliminary & General | % | 3,280,000 | 0.15 | 492,000 |
| 29 | Professional Fees | % | 3,772,000 | 0.15 | 565,800 |
| 30 | Contingency | % | 4,338,000 | 0.30 | 1,301,400 |
| | **TOTAL** | | | | **5,640,000** |
| | | | | | |
| | **Project 6 - Rendering Boiler Replacement - Electric Boiler** | | | | |
| | DIRECT COSTS | | | | |
| 31 | 4.5MW Electric Boiler | LS | 1 | 900,000 | 900,000 |
| 32 | Piping upgrades | Allow | 1 | 50,000 | 50,000 |
| 33 | Civil and Building works (Plinths etc.) | Sum | 1 | 20,000 | 20,000 |
| 34 | Mechanical Installation | Sum | 1 | 10,000 | 10,000 |
| 35 | Allowance for electrical and controls | Sum | 1 | 15,000 | 15,000 |
| | **Subtotal - Direct Costs** | | | | **995,000** |
| | INDIRECT COSTS | | | | |
| 36 | Contractors Preliminary & General | % | 995,000 | 0.15 | 149,250 |
| 37 | Professional Fees | % | 1,145,000 | 0.15 | 171,750 |
| 38 | Contingency | % | 1,316,000 | 0.30 | 394,800 |
| | **TOTAL** | | | | **1,711,000** |
| | | | | | |
| | **Project 8 - Rendering Boiler Replacement - Biogas + wood Chip** | | | | |
| | DIRECT COSTS | | | | |

| | | | |
|---|---|---|---|
| **Project:** | Boiler Options for GIDI | **Details:** | Concept Capital Cost Estimate |
| **Building:** | Blue Sky Meats | | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 39 | Wood Chip/biogas Boiler | LS | 1 | 4,000,000 | 4,000,000 |
| 40 | Fuel reception and conveyor system | LS | 1 | 380,000 | 380,000 |
| 41 | Biogas Scrubber - 78 m³/hr gas flow | LS | 1 | 200,000 | 200,000 |
| 42 | Piping upgrades | LS | 1 | 100,000 | 100,000 |
| 43 | Civil and Building works (Plinths etc.) | Sum | 1 | 80,000 | 80,000 |
| 44 | Mechanical Installation | Sum | 1 | 60,000 | 60,000 |
| 45 | Allowance for electrical and controls | Sum | 1 | 50,000 | 50,000 |
| | **Subtotal - Direct Costs** | | | | **4,870,000** |
| | INDIRECT COSTS | | | | |
| 46 | Contractors Preliminary & General | % | 4,870,000 | 0.15 | 730,500 |
| 47 | Professional Fees | % | 5,601,000 | 0.15 | 840,150 |
| 48 | Contingency | % | 6,441,000 | 0.30 | 1,932,300 |
| | **TOTAL** | | | | **8,373,000** |
| | | | | | |
| | **Project 11 - Rendering Water Supply Upgrade and Electric Boiler** | | | | |
| | DIRECT COSTS | | | | |
| 49 | 100mm SS piping - Rendering Supply Piping | m | 200 | 420 | 84,000 |
| 50 | 100mm SS piping, lagged - Heat Recovery Return Piping | m | 300 | 520 | 156,000 |
| 51 | 5kW Water return pump | LS | 1 | 3,500 | 3,500 |
| 52 | 25mm SS piping, lagged - Boiler feed preheating piping - cold side | m | 25 | 140 | 3,500 |
| 53 | 100mm SS piping, lagged - Boiler feed pre-heating piping - hot side | m | 25 | 420 | 10,500 |
| 54 | 120kW Heat Transfer - Plate Heat Exchanger | No | 1 | 1,500 | 1,500 |
| 55 | 10kW Plant Boiler supply pumps | No | 2 | 5,000 | 10,000 |
| 56 | 350kW heating Electric Boiler | LS | 1 | 185,000 | 185,000 |
| 57 | Insulated 75 m³ Hot water storage tanks | No | 2 | 130,000 | 260,000 |
| 58 | Piping upgrade allowance | LS | 1 | 50,000 | 50,000 |
| 59 | Mechanical Installation | Sum | 1 | 120,000 | 120,000 |
| 60 | Allowance for electrical and controls | Sum | 1 | 40,000 | 40,000 |
| | **Subtotal - Direct Costs** | | | | **924,000** |
| | INDIRECT COSTS | | | | |
| 61 | Contractors Preliminary & General | % | 924,000 | 0.15 | 138,600 |
| 62 | Professional Fees | % | 1,063,000 | 0.15 | 159,450 |
| 63 | Contingency | % | 1,223,000 | 0.30 | 366,900 |
| | **TOTAL** | | | | **1,590,000** |
| | | | | | |
| | **Project 12 - Rendering Water Supply Upgrade and Biomass Boiler** | | | | |
| | DIRECT COSTS | | | | |
| | | | | | |

| | |
|---|---|
| **Project:** Boiler Options for GIDI | **Details:** Concept Capital Cost Estimate |
| **Building:** Blue Sky Meats | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 64 | 100mm SS piping - Rendering Supply Piping | m | 200 | 420 | 84,000 |
| 65 | 100mm SS piping, lagged - Heat Recovery Return Piping | m | 300 | 520 | 156,000 |
| 66 | 5kW Water return pump | LS | 1 | 3,500 | 3,500 |
| 67 | 25mm SS piping, lagged - Boiler feed preheating piping - cold side | m | 25 | 140 | 3,500 |
| 68 | 100mm SS piping, lagged - Boiler feed pre-heating piping - hot side | m | 25 | 420 | 10,500 |
| 69 | 120kW Heat Transfer - Plate Heat Exchanger | No | 1 | 1,500 | 1,500 |
| 70 | 10kW Plant Boiler supply pumps | No | 2 | 5,000 | 10,000 |
| 71 | 350kW heating Biomass Boiler | LS | 1 | 350,000 | 350,000 |
| 72 | Insulated 75 m³ Hot water storage tanks | No | 2 | 130,000 | 260,000 |
| 73 | Piping upgrade allowance | LS | 1 | 50,000 | 50,000 |
| 74 | Mechanical Installation | Sum | 1 | 130,000 | 130,000 |
| 75 | Allowance for electrical and controls | Sum | 1 | 40,000 | 40,000 |
| | **Subtotal - Direct Costs** | | | | **1,099,000** |
| | INDIRECT COSTS | | | | |
| 76 | Contractors Preliminary & General | % | 1,099,000 | 0.15 | 164,850 |
| 77 | Professional Fees | % | 1,264,000 | 0.15 | 189,600 |
| 78 | Contingency | % | 1,454,000 | 0.30 | 436,200 |
| | **TOTAL** | | | | **1,890,000** |
| | | | | | |
| | **NOTES** | | | | |
| 79 | This Concept Capital Cost Estimate was prepared as part of the Boiler options study for GIDI Funding | | | | |
| 80 | A contingency has been included in the estimate to cover items of unforeseen detail and design development. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary. The accuracy range indicated above reflects the accuracy after and including the contingency. | | | | |
| 81 | Note that the indicated accuracy above is based on the scope of the mentioned information only and there are no allowances for work outside these boundaries or for scope changes. | | | | |
| | **Note that these estimates are incomplete (not full project estimates) as it only covers items mentioned and excludes any other potential project related items (demolitions and alterations to buildings, existing services/utilities relocation, making good to areas, etc.)** | | | | |
| 82 | Costs are in May 2021 $NZD | | | | |
| 83 | This Concept Capital Cost Estimate was prepared as part of the Boiler options study for GIDI Funding | | | | |
| 84 | A contingency has been included in the estimate to cover items of unforeseen detail and design development. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary. The accuracy range indicated reflects the accuracy after and including the contingency. | | | | |
| | | | | | |
| | **Assumptions** | | | | |

**Project:** Boiler Options for GIDI
**Details:** Concept Capital Cost Estimate
**Building:** Blue Sky Meats

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 85 | Estimates are as at May 2021, with implementation assumed in 2021-2022, and no provision is made for escalation. | | | | |
| 86 | Assumes that Blue Sky Meats procure the main equipment directly for installation by local contractors. | | | | |
| 87 | Assumes that on site work is competitively tendered to local contractors. | | | | |
| 88 | Assumes that where necessary existing equipment and facilities are shutdown and made safe such that the contractor has unrestricted access for installation. | | | | |
| | **Type of Estimate** | | | | |
| 89 | Accuracy of the estimates is in the order of -30+50% | | | | |
| 90 | Note that the indicated accuracy above is based on the scope of the mentioned information only and there are no allowances for work outside these boundaries or for scope changes. | | | | |
| | **Exclusions** | | | | |
| 91 | GST | | | | |
| 92 | Escalation beyond 2021 | | | | |
| 93 | No allowance has been made for the impacts of extraordinary global events (such as the current COVID-19 outbreak) within the base estimate. | | | | |
| 94 | The estimate does not allow for possible increases in rates or material prices as a result of disruption caused by COVID-19, nor for the risk of indefinite suspension of project works due to unavailability of materials and/or labour due to restrictions. | | | | |

**Project:** Boiler Options for GIDI **Details:** Concept Capital Cost Estimate
**Building:** Blue Sky Meats

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|

**Elemental Summary**

| | |
|---|---|
| **Project:** Boiler Options for GIDI | **Details:** Concept Capital Cost Estimate |
| **Building:** Blue Sky Meats | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| | **NOTES** | | | | |
| 95 | These estimates are based on the info from Matt Marshal with the spreadsheet of the various projects/options, undated. | | | | |
| 96 | A contingency has been included in the estimate to cover items of unforeseen detail and design development. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary. The accuracy range indicated above reflects the accuracy after and including the contingency. | | | | |
| 97 | Note that the indicated accuracy above is based on the scope of the mentioned information only and there are no allowances for work outside these boundaries or for scope changes. | | | | |

| | | | |
|---|---|---|---|
| **Project:** | Boiler Options for GIDI | **Details:** | Concept Capital Cost Estimate |
| **Building:** | Blue Sky Meats | | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| | **Note that these estimates are incomplete (not full project estimates) as it only covers items mentioned and excludes any other potential project related items (demolitions and alterations to buildings, existing services/utilities relocation, making good to areas, etc.)** | | | | |
| 98 | Costs are in May 2021 $NZD | | | | |
| | | | | | |
| | **ASSUMPTIONS** | | | | |
| 99 | Work during normal hours only . | | | | |
| 100 | The project will be procured on a competitive basis. | | | | |
| 101 | The Contractor will be given free access to the Contract Works site. | | | | |
| | | | | | |
| | **EXCLUSIONS** | | | | |
| 102 | Removal of any existing equipment being replaced | | | | |
| 103 | Relocation of existing services / utilities | | | | |
| 104 | Alterations to existing buildings, structures and equipment | | | | |
| 105 | Repairs to existing surfaces and structures | | | | |
| 106 | Asbestos removal / disposal | | | | |
| 107 | Spares | | | | |
| 108 | Training | | | | |
| 109 | GST | | | | |
| 110 | FOREX fluctuations | | | | |
| 111 | Hedging | | | | |
| 112 | Escalation | | | | |
| 113 | Capitalised interest | | | | |
| 114 | Costs to date | | | | |
| 115 | Operating cost | | | | |
| 116 | Insurance costs | | | | |
| 117 | Legal and finance fees | | | | |
| 118 | Risk items | | | | |
| 119 | Covid-19 related costs | | | | |
| 120 | Consent fees | | | | |
| | | | | | 21,470,690 |

**Project:** ETA Project **Details:** Concept Capital Cost Estimate

**Building:** Blue Sky Meats

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| | **BLUE SKY MEATS (N.Z.) Limited** | | | | |
| | **ETA Projects** | | | | |
| | **Concept Capital Cost Estimates** | | | | **(NZD)** |
| 1 | Accuracy (-30%+50%) | | | | |
| 2 | It should be noted that the cost estimates provided as part of the Services are not a statement of absolute cost, rather they will have an accuracy range commensurate with various factors such as the extent of relevant information provided, the certainty of data and the level of detail available at the time of preparation. | | | | |
| 3 | The high level cost estimates presented in this section are typically developed based on extrapolation of recent similar project pricing, new and historical quotes for some equipment items, industry unit rates and Beca's general experience. The estimates are based on incomplete design and other information and are not warranted or guaranteed by Beca. The accuracy of these estimates is not expected to be better than approximately -30% to +50% for the scope of work described in this document and are not suitable for final Capex approval. Further design should be undertaken if a more reliable estimate is required. | | | | |
| | | | | | |
| | **Rendering Water Supply Upgrade** | | | | |
| | DIRECT COSTS | | | | |
| 4 | 120kW heat transfer - Plate heat exchangers | No | 1 | 1,500 | 1,500 |
| 5 | Heat exchanger supply pumps - assume 10kW motors | No | 2 | 5,000 | 10,000 |
| 6 | Insulated 75 m³ Hot water storage tanks | No | 2 | 130,000 | 260,000 |
| 7 | 100mm SS pipe - Rendering supply piping | m | 200 | 420 | 84,000 |
| 8 | 100mm SS pipe, lagged - Heat recovery return piping | m | 300 | 520 | 156,000 |
| 9 | 5kW Water return pump | LS | 1 | 3,500 | 3,500 |
| 10 | 100mm SS piping, lagged - Boiler feed preheating piping | m | 25 | 520 | 13,000 |
| 11 | 25mm SS piping, lagged | m | 25 | 140 | 3,500 |
| 12 | Civil and Building works (Plinths etc.) | Sum | 1 | 50,000 | 50,000 |
| 13 | Mechanical Installation | Sum | 1 | 230,000 | 230,000 |
| 14 | Allowance for commissioning | Sum | 1 | 25,000 | 25,000 |
| | **Subtotal - Direct Costs** | | | | **840,000** |
| | INDIRECT COSTS | | | | |
| 15 | Contractors Preliminary & General | % | 840,000 | 0.15 | 126,000 |
| 16 | Professional Fees | % | 963,000 | 0.15 | 144,450 |
| 17 | Contingency | % | 1,107,000 | 0.30 | 332,100 |
| | **TOTAL** | | | | **1,440,000** |
| | | | | | |
| | **Insulation of hot water ring main** | | | | |
| | DIRECT COSTS | | | | |
| 18 | Lagging for 100mm SS pipe | m | 350 | 100 | 35,000 |
| | | | | | |

| | | | |
|---|---|---|---|
| **Project:** | ETA Project | **Details:** | Concept Capital Cost Estimate |
| **Building:** | Blue Sky Meats | | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 19 | Mechanical Installation | Sum | 1 | Included | - |
| | **Subtotal - Direct Costs** | | | | **35,000** |
| | INDIRECT COSTS | | | | |
| 20 | Contractors Preliminary & General | % | 35,000 | 0.15 | 5,250 |
| 21 | Professional Fees | % | 41,000 | 0.15 | 6,150 |
| 22 | Contingency | % | 47,000 | 0.30 | 14,100 |
| | **TOTAL** | | | | **61,000** |
| | | | | | |
| | **Rendering Boiler Replacement - Tallow Boiler** | | | | |
| | DIRECT COSTS | | | | |
| 23 | Tallow Boiler | Sum | 1 | 1,400,000 | 1,400,000 |
| 24 | Heated tallow storage tank | sum | 1 | 35,000 | 35,000 |
| 25 | Feed pump 5kW | No | 1 | 3,500 | 3,500 |
| 26 | Piping upgrades | Sum | 1 | 50,000 | 50,000 |
| 27 | Mechanical Installation | Sum | 1 | 20,000 | 20,000 |
| | **Subtotal - Direct Costs** | | | | **1,509,000** |
| | INDIRECT COSTS | | | | |
| 28 | Contractors Preliminary & General | % | 1,509,000 | 0.15 | 226,350 |
| 29 | Professional Fees | % | 1,735,000 | 0.15 | 260,250 |
| 30 | Contingency | % | 1,996,000 | 0.30 | 598,800 |
| | **TOTAL** | | | | **2,594,000** |
| | | | | | |
| | **Standby Heat exchanger - process water** | | | | |
| | DIRECT COSTS | | | | |
| 31 | Plate Heat Exchanger | No | 2 | 1,500 | 3,000 |
| 32 | Piping upgrades | Sum | 1 | 5,000 | 5,000 |
| 33 | Mechanical Installation | Sum | 1 | 1,600 | 1,600 |
| | **Subtotal - Direct Costs** | | | | **10,000** |
| | INDIRECT COSTS | | | | |
| 34 | Contractors Preliminary & General | % | 10,000 | 0.15 | 1,500 |
| 35 | Professional Fees | % | 12,000 | 0.15 | 1,800 |
| 36 | Contingency | % | 13,000 | 0.30 | 3,900 |
| | **TOTAL** | | | | **17,000** |
| | | | | | |
| | **Standby Heat exchanger - rendering** | | | | |
| | DIRECT COSTS | | | | |
| 37 | Plate Heat Exchanger | No | 1 | 1,500 | 1,500 |
| | | | | | |

| **Project:** ETA Project | **Details:** Concept Capital Cost Estimate |
|---|---|
| **Building:** Blue Sky Meats | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 38 | Piping upgrades | Sum | 1 | 5,000 | 5,000 |
| 39 | Mechanical Installation | Sum | 1 | 1,300 | 1,300 |
| | **Subtotal - Direct Costs** | | | | **8,000** |
| | INDIRECT COSTS | | | | |
| 40 | Contractors Preliminary & General | % | 8,000 | 0.15 | 1,200 |
| 41 | Professional Fees | % | 9,000 | 0.15 | 1,350 |
| 42 | Contingency | % | 11,000 | 0.30 | 3,300 |
| | **TOTAL** | | | | **14,000** |
| | | | | | |
| | **Piping for refrigeration heat recovery** | | | | |
| | DIRECT COSTS | | | | |
| 43 | Plate Heat Exchanger | No | 1 | 1,500 | 1,500 |
| 44 | 100mm SS pipe, lagged | m | 25 | 520 | 13,000 |
| 45 | 100mm SS pipe | m | 25 | 420 | 10,500 |
| 46 | 5 kW Pump | No | 1 | 3,500 | 3,500 |
| 47 | Mechanical Installation | Sum | 1 | 5,800 | 5,800 |
| | **Subtotal - Direct Costs** | | | | **35,000** |
| | INDIRECT COSTS | | | | |
| 48 | Contractors Preliminary & General | % | 35,000 | 0.15 | 5,250 |
| 49 | Professional Fees | % | 40,000 | 0.15 | 6,000 |
| 50 | Contingency | % | 46,000 | 0.30 | 13,800 |
| | **TOTAL** | | | | **60,000** |
| | | | | | |
| | **Replacement of sterilisers - ring main option** | | | | |
| | DIRECT COSTS | | | | |
| 51 | Sterilisers | No | 28 | 5,600 | 156,800 |
| 52 | 100mm SS piping, lagged. | m | 84 | 520 | 43,680 |
| 53 | Mechanical Installation | Sum | 1 | 40,000 | 40,000 |
| | **Subtotal - Direct Costs** | | | | **241,000** |
| | INDIRECT COSTS | | | | |
| 54 | Contractors Preliminary & General | % | 241,000 | 0.15 | 36,150 |
| 55 | Freight | % | 156,800 | 0.04 | 6,272 |
| 56 | Professional Fees | % | 283,000 | 0.15 | 42,450 |
| 57 | Contingency | % | 326,000 | 0.30 | 97,800 |
| | **TOTAL** | | | | **424,000** |
| | | | | | |
| | **Replacement of sterilisers - Electric heater option** | | | | |
| | | | | | |

## Elemental Summary

| | | | |
|---|---|---|---|
| **Project:** | ETA Project | **Details:** | Concept Capital Cost Estimate |
| **Building:** | Blue Sky Meats | | |

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| | DIRECT COSTS | | | | |
| 58 | Sterilisers | No | 28 | 8,600 | 240,800 |
| 59 | Mechanical Installation | Sum | 1 | 48,200 | 48,200 |
| | **Subtotal - Direct Costs** | | | | **289,000** |
| | INDIRECT COSTS | | | | |
| 60 | Contractors Preliminary & General | % | 289,000 | 0.15 | 43,350 |
| 61 | Freight | % | 240,800 | 0.04 | 9,632 |
| 62 | Professional Fees | % | 342,000 | 0.15 | 51,300 |
| 63 | Contingency | % | 394,000 | 0.30 | 118,200 |
| | **TOTAL** | | | | **512,000** |
| | | | | | |
| | **Replacement of Shrink Tunnels** | | | | |
| | DIRECT COSTS | | | | |
| 64 | Shrink tunnels | No | 2 | 100,000 | 200,000 |
| 65 | Mechanical Installation | Sum | 1 | 40,000 | 40,000 |
| | **Subtotal - Direct Costs** | | | | **240,000** |
| | INDIRECT COSTS | | | | |
| 66 | Contractors Preliminary & General | % | 240,000 | 0.15 | 36,000 |
| 67 | Professional Fees | % | 276,000 | 0.15 | 41,400 |
| 68 | Contingency | % | 318,000 | 0.30 | 95,400 |
| | **TOTAL** | | | | **413,000** |
| | | | | | |
| | **NOTES** | | | | |
| 69 | This Concept Capital Cost Estimate was prepared as part of the ETA study | | | | |
| 70 | A contingency has been included in the estimate to cover items of unforeseen detail and design development. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary. The accuracy range indicated above reflects the accuracy after and including the contingency. | | | | |
| 71 | Note that the indicated accuracy above is based on the scope of the mentioned information only and there are no allowances for work outside these boundaries or for scope changes. | | | | |
| 72 | Costs are in May 2021 $NZD | | | | |
| | | | | | |
| | **Assumptions** | | | | |
| 73 | Estimates are as at May 2021, with implementation assumed in 2021-2022, and no provision is made for escalation. | | | | |
| 74 | Assumes that Blue Sky Meats procure the main equipment directly for installation by local contractors. | | | | |
| 75 | Assumes that on site work is competitively tendered to local contractors. | | | | |
| | | | | | |

**Project:** ETA Project **Details:** Concept Capital Cost Estimate
**Building:** Blue Sky Meats

| Code | Description | Unit | Quantity | Rate | Total |
|---|---|---|---|---|---|
| 76 | Assumes that where necessary existing equipment and facilities are shutdown and made safe such that the contractor has unrestricted access for installation. | | | | |
| | **Type of Estimate** | | | | |
| 77 | Accuracy of the estimates is in the order of -30+50% | | | | |
| 78 | Note that the indicated accuracy above is based on the scope of the mentioned information only and there are no allowances for work outside these boundaries or for scope changes. | | | | |
| | **Exclusions** | | | | |
| 79 | GST | | | | |
| 80 | Escalation beyond 2021 | | | | |
| 81 | No allowance has been made for the impacts of extraordinary global events (such as the current COVID-19 outbreak) within the base estimate. | | | | |
| 82 | The estimate does not allow for possible increases in rates or material prices as a result of disruption caused by COVID-19, nor for the risk of indefinite suspension of project works due to unavailability of materials and/or labour due to restrictions. | | | | |
| | | | | | 5,530,684 |

# D

## Appendix D – PowerNet Network Upgrade Proposal

# Blue Sky Meats Network Upgrade Supply Arrangements 600kW & 5MW Summary

PowerNet Limited

May 2021

## 1 Purpose

Blue Sky Meats (BSM) Morton Mains site is connected to the electricity distribution network of The Power Company Limited (TPCL). PowerNet manages the electricity distribution network on behalf of TPCL.

The purpose of this summary is to provide BSM with estimated costs and contractual arrangements relating to the electricity distribution supply upgrades to meet the proposed expansion of an additional 600 kilowatts (kW) for refrigeration and heat-pumps and a proposed 5 megawatt (MW) electric boiler at the Morton Mains plant.

All costs and charges in this summary are excluding GST. Energy charges from an electricity retailer are not part of this scope of work and will be additional to Transpower and Distribution charges.

## 2 Upgrade 600kW

This proposal is for an additional 600kW supply, to supply additional refrigeration and heat –pumps on site. The existing lines from the Edendale zone substation which supply ICP 0008001316TP078 have sufficient capacity to allow the additional load to be delivered. ICP0008001316TP078 has two transformers with a total capacity of 1,750kVA and sufficient spare capacity for the new load. There are no network upgrades required to supply the new load via this supply arrangement.

This new load cannot be supplied by the alternative supply coming from the Kennington zone substation due to current network constraints, therefore there is no back-up supply options under fault conditions.

**Estimated Line Charges**

The estimated increment annual line charge for this increase in load to ICP 0008001316TP078 is $51,000.

## 3 5MW Electrode Boiler

To provide an additional 5MW supply to BSM, a new 33 kilovolt (kV) line will be required to be established from the Kennington zone substation to BSM, the existing lines from the Invercargill Grid

Exit Point (GXP) to the Kennington zone substation will be upgraded to Neon conductor, a new 10MW substation would be established at BSM to supply the new and existing load.

Two options have been proposed for the new line from the Kennington zone substation to BSM, the first option being an underground cable and the second option an overhead line. Both options do not allow for a back-up supply should there be an outage on the network.

Outlined below are the two options with annual line charges for each options which incorporates the existing line charges and the new 600kW load. Distribution line charges are calculated using a WACC return. The WACC is subject to review each year with lines charges altered accordingly.

## 4 Option A – Underground 33kV Cable

TPCL's estimated capital costs to build is $13,938,593. (this is not a charge to BSM)

**Annual Line charges** (these are inclusive of current line charges)

| | |
|---|---|
| Transpower Connection Charges | $ 53,432 |
| Transpower Interconnection Charges | $ 587,243 |
| TPCL Distribution Charges | $1,146,940 |
| **Total** | **$1,787,615** |

## 5 Option B – Overhead 33kV Line

TPCL's estimated capital costs to build is $18,491,334. (this is not a charge to BSM)

**Annual Line charges** (these are inclusive of current line charges)

| | |
|---|---|
| Transpower Connection Charges | $ 53,432 |
| Transpower Interconnection Charges | $ 587,243 |
| TPCL Distribution Charges | $1,634,994 |
| **Total** | **$2,275,669** |

## 6 Transpower

All Transpower charges are estimates only.

The Transpower interconnection charges have been calculated with the assumption that the full 5MW will be co-incident with Transpower's 100 highest peaks for the lower South Island. This assumption is based on the fact that if a number of electrification project upgrades take place, these will now be the cause of the peak periods in the lower South Island. We also point out that Transpower's pricing methodology is to change from 2023, which will see the removal of the regional peak demands as the driver for the interconnection charge, and this may be replaced with an installed capacity factor.

## 7 Capital Contributions

The options outlined above have allowed for TPCL to fully fund the capital costs. TPC would consider capital contributions from BSM towards the TPCL capital costs to help lower line charges.

## 8 Contracts

For works to proceed, a Delivery Services Agreement (DSA) between TPCL and BSM will be required to be signed. The DSA will commit BSM to the arrangements outlined in this summary.

## 9 Prudential Security

Due to the large capital investment required by TPCL, prudential security in the form of a bank bond will be required as security covering all assets and line charges.

## 10 Board Approval

Please note that all options and costs are subject the approval of TPCL Board due to the size of capital investment.

# E

Appendix E – Analysis, Cost Estimating and the ETS

## Analysis, Cost Estimating and the ETS

The capital costs, operational costs and operational GHG emissions estimates have been prepared for shortlisted options for the purpose of comparing options only and should not be used as a guide to overall final costs or emissions. Overall cost estimates are of the accuracy of -30% +50%, but budget prices were sought on major mechanical equipment at a greater level of accuracy. Only operational GHG emissions have been considered, with embedded carbon in equipment and construction omitted (which is expected to be considerable for some options). Relativity is

emphasised rather than absolute cost and all options are considered to have a similarly low level of accuracy.

### a. Emissions Trading Scheme and the Cost of Carbon

When assessing the NPV of each project, the cost of purchasing carbon credits under the New Zealand Emissions Trading Scheme (ETS) has been set at $40 per tonne of $CO_2$ equivalent.

Carbon cost is set to zero in the preparation of marginal abatement cost curves (the additional cost to abate one more unit of carbon). Part of the benefit of these curves is to identify the carbon price at which these projects will be financially beneficial to the business. Including the current carbon cost in the preparation of those curves will needlessly complicate the accounting.

For coal, the cost of carbon abatement is generally stated as a line item on the invoice. It is simple to identify the coal price only, independent of the cost of carbon, and use that as an input to analysis.

In the case of electricity, a relatively small percentage of New Zealand's grid is non-renewable, and so there are emissions associated with electricity consumption. At present credits to cover these emissions are heavily subsidised by the Crown, and so the impact on the cost of electricity is small. The draft report of the Climate Change Commission, released in January 2021, forecast that as this subsidy is removed additional zero-carbon capacity will be added to the grid. Consequently, the price of electricity is not forecast to increase. For these reasons we have not attempted to remove the carbon price from electricity in the way that we have removed if for coal.

Emissions estimates are for comparison purposes. Emission factors are taken from the New Zealand Ministry for the Environment *Measuring Emissions: A Guide for Organisations* 2020 Summary of Emissions Factors and Intergovernmental Panel on Climate Change (IPCC) *2006 IPCC Guidelines for Nation Greenhouse Gas Inventories* Volume 2: Energy. We have assumed that the emission factor for grid-distributed electricity will remain constant into the future. It has also been assumed that the greenhouse gas emissions will remain constant for flaring the biogas compared to combustion by other means (e.g. biogas boiler). There may be some differences in the emissions based on combustion completion and efficiency, but these differences have not been considered at this level of study.

A major electricity supply infrastructure upgrade would be required for the electric boiler option for rendering boiler replacement (see Projects 3A1 and 3B1). The high-level cost estimate provided by the network provider have been included in the project costing. At this stage it appears that the supply will support the installation of a heat pump to replace the main boiler, however the current power supply to site is severely constrained. Smaller scale infrastructure upgrades will likely be required for other electrically powered projects in the future.

### b. Cost Estimating Methodology and Notes

The cost estimating methodology involves significant factoring based on similar installations and estimates used previously, budget pricing from vendors and in some cases simplistic "rule of thumb" estimates.

Indirect costs such as freight and insurance, engineering, project management, owner's costs, etc. have been included as a percentage of the overall project cost estimate. A design development contingency of 20% has been included.

All costs are nominally in 2021 dollars and no escalation has been included.

Certain aspects have not been included in the cost estimates. These include:

- Finance costs, currency fluctuations, taxes, permits, consenting and approvals
- Land acquisition costs
- Any associated environmental costs
- GST.

Maintenance costs are typically estimated as a simple 10% of capital cost per annum.

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ENERGY EFFICIENCY & CONSERVATION AUTHORITY

# F

## Appendix F – Emission Reduction Projects Not Assessed Further

## Heat Demand Reduction Opportunities

### Project 6 – Air Compressor Heat Recovery

There is heat recovery installed on the newly installed main air compressor. There is only a single back up air compressor, therefore there is limited opportunity for additional installation of heat recovery. Therefore, **this project was not considered further.**

### Project 11 – Heat Recovery from Steriliser Water

Steriliser water is at a minimum 82 °C. It is estimated that BSP consumes 144 m³/day of steriliser water. Once used, this water currently goes down the drain mixing with other wastewater of lower temperatures with no recovery of heat.

Heat could be recovered from spent steriliser water if it were to be collected separately in a centralised sump. After heat is recovered, this wastewater could be recycled for uses such as yard washing. However, the proposed upgrade of the sterilisers to spray sterilisers will reduce the volume of wastewater from the sterilisers (see 6.3.1 – Project 2), making the amount heat recovery from the sterilisers insufficient to be economically viable. This is summarised in Table 9-1.

Table 9-1: Estimated energy savings from steriliser wastewater

| | Total Steriliser Flow (L/minute) | Heat Recoverable (kW) |
|---|---|---|
| Existing Sterilisers | 133 L/minute | 685 |
| Upgraded Sterilisers | 5.3 L/minute | 30 |

Based on the negligible recoverable heat from the upgraded sterilisers**, this project has not been considered further.**

### Project 17 – Stand-by Heat Exchangers for Rendering

A heat exchanger is used to transfer heat from the cooker condenser cooling water to a closed loop cooling tower. As per 6.2.6 - Project 12, fouling and reliability are concerns which would be improved by installing a stand-by heat exchanger. This would have the additional benefit of reliable heat removal for the cooker condenser, however as the heat exchanger is on a cooling loop we expect any emissions reductions to be negligible.

As for the processing heat exchangers, the extent of fouling, and the changes to maintenance schedules cannot be well defined, therefore the energy saving cannot be assessed for this project. As above, the operational benefits suggest this project should be considered further.

| Summary Card – Standby Heat Exchangers for Rendering | |
|---|---|
| Application | Improve the reliability of heat transfer from cooker condenser cooling water to closed loop cooling. |
| Description of Opportunity | Install standby heat exchangers for heat removal from cooker condenser cooling water to allow more regular servicing of existing heat exchangers and increased reliability of heat transfer. |
| Energy Used | None |
| Energy Saving Expected | Not Assessed |
| Co-benefits Reported | • Improved operational reliability |
| Cost Indicators | • CAPEX: $14,000 |

## Alternative Technologies/Methods

### Project 13 – Water Softening

Water softening of the bore water supply would reduce the fouling on heat exchangers and other equipment. Refer to 6.3.8 – Project 22 for further information.

### Project 18 – Rendering Hot Well Upgrade

Steam has been seen flashing off the condensate in the hot well. A vent condenser could be installed to preheat boiler feed water using this steam, thus saving on coal consumed.

Boiler feed pre-heating using heat recovered from the cooker condenser has been considered in other projects including the rendering water supply upgrade and rendering boiler replacements.

The energy savings from this project are likely to be minor based on the amount of heat able to be captured, therefore **has not been investigated further**. It is recommended that this be investigated further outside the scope of the ETA project.

### Project 21 – Composting Paunch

Paunch and yard waste can be composted. During the composting process heat is generated. This represents an opportunity for heat capture for pre-heating water. However, this heat is likely to be low grade with compost reaching temperatures of approximately 50 °C (Smith, Aber, & Rynk, 2017) combined with limited energy recovery due to poor heat conduction characteristics of composting feedstock. **Therefore, this project has not been considered further.**

A well-managed compost with sufficient aeration should not produce significant volumes of methane (which is produced in oxygen-poor anaerobic conditions). Based on this, gas recovery is not considered to have significant benefit and was not considered further.

### Project 22 – Water System Review (Including Softening)

Water for the site is taken from three bores. The water is treated onsite to be potable quality, though the treated water has a high hardness.

A review of the water system, treatment, and increased softening is recommended to minimise fouling in heat exchangers. The costs cannot be determined at this stage as a more in-depth review is required.

| **Summary Card – Water System Review** | |
|---|---|
| Application | Water supply and treatment from bores. |
| Description of Opportunity | General review of the water supply and treatment system, including water softening. |
| Energy Used | Not Assessed |
| Energy Saving Expected | Not Assessed |
| Co-benefits Reported | • Improved heat transfer due to less fouling of heat exchangers and boilers. |
| Cost Indicators | Not Assessed |

## Fuel Switching Analysis

### Project 5 – Increase Biogas Generation

Increased biogas production by changing the configuration of the wastewater treatment system – such as feeding 100% of the influent to the anaerobic pond. Although this will provide additional biogas generation in the order of 50%, considerations are required around:

- Anaerobic lagoon capacity to handle additional load
- Consent requirements for effluent quality as reduced carbon loading on SBR may reduce treatment effectiveness
- Carbon dosing required to SBR and associated costs to achieve sufficient nitrogen removal
- Reduced aeration requirements resulting in electricity savings.

It is recommended that further investigation be conducted on the wastewater treatment plant capacity to increase biogas production and investigation into alternative treatment methods, such as Anammox reactors, to reduce aeration and carbon dosing requirements.

| **Summary Card - Increase Biogas Generation** | |
|---|---|
| Application | Fuel for heat and/or energy generation |
| Description of Opportunity | Increase biogas production by further assessment of biogas opportunities |
| Energy Used | Not Assessed |
| Energy Saving Expected | Not Assessed |
| Co-benefits Reported | Not Assessed |
| Cost Indicators | Not Assessed |

# H

## APPENDIX H

Blue Sky Meats Morton Mains Processing Plant Resource Consent Applications – Summary Document for Consultation

BLUE SKY MEATS (N.Z.) LTD

# MORTON MAINS PROCESSING PLANT RESOURCE CONSENT APPLICATIONS

# SUMMARY DOCUMENT FOR CONSULTATION

9 May 2022

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## REPORT INFORMATION

| | |
|---|---|
| **Report Status** | Final for Consultation |
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| **Author** | Nicolai Berry |
| **Review By** | Doyle Richardson |
| **Date** | 9 May 2022 |

# 1. INTRODUCTION

## 1.1 ABOUT BLUE SKY MEATS

Blue Sky Meats Limited (**BSM**) owns and operates a lamb and sheep processing plant and ancillary meat rendering plant located at 729 Woodlands-Morton Mains Road, Morton Mains, Southland (**the Site**), as shown below:


**Figure 1:** Site Location

Operations started in 1987 at the present site, and now 30 years later BSM has gained a strong reputation by providing high-quality primary products to national and international markets.

BSM sources raw material from a network of farmers and the Plant is an essential component supporting these farmers and their families and boosting Southland's agricultural sector. BSM forms an important part of the local, regional, and national economy, employing over 350 people in Southland, with an Auckland based Sales Team of four. During the peak season, the Plant processes up to 27,750 stock units per week and operates for 20 hours a day across a six-day operation during peak periods.

## 1.2 OVERVIEW OF THIS REPORT

BSM currently hold nine resource consents, of which eight expire on 31 December 2022. BSM are currently investigating options to renew these resource consents. This application relates to the renewal of six resource consents[1] which relate to the following activities:

- The take of groundwater (for a meat processing plant and a rendering and blood drying plant);
- The take of groundwater, via the leak detection system for the wastewater treatment plant;
- The discharge of wastewater and biosolids to land via a spray irrigator (from the meat processing plant and rendering plant);
- The discharge of screened stockyard solids, paunch, and sand and grit to land via a muck spreader;
- The discharge of contaminants to air (from a meat processing plant, rendering and blood drying plant and associated boilers) that combines two existing air discharge consents; and
- The discharge of land drainage water and stormwater to water.

BSM are seeking to replace these resource consents for a term of 35 years.

To assist with the renewing of these resource consents, BSM has made a significant investment in its infrastructure on the Site as part of their commitment to reducing their impact on the environment, and to ensure the ongoing sustainability of the processing plant operations. This is predominantly through the construction and commissioning of substantial upgrades to their onsite wastewater treatment facility in 2019 / January 2020 to provide for primary and secondary wastewater treatment. BSM have also carried out riparian planting on the Site to further restore the onsite waterways

Furthermore, through the renewal of these resource consents, BSM will continue to reduce environmental effects and emissions through the de-commissioning of one of two coal-fired boilers on the Site by late 2024. This is in accordance with government direction and legislation[2] and will provide decarbonisation and air quality discharge improvements.

Overall, the renewal of the consents for these activities will enable the Plant to continue to operate and contribute in a major way to the social and economic wellbeing of the surrounding community.

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1 With the renewal of the other resource consents to be managed separately.

2 The government's preferred approach for existing fossil fuel-fired assets is to phase out coal in existing sites by 2037 for low and medium temperature processes through the consenting process.

BSM has commenced a consultation programme with directly affected and interested parties during the past 18 months, including hosting two tours around the Site and surrounding pastoral land. The provision of this Assessment of Environmental Effects (**AEE**) summary document is the next stage of this consultation programme, providing an opportunity to engage and seek a successful outcome for all parties involved. It includes:

- Details of the current activities of the Plant and the proposed activities;
- Details of recent site improvements;
- A summary of the existing environment at the Site;
- Summaries of the findings of the technical experts – these experts have evaluated the activities to assess the environmental effects and develop mitigation, management, and monitoring actions where necessary; and
- The next steps in the consultation process.

These details are discussed in the following sections of this report.

# 2. CURRENT PLANT ACTIVITIES

## 2.1 OVERVIEW

A range of processes are required to be undertaken by BSM on the Site to support the processing activities – these include a meat processing plant, an animal by-product rendering plant and a blood drying plant. Furthermore, a wastewater treatment plant treats wastewater from the Site before irrigation to BSM and privately owned land around the Plant.

These processes currently being undertaken are summarised in the sections below.

The site layout with the main process units is shown in Figure 2 below.

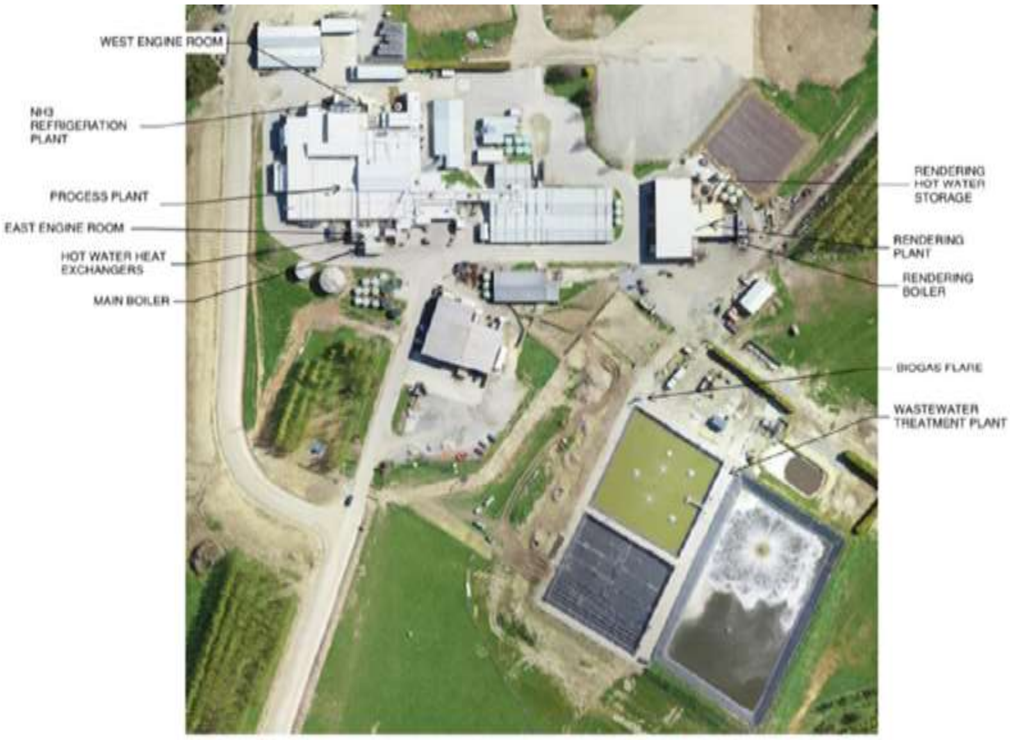


**Figure 2: BSM Site Layout**

## 2.2 PRODUCT PROCESSING

As discussed above, the BSM processing plant receives and processes a combination of lamb, sheep, bobby calves, and goats to provide a range of specialist cuts primarily for export. Operations on the Site include:

- Edible product processing, stockyards/holding areas, slaughter and boning processes and chilled and frozen storage; and

- On-site rendering, which can process up to 6 tonnes of raw material per hour, with associated blood drying.

Current production capacity in peak season can process up to 30,000 stock units per week (20 hours per day for six days per week) and up to 900,000 animals per annum. However, at present, the site is processing up to 27,750 animals per week across a six-day operation during peak periods.

In the 2020 / 2021 season, the site processed a total of 807,160 animals.

Production runs from the end of July to early June each year, with processing typically peaking from January through to May and dropping off in June. In the 2020 / 2021 season, the site moved from a 10-month to an 11-month processing season and is targeting 12-month processing to ensure that global chilled customer demand can be met. The plant closes for a brief period between Christmas and New Year.

## 2.3 WASTEWATER TREATMENT PROCESSES

Meat processing wastewater contains diluted blood, protein, and fats and solids which are high in organic material and nutrients (nitrogen and phosphorus). A Wastewater treatment Plant (**WWTP**) treats the meat processing and rendering wastewater prior to irrigation to land.

BSM upgraded their onsite wastewater treatment system in 2019, with the upgraded plant commissioned in January 2020. Refinements to the treatment system continued until January 2021 (refer to section 4 below for further detail).

The upgraded WWTP includes the following components:

1. Screening of all meat processing wastewaters generated from the site prior to further treatment to remove larger solids;
2. Screened stockyard solids are recovered separately and disposed of onto land as solids. All non-stockyard solids (bone, meat offcuts and marbled fat pieces) recovered from screening processes are incorporated into rendering raw material. Any sand and grit recovered is disposed of onto land;
3. Wastewater storage to help provide consistent flows into the wastewater treatment plant and to assist with spill management;
4. A covered anaerobic lagoon to reduce the loads associated with solids, organic matter and oil and grease. This lagoon also allows for the conversion of organic nitrogen into mineralisable ammoniacal nitrogen which can be treated as discussed below. The lagoon is covered so all biogas and associated odorous gasses are collected and then combusted in a dedicated biogas flare unit. A contingency biofilter is provided to treat the biogas in the event the biogas flare unit is inoperable, and the biogas requires discharge;

5. A biological nitrogen removal (**BNR**) activated sludge system operated as a Sequencing Batch Reactor (**SBR**). The SBR consists of mechanical aeration supply and assists with reduction of ammoniacal nitrogen generated from the anaerobic treatment processes; and
6. Discharge of SBR decant (wastewater) into a dedicated irrigation holding lagoon that provides for storage of up to 15,000 $m^3$ of treated wastewater for land treatment. The lagoon is normally operated at a low water level to allow for storage during periods when the land treatment system soils may be too wet to allow discharge to land via irrigation.

Overall, the WWTP can treat up to approximately 1,000 $m^3$ of wastewater per day.

Waste biosolids generated in the SBR are also discharged to land.

Additionally, a leak detection underdrainage system is currently installed below the base of the WWTP lagoons. This leak detection system discharges to a manhole with a closed value on the outlet. BSM personnel periodically inspect the manhole to check for leakage of wastewater. The leak detection system may from time-to-time intercept groundwater, with any intercepted groundwater discharged to the stormwater system.

## 2.4 LAND TREATMENT SYSTEM MANAGEMENT

Following the treatment of the wastewater, BSM currently discharge the treated wastewater and biosolids to surrounding pastoral land. BSM own 130 ha of pastoral land and have access to 122 ha of third-party owned and operated farmland for wastewater and biosolids irrigation. The land area for discharge of treated wastewater is illustrated in **Figure 3** below.

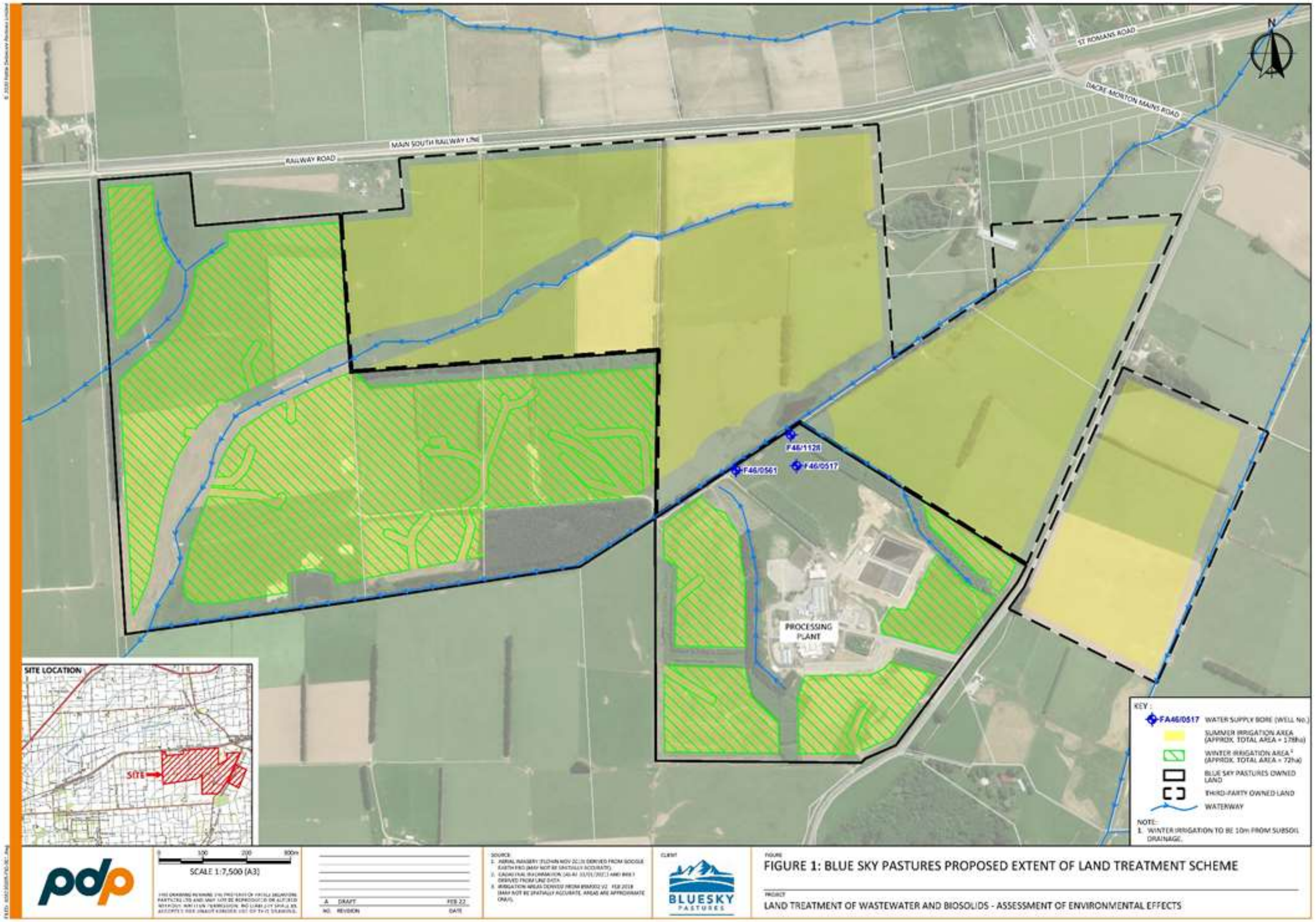


**Figure 3:** **BSM Proposed Extent of Land Treatment Scheme**

### 2.4.1 BSM Owned Land

- BSM own 130 ha of pastoral land, with approximately 77 ha of this land suitable for irrigation.
- This area is predominantly operated as a pastoral cut and carry system.
- Irrigation on this land is proposed to occur year-round.

### 2.4.2 Third-Party Owned Land

- BSM have access to 122 ha of third-party owned land, with approximately 101 ha of this land suitable for irrigation.
- The area is predominantly operated for pastoral sheep and beef grazing (however the farming operations in this area are outside the direct control of the applicant).
- Irrigation on this land is proposed to occur during dry periods when the treated wastewater and biosolids is beneficial for grass growth. Irrigation during dry periods is preferred for third-party owned land as it:
  - Has the least impact on soil drainage rates;
  - Avoids exacerbation of pugging (which can occur with saturated ground conditions and heavy stock); and
  - Applies the treated wastewater when it is beneficial for pastoral growth.

## 2.5 PROCESSES PRODUCING AIR DISCHARGES

The Plant and associated processes undertaken within the Site that produce discharges to air are summarised in the sections below.

### 2.5.1 Boilers

Two coal-fired boilers are operated at the Site to produce steam and hot water:

- A steam boiler (**SB**) supplies steam to the rendering plan; and.
- A hot water boiler (**HWB**) supplies hot water to the processing area for cleansing / sterilising purposes.

Key details of these boilers are outlined in Table 1 below:

**Table 1: Boiler Details**

| | Steam Boiler | Hot Water Boiler |
|---|---|---|
| Dimensions | 20 m high with a diameter of 750 mm | 20 m high with a diameter of 535 mm |
| Output | 4.3 MW output (Although it is designed for 6 MW) | 1.9 MW |

Coal from Newvale Mine is used to fire the two boilers. This coal has been tested for the 12 months between July 2019 and August 2020, with results showing that the coal quality complies with the existing consent limits.

### 2.5.2 Rendering Plant

Up to 4,500kg / per hour of inedible animal by-products (meat, bone and offal) is rendered over two shifts for the production of tallow, and high quality protein meat and bone meal. Additionally, 1000kg / per hour of blood is processed.

The majority of the by-products are generated from the onsite slaughter and boning operations, however some raw materials (up to 90 tonnes/day) are brought in from other meat processing plants such as Silver Fern Farms Waitane and Finegand. All raw materials from other meat processing plants are processed fresh within 24 hours of kill and are acid dosed to aid in preservation of product before dispatched from their Plants to BSM.

A formal Toll Processing agreement is in place with Silver Fern Farms / Farm Brands which stipulate all raw material must be delivered in a fresh state. Inspections by BSM staff are carried out on all raw material received each day. This includes a visual assessment of freshness and pH test to confirm the material has been acid dosed.

The plant is contained within a purpose-built structure designed to contain odorous contaminants and the building is force-ventilated to comply with existing conditions. Point source vapours produced in meal and tallow cooking process in the rendering plant are collected and vented directly to a condenser and then to the plant biofilter (See section 2.5.4).

Figure 4: Continuous cooker in rendering plant

### 2.5.3 Blood Drier

Blood is transported from the slaughter board to the blood processing area. The blood processing system is fully contained with all air discharges vented to a condenser before being vented to the rendering plant biofilter.

Figure 5: Rotary blood drier

### 2.5.4 Biofilter

The discharges to air from the tallow and meal cooking point sources in the rendering plant room (including the room air) and the blood drier are ducted via a condenser to the biofilter (see **Figure 6** below).

A micro-organism community is present in the biofilter to remove odorous components from the biogas. The biofilter media consists of fine bark and lime mix. To maximise efficiency, the biofilter must be kept moist and maintained at a pH level of between 5 and 8, with the lime helping to maintain the pH of the media to allow for efficient removal of pollutants.

**Figure 6: Plant biofilter**

### 2.5.5 Stockyards

Stock is transported to the plant in trucks and held in stockyards, then washed prior to slaughter. The stockyards are covered but have open sides to allow natural light and ventilation. The stock holding yards are elevated approximately 1 m above ground level and the stock are held in mesh floor pens, which allows faecal material to drop through onto a concrete slab that is graded and slopes towards a drain. The pens are washed regularly, with faecal material being hosed to the drain. This prevents the accumulation of faecal material under the stock holding area and prevents the onset of anaerobic activity and minimises the production of odours.

The effluent and washdown water from the yards are drained to a screen before being pumped to the WWTP for treatment.

# 3. THE PROPOSAL

## 3.1 EXISTING CONSENTS

To operate and undertake its activities, BSM currently hold nine resource consents that have been issued by Environment Southland. Eight of these resource consents expire on 31 December 2022. BSM are seeking to renew six of these resource consents which are summarised in **Table 2** below. The remaining resource consents will be managed separately.

Table 2: Existing Blue Sky Meats Consents to be Renewed

| Consent No | Purpose |
|---|---|
| 201190-V1 | To take groundwater for a meat processing plant and a rendering and blood drying plant. |
| 201191-V1 | To discharge meat processing and rendering plant wastewater to land via a spray irrigator. |
| 201193-V5 | To discharge contaminants to the air from a meat processing plant, rendering and blood drying plant and associated boilers. |
| 20181937-03 | To discharge land drainage water and stormwater to water. |
| 20181937-02 | To take and use groundwater for the purpose of dewatering. |
| 20181937-04 | To discharge contaminants to air from a wastewater treatment system. |

## 3.2 PROPOSAL TO RENEW CONSENTS

BSM are seeking to replace these resource consents for a term of 35 years. The extent of these activities requiring consent renewal are summarised below:

### 3.2.1 Groundwater take for the processing plant

The current consent BSM holds sets out the maximum weekly rates of water take from three deep bores on the Site. This consent states that the rate of abstraction must not exceed:

- 1,200,000 litres per day; and
- 7,000,000 litres per week.

In seeking a new consent, BSM are proposing the following abstraction rate limits:

- 1,500,000 litres per day; and
- 7,500,000 litres per week.

This change would allow an additional 300,000 litres per day to be taken to meet peaks in processing demand. The weekly total will increase by approximately 7% which is considered acceptable to manage the longer-term sustainability of the water resource.

As discussed in Section 2.3, a leak detection underdrainage system is currently installed below the base of the WWTP lagoons. The leak detection system may from time-to-time intercept groundwater. This system will discharge any intercepted groundwater to the stormwater system (which is discussed below).

### 3.2.2 Discharge of treated wastewater, wastewater solids and biosolids to land

BSM propose to discharge the following to BSM owned pastoral land and third-party owned and operated farmland:

- Treated wastewater and biosolids; and
- Screened stockyard solids, paunch, and sand and grit.

These areas of pastoral land are situated south of the intersection of Railway Road and Dacre-Morton Mains Road and adjacent to Woodlands-Morton Mains Road.

### 3.2.3 Discharges to air

As shown in **Table 2** above, the Site currently operates under two consents to discharge combustion contaminants from two coal-fired boilers and to discharge odour from the Site. BSM propose to replace these consents with *one* new air discharge consent which will include all of the discharges to air from the Site, including from:

- Two coal-fired boilers that operate at the Site to produce hot water and steam – emissions from these boilers are predominantly in the form of contaminants such as fine particulate matter ($PM_{10}$), oxides of nitrogen ($NO_X$) and sulphur dioxide ($SO_2$);
- The processing plant – emissions are predominantly in the form of odorous compounds;
- The biofilter – These filters absorb noxious gases into a biofilm where microorganisms break down the gases into carbon dioxide, water and salts and use the energy and nutrients to grow and reproduce. Emissions are predominantly in the form of carbon dioxide (CO2), water, salt, minerals and microbial biomass;
- The wastewater treatment plant, including the biogas flare – odour compounds may be generated during the treatment, storage and transfer of the wastewater through the anaerobic decomposition of organic material (carbohydrates, fats and proteins);

- The application of the treated wastewater to land – odour is sometimes associated with the generation of hydrogen sulphide which is formed under anaerobic conditions.

### 3.2.4 Discharge of land drainage water and stormwater to water

BSM propose to continue to discharge stormwater and dewatering water (primarily from the leakage detection system) from the upgraded WWTP.

With regards to land drainage water, existing 160 mm groundwater dewatering drains are installed around the perimeter of the upgraded WWTP wastewater lagoons. These drains discharge to a surface drain to the northeast of the site

With regards to stormwater, the primary impervious area associated with the WWTP is the anaerobic lagoon. Rainfall on the anaerobic lagoon cover is directed to a sump at the centre of the lagoon via preformed channels. From there, the stormwater is pumped to a manhole and discharged to the surface drain to the northeast of the site.

## 4. EXISTING SITE IMPROVEMENTS

Preparation for the renewal of these consents commenced in early 2017 / 2018 when changes to the current wastewater treatment operation at the Site were identified as necessary. A review of the current wastewater system indicated difficulties in adequately managing the nitrogen load within the wastewater that was being applied to the land via irrigation.

In 2019, BSM constructed and commissioned substantial upgrades to their onsite wastewater treatment facility – this was to allow the plant to properly operate at full capacity, and to reduce nitrogen loading to the land treatment area.

The following sections summarise the pre-2019 and post-2019 wastewater systems.

### 4.1 PRE-2019 WASTEWATER SYSTEM

Prior to these upgrades, the wastewater treatment provided on site was limited, and over reliant on land treatment to provide primary, secondary and tertiary treatment functions. As a consequence, the pre-2019 wastewater system was loading fats, oils, greases and nitrogen at rates higher than the pasture and soil systems could manage. This resulted in numerous environmental effects, including:

- Elevated levels of nitrogen into shallow groundwater and the connected surface water; and
- Binding of soil pores with fats, oils and greases to levels that reduced hydraulic capacity and resulted in wastewater runoff.

Overall, the system was performing poorly.

**Figure 7** below illustrates the Pre-2019 Wastewater System.

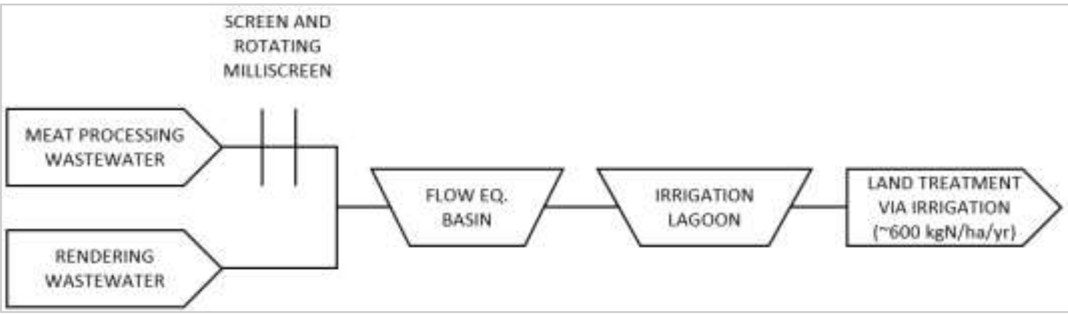


Figure 7: **Process Diagram of Pre-2019 Wastewater System**

### 4.2 POST-2019 WASTEWATER SYSTEM

The post-2019 wastewater treatment system includes primary treatment via a covered anaerobic lagoon and secondary treatment via biological nitrogen removal in an SBR wastewater treatment plant.

This treatment process provides for substantial removal of organic matter (including fats, oils and greases) as biogas via a flare, and substantial removal of nitrogen as inert nitrogen gas.

**Figure 8** below illustrates the Post-2019 Wastewater System.

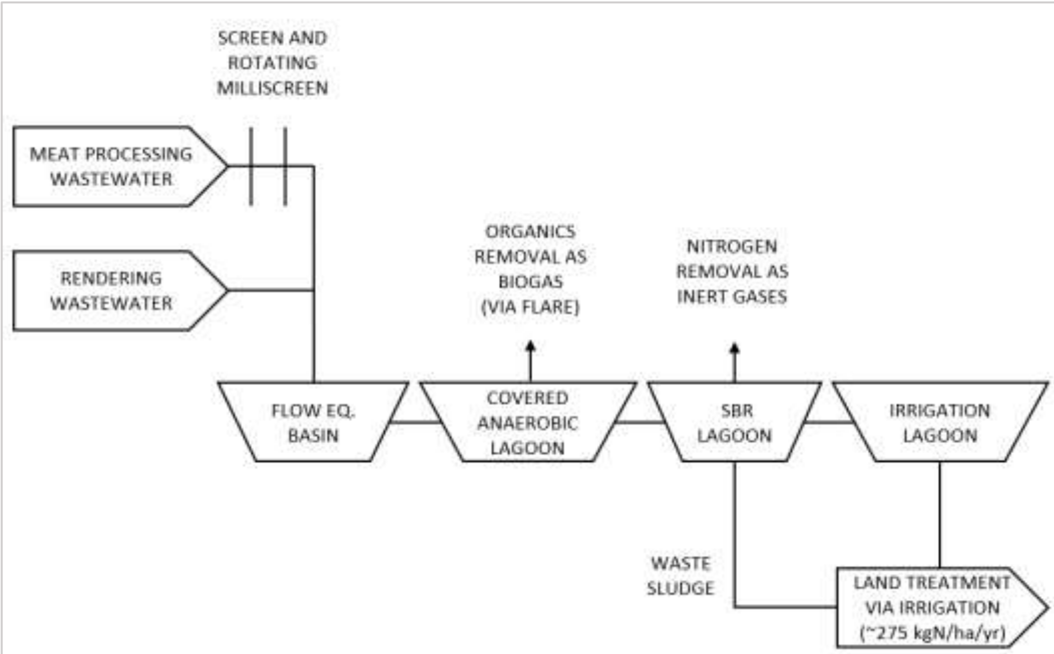


**Figure 8: Process Diagram of Post-2019 Wastewater System**

These wastewater treatment system upgrades have resulted in a significant improvement in the removal of contaminants from the wastewater on site, with **Table 3** below highlighting the improvements for the following key contaminants:

Table 3: Pre and Post-2019 Wastewater Treatment Upgrades Performance

| Parameter | Pre-WWTP Upgrade | Post WWTP Upgrade | Percent Removal |
|---|---|---|---|
| Biochemical Oxygen Demand (mg/L) | 6,200 | 62 | 99% |
| Total Nitrogen (mg/L) | 330 | 87 | 74% |
| Ammoniacal Nitrogen (mg/L) | 290 | 7.7 | 97% |
| Total Phosphorus (mg/L) | 37 | 24.6 | 33% |
| Fats, Oils and Grease (mg/L) | 626 | 9.4 | 99% |

*Notes:*

1. *Pre-WWTP upgrade based on average of monthly effluent monitoring concentrations for period 1 January 2021 to 31 December 2018.*
2. *Post-WWTP upgrade concentrations based on average of monthly effluent monitoring concentrations for period 1 July 2020 to 30 June 2021.*
3. *Phosphorus removal is in the wasted bacterial solids. BSM recombines the wasted bacterial solids with the treated wastewater prior to irrigation to the land treatment system via injection into the irrigation line. Therefore, the treatment system does not reduce phosphorus loading to the land treatment system.*
4. *The BOD Post WWTP Upgrade result is based on effluent sampling in October 2021.*

Under this system, land treatment is providing a secondary / tertiary polishing treatment function, where the hydraulic, nitrogen and phosphorus loads meet pastoral requirements, and are converted into biomass for export as supplementary feeds off farm (grass silage, hay, etc.).

Overall, the system upgrade has ensured compliance with the current limitations of the key wastewater to land discharge consents that the plant holds.

BSM have implemented these substantial site upgrades as part of their commitments to reduce their impact on the environment. These upgrades are in addition to other site improvements, including riparian planting to further restore the waterways on the Site.

# 5. ENVIRONMENTAL SETTING

## 5.1 LAND USE

BSM owns and occupies the property on which the processing plant and WWTP are situated. As discussed in Section 2.4 BSM owns part of the proposed wastewater and biosolids wastewater irrigation land with the remainder owned by a third party.

The Site is located within the Rural Zone under the Southland District Plan. The predominant surrounding land use is pasture. The closest residential zoned land to the Site is located 12 km to the northeast (the 'Edendale Urban Zone').

However, there are a number of rural residential properties within 500 m of the irrigation area.

## 5.2 TOPOGRAPHY

The topography of the Site is flat to slightly undulating, and gently graded towards the tributaries which pass through the Site. The overall grading is towards the south-eastern corner of the Site.

## 5.3 WIDER CATCHMENT

The BSM Site is located within the Waihopai River catchment – an area that is approximately 18,300 ha.

The Waihopai River is approximately 34 km in length, originating from the gentle rolling hills above the lower Matuara River Valley (to the north of Morton Mains) and draining from intensive farmland in the surrounding area.

The Waihopai River flows into the New River Estuary, a large tidal lagoon type estuary (approximately 4,100 ha in size) near Invercargill. This estuary contains high nutrient levels and is heavily impacted by upstream land uses. However, studies undertaken by Environment Southland in recent years have indicated that the water quality of the Waihopai River is improving.

## 5.4 GROUNDWATER

The Site is underlain by a shallow unconfined aquifer which is formally classified as part of the Waihopai Groundwater Management Zone, along with a deeper confined aquifer where the abstraction bores take water from. Across the Site the shallow aquifer is approximately 10 m thick and made up of sandy gravels within a matrix of weathered clays.

## 5.5 SURFACE WATERCOURSES

Two permanent watercourses flow through the land that is used for the irrigation of treated wastewater on the Site. These two tributaries are small, first-order tributaries of the

Waihopai River and flow from the north-eastern boundary to the south-western boundary of the Site (Refer to Figure 3 above) and converge and join with the Waihopai River approximately 14km downstream of the confluence point.

These two streams flowing through the BSM Site are fed by surface water runoff and shallow groundwater on the Site. Visual observations and ecological field investigations have stated that the tributaries are characterised by low flows and dry or stagnant conditions can occur. Overall, the streams are characterised as being typical of those passing through pastoral land in the area (notably including poor water quality, minimal shading and dense instream vegetation cover), however ecological surveys indicated that the streams are able to support native aquatic species with a conservation threat classification.

# 6. ASSESSMENT OF ENVIRONMENTAL EFFECTS

BSM have commissioned a range of technical assessments to inform the Assessment of Environmental Effects. These assessments relate to the effects from:

- The abstraction of groundwater on the site, including effects on neighbouring bores, surface water and the overall groundwater and surface water resources;
- The discharge of treated wastewater to land including effects on soil, surface water quality, ecology; and
- The discharge of contaminants to air from the site.

The reports have considered the recent changes to the wastewater treatment plant and have assessed whether any further improvement is necessary to ensure all adverse effects are appropriately managed.

The following sections provide a summary of these assessments.

## 6.1 ECONOMIC EFFECTS

The proposed activities will enable the Morton Mains plant to continue to operate on the site in an effective and efficient manner, making a positive contribution to the social and economic wellbeing of people and communities in the area, including the employment of 350 staff.

The plant pays out $25 million in wages and salaries per annum and spends an estimated additional $87.5 per annum in the Southland region on goods and services. These are direct economic benefits to the regional economy arising from the operation of the Plant.

## 6.2 EFFECTS FROM GROUNDWATER TAKE

### 6.2.1 Effects on the Groundwater Resource

#### 6.2.1.1 Confined Aquifer Resource

The proposed Southland Water and Land Plan (**pSWLP**) states that the primary annual allocation for the confined aquifer where the current bores take water is 75% of the throughflow at the well location.

Aquifer throughflow on a daily basis for the confined aquifer zone utilised by the Site has been assessed / estimated to range from about 3,630 $m^3$ per day to 9,770 $m^3$ per day.

BSM's proposed maximum daily take is 1,500 $m^3$ and is therefore expected to potentially take between approximately 14% and 39% of the throughflow of the aquifer on a daily basis. This will not result in the primary allocation limit being exceeded. Furthermore, the two other consented abstractions in this confined aquifer zone from bores are only consented to take a maximum of 168 $m^3$ per day and 78 $m^3$ per day.

Overall, this assessment concludes that the effects on the overall confined groundwater resource are expected to the less than minor.

#### 6.2.1.2 Unconfined Aquifer Resource

Regarding any groundwater abstraction from the unconfined aquifer, the Site is in the Waihopai Groundwater Management Zone under both the Southland Regional Water Plan (RWP) and the pSWLP.

As of November 2020, Environment Southland have confirmed that the allocation of groundwater in this zone is much less than the defined allocation limit, therefore any effects on the unconfined groundwater resource is expected to be less than minor.

### 6.2.2 Effects on Neighbouring Bores

The pSWLP sets the criteria for assessing drawdown interference in neighbouring bores. The criteria states that:

- For any existing bores screened in a **confined aquifer**, the cumulative drawdown effect should be no more than 50% of the potentiometric head[3]; and
- For any existing shallower bores screened in the **unconfined aquifer**, the cumulative drawdown effect should be no more than 20% of the available drawdown[4].

There is one neighbouring bore within 2 km of the BSM bore in the confined aquifer. The assessment states that the maximum drawdown interference from BSM is estimated to be about 1% to 6% of the possible 86 m potentiometric head which is acceptable.

There is one shallower confined aquifer bore (intermediate depth) in close proximity to the Site consented to take water at a relatively low rate. A very conservation assessment states that the maximum drawdown interference from BSM is estimated to be about 15% of the potential 35 m potentiometric head which is acceptable.

The closest neighbouring bore that is likely to be screened in the shallow unconfined aquifer system is a domestic supply bore approximately 1.1 km to the northeast of BSM's bore. The assessment states that any short or long-term drawdown effects on this neighbouring bore will be less than 0.05 m, with an estimated available drawdown of approximately 7 m at this bore which is acceptable.

---

3 Metres between the mean annual maximum groundwater level and the top depth of the confined aquifer strata.

4 Metres between the mean groundwater level and the top screened interval.

Importantly, it is noted that the long term consented interference effect will not change as a result of this new consent, as only a change in the short-term rate of water abstraction is sought, and only very minimal changes could occur in the short term (five-day effect).

#### 6.2.3 Effects of Surface Water

The technical assessment results state that the estimated stream depletion effect on the closest drain (5 m from the nearest bore) is low due to the depth of the bores and the low hydraulic connection between the bores and the surface water.

According to the Environment Southland database, there are no regionally significant wetlands or sensitive waterbodies that are anticipated to be affected by the proposal.

#### 6.2.4 Other Effects

Additionally:

- Any potential seawater intrusion effects will be less than minor due to the abstraction bores being located approximately 25 km north of the coast; and
- Any potential effects on the aquifer stability will be less than minor as the aquifer material is not expected to consolidate due to lowering groundwater pressures.

### 6.3 EFFECTS FROM DISCHARGE OF TREATED WASTEWATER AND BIOSOLIDS TO LAND

#### 6.3.1 Effects on Soils

The potential effects on soils with the irrigation of treated wastewater and biosolids to land are:

- Irrigating in excess of the soil / pasture system capacity – this can cause excess ponding, runoff, drainage and damage to the soil structure;
- Impacts on soil chemistry, causing damage to the soil structure; and
- Accumulation of contaminants (e.g. heavy metals) in the soil to toxic levels

##### 6.3.1.1 Hydraulic Loading

To minimise excessive irrigation, BSM propose to maintain the current daily irrigation rates to within the measured capacity of the soils on the Site. This will ensure that saturated conditions, ponding and runoff are minimised and will not occur as a result of the irrigation activity and the soil structure and microbial health are generally maintained. These limits are proposed as follows:

- The maximum irrigator hydraulic application rate is proposed as 6 mm/hr;

- In the drier periods (October to March inclusive), to a maximum daily application depth of 35 mm; and
- In the wetter periods (April to September inclusive), to a maximum daily application depth of 15 mm.

Additionally:

- The BSM land treatment system includes an irrigation lagoon which provides a water storage volume of 15,000 $m^3$ – this means irrigation can be minimised during wet periods; and
- No irrigation will occur on the gley soils[5] onsite, which have poor drainage and can be more prone to effects from hydraulic loading

#### 6.3.1.2 Soil

The proposal is a substantial improvement relative to the wastewater discharges that were occurring prior to the 2019 WWTP upgrades that adversely impacted the soil chemistry on the Site. These improvements include:

- Biological nitrogen removal that significantly reduces the nitrogen loading rate on the irrigated areas so that it closely matches pastoral demand for nitrogen, reducing any effects associated with excess nitrogen;
- Biosolids loading to target paddocks with low soil fertility and quality indicators (low Olsen P levels) that previously haven't been irrigated in addition to existing land to maximise all land available to match the agronomic requirements of the farming system;
- Anaerobic digestion to reduce sulphur levels in the raw wastewater. This, in combination with the export of sulphur as supplementary feed or animal biomass, this will reduce soil sulphate sulphur levels over time with no adverse effects expected; and
- Continuing to manage sodium, potassium and Exchangeable Sodium Percentage (**ESP**). Pre-2019 WWTP upgrade operations resulted in sodium, potassium and ESP levels above the recommended range, however the WWTP upgrades will not provide for any reductions of these nutrients in the treated wastewater. Management of excess sodium, potassium and ESP (which can result in soil dispersion and lower hydraulic conductivities) will be done with the addition of soil additives, e.g., lime or gypsum. These cations can displace sodium and potassium in the soil and can maintain and sometimes restore soil structure.

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5 A poorly drained soil with high water logging vulnerability.

#### 6.3.1.3 Heavy Metals Loading and Effects

An assessment of the heavy metal concentrations in the biosolids has been provided against the following guidelines:

- Guidelines for the Safe Application of Biosolids to Land in New Zealand (2003); and
- Guidelines for Beneficial Use of Organic Materials on Productive Land (2017) (a draft for public comment which will supersede the 2003 guidelines once finalised).

This assessment showed that:

- Biosolid concentrations of heavy metals (arsenic, cadmium, chromium, copper, lead and nickel) all comply with the guidelines outlined above; and
- Zinc levels exceed the margin for the Grade A classification but are well below the compliance limit of the more recent guidelines.

Furthermore, BSM will monitor the actual levels of heavy metal accumulation on an ongoing basis by taking representative samples of the heavy metals outlined above on a five-yearly interval. If an adverse effect is identified, the consent conditions will be reviewed accordingly to provide adequate mitigation.

### 6.3.2 Groundwater Effects

Shallow groundwater generally feeds the tributaries on the Site, which enter into the Waihopai River. Potential downstream users or receivers of groundwater include surface water bodies and domestic users downgradient for potable water supply.

There is the potential for the following groundwater effects as a result of the proposed irrigation of treated wastewater and biosolids to land:

- Nutrient leaching;
- Pathogen migration;
- Heavy metals; and
- Sodium and chloride leaching

#### 6.3.2.1 Nutrient Leaching

The proposed land treatment activity applies up to 200 and 350 kg Nitrogen/ha/yr, and up to 70 and 110 kg Phosphorus/ha/yr (depending on if the concurrent land use is stocked or cut and carry, respectively) as residual nutrients in the wastewater and biosolids applied to land. Some of this nitrogen, and small quantities of phosphorus, will be flushed through the soil system and enter groundwater.

Assessment of these effects with Overseer nutrient modelling and groundwater modelling demonstrate that the activity will result in nutrient losses well below average and median nutrient losses for agricultural land use in the Southland Region. In addition, modelling has also shown that the current worst-case proposal for nutrient leaching is predicted to be within typical ranges for sheep and beef farming which could occur on this land.

Groundwater monitoring show a measurable increase in groundwater total oxidised nitrogen in down gradient bores (relative to the upgradient bores), which is likely a result of the pre-2019 wastewater treatment operations. The completed WWTP upgrades will significantly reduce nitrogen loading to the soil, and therefore nitrogen leaching, to levels less than the average surrounding land use. This will reduce the concentrations of oxidised nitrogen in the shallow groundwater on the Site over time. This improvement will be seen in the receiving surface water environments once the aquifer 'flushes' the legacy impacted groundwater through the aquifer.

BSM will continue quarterly sampling of groundwater bores to confirm this expected improvement in groundwater quality going forward.

#### 6.3.2.2 Pathogen Migration

Groundwater monitoring on the Site has indicated some infrequent increases in groundwater *E. coli* levels in both upstream and downstream wells. The results of this monitoring suggest that BSM's activities have an impact on the groundwater *E. coli*, increasing median and maximum *E. coli* concentrations from 2.5 to 10 cfu/100 mL and from 23 to 560 cfu/100 mL, respectively.

The nearest drinking water supply bore to the discharge site on BSM land is approximately 700 m away from the property boundary in the direction of groundwater flow. Environment Southland record this as a domestic supply bore.

As drainage water enters groundwater, any surviving *E. coli* will undergo attenuation as the shallow groundwater flows laterally through the saturated zone. The attenuation rates for relevant aquifers state that a complete *E. coli* die-off should occur within the 700 m between the irrigation system and the closest drinking water supply bore. Therefore, the risk of contamination of the nearest supply bore is considered low.

BSM propose to undertake monitoring of shallow groundwater for E. *coli* on the Site going forward.

#### 6.3.2.3 Heavy Metals

Wastewater sampling on the Site suggests metal concentrations are expected to be low, given that heavy metals are likely to bind to soil, therefore it is considered unlikely that heavy metals will migrate to groundwater.

However, to ensure this is the case, BSM propose to test groundwater monitoring wells for heavy metals at five-yearly intervals.

#### 6.3.2.4 Sodium and Chloride Leaching

BSM's proposal will increase loading rates of sodium and chloride and corresponding changes to leaching rates to groundwater are expected.

Whilst the affected area will increase by increasing the area of irrigated land, the loading intensity will decrease by an average of 60% in the dry season and 6% in the wet season compared to the existing case.

Groundwater monitoring undertaken shows that the chloride and sodium concentrations measured do not exceed any potable water requirements or pose any human health risk for downstream drinking water users. The downgradient shallow groundwater concentrations of sodium are well below the New Zealand Drinking Water Standards (**NZDWS**). However, groundwater concentrations of chloride occasionally breach the guideline for 'aesthetic determinands' – water that exceeds this guideline is still potable, however it can contribute to taste and corrosion effects.

The proposed decrease in loading intensity will lower overall concentrations of sodium and chloride in the groundwater and instances where the water exceeds the aesthetic chlorine determinands are expected to decrease accordingly. Furthermore, the nearest drinking water bore is located 700 m away from the land treatment system, and it is expected that exceedances will be diluted.

Overall, any potential effects will be negligible, and even the worst-case scenario (with no allowances for dilution or improvement from reduced loading) any effect will be infrequent and aesthetic (taste and corrosion)

### 6.3.3 Surface Water Effects

The proposed irrigation of treated wastewater may have follow-on effects into surface water via the following mechanisms:

- Phosphorus loss via runoff; and
- The discharge of impacted groundwater with elevated contaminants to surface water (e.g., nitrate-N, sodium, chloride, and E. *coli)*

#### 6.3.3.1 Runoff

Typically, surface water runoff from the irrigated land area is responsible for the loss of phosphorus to the environment. This is because phosphorus binds to the soil particles and is mobilised where overland flow moves soil as suspended sediments. The Site's surface water runoff drains to the two unnamed tributaries on the Site either directly, or via onsite drains.

The target levels of phosphorus loading onto the proposed irrigation land will result in no increase in annual phosphorus. Furthermore, to ensure that the proposed discharge to land does not adversely affect surface water with excess phosphorus, BSM have established riparian planting on all streams and drains on their land as mitigation. This will act as a buffer to absorb phosphorus and ensure that the proposed activity will result in less phosphorus discharging to surface water than is currently occurring, and lead to improved phosphorus concentrations in the receiving streams.

The proposal was also compared to sheep and beef farming (a permitted activity) in the region. Modelling has shown that the phosphorus loss (primarily via runoff into surface water) from the proposal is at the lower end of typical phosphorus loss from sheep and beef farming.

#### 6.3.3.2 Groundwater Daylighting

When the groundwater discharges into nearby surface waterbodies, any contaminants will potentially enter the surface water which can then result in adverse ecosystem effects.

The effects of the proposal on groundwater (and therefore any groundwater effects on surface water) are discussed in Section 6.3.2 above.

### 6.3.4 Ecological Effects

The current waterways on the Site (tributaries to the Waihopai Stream) are impacted by poor water quality, minimal shading, high fine sediment deposits and dense instream vegetation cover. Despite this, various ‘at risk’ and ‘threatened’ species are present, including giant kōkopu, inanga, Gollum galaxias and freshwater kōura.

BSM are committed to improving the quality of the waterways on the Site. This has included the implementation of native riparian planting along all watercourses that run through the property – these are expected to provide shading and greater habitat quality in these reaches of stream.

Furthermore, BSM’s proposal will further improve these waterways as the proposal will result in:

- Very low nitrate levels in the groundwater (once the historically impacted groundwater passes through the shallow aquifer system), resulting in nitrate levels and any potential toxicity effects impacting ecology reducing; and
- Less nitrogen and phosphorus loads entering the ground (and eventually entering the streams), reducing the extent and frequency of nuisance instream plant growth and low dissolved oxygen conditions present in the stream.

These improvements should result in significant improvements in water quality and habitat in the onsite reaches of the stream and downstream from the Site. This will ensure that the instream conditions that currently provide refuge for ‘at risk’ and ‘threatened’ aquatic species will continue to do so, and improvements to aquatic ecology are observed.

In addition, BSM propose to monitor instream ecology on a five-yearly basis (as the improvements are expected over a large timescale) to monitor the impacts of the improved discharge.

### 6.3.5 Wider Effects on the New River Estuary

#### 6.3.5.1 Cumulative Nitrogen Effects

As discussed in the Sections above, the improvements will result in substantial reductions in nitrogen loading (resulting in significant reductions in nitrogen leaching). This will result in a reduction in cumulative loads of nitrogen flowing into the New River Estuary and therefore improvements in nitrogen loads to the New River Estuary.

Furthermore, these nitrogen losses are within typical ranges of sheep and beef farming (which are considered permitted activities).

#### 6.3.5.2 Cumulative Phosphorus Effects

As discussed in Sections above, the improvements and associated mitigation will result in less phosphorus entering nearby waterways, and consequently into the New River Estuary. This will result in improvements in phosphorus loads to the New River Estuary, such that this degraded environment in maintained and enhanced.

### 6.3.6 Effects on Human Health

The public health risk from microbiological components such as potential pathogens and other micro-organisms of the wastewater is not considered significant. However, additional steps to ensure public health risk is minimised will include measures such as:

- Operational management and physical methods used for irrigation/spreading to avoid staff contact with the wastewater;
- Minimising public contact with sprayed wastewater through the use of appropriate buffer zones; and
- Ensuring irrigation does not occur near a downwind boundary during windy conditions;

Based on compliance with standards and guidelines, the effects of the irrigated wastewater on human health will be no more than minor. Furthermore, once irrigated, microbial die-off in the irrigated/spread biosolids will naturally occur as it dries out and is exposure to natural ultraviolet light.

### 6.3.7 Effects on Stock Health

Effects on stock health are considered less than minor, and with be managed by maintaining a minimum stock withholding period of 14 days following wastewater and/or biosolids irrigation. This will allow time for the treated wastewater to dry out and or/the grass to regenerate prior to the return of the stock, ensuring any potential microbial pathogens will have died off.

Potential effects on stock health from bores used for stock supply are also considered less than minor.

## 6.4 AIR QUALITY EFFECTS

### 6.4.1 Effects of Combustion Plant (Boilers)

An assessment has been undertaken to model the dispersion of emissions from the coal fired boiler stacks to demonstrate the effects on ambient air quality in the vicinity of the BSM plant. The ambient concentrations predicted by the modelling were then compared to the relevant ambient air quality standards and guidelines to assess the potential for adverse health effects on sensitive receptors (nearby dwellings).

The primary pollutants of concern are:

- Particulate matter with a diameter less than 10 micrometers ($PM_{10}$);
- Sulphur dioxide ($SO_2$);
- Oxides of nitrogen $NO_x$.; and
- Mercury.

The results of the modelling show that discharges of the primary pollutants from the existing boiler stacks ($PM_{10}$, $PM_{2.5}$, $SO_2$ and $NO_x$ and mercury) do not exceed any of the relevant air quality criteria limits outside the Site boundary. This modelling has assumed that both boilers are operating continuously at either 75% or 100% of maximum continuous rating (**MCR**). Since the operation of the boilers varies throughout the year in response to processing demands, this modelling is considered conservative and therefore expected to over-predict air quality effects.

Overall, as the emissions from the existing boilers comply with the relevant standards and guidelines any effects associated with the emissions will be less than minor and the public health risks from the boiler discharges are consequently very low beyond the Site boundary.

### 6.4.2 Energy Efficiency and Carbon Reduction

The Government's preferred approach for existing fossil fuel-fired assets is to phase out coal in existing sites by 2037 for low and medium temperature processes through the consenting process.

BSM have completed a study to identify site emissions and assess emission reduction opportunities[6], with the primary objective to demonstrate a decarbonisation transition pathway for the Site to support the application for a new air discharge consent.

Following this, BSM are proposing to decommission the existing HWB boiler by late 2024. This will be achieved through improved heat recovery, reduced hot water demand and the installation of a new high temperature electric heat pump.

Furthermore, BSM will seek to replace the rendering SB boiler when a practicable alternative technology is available (in accordance with carbon reduction requirements). Options for this may include a bio-mass boiler, a tallow-fired boiler or an electric boiler.[7]

Furthermore, the discharges to air of particulate and combustion emissions from the Site sources will be appropriately avoided and mitigated through boiler maintenance and monitoring measures. These are outlined in Section 7 below.

Overall, the public health risks from the boiler discharges are considered to be very low beyond the site boundary.

### 6.4.3 Effects of Odour on Amenity Values

The main potential sources of odour on the Site are from the processing plant, the rendering plant and the WWTP. Poor plant performance from these sources can result in the emission of offensive or objectionable odours, complaints from neighbours and non-compliance with consent conditions

The assessment of effects of odour has therefore focussed on the current performance of these facilities. Discharges of odour to air have been assessed qualitatively based on current performance of the plant (including complaints), as well as existing and proposed mitigation measures.

While the plant is located in a rural area that is relatively insensitive to odour, there are a number of residential dwellings in the vicinity of the plant which have a moderate to high sensitivity to odour and site operations have historically resulted in odour effects that were unacceptable to these neighbours.

Process upgrades to the WWTP (refer back to Section 4 for further details) and processing plants have recently occurred along with fine tuning of odour management and controls. This has included a range of management plans to mitigate the generation of odour from

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6 An Opportunity Assessment Report prepared as part of the Energy Efficiency and Conservation Authority (EECA)'s ETA programme.

7 An electric boiler would require a significant upgrade to the electricity supply network.

the processing plant, rendering and blood drying the WWTP and wastewater irrigation, including:

- A site Air Discharge Management Plan;
- A WWTP Operations and Maintenance (O&M) Manual; and
- A Farm Environmental Management Plan.

Section 7 below provides details on the various odour management and controls measures proposed as part of these plans.

These upgrades have significantly reduced odour beyond the boundary of the Site compared to historical levels, and subsequently there has been no recent complaints recorded.

Overall, the current processes, controls and management systems at the BSM plant are acceptable for this activity in this location, and with ongoing diligent management, odour from the site is unlikely to be offensive or objectionable to the extent that there is an adverse effect beyond the site boundary.

## 6.5 GROUNDWATER TAKE, VIA THE LEAK DETECTION SYSTEM OF THE WASTEWATER TREATMENT PLANT

### 6.5.1 Groundwater Levels

The leak detection system draws the localised groundwater level down by a maximum of approximately 1 - 1.5 m and the zone of influence of the leak detection system is expected to be limited to the immediate area surrounding the WWTP.

In turn the PDP Report concludes that no effects are expected on other groundwater users, as the drawdown effect will be localised, and nearby production bores generally draw water from deeper aquifers.

### 6.5.2 Groundwater Quality

The wastewater lagoons are lined with a 1.5 mm thickness HDPE liner. The liner material is subject to a manufacturer's guarantee of 20 years minimum design life applicable to water holding applications and use for wastewater containment.

A leak detection system has been installed and monitored to provide first warning of any leakage which may occur in accordance with the site O&M manual. This containment system is at least equivalent to the industry standard level of groundwater protection for a WWTP of this type and groundwater environment.

## 6.6 DISCHARGE OF LAND DRAINAGE WATER AND STORMWATER TO WATER

As discussed in Section 3.2.4 above, the upgraded WWTP discharges dewatered water (from the leakage detection system) and stormwater to the nearby drain via an existing outfall.

In summary, the quality of water in the drain is expected to reflect that of shallow groundwater, and in turn, it is not expected that the discharge of groundwater from the leakage detection system will have an adverse effect on water quality. Additionally:

- There will be no direct pathways for wastewater contamination to occur in routine stormwater discharges and all hazardous substances will be contained or kept indoors; and
- The stormwater from the lagoon cover will have similar quality characteristics as roof water runoff, while stormwater runoff from gravel slabs and other surrounding areas of the upgraded WWTP will have similar characteristics to runoff which already enters this as a permitted activity from other areas on site.

Discharge rates are expected to be negligible for the leakage detection system and approximately 4.5 l/s for the stormwater depending on rainfall. This will be readily accommodated by the drain and does not present any flooding issues.

## 6.7 EFFECTS CONCLUSION

In summary, these assessments have made the following conclusions:

- **Groundwater take effects:** the potential effects on neighbouring bores, surface water and the overall groundwater and surface water resources are considered less than minor.
- **Discharges to land effects:**
  - The proposed discharge of treated wastewater to land is unlikely to result in the hydraulic capacity of the soils to be exceeded;
  - Any effects on pasture health due to nutrient loads, anion and cation interactions or animal health are likely to be minor;
  - The long-term contaminant loadings in the soil, as well as the migration of nutrient into the groundwater and surface water systems are also likely to be minor or able to be mitigated through site management; and
  - Monitoring will be undertaken to ensure that effects are as anticipated.
- **Discharges to air effects**:
  - Ambient combustion contaminations ($SO_2$, TSP, $PM_{10}$ and $NO_X$) are expected to meet all relevant air quality criteria beyond the site boundary;

- Through the renewal of these resource consents, BSM will reduce its carbon emissions by de-commissioning the HWB boiler by late 2023.
- Objectionable and offensive odours from the Plant processes, rendering, the WWTP and wastewater irrigation will be managed in accordance with the requirements of numerous management plans[8] to ensure these odours are unlikely to occur at the closest sensitive receptors (nearby dwellings etc) outside the site boundary; and
- No odour complaints have been recorded following the WWTP upgrades.

[8] The Site Air Discharges Management Plan, the WWTP Operations and Maintenance Manual and the Farm Environmental Management Plan

# 7. MITIGATION AND MANAGEMENT OF ADVERSE EFFECTS

As noted above, there are some circumstances where adverse effects will be generated by the Project. Where this is the case, recommendations have been made in order to identify how to best avoid, remedy, mitigate or otherwise address such effects. In some instances, monitoring is proposed to confirm the extent of effect arising.

The mitigation, monitoring and management measures that are proposed are summarised in **Table 4** below.

These measures will also be reflected in proposed conditions offered by BSM as part of its applications.

Table 4: Summary of effects management and monitoring

| Actual or Potential Effect | Recommended Mitigation / Management | Recommended Monitoring |
|---|---|---|
| **Groundwater** | | |
| Effects on the groundwater resource<br><br>Effects on neighbouring bores<br><br>Effects on surface water<br><br>Effects on aquifer stability, seawater intrusion and groundwater quality | Groundwater abstraction rates will be limited to:<br>› 1,500,000 litres per day; and<br>› 7,500,000 litres per week.<br>And will be taken from the existing bores. | › Monitor groundwater levels at each bore once each calendar month<br>› Measure the daily abstraction from the bores |
| **Effects from land discharge of treated wastewater and biosolids** | | |
| Effects on soil | › Limit the maximum daily irrigation rates to within the measured capacity of the soils on the site to minimise hydraulic loading effects.<br>› Managing soil chemistry effects by:<br>  › Undertaking biosolids loading to target paddocks with low soil fertility and quality indicators (low Olsen P levels).<br>  › Management of excess sodium, potassium and Exchangeable Sodium Percentage (ESP) through soil additives. | › Monitoring the actual levels of heavy metal accumulation on an ongoing basis by taking representative samples of the heavy metals outlined above on a five-yearly interval. |

| Actual or Potential Effect | Recommended Mitigation / Management | Recommended Monitoring |
| --- | --- | --- |
| Effects on groundwater | › The nitrogen loading rate from wastewater irrigation will be limited. | › Quarterly sampling of groundwater bores for nitrogen leaching to confirm the expected improvement in groundwater quality.<br>› Ongoing monitoring of shallow groundwater for E.*coli* on the site.<br>› Testing groundwater monitoring wells for heavy metals at five-yearly intervals. |
| Surface water effects | › The nitrogen loading rate from wastewater irrigation will be limited.<br>› The establishment of riparian planting on all streams and drains on their land to act as a buffer to absorb excess phosphorus. | › To maintain a conductivity meter downstream of the land treatment area to continuously monitor electrical conductivity in the tributary. |
| Ecological Effects | › Implementing native riparian planting along all watercourses that run through the property to provide shading and greater habitat quality. | › Ecological monitoring on a five-yearly basis. |
| Effects on human health | › Operational management and physical methods used for irrigation/spreading to avoid staff contact with the wastewater;<br>› Minimising public contact with sprayed wastewater through the use of appropriate buffer zones; and<br>› Ensuring irrigation does not occur near a downwind boundary during windy conditions. | |
| Effects on stock health | › Maintaining a minimum stock withholding period of 14 days following wastewater and/or biosolids irrigation. | › None required. |

| Actual or Potential Effect | Recommended Mitigation / Management | Recommended Monitoring |
|---|---|---|
| **Air Quality** | | |
| Carbon emissions from combustion plant (boilers) | - Decommission the existing HWB boiler by late 2024;and<br>- Seek to replace the rendering SB boiler when a practicable alternative technology is available. | - None required. |
| Emission of contaminants from the combustion plant (boilers) | Boiler control and maintenance, including:<br>- 12-monthly servicing of each boiler with reports provided to Environment Southland;<br>- Tuning boilers to ensure optimal fuel combustion, minimum fuel use and minimum particulate emissions; and<br>- Discharging emissions via two 20 m stacks to ensure adequate dilution and dispersion. | - Undertaking emissions testing of the SB once every five years to ensure compliance with emission limits with reports provided to Environment Southland;<br>- Monitoring opacity of emissions to ensure compliance with consent limits; and<br>- Carrying out regular review of the Newvale coal to ensure compliance. |
| Emission of objectionable odours from processing plant (rendering and blood drying0 | An Air Discharge Management Plan that includes numerous controls and management processes including:<br>- Ensuring material is processes and rendered as soon as practicable;<br>- Collecting all point sources of vapour from the rendering plant and venting this directly to a condenser and then plant biofilter;<br>- Ensuring sufficient changes of rendering building air per hour;<br>- Minimising external door opening times; | - Ensuring moisture, pH and air distribution conditions are maintained in the biofilter. |

| Actual or Potential Effect | Recommended Mitigation / Management | Recommended Monitoring |
|---|---|---|
| | - Undertaking daily housekeeping and thorough cleaning; and<br>- Undertaking daily visual checks of the biofilter. | |
| Emission of odour from the Wastewater Treatment and Disposal System | - An overall Air Discharges Management Plan to detail actions taken to minimise odour and particulate matter emissions from the site;<br>- Management and monitoring of the creation and discharge of odours from WWTP under the requirements of the WWTP Operation and Maintenance Manual and Farm Environmental Management Plan. This includes management practices such as regular inspections and maintenance of equipment, daily cleaning, contingency methods for plant malfunctions and training procedures;<br>- Operation of the biogas flare; and<br>- Utilization of the Farm Environmental Management Plan. | |
| Emission of odour from wastewater irrigation | A Farm Environmental Plan that includes numerous controls and management processes including:<br>- Twice-daily checks of irrigation operation and maintaining plant equipment to a high standard;<br>- Appropriately managing the WWTP to ensure the wastewater does not become anaerobic; and<br>- Reviewing prevailing winds directions before irrigating and adjusting irrigator speeds in response to climatic and soil conditions. | |

# 8. ALTERNATIVES ASSESSMENT

As part of the investigation to determine the most suitable treated wastewater discharge option prior to the 2019 upgrade, BSM reviewed multiple options for the Site. These options included:

- Discharge to surface water;
- Combined land and water discharge (dual discharge);
- discharge to land – physio-chemical treatment;
- Discharge to land – anaerobic treatment and biological nitrogen removal;
- Water re-use for closed loop operations;
- Discharge to trade waste; and
- Managed aquifer recharge.

BSM selected the option to discharge to land with anaerobic treatment and biological nitrogen removal (including the wastewater treatment system upgrades already implemented). This option involves complete biological treatment by upgrading the wastewater treatment facility to include:

- An anaerobic treatment process for the removal of solids and organic material; and
- An aerobic treatment process for the biological removal of nitrogen.

This option was considered the most suitable as it:

- Significantly reduces nitrogen loads to the land treatment system, reducing the potential risk of nitrogen leaching;
- Provides for removal of fats, oils and greases to improve soil infiltration rates;
- Provides for beneficial reuse of nutrients in the pastoral system;
- Provides sufficient capacity to store wastewater during rain events until soil conditions are suitable for irrigation; and
- Reduces reliance on third-party owned farmland, which would have otherwise been required for reducing nitrogen loads. This in turn provides BSM with certainty that environmental effects are minimised without relying on participation of third parties.

# 9. NEXT STEPS

## 9.1 FURTHER INFORMATION AND PROCESS

The above summary provides an overview of BSM's proposal to discharge treated wastewater, wastewater solids and biosolids to land, discharge to air from the operations on the Site and abstract groundwater for processing water. A full copy of the AEE and supporting technical reports can be made available when finalised. If you would like to be provided copies of these please don't not hesitate to contact Mark Frisby (details provided in the following section).

This application will likely be limited notified if written approvals from potentially affected parties are not obtained. This initiates a process where potentially affected parties are able to review the applications and prepare a submission to become involved in the formal Council proceedings. Should you wish to discuss this aspect of the process further please contact Environment Southland.

Following this consultation process, the next steps associated with this application are:

- The application for resource consent is prepared and finalised (including an assessment of environmental effects and any changes needed resulting from this consultation);
- The application is lodged with Environment Southland; and
- The application progresses through the council process.

## 9.2 FEEDBACK AND FURTHER CONSULTATION

BSM are committed to providing the opportunity for all parties to be involved in consultation and welcome further questions or feedback. We invite interested parties or parties that consider that they may be affected to provide feedback on any of the information contained in this document or on any other matter that is considered relevant to the proposed activities.

As BSM are working towards lodgement of the resource consent application in June, please provide any feedback by the 20th May 2022 so that it can be considered for the application documents.

Feedback can be provided directly to Mark Frisby by email at mark.frisby@bluesky.co.nz.

# APPENDIX I

Public Health Southland Feedback on Summary Document for Consultation

**<u>Morton Main Meat Processing Plant-Blue Sky Feedback for consideration</u>**

Thank you for Giving Public Health South an opportunity to provide feedback. We acknowledge that Blue Sky Meats (NZ) Ltd (BSM) is a crucial part of Southland' economy and contributes to the social and economic wellbeing of the surrounding community which includes providing employment opportunities to the local community.

From a Public Health perspective, we would like to provide feedback as follows:

- **Ground Water takes and Surface Water Effects**

Section 3.2.1 of the document states that there are three deep bores available to BSM. We recommend adding more details about these bores especially regarding bore head protection. This is because where an aquitard is patchy or lacking (e.g., tapers out) an aquifer may be more vulnerable to contamination from the ground surface i.e., will no longer be confined, or springs can emerge at the ground surface. Springs can be contaminated directly from surface sources and can act as conduits for contaminants to move down into the underlying groundwater particularly if they dry out during drought periods.

**Sanitary bore head protection** should include an effective casing grout seal to prevent contamination from the ground surface. Where there is doubt about bore integrity there are a number of techniques, such as casing pressure tests and down-hole photography, which could be used but are likely to be beyond normal requirement. In general, above ground visual inspection and bore construction data would provide sufficient information. WHO (2006) notes that poorly mixed concrete used for linings and aprons may result in seepage of contaminated water into groundwater sources. We strongly recommend getting a bore head inspection done on a timely basis. This includes steps such as Stock prevented from getting within 5 m of the bore, Vandal proof, sloping concrete apron surrounding the bore with 2 m radii, Backflow protection exists and is checked changing raw water conditions between surveys, what changes have occurred upstream of the bores i.e., new trade waste practises, sceptic tanks, structures with deep foundations. (What might be heading towards the bores). This will involve forming a good relationship with the relevant Regional Council.

Table 4 in the proposed plan on page 35**,** recommends **monitoring groundwater levels**, and daily abstraction. This will be very beneficial as the Groundwater changes over time. Groundwater levels rise and fall as the seasons change, and in response to heavy rainfall and groundwater use. Groundwater quality can also respond to changes in the seasons and to rainfall events, as well as to changes in land use. By monitoring groundwater, regional councils and unitary authorities can track and understand these changes. This information is helpful for resource management.

We note that it is recommended to look for and monitor nitrogen loading rate, E. coli and for heavy metals in regular intervals in the plan. In our view this is a very useful and positive step. As mentioned, the Topography of the site of BSM plant is quite undulating and gently towards the tributaries Therefore we also recommend adding Nitrate-Nitrogen, dissolved reactive phosphorus, and other chemicals such as, boron, arsenic, fluoride, pesticides etc. to the monitoring plan. At present Waihopai river catchment is in the following state, source Land Air and Water Aotearoa (LAWA)

At Otepuni Creek at Nith Street

Ammoniacal Nitrogen
5-year median 0.052 mg//l
Very Likely Degrading
Nitrate Nitrogen 1.19 mg/L
Not assessed
Total Phosphorus 0.043 mg/L
Likely Degrading

Waihopai River u/s Queens Drive

E. coli E band intermediate trend
Total Nitrogen 3.1 mg/L Very Likely Degrading
Total Oxidised Nitrogen 2.50 mg/L Very Likely Degrading
Dissolved Inorganic Nitrogen 2.55 mg/l Verly Likely Degrading
Ammoniacal Nitrogen
5-year median 0.022 mg/l
Very Likely Degrading
Nitrate Nitrogen 2.4 mg/L
Not assessed

Levels of nitrate in groundwater used for drinking have been monitored for many years with an increasing trend noted across many parts of Southland including in the locality of the BSM plant. Objective 6 of the pSLWP is for no reduction in freshwater quality but this can only be achieved through the reduction of nitrogen inputs. High nitrate levels in drinking water have been known to cause Methaemoglobinaemia or Blue Baby Syndrome in infants less than six months of age and the unborn foetus of pregnant women through exposure to high nitrate levels[1].Appears to be a paucity of monitoring data and or interception bores upgradient and downgradient and certainly not included in the summarised AEE

We also encourage you to look at the Proposed Southland Water and Land Plan that includes region wide policies, Ngai Tahu policies, Physiographic Zone Policies, Water quality, Water quantity, Discharge and Land use rules before you apply for a new consent. Available here - https://www.es.govt.nz/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan

This is "…intended to provide direction and guidance regarding the sustainable use, development and protection of water and land resources in the Southland region".

There are 18 objectives outlined in the pSWLP; objectives 1 and 6 are particularly relevant for this application and are outlined here for ease of reference:

Objective 1 Land and water and associated ecosystems are managed as integrated natural resources, recognising the connectivity between surface water and groundwater, and between freshwater, land and the coast.

Objective 6 There is no reduction in the quality of freshwater, and water in estuaries and coastal lagoons, by:

a) maintaining the quality of water in waterbodies, estuaries and coastal lagoons, where the water quality is not degraded; and

b) improving the quality of water in waterbodies, estuaries and coastal lagoons, that have been degraded by human activities.

In February 2021, the Government announced it would repeal the RMA and enact new legislation based on the recommendations of the Resource Management Review Panel. The three proposed acts are:

- Natural and Built Environments Act (NBA), as the main replacement for the RMA, to protect and restore the environment while better enabling development
- Strategic Planning Act (SPA), requiring the development of long-term regional spatial strategies to help coordinate and integrate decisions made under relevant legislation; and
- Climate Adaptation Act (CAA), to address complex issues associated with managed retreat.

The National Policy Statement for Fresh Water

Objective A1 Water quality

- To safeguard
- a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and
- b) the health of people and communities, as affected by contact with fresh water; in sustainably managing the use and development of land, and of discharges of contaminants

Limit setting a) Setting limits for water quality and quantity is one of the requirements for all regional councils under the Government's National Policy Statement for Freshwater Management. Limits include restricting the number of contaminants that can be discharged into waterways and how much water can be removed (extracted). The limit setting process is the third main component of the Water and Land 2020 and Beyond project.1 Public Health South suggests that proposed catchment limit setting processes are completed.

More information available here - https://environment.govt.nz/what-government-is-doing/areas-of-work/rma/resource-management-system-reform/overview/

- **Soil Characteristics**

The Waikiwi soil type is graded severe in reference to nutrient leaching allowing nitrates and other contaminants to leach directly to underlying groundwater[2]. It is noted that there is inadequate storage onsite to buffer the wastewater when conditions are not ideal for irrigation and the depth of irrigation is excessive at 20mm with good management practices recommending no more than 10mm.

- **Discharge Contaminants to the air**

We noted that BSM have a plan for decommissioning the existing HWB boiler by late 2024, however, it also mentioned on pg. 33 that it was planned for late 2023. This is a great initiative and will certainly make a significant impact on reducing the impact on Southlands Air quality. However, the future phasing out of the remaining coal fired boiler is not included (or may not be known). Some predictive information would be useful

The impacts of air contaminants on human health such as $PM_{10}$ (particles less than 10 microns in diameter), $PM_{2.5}$, sulphur dioxide, carbon monoxide and nitrogen dioxide. These contaminants are primarily the emissions from wood burners for domestic heating, transport emissions and discharges from industrial sources.
In 2020, the Government proposed amendments to some provisions of the National Environmental Standards for Air Quality (NES). Consultation on the proposed amendments was held from February to July 2020.

Timeframes for the proposed amendments to the National environmental standards for air quality are subject to the release of new evidence. This includes the updates to the World Health Organisation guidelines and the Health and Air Pollution in New Zealand study. These are expected to be released mid-late 2021. (Source MfE) full document can be found here-

https://environment.govt.nz/publications/proposed-amendments-to-the-national-environmental-standards-for-air-quality-particulate-matter-and-mercury-emissions-consultation-document/

- **Future Proposed plans**

We would recommend a shorter consent period to a time when catchment setting limits under the sRLWP have been made and or climate change direction is clearer in relation to the final phasing out of coal fired boilers.

We also recommend the plant to invest in future innovations to help with sustainability of environment. The animal dejections, the water resulted from the meat processing, the animal corpses, and all represent biodegradable wastes, which might also be used, by transforming their energy content into electrical and thermal energy. This can be made possible, for example, by using these wastes as raw material for producing biogas[3].

The private sector plays an important role in addressing the challenges of climate change. In order to make serious changes and achieve climate-related goals, the mindset and behaviour of citizens need to start changing to realize that climate change will not simply resolve itself and allow people to maintain their current lifestyle.[4]

**Jitender Arora**
**Health Protection Officer**
**Public Health South,**
**Southern DHB**

## Reference


1 Canterbury District Health Board (2013). Nitrate in Drinking Water “Blue Baby” Syndrome

2 Environment Southland 2009 The Influence of Soil Drainage Characteristics on Contaminant Leakage Risk Associated With the Land Application of Farm Dairy Effluent https://www.es.govt.nz/Document%20Library/Research%20and%20reports/Land%20and%20soil%20reports/agresearch-report.pdf

3 Halmaciu IA, Ionel I, Vetres I, Balogh RM, Bisorca D. Challenges and performance evaluation of livestock waste energy content. InIOP Conference Series: Earth and Environmental Science 2022 (Vol. 960, No. 1, p. 012017). IOP Publishing.

4 Sharma P, Gaur VK, Gupta S, Varjani S, Pandey A, Gnansounou E, You S, Ngo HH, Wong JW. Trends in mitigation of industrial waste: Global health hazards, environmental implications and waste derived economy for environmental sustainability. Science of The Total Environment. 2022 Mar 10;811:152357.

J

# APPENDIX J

Fish and Game Southland –
Feedback on Summary Document for Consultation

## Nicolai Berry

**Subject:** FW: Blue Sky Meats - Resource Consent Application Summary Document for Consultation

**From:** Jacob Smyth <jacob.smyth@southlandfishgame.co.nz>
**Sent:** Tuesday, 21 June 2022 12:36 pm
**To:** Doyle Richardson <doyle.richardson@mitchelldaysh.co.nz>
**Subject:** RE: Blue Sky Meats - Resource Consent Application Summary Document for Consultation

Good afternoon Doyle

Thank you for following up on feedback by Fish & Game on the application by Blue Sky Meats ('the applicant') for consents associated with its processing plant at Morton Mains. The following comments are provided in response to the summary document circulated by you:

1. Fish & Game's primary interest in the suite of consents sought by the applicant relates to the proposed discharge of contaminants (wastewater and biosolids) to land.

2. Fish & Game is supportive of:

    a. The proposed discharge of contaminants to land. Fish & Game generally considers discharge of contaminants to land preferable to discharges of contaminants to surface water, particularly where the effects of the activity are less; and

    b. The upgrades undertaken by the applicant to the onsite wastewater treatment system in 2019 / 2020 to improve the quality of its wastewater discharge to land, including the provision of a sealed storage pond to avoid applying waste water to land when soils are saturated / unsuitable. The summary document provides that the upgrades have significantly decreased the concentration of contaminants, particularly nitrogen, in the wastewater prior to discharge to land.

3. The application provides that the application is seeking to discharge wastewater and biosolids to the following areas of land:

    a. 77ha of pastoral land owned by the applicant; and

    b. 101ha of pastoral land owned and farmed by a third party.

    In response, Fish & Game considers that:

    a. The assessment of effects should be clear about the area of land used to determine the scale of effects; and

    b. If the assessment of effects relies on / assumes discharge of wastewater to third party owned land, it is important that the applicant has appropriate arrangements in place to facilitate the discharge to this land. If not, the assessment of effects would need to be reconsidered.

4. Fish & Game considers that it is important for any discharge to land consent(s) to address :

    a. Application rates - wastewater should be applied at rates that match the ability of land, including differing soil types, to absorb and filter it. Application rates should be guided by onsite soil moisture monitoring, which considers differing soil types and any difference in infiltration rates / properties.

b. Avoidance of any surface run off /overland flow, ponding or contamination of ground / surface water resulting from the application of wastewater to land.

c. Monitoring conditions - this should include monitoring water quality (representative surface water samples upstream and downstream and groundwater monitoring), and soil nitrogen loads.

Fish & Game is supportive of the applicant developing a discharge management plan to guide its wastewater discharge, including how it will achieve compliance with consent conditions.

5. The applicant is seeking a 35-year consent for the discharge of wastewater and biosolids to land, which is the maximum duration available under the RMA. The applicant should be aware that notwithstanding recent investment in wastewater treatment infrastructure that Environment Southland intends through Plan Change Tuatahi (to be notified in December 2023) to set limits, targets, and methods (including for discharges to land and water) that will help achieve hauora, a state of healthy resilience, for waterbodies in the Southland region. Research recently commissioned (November 2021) by Environment Southland shows that that the following region wide nutrient load reductions are required to achieve bottom lines and hauroa. Accordingly, it should not be assumed by the applicant that conditions will not be amended during the life of any discharge consent(s) issued, particularly in response to future plan changes.

Please contact me if you need to confirm anything in relation to the above feedback.

Kind regards

Jacob Smyth

K

# APPENDIX K

Proposed Conditions

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| 1 | This resource consent authorises the discharge of contaminants to air from the applicant's industrial premises at Morton Mains from the following sources, as described in the application dated June 2022, subject to the conditions set out in this consent:<br>a. a rendering plant processing up to 5,750 kg of raw material per hour;<br>b. a blood processing and drying operation;<br>c. a meat processing plant;<br>d. collection and treatment of wastewater from rendering, meat processing and site wide washing processes;<br>e. irrigation of treated wastewater onto land;<br>f. one 4.3 MW coal-fired boiler (rendering steam boiler);<br>g. one 1.9 MW coal-fired boiler (hot water boiler); and<br>h. salting shed. |
| **Boilers** | |
| 2 | a. The maximum coal burning rate in the rendering steam boiler shall not exceed 1,400 kilograms of coal per hour; and<br>b. The maximum coal burning rate in the hot water boiler shall not exceed 630 kilograms of coal per hour. |
| 3 | The opacity of emissions from the chimney stacks of the boilers shall not be darker than Ringelmann Shade 1 as described in New Zealand Standard 5201:1973 except:<br>a. in the case of a cold start, for a period not exceeding 30 minutes in the first hour of operation; and<br>b. for a period not exceeding a total of four minutes in each succeeding hour of operation. |
| 4 | a. The discharge into air from the rendering steam boiler shall occur via a stack at a height of at least 20 metres above ground level and at least 9 metres above the roof ridgeline of any adjacent building; and<br>b. the discharge into air from the hot water boiler shall occur via a stack at a height of at least 18.6 metres above ground level and at least 9.6 metres above the roof ridgeline of any adjacent building. |

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| | c. the discharges from the boilers shall be directed vertically into air and shall not be impeded by any obstruction above the stack which decreases the vertical efflux velocity. |
| 5 | The sulphur content of a representative sample of the coal burned in the boilers shall not exceed 0.5 percent by weight. The ash content of that sample shall be less than 7 percent by weight. The sample shall contain less than 30 percent by weight of fine particles having a diameter of less than 3.35 millimetres. |
| 6 | a. The mass emission of total particulate matter discharged from the rendering steam boiler shall not exceed 3.10 kg/hr; and<br>b. the mass emission of total particulate matter discharged from the hot water boiler shall not exceed 2.60 kg/hr. |
| 7 | The boiler stacks shall be fitted with source emission test ports and safe access for testing, to the satisfaction of the Environment Southland Compliance Manager. |
| 8 | a. The rendering steam boiler identified in Condition 1(f) shall be tested annually to confirm compliance with Condition 6(a) prior to the first, second and third anniversaries of the date of the commencement of this consent.<br>b. Testing of the rendering steam boiler can reduce to once every three years if compliance with Condition 6(a) has always been achieved during the testing undertaken in accordance with Condition 8(a).<br>c. If compliance with Condition 6(a) has not always been achieved during testing undertaken under Condition 8(a) then annual testing shall be undertaken until compliance with Condition 6(a) over three consecutive years of monitoring has been achieved. |
| 9 | a. The hot water boiler identified in Condition 1(g) shall be tested annually to confirm compliance with Condition 6(b) prior to the first and second anniversaries of the commencement of this consent. |
| 10 | Testing to confirm compliance with the particulate mass emission limit shall occur when the tested boiler is operating at greater than 75 percent of the boiler heat output stated in Condition 1(f) for the rendering steam boiler and Condition 1(g) for the hot water boiler. The method of sampling and analysis shall be to stack testing industry standards such as USEPA, ASTM or ISO testing methods. All analyses shall be performed by an International Accreditation New Zealand (IANZ) registered laboratory or otherwise as specifically approved by the Environment Southland Compliance Manager. |

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| 11 | Results of testing undertaken by Condition 8 and 9 shall be forwarded to the Environment Southland Compliance Manager within 30 working days of the results being made available to the Consent Holder. |
| 12 | The boilers shall be serviced and maintained to ensure compliance with Conditions 3 and 6 at all times. Service reports shall be prepared and retained for at least 7 years, and copies shall be provided to the Environment Southland Compliance Manager on request. |
| 13 | The Consent Holder shall cease using the hot water boiler identified in Condition 1(g) after August 2024. |
| 14 | At five yearly intervals, following the commencement of this consent, the Consent Holder shall conduct a review of low carbon alternatives for the rendering steam boiler identified in 1(f). The review shall detail:<br>a. any changes in central or local government policies or rules regarding the burning of coal in that boiler;<br>b. the availability of alternative fuel sources that provide the necessary energy output requirements;<br>c. the availability of new technologies which could be used in place of the rendering steam boiler and the feasibility of those; and<br>d. the financial implications and energy capacity of alternative fuel sources or technologies identified in Conditions 14(b) and 14(c). |
| 15 | A report detailing the findings of Condition 14 shall be provided to the Environment Southland Compliance Manager within 30 working days of the review being undertaken. |
| **Rendering and meat processing** | |
| 16 | The Consent Holder shall ensure that only fresh or suitably preserved raw material is processed in the rendering plant. Unpreserved raw material for rendering shall not be held on-site for more than 24 hours. Suitably preserved material shall be material that is chilled or frozen and is derived from cutting, boning or further processing of animal tissue that has been chilled or frozen within 24 hours of the time of slaughter. |
| 17 | The Consent Holder shall ensure that the ventilation system draws adequate negative pressure to ensure the effective capture of contaminants from the rendering plant building and all other areas from which air is extracted to |

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| | minimise fugitive emissions. The ventilation air shall be discharged via the rendering plant biofilter, as described in Condition 18.<br><br>The Consent Holder shall undertake an inspection of the ventilation and pre-treatment (condensers etc) equipment every 5 years from the commencement of this consent. A record of these inspections must be retained and be available to the Environment Southland Compliance Manager on request. |
| 18 | The rendering plant biofilter shall be capable of treating an air volume of at least 12 air changes per hour of the rendering building and the air volume from point sources within the rendering plant. The biofilter shall contain filter media to a depth of at least 1 metre over an area of at least 1024 $m^2$. |
| 19 | The Consent Holder shall measure and record the following biofilter parameters:<br><br>a. the air pressure of the biofilter inlet duct compared to atmospheric pressure by pressure gauge or U-tube manometer and the pH and moisture content of the biofilter media via a handheld soil tester on a monthly basis;<br>b. odour characteristic of the air discharged from the biofilter on the downwind edge of the biofilter on a weekly basis;<br>c. the temperature of the air entering the biofilter on a continuous basis; and<br>d. observations of the air distribution through the biofilter media on a yearly basis to assess whether it is evenly distributed |
| 20 | The biofilter shall be operated in accordance with the following triggers:<br><br>a. the pressure drop measured at the biofilter inlet duct should not exceed 150 millimetres water gauge or 1.5 kilopascals;<br>b. the moisture content of the biofilter media should be maintained between 40% and 60% on a wet weight basis;<br>c. the target pH for the biofilter media is pH 6 to pH 8; and<br>d. the maximum inlet air temperature shall be 40 degree celsius. |
| 21 | The Consent Holder shall maintain at least 12 months of records of all measurements undertaken in accordance with Condition 19. This record shall be provided to an Environment Southland Compliance Manager on request. |
| 22 | Processing areas, collection sumps and traps in the meat processing plant and rendering plant shall be cleaned at least daily to minimise odour emissions. |

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| **Wastewater treatment and irrigation** | |
| 23 | The Consent Holder shall ensure that biogases generated from the Wastewater Treatment Plant (WWTP) anaerobic pond are combusted via a flare or an energy recovery system at all times except under the following circumstances:<br><br>a. in the event of a combustion equipment failure; or<br>b. for combustion equipment maintenance purposes; or<br>c. for periodic venting of biogases via the flare blower as part of the routine maintenance programme; or<br>d. for the purposes of providing a small continuous supply of biogas from the covered anaerobic treatment facility to the WWTP biofilter to maintain the active bacteria population in the WWTP biofilter. |
| 24 | Under the circumstances where biogases are not flared and/or utilised for energy recovery as described in Condition 22, then biogases shall be vented to the WWTP biofilter. If use of the WWTP biofilter is required for more than 20 days in any calendar year ending 31 December, the Consent Holder shall within 60 days of the end of the year provide the Environment Southland Compliance Manager with a report which details the reason for the use of the WWTP biofilter for treating biogas in excess of 20 days during the year. |
| 25 | The Consent Holder shall maintain treated wastewater in an aerobic condition using aerators to minimise odour in the irrigation lagoon. If irrigation of treated wastewater does not occur for than more than two days, the irrigation lagoon shall be aerated to avoid the onset of anaerobic conditions. |
| 26 | Wastewater shall not be irrigated onto land within 20 metres of any property boundary. There shall be no spray drift of wastewater beyond that property boundary. |
| **Odour** | |
| 27 | The air discharges from the Consent Holder’s processes shall not cause odour that is offensive or objectionable to such an extent that it has an adverse effect on the environment beyond the boundary of the property on which the consent is exercised. |

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| **Complaints** | |
| 28 | The Consent Holder shall maintain a 24 hour contact number for the receipt of complaints and concerns from the public. This contact number shall be listed on the Consent Holder's website (https://bluesky.co.nz). |
| 29 | The Consent Holder shall maintain a diary of odour and spray drift complaints.<br>The diary shall record:<br>a. the effect observed by the complainant;<br>b. the date and time the effect was detected, or the complaint was made;<br>c. the location where the effect was detected by the complainant;<br>d. weather conditions (such as wind direction, approximate wind speed, temperature) when the effect was detected by the complainant;<br>e. nature and intensity of the odour or spray drift;<br>f. the most likely cause of the effect detected; and<br>g. the action taken by the Consent Holder in response to the complaint.<br>*Advice Note: This condition does not require the Consent Holder to take action over every complaint, but it does require that that decision is recorded.* |
| 30 | The complaint record required by Condition 29 shall be provided to the Environment Southland Compliance Manager annually by 31 July and otherwise on request. |
| **Air Discharge Management Plan** | |
| 31 | No later than three months from this consent commencing the Consent Holder shall prepare and submit to the Environment Southland Compliance Manager an Air Discharge Management Plan for certification that it is in accordance with this condition.<br>The objective of the Air Discharge Management Plan shall be to detail all actions to be taken to minimise odour and particulate matter emissions from the plant and to ensure compliance with the conditions of this consent.<br>The Air Discharge Management Plan shall include:<br>a. a description of the contents and purpose of the Air Discharge Management Plan in accordance with this condition; |

| Proposed Conditions: | Discharge of contaminants to air |
|---|---|
| | b. a summary of the plant purpose, location, layout, and production equipment with specific reference to contaminant discharge, extraction and treatment equipment, discharge stacks and processes;<br>c. responsibilities and contact details of key personnel;<br>d. operation, inspection and maintenance of the rendering plant equipment, boilers, WWTP (including wastewater irrigation procedures and set back distances) and the biofilters including the extraction and treatment equipment;<br>e. procedures adopted to ensure that the odour extraction equipment in the rendering plant is fully functional before operations commence;<br>f. procedures adopted to ensure that the plant complies with the conditions of this consent at all times;<br>g. measures to be implemented in the event that the trigger levels in Condition 20 are not met;<br>h. details of how emissions will be contained within the rendering building to minimise the potential for fugitive emissions. |
| 32 | The Consent Holder shall undertake all onsite activities in accordance with the Air Discharge Management Plan, and all other conditions of this consent. In the event of any inconsistencies between the conditions of consent and the provisions of the Air Discharge Management Plan, the conditions of this consent shall apply. |
| 33 | The Air Discharge Management shall be reviewed by the Consent Holder every three years. The purpose of this review shall be to confirm that the Air Discharge Management Plan accurately reflects current on-site activities and operations and to identify if changes to procedures contained within the Air Discharge Management Plan are required to achieve the objective of this condition. A written report detailing the results of the review shall be submitted to the Environment Southland Compliance Manager within 30 working days of the review being undertaken. If the review results in amendments to the Air Discharge Management Plan, the amended sections shall be provided to the Environment Southland Compliance Manager for certification at this time. |

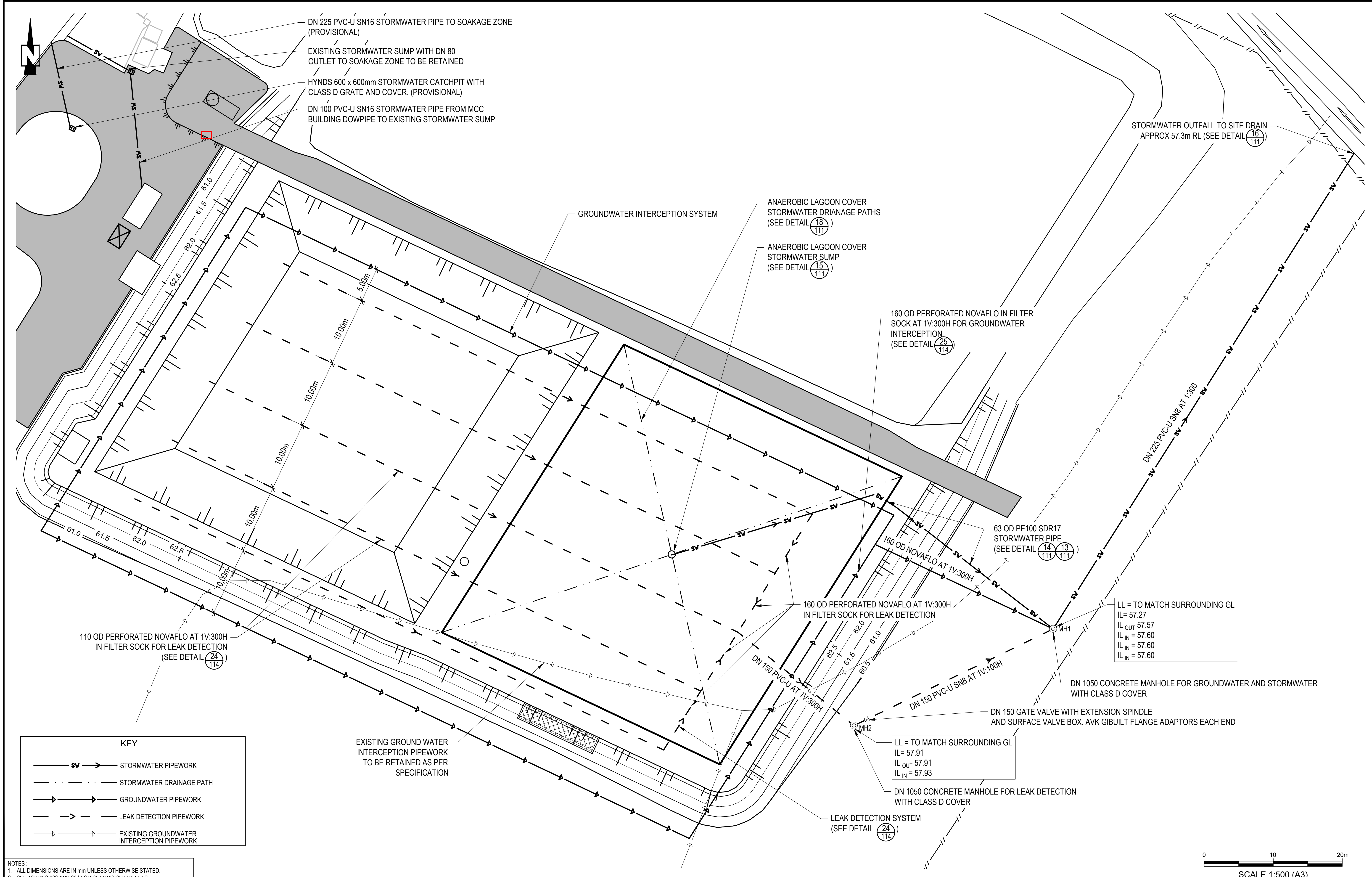
| Proposed Conditions: | Abstraction and use of groundwater |
|---|---|
| 1 | This permit authorises the abstraction of water from up to three bores. These bores are:<br>a. F46/0517;<br>b. F46/0561; and<br>c. F46/1128. |
| 2 | The combined rate of abstraction from the three bores identified in Condition 1 shall not exceed:<br>a. 1,500,000 litres per day; and<br>b. 7,000,000 litres per week. |
| 3 | The Consent Holder shall install a backflow prevention device on the bores identified in Condition 1 or take other appropriate measures to ensure water and/or contaminants cannot return to the water source. |
| 4 | The bores identified in Condition 1 are to be maintained so that:<br>a. there is a seal, made of concrete or similar material, placed at ground level around the outside of the casing. The seal will be sufficient to prevent foreign material, surface water, spillage or other leakage entering the space between the casing and the wall of the borehole;<br>b. the top of the casing is sealed to prevent the entry of contaminants into the casing; and<br>c. fencing is installed to prevent stock accessing the bores. |
| **Monitoring and reporting** | |
| 5 | The Consent Holder shall:<br>a. provide and maintain access to the heads of each bore to enable measurement of water level in each bore;<br>b. monitor groundwater levels at each bore once each calendar month; and<br>c. when monitoring groundwater levels, record whether or not the bore has been in use during the previous 24 hours and, if it has, the rate of abstraction from the bore during the previous 24 hour period. |
| 6 | A system must measure on a continuous basis the volume taken via the bores identified in Condition 1. The system must have a reliable calibration and must be maintained to an accuracy of +/- 5 percent. |

| Proposed Conditions: | Abstraction and use of groundwater |
|---|---|
| 7 | Within six months of the commencement of this consent the Consent Holder must provide the Environment Southland Compliance Manager:<br><br>a. a copy of any relevant manufacturer calibration certificate; or<br><br>b. evidence from a suitably qualified person showing that the system required by Condition 6 is verified as accurate to +/- 5 percent. |
| 8 | The consent holder must engage a suitably qualified person to undertake additional verification of the accuracy of the system required by Condition 6:<br><br>a. at a frequency of no less than five yearly from the date of the first verification required by Condition 7; and<br><br>b. to the satisfaction of the Environment Southland Compliance Manager.<br><br>Evidence documenting each additional verification must be forwarded to the Environment Southland Compliance Manager within 30 working days of the verification being completed. |
| 9 | The Consent Holder must measure and record the volume of water taken on a cubic meter basis to confirm compliance with Condition 2.<br><br>When no groundwater is being taken the data must specify the take volume as zero. |
| 10 | The Consent Holder must submit a report in electronic spreadsheet format to the Environment Southland Compliance Manager by 1 August each year that contains daily and weekly values for the immediately preceding year ending 30 June – of the volume of groundwater taken pursuant to this consent. |

| Proposed Conditions: | Take groundwater for dewatering |
|---|---|
| 1 | The permit authorises the passive taking of groundwater for dewatering the ground beneath the wastewater treatment plant via the subsoil drainage system shown in Attachment 1 - (A03220201 – Drawing No. 007) located at 729 Woodlands Morton Mains Road (1,265,070E 4,857,630 N). |

**Attachment 1**

A03220201 – Drawing No. 007




NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. SEE TO DWG 003 AND 004 FOR SETTING OUT DETAILS.
3. THE IDENTITY AND LOCATION OF ANY SERVICES SHOWN ON THIS DRAWING CANNOT BE GUARANTEED TO BE COMPLETE OR ACCURATE.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL SERVICES PRIOR TO UNDERTAKING ANY EXCAVATION.

SOURCE:

1. SURVEY DATA SUPPLIED BY BONISCH CONSULTANTS LTD. 181102 6700 RevB, SURVEYED ON 08/08/2018 AND 26/10/2018
2. AERIAL IMAGERY (FLOWN 01/13/2018) DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE)

FILED: A03220201D002.dwg

| NO. | REVISION | DATE | APP. |
|---|---|---|---|
| 0 | FOR TENDER | DEC 18 | |
| A | FOR REVIEW | NOV 18 | |

| | BY | CHECKED | DATE |
|---|---|---|---|
| DESIGNED | A.D. | D.G. | OCT 18 |
| DRAWN | D.F.P. | D.R. | OCT 18 |
| APPROVED ISSUE FOR : | TENDER | | DEC 18 |
| APPROVED : | | | |

THIS DRAWING IS NOT FOR CONSTRUCTION UNLESS SIGNED AS APPROVED



CLIENT: BlueSkyMeats

PROJECT: NEW WASTEWATER TREATMENT PLANT

TITLE: STORMWATER AND GROUNDWATER LAYOUT

PROJECT NO. : A03220201 | SCALE 1:500 (A3) | SHEET : OF : | DRAWING NO. : 007 | REV : 0

pdp solutions for your environment
PATTLE DELAMORE PARTNERS LTD
Level 4, PDP House, 235 Broadway, Newmarket, Auckland
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Telephone : (09) 523 6900
Auckland Tauranga Wellington Christchurch

| Proposed Conditions: | Discharge of land drainage water and stormwater to water |
|---|---|
| 1 | This consent authorises the discharge of land drainage water taken in accordance with Consent [reference take of groundwater for dewatering consent], and stormwater from the wastewater treatment plan, to water in an open drain, as described in the application dated June 2022. |
| **Monitoring and reporting** | |
| 2 | a. The Consent Holder shall sample the land drainage water prior to the discharge point within one year of the commencement of this consent and annually thereafter and have it analysed for the following:<br>i. biochemical oxygen demand<br>ii. total ammonia nitrogen<br>b. the Consent Holder shall also sample water from the open drain between 5 and 20 metres upstream of the discharge point, and have the samples analysed for the same parameters as are listed in Condition 2(a);<br>c. sampling in accordance with Condition 2(b) shall occur within 2 hours of samples taken in accordance with Condition 2(a);<br>d. sample collection, preservation and analysis shall be carried out in accordance with the most recent edition of APHA "Standard Methods for the Examination of Water and Wastewater"; and<br>e. the monitoring and analyses are to be carried out by a laboratory with IANZ registration or equivalent, or as agreed to in writing with the Environment Southland Compliance Manager. |
| 3 | a. The Consent Holder shall report to the results of monitoring required by Condition 2 in writing to the Environment Southland Compliance Manager (email: escompliance@es.govt.nz) within 30 working days of receipt of the sample results.<br>b. The report shall include the sample locations, comparison of the land drainage water and the water in the open drain, and comment whether the parameters sampled in Condition 2(a) indicate any contamination of the land drainage water by wastewater.<br>c. If the total ammonia nitrogen exceeds a concentration of 1 gram per cubic metre and/or the biochemical oxygen demand exceeds a concentration of 2 grams per cubic metre in the sample collected in accordance with Condition 2(a), the Consent Holder shall prepare a report identifying the cause of the exceedance and if needed, identify a preferred mitigation option for addressing the cause of the exceedance.<br>d. The Consent Holder shall implement the preferred mitigation option identified in the report prepared in accordance with Condition 3(c) as soon as practicable. |

| Proposed Conditions: | Discharge of land drainage water and stormwater to water |
|---|---|
| | e. A copy of the report prepared in accordance with Condition 3(c) shall be provided to the Environment Southland Compliance Manager within 10 working days of the report being completed. |
| 4 | After reasonable mixing:<br><br>a. the discharge shall not result in the following effects in the open drain:<br>i. the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;<br>ii. any conspicuous plumes, change in colour or reduction of visual clarity<br>iii. any emission of objectionable odour;<br><br>b. the discharge shall not result in the following effects in the tributary of the Waihopai River that the drain flows into:<br>i. the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;<br>ii. any conspicuous plumes, change in colour or reduction of visual clarity<br>iii. any emission of objectionable odour;<br>iv. the rendering of fresh water as unsuitable for consumption by farm animals;<br>v. any significant adverse effects on aquatic life;<br>vi. exceedance of the water quality standards for "Lowland Hard Bed" water bodies (Appendix 1) |
| 5 | For the purposes of Condition 4, reasonable mixing shall have occurred:<br><br>a. in the drain within 20 metres of the point of discharge to the drain, and<br>b. in the tributary within 30 metres of the confluence of the drain with the tributary. |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
|---|---|
| 1 | This consent authorises the discharge of treated wastewater, stockyard solids, paunch and biosolids onto land at the following legal descriptions: Lot 1 DP 14802, Pt Lot 7 DP 159, Pt Lot 8 DP 159, Lot 1 DP 595, Lot 9 DP 159, Lot 12 DP 159, Lot 13 DP 159, Lot 292 DP 155, Lot 293 DP 155, Lot 1 DP 12194, and Lot 1 DP 8287. |
| 2 | Irrigation of wastewater, biosolids, and land application of stockyard solids, paunch to third-party owned land shall only occur from October to March (inclusive). Third-party land is at the following legal descriptions: Lot 9 DP 159, Lot 12 DP 159, Lot 13 DP 159, Lot 292 DP 155, Lot 293 DP 155 Lot 1 DP 12194, and Lot 1 DP 8287. |
| 3 | No discharge shall occur onto land that is predominantly Paroa (formally Dacre) Silt Loam soils. |
| 4 | The Consent Holder shall permanently block or otherwise decommission the subsoil drainage underneath the irrigation areas prior to exercising this consent. |
| 5 | The treated wastewater, biosolids, stockyard solids and paunch authorised to be applied to land under this consent shall be applied no closer than:<br>a. 10 metres to any watercourse or open drain, whether flowing continuously or intermittently;<br>b. 10 metres from any tile drain between 1 April and 30 September;<br>c. 20 metres to any external property boundary or public road. The distance to a property boundary may be reduced with the written agreement of the adjacent property owner and occupier. A copy of this written agreement shall be provided to the Environment Southland Compliance Manager prior to disposal of treated wastewater, stockyard solids, paunch or biosolids occurring;<br>d. 100 metres to any residential dwelling, school, or marae (excluding any dwellings owned by the Consent Holder) unless the written agreement of the owner and occupier has been obtained. A copy of this written agreement shall be provided to the Environment Southland Compliance Manager prior disposal of wastewater, stockyard solids, paunch or biosolids occurring; and<br>e. 100 metres from any potable water abstraction point. |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| **Compliance limits** | |
| 6 | The depth of treated wastewater application onto any area of land shall not exceed:<br>a. 35 mm for any individual application in the period 1 October to 31 March;<br>b. 15 mm for any individual application in the period 1 April to 30 September.<br>The rate of application of treated wastewater and/or biosolids to land must not exceed 6 mm per hour. |
| 7 | Discharge of treated wastewater and biosolids must be withheld for a minimum period of 7 days before another application of that material can be applied onto the same area of land. |
| 8 | Stock must be withheld from accessing the land area subject to a discharge event for a minimum of 14 days following the completion of that event. |
| 9 | Plant available nitrogen loads from all sources must not exceed a maximum of:<br>a. 200 kgN/ha/yr on grazed pasture;<br>b. 350 kgN/ha/yr on cut and carry operations; or<br>c. A pro-rated nitrogen load, in the case of mixed land use.<br>Plant available nitrogen shall be assessed as follows:<br>a. nitrogen applied from treated wastewater, stockyard solids and paunch shall be considered as 100 % plant available; and<br>b. nitrogen applied from biosolids shall be considered 58 % plant available. |
| 10 | The annual phosphorus loading rate from the irrigation of treated wastewater, stockyard solids, paunch, biosolids and fertiliser applications shall not exceed 70 kgP/ha/yr. |
| 11 | The Consent Holder may apply plant available phosphorus up to 110 kgP/ha/yr on land owned by the Consent Holder and operated as cut and carry subject to:<br>a. riparian planting as per the Riparian Planting Plan (Attachment - Figure 17 Riparian Planting Plan for Mitigation of Higher Nutrient Loading).<br>i. areas of new riparian planting shall be high density native grasses and sedges; and<br>ii. achieve a minimum 80% ground cover; and |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | iii. achieve a minimum of 5 m width as measured from the stream and/or drain bank.<br>b. areas of existing riparian planting are to be maintained wherever possible. If these need to be removed, the planting shall be replaced in accordance with Condition 11 (a) i-iii above.<br>c. the riparian planting shall be carried out with the advice of a suitably qualified expert. |
| 12 | Plant available phosphorus shall be assessed in Conditions 10 and 11 as follows:<br>a. phosphorus applied from treated wastewater, stockyard solids and paunch shall be considered 100 % plant available; and<br>b. phosphorus applied from biosolids shall be considered 85 % plant available. |
| 13 | The oil and grease concentration of the treated wastewater discharged shall not exceed 50 grams per cubic metre. |
| **Monitoring, record keeping and reporting** | |
| 14 | The Consent Holder shall monitor the treated wastewater discharge by taking representative samples of the wastewater from the irrigation storage pond at least once per month, and analysing each sample for the following:<br>a. pH;<br>b. sodium adsorption ratio;<br>c. electrical conductivity;<br>d. total nitrogen concentration;<br>e. nitrate nitrogen concentration;<br>f. nitrite nitrogen concentration;<br>g. ammoniacal nitrogen concentration;<br>h. e. coli concentration;<br>i. total phosphorus concentration; and<br>j. dissolved reactive phosphorus. |
| 15 | The Consent Holder shall monitor the biosolids at least once per month, and analysing each sample for the following:<br>a. total solids; |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | b. total kjeldahl nitrogen;<br>c. ammoniacal nitrogen;<br>d. total phosphorus; and<br>e. dissolved reactive phosphorus. |
| 16 | The Consent Holder shall monitor heavy metal concentrations in the biosolids by taking representative samples annually, and analysing each sample for the following:<br>a. total arsenic;<br>b. total cadmium;<br>c. total chromium;<br>d. total copper;<br>e. total lead;<br>f. total nickel; and<br>g. total zinc. |
| 17 | The Consent Holder shall monitor the combined paunch, stockyard solids and all other solids (combined as wastewater solids) applied to land by taking representative samples of the solids at least once per month, and analysing each sample for the following:<br>a. total solids;<br>b. total kjeldahl nitrogen;<br>c. ammoniacal nitrogen;<br>d. total phosphorus; and<br>e. dissolved reactive phosphorus. |
| 18 | The Consent Holder shall monitor the unnamed tributary of the south branch of the Waihopai River that runs through the disposal area as follows:<br>a. the unnamed tributary is to be monitored upstream and downstream of the land treatment site, at the locations shown in Attachment 2 - Figure 11 Surface Water Monitoring Locations;<br>b. samples are to be taken at least once per month;<br>c. the samples taken at the upstream and downstream sites on each monitoring occasion are to be taken at about the same time, within the |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | period of 1 hour. The downstream sample should be taken first on each occasion;<br>d. the samples are to be analysed for:<br>i. pH<br>ii. electrical conductivity<br>iii. dissolved oxygen concentration<br>iv. ammoniacal nitrogen concentration<br>v. total nitrogen concentration<br>vi. dissolved reactive phosphorus concentration<br>vii. e. coli concentration<br>viii. nitrate nitrogen<br>ix. nitrite nitrogen<br>x. temperature (field measurement); and<br>xi. carbonaceous biochemical oxygen demand ($cBOD_5$). |
| 19 | The Consent Holder shall maintain the conductivity meter at a site downstream of the land treatment area in the unnamed tributary. The conductivity meter shall continuously monitor and electronically record (at 15 minute intervals) electrical conductivity.<br>a. The meter shall be calibrated periodically, and shall be maintained in accordance with the manufacturers guidelines;<br>b. the conductivity readings are to be reported to the Environment Southland Compliance Manager via a system that can automatically send the data into Environment Southland's computer database in CSV format, Hilltop or Tideda format, or XML formatted or formatted as required by the Environment Southland Compliance Manager. The data is to be provided at least once per day; and<br>c. if the electrical conductivity readings exceed 280 µs/cm (or other value agreed in writing by the Environment Southland Compliance Manager), the Consent Holder shall, without undue delay, inspect the unnamed tributary at the upstream and downstream sites identified in Attachment 2 - Figure 11 Surface Water Monitoring Locations. If the inspection shows a conspicuous change in the colour or clarity of the tributary, the Consent Holder shall advise the Environment Southland Compliance Manager (email: escompliance@es.govt.nz, or phone 0800 76 88 45) and shall immediately inspect the wastewater irrigation to ensure that wastewater is not causing the effect in the tributary. |
| 20 | Water, treated wastewater, biosolids, stockyard solids and paunch quality monitoring shall comply with the following criteria: |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | a. the results of the monitoring specified in Conditions 14 to 18 are to be supplied to the Environmental Southland Compliance Manager no later than 20 working days after the receipt of the laboratory analytical data;<br>b. the results of the monitoring specified in Conditions 14 to 18 are to include reference to the method of analysis;<br>c. the parameters specified in conditions 14 to 18 shall be analysed in accordance with the most recent edition of APHA "Standard Methods for the Examination of Water and Wastewater" or by the methods approved in writing by the Environment Southland Compliance Manager; and<br>d. where the laboratories carrying out analyses required by this consent are not accredited to ISO7025, either by IANZ (formerly TELARC) or by an organisation with a mutual recognition agreement with the IANZ, for those analyses, then the Environment Southland Compliance Manager may once every 12 months audit the Consent Holder's monitoring methods and analyses by obtaining and analysing split samples of the samples taken in accordance with conditions 14 to 18 above. The cost of each audit is to be met by the Consent Holder. |
| 21 | The Consent Holder shall monitor soil on the site during the month of May each year as follows:<br>a. Samples shall be taken from, and the measurements made in, at least seven treated wastewater, biosolids, stockyard solids and paunch disposal sites:<br>i. at least four sites on land operated as cut and carry;<br>ii. at least two sites on land operated as grazed pasture; and<br>iii. at least one control site (in an area where treated wastewater, biosolids, stockyard solids and paunch are not discharged).<br>b. to this end, the Consent Holder shall take no less than 10 representative subsamples to a minimum depth of 15 cm at each site to form one composite for each site;<br>c. soil samples shall be analysed for the following:<br>i. soil pH;<br>ii. exchangeable calcium;<br>iii. exchangeable magnesium;<br>iv. exchangeable potassium;<br>v. exchangeable sodium;<br>vi. phosphorus (Olsen P);<br>vii. cation exchange capacity; and<br>viii. total nitrogen concentration. |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | d. analysis shall include the calculation of exchangeable sodium percentage (ESP) values for each sampling site; and<br>e. at each site, at least one sample shall be taken and tested for soil infiltration. |
| 22 | The Consent Holder shall maintain the soil's natural infiltration capacity by ensuring the exchangeable sodium percentage (ESP) of the soil at annual monitoring compliance sites does not exceed 5%, and that saturated soil infiltration rates are not less than 6 mm/hr. |
| 23 | If it is determined by monitoring required by Condition 21 that ESP exceeds 5%, action, such as fertilisation with gypsum or other suitable method, shall be undertaken such that the elevated ESP reduces to less than 5%. |
| 24 | If it is determined by monitoring required by Condition 21 that saturated soil infiltration rates are less than 6 mm/hr, the Consent Holder shall take appropriate remedial action by ripping the paddock, tilling the paddock and resowing, or other suitable mechanical method. |
| 25 | After the first full year of authorised irrigation, and at five yearly intervals thereafter, the Consent Holder shall take composite soil samples from the locations in Condition 21(a) following the requirements in Condition 21(b) and analyse these for arsenic, cadmium, copper, chromium, zinc, nickel, and lead.<br>*Advice Note: The monitoring required by this Condition should, wherever possible, coincide with the monitoring required by Condition 21.* |
| 26 | The Consent Holder shall sample the seven groundwater monitoring bores quarterly each year and test for pH, electrical conductivity, ammonium-N, nitrate-N, dissolved reactive phosphorus, E coli, sodium, and chloride. The monitoring bores are located as follows (NZTM coordinates):<br>a. CG11/0016 (Consent holder reference MW1D) 1263261E 4857819N (depth 10 m)<br>b. CG11/0017 (Consent holder reference MW1D) 1263261E 4857819N (depth 40 m)<br>c. CG11/0018 (Consent holder reference MW1U) 1263762E 4858472N (depth 10 m)<br>d. CG11/0019 (Consent holder reference MW2D) 1264081E 4857674N (depth 10 m) |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
|---|---|
| | e. CG11/0020 (Consent holder reference MW2U) 1264988E 4858679N (depth 10 m)<br>f. CG11/0021 (Consent holder reference MW3D) 1264809E 4857227N (depth 10 m)<br>g. CG11/0022 (Consent holder reference MW3U) 1265681E 4858461N (depth 10 m) |
| 27 | From the date that this consent commences, in addition to the monitoring requirements stipulated by Condition 26, the Consent Holder shall also sample bore water at the seven bores identified in Condition 26 for heavy metals arsenic, cadmium, chromium, copper, nickel and zinc at five yearly intervals. |
| 28 | The Consent Holder shall carry out, on-site soil moisture measurements within the wastewater irrigation areas as follows:<br>a. the Consent Holder shall record soil-moisture measurements using a device as agreed by the Environment Southland Compliance Manager;<br>b. unless otherwise agreed by the Environment Southland Compliance Manager the soil moisture data collected in accordance with this condition is to be recorded and made available to the Council on request;<br>c. the Consent Holder shall, from the on-site monitoring record, determine the soil-moisture contents that are equivalent to field capacity at each of the monitoring sites and shall report this to the Environment Southland Compliance Manager. |
| 29 | The Consent Holder shall, unless otherwise agreed to in writing by the Environment Southland Compliance Manager, undertake ecological monitoring after the first full year of treated wastewater, biosolids, stockyard solids and paunch disposal and at 5 yearly intervals after that. The ecological monitoring shall occur along approximately 50 m lengths of the two unnamed tributaries, upstream and downstream of the boundaries of the disposal area. These locations shall be monitored at the same time.<br>The ecological monitoring shall comprise of:<br>a. macroinvertebrate community index for soft bottomed streams (MCI-sb)<br>b. relative abundance of ephemeroptera, plecoptera and trichoptera (EPT)<br>c. taxonomic richness<br>d. stream ecological evaluation (SEV) |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| 30 | The Consent Holder shall keep daily records on a per paddock basis of the following:<br><br>a. the amount of:<br>i. treated wastewater irrigation; and<br>ii. biosolids irrigation; and<br>iii. paunch, stockyard solids, and all other solids applied to the land.<br><br>b. the total nitrogen and phosphorus loadings applied to the disposal area from:<br>i. treated wastewater irrigation;<br>ii. biosolids irrigation; and<br>iii. paunch, stockyard solids, and all other solids applied to the land.<br><br>c. the calculated available nitrogen and available phosphorus loading applied to the disposal area.<br><br>The Consent Holder shall make these records available to the Environment Southland Compliance Manager upon request at any reasonable time. |
| 31 | The Consent Holder shall prepare and submit an Annual Monitoring Report to the Environment Southland Compliance Manager. The report shall include the 1 July to 30 June period and shall be provided to the Environment Southland Compliance Manager by 31 August each year. The report shall include, but not be limited to the following information:<br><br>a. presentation and summary of all treated wastewater, biosolids, stockyard solids, paunch, receiving environment, and biological monitoring results as required by this consent; including any recommendations for improved monitoring;<br>b. the identification of any recorded non-compliances with consent limits and standards and the measures taken to ensure compliance is achieved;<br>c. assessment of the effects of the discharges on the receiving environment; and<br>d. any corrective actions undertaken as required by Conditions 23 and 24. |
| 32 | The Consent Holder shall provide to the Environment Southland Compliance Manager by 31 August each year a nutrient management budget for the irrigation area including the overall grazed-farm, that has been developed based on the outputs of either Overseer or any other nutrient management planning tool approved by the Environment Southland Compliance Manager. |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
| --- | --- |
| 33 | The nutrient management budget required by Condition 32 shall as a minimum record the following information for at least nitrogen (N) and phosphorus (P) (in units of kilograms of N and P per hectare per year):<br>a. Inputs from treated wastewater and biosolids irrigation, other solids spreading, fertiliser, and any nutrient source;<br>b. Outputs in product, including percentage dry matter; and<br>c. Results of soil testing. |
| **Management** | |
| 34 | The irrigation of treated wastewater and/or biosolids shall not cause significant prolonged ponding. For the purpose of this consent, significant prolonged ponding is deemed to occur if treated wastewater and/or biosolids remains on an area of more than ten square metres 24 hours after being irrigated. |
| 35 | The treated wastewater and/or biosolids irrigation shall not cause overland flow of treated wastewater and/or biosolids to any flowing watercourse, drainage ditch, permanent pond, or property outside the boundary of this Consent. |
| 36 | If treated wastewater and/or biosolids irrigation occurs when soils are at or above field capacity as determined by Condition 28, the Consent Holder shall take additional precautions, including but not limited to, inspection of each of the irrigators while irrigating to check for conspicuous signs of wastewater ponding or run-off and the position of the irrigator relative to known drains. These inspections shall be noted, and the upstream and downstream conductivity recorded at the time of the inspection.<br>A copy of this record shall be included with the Annual Monitoring Report specified in Condition 31. |
| 37 | Irrigation of wastewater shall be with equipment such that aerosols and spray drift are minimised, and there shall be no detectable spray drift beyond the property boundary. |
| **Complaints** | |
| 38 | The Consent Holder shall maintain a diary of complaints for complaints received by the Consent Holder about all aspects of operations at the site. |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | The diary shall record:<br><br>a. the issue that observed by the complainant;<br>b. the date and time the issue was detected, or the complaint was made;<br>c. the location where the issue was detected by the complainant;<br>d. weather conditions (such as wind direction, approximate wind speed, temperature and rain) when the issue was detected by the complainant;<br>e. the most likely cause of the issue detected;<br>f. the action taken by the Consent Holder in response to the complaint.<br>*Advice Note: This condition does not require the Consent Holder to take action over every complaint, but it does require that that decision is recorded.* |
| 39 | The complaints register required by Condition 38 shall be available to the Environment Southland Compliance Manager on request. Complaints received by the Consent Holder which may indicate non-compliance with the conditions of this consent shall be forwarded to Environment Southland Compliance Manager within 5 days of the complaint being received. The complaint information provided to the Environment Southland Compliance Manager shall include all information recorded in Condition 38 above. |
| 40 | Details of all complaints received in accordance with Condition 38 shall be forwarded to the Environment Southland Compliance Manager on a monthly basis. |
| **Incident management** | |
| 41 | The Consent Holder shall notify, in the event of any treatment system failure which may cause a public health nuisance or risk, or the discharge of wastes to areas other than the disposal field, without undue delay, both the Medical Officer of Health (or Health Protection Officer) and the Environment Southland Compliance Manager, as appropriate. |
| 42 | Should an adverse event occur that results in a non-compliance with the Conditions of this Consent, the Consent Colder shall notify the Environment Southland Compliance Manager immediately and shall provide a written report to the Environment Southland Compliance Manager within five working days of the Environment Southland Compliance Manager being notified. The report shall specify: |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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| | a. The cause or likely cause of the event and any factors that influenced its severity;<br>b. The nature and timing of any measures implemented by the Consent Holder to avoid, remedy, or mitigate adverse effects; and<br>c. the action to be taken in future to prevent recurrence of similar events. |
| **Wastewater Farm Environmental Management Plan** | |
| 43 | No later than three months from the consent commencing the Consent Holder shall prepare and submit to the Environment Southland Compliance Manager an updated Wastewater Farm Environment Management Plan for certification that it is in accordance with this condition.<br><br>The objective of the Wastewater Farm Environmental Management Plan shall be to detail all actions to be taken to minimise the impacts of the activities authorised by this consent and to ensure compliance with the conditions of this consent.<br><br>The Wastewater Farm Environmental Management Plan shall include:<br><br>a. a description of the contents and purpose of the Wastewater Farm Environmental Management Plan in accordance with this condition;<br>b. responsibilities and contact details of key personnel;<br>c. a summary of the plant purpose, location, layout, and wastewater management infrastructure with specific reference to the treated wastewater, biosolids, stockyards solids and paunch discharge;<br>d. a description of how the following will be managed to ensure compliance with the conditions of this consent:<br>i. disposal buffer zones;<br>ii. irrigation depths and nutrient loading rates;<br>iii. withholding periods;<br>iv. riparian planting;<br>v. monitoring;<br>vi. records of monitoring and treated wastewater, biosolids, stockyard solids and paunch application;<br>vii. reporting; and<br>viii. complaints management.<br>e. a description of how soil moisture monitoring will be used to assist in the management of irrigation, including the avoidance of significant ponding and overland flow; |

| Proposed Conditions: | Discharge of treated wastewater, stockyard solids, paunch and biosolids to land |
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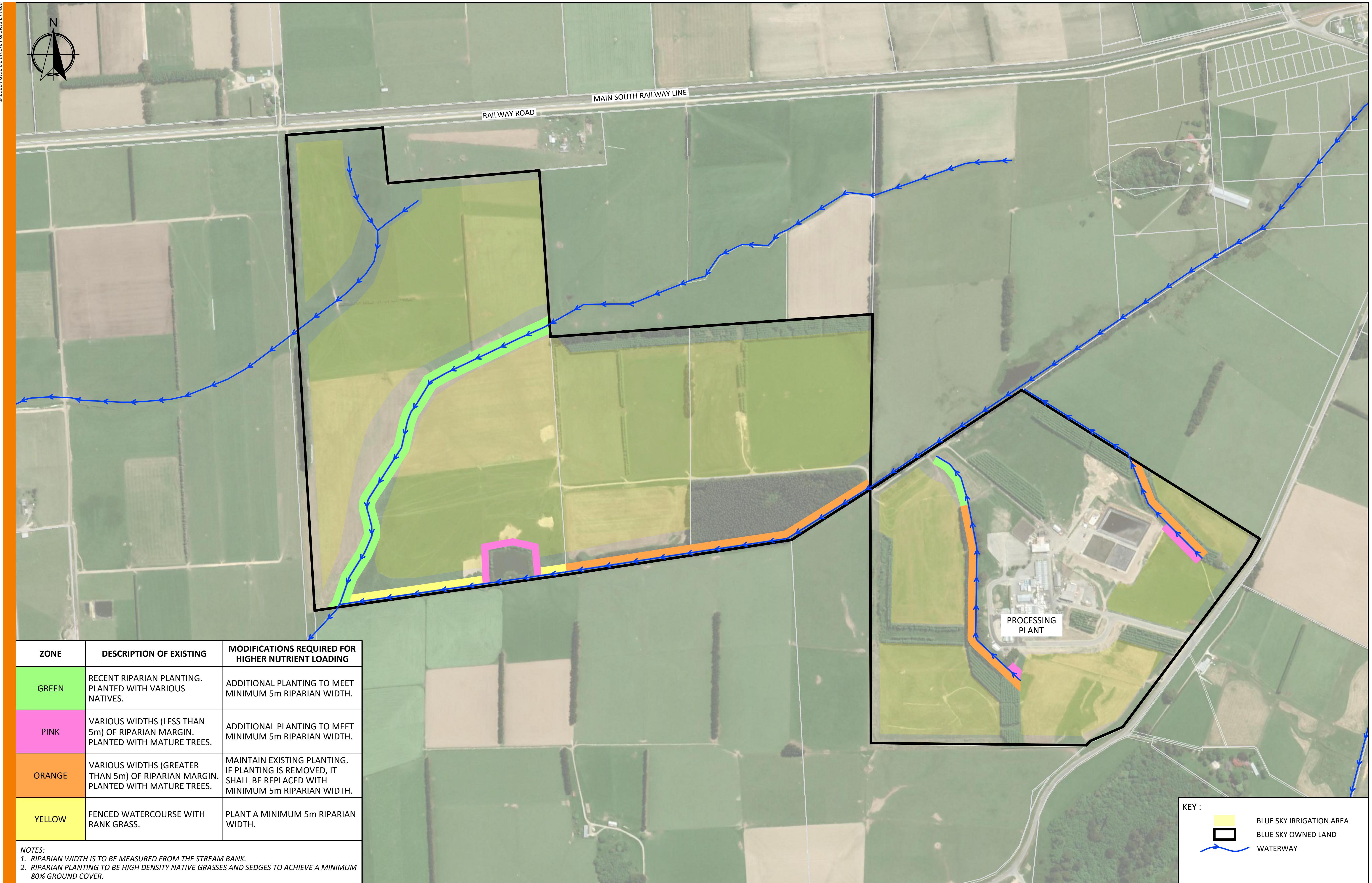
| | f. a description of how treated wastewater and/or biosolids irrigation will be managed to ensure there is no detectable spray drift beyond the property boundary; and<br>g. details of how incidents will be managed, including reporting requirements. |
| 44 | The Consent Holder shall undertake all onsite activities in accordance with the certified Wastewater Farm Environmental Management Plan, and all other conditions of this consent. In the event of any inconsistencies between the conditions of consent and the provisions of the Wastewater Farm Environmental Management Plan, the conditions of this consent shall apply. |
| 45 | The Wastewater Farm Environmental Management Plan shall be reviewed by the Consent Holder every three years. The purpose of this review shall be to confirm that the Wastewater Farm Environmental Management Plan accurately reflects current on-site activities and operations and to identify if changes to procedures contained within the Wastewater Farm Environmental Management Plan are required to achieve the objective of this condition. A written report detailing the results of the review shall be submitted to the Environment Southland Compliance Manager within 30 working days of the review being undertaken. If the review results in amendments to the Wastewater Farm Environmental Management Plan, the amended sections shall be provided to the Environment Southland Compliance Manager for certification at this time. |

**Attachment 1**

Figure 17 Riparian Planting Plan for Mitigation of Higher Nutrient Loading




| ZONE | DESCRIPTION OF EXISTING | MODIFICATIONS REQUIRED FOR HIGHER NUTRIENT LOADING |
|---|---|---|
| GREEN | RECENT RIPARIAN PLANTING. PLANTED WITH VARIOUS NATIVES. | ADDITIONAL PLANTING TO MEET MINIMUM 5m RIPARIAN WIDTH. |
| PINK | VARIOUS WIDTHS (LESS THAN 5m) OF RIPARIAN MARGIN. PLANTED WITH MATURE TREES. | ADDITIONAL PLANTING TO MEET MINIMUM 5m RIPARIAN WIDTH. |
| ORANGE | VARIOUS WIDTHS (GREATER THAN 5m) OF RIPARIAN MARGIN. PLANTED WITH MATURE TREES. | MAINTAIN EXISTING PLANTING. IF PLANTING IS REMOVED, IT SHALL BE REPLACED WITH MINIMUM 5m RIPARIAN WIDTH. |
| YELLOW | FENCED WATERCOURSE WITH RANK GRASS. | PLANT A MINIMUM 5m RIPARIAN WIDTH. |

*NOTES:*
1. *RIPARIAN WIDTH IS TO BE MEASURED FROM THE STREAM BANK.*
2. *RIPARIAN PLANTING TO BE HIGH DENSITY NATIVE GRASSES AND SEDGES TO ACHIEVE A MINIMUM 80% GROUND COVER.*



FILED: A03220205-FIG-017.dwg

pdp

0 100 200 300m

SCALE 1:7,500 (A3)



| NO. | REVISION | DATE |
|---|---|---|
| B | FOR CONSENT | JUN 22 |
| A | DRAFT | APR 22 |

SOURCE:
1. AERIAL IMAGERY (FLOWN NOV 2019) DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE).
2. CADASTRAL INFORMATION (AS AT 06/12/2021) DERIVED FROM LINZ DATA.

CLIENT

BLUESKY PASTURES

FIGURE

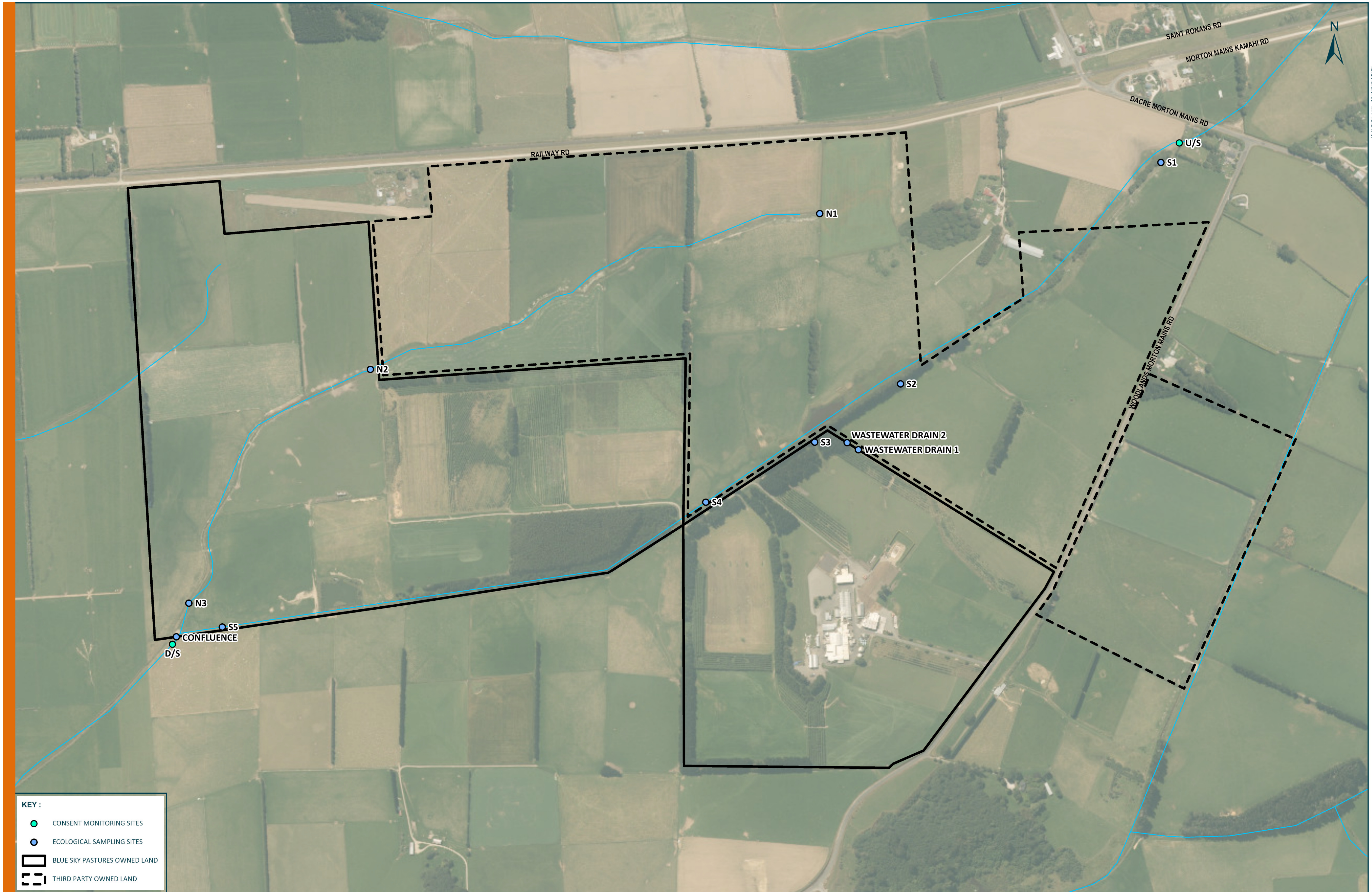
FIGURE 17: RIPARIAN PLANTING PLAN FOR MITIGATION OF HIGHER NUTRIENT LOADING

PROJECT

LAND TREATMENT OF WASTEWATER AND BIOSOLIDS - ASSESSMENT OF ENVIRONMENTAL EFFECTS

**Attachment 2**

Figure 11 Surface Water Monitoring Locations




0 150 300
METRES
SCALE : 1:8,000 (A3)



| NO. | REVISION | DATE | BY |
|---|---|---|---|
| A | DRAFT | MAR 22 | TK |

SOURCE:
1. AERIAL IMAGERY (FLOWN 2017-2020) SOURCED FROM THE LINZ DATA SERVICE www.linz.govt.nz/about-linz/linz-data-service/help/using-linz-data/attributing-aerial-imagery-data AND LICENCED FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.
2. WELL DATA SOURCED FROM SOUTHLAND REGIONAL COUNCIL REST SERVICES.

CLIENT
BLUESKY PASTURES

FIGURE
FIG 11: SURFACE WATER MONITORING LOCATIONS

PROJECT
LAND DISCHARGE OF WASTEWATER AND BIOSOLIDS – TECHNICAL ASSESSMENT OF ENVIRONMENTAL EFFECTS