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Managing noise effects from dairy factories

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ABSTRACT

Over the last six years we have been involved in the design, consenting, construction and commissioning of a number of large green- and brown-field dairy factory developments. In addition we have assisted in the statutory review process of several Local Territorial Authority District Plans with respect to the management of dairy factory noise. One interesting legal aspect is the handling of "reverse sensitivity" with regard to local communities adjacent to large dairy factory sites. This paper describes the planning framework and rules that have resulted from that work. We explain how we have been able to utilize this detailed understanding of the noise sources of dairy factories into the means to mitigate noise emissions using best practicable options. Large scale dairy factories represent an interesting challenge in terms of noise modeling and control because of both the scale of the fixed plant and the intensity of heavy vehicle traffic involved. We illustrate the issues above with reference to two specific case studies. One is a green field factory in a rural farming area. The other is the major expansion of an existing small factory immediately adjacent to a settlement and nearby town.

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1. INTRODUCTION

The New Zealand economy is heavily dependent on agricultural production for export earnings. It is therefore common place to find large industrial facilities in rural areas. Often such facilities are on the outskirts of small towns, or have even had towns grow around them. In recent years high world market prices encouraged many farmers to convert from arable farming to dairy production. This trend was of great significance to Fonterra Co-operative Group Ltd, the largest dairy producer/processor in New Zealand and one of the largest dairy exporting companies in the world. Formed in 2001 from the merger of other dairy co-operatives, Fonterra represented around 95% of all dairy farmers in New Zealand at formation (1). In order to avoid the potential for monopolistic abuse the Government placed a legislative requirement on Fonterra to accept all milk from farmers who wished to supply the Co-operative; and to also provide a significant amount of milk (currently 795 million litres) on demand to any independent processor who requested it at a regulated price

As a result, when milk production began to rise rapidly, Fonterra responded by building new processing factories at existing sites aimed at producing dairy commodities. While this included cheeses, butter, lactose and purified proteins, by far the largest volume of product produced was whole milk powder (WMP). WMP dryers capable of producing up to 30 MT/hour have been developed. In total Fonterra now collects and processes approximately 22 billion litres of milk each year.

As plans to expand sites were publicised it rapidly became apparent that there was a level of community dissatisfaction surrounding the operation of existing factories. In many case excessive and/or unpleasant noise was a large part of the concern.

2. LEGISLATIVE ENVIRONMENT

2.1 National Level - Acts

Arguably, one of the drivers of the growth of Fonterra since its formation has been the Dairy Industry Restructuring Act 2001 (DIRA) (2). It is this Act that requires Fonterra to accept milk supply

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and to in turn supply independent processors. Other than as a driver for growth DIRA is of no relevance to noise.

The overarching legislation in New Zealand with respect to the environment and amenity is the Resource Management Act 1991 (RMA) (3). This legislation requires a Local Territorial Authority (LTA) to create a District Plan. The RMA does not itself set performance standards. Rather it creates a standardised frame work for the development and review of District Plans, the assessment of environmental effects (including noise) and the review, granting and appeal of resource consents.

With few exceptions it is the responsibility of the LTA to set performance standards, appropriately zone land and enforce compliance with the performance standards for any resource consent granted.

2.2 District Plans & Resource Consents

With respect to noise a District Plan will typically define the way in which noise is to be measured and assessed, the parameters to be used and the performance standards that are to be applied. New Zealand has a range of noise standards available, as described below. Based on the level of noise generated, along with other factors such as the zoning applied to land, the nature, scale and intensity of an activity, the status of the activity may fall into different categories. Typically these are:

- Permitted – where all standards are met and no resource consent is required;
- Controlled – where the LTA must grant consent if the applicant demonstrates that relevant performance standards are met;
- Restricted Discretionary – where the LTA can have regard to only certain specified matters;
- Discretionary – where the LTA can have a wide regard for potential effects arising from a proposed activity and may set conditions that are more stringent than the underlying zone performance standard where it feels this is appropriate;
- Non-complying – where a resource consent may be granted in exceptional circumstances, where an activity is consistent with the policies and objectives of the District Plan and the effects arising will be minor; and
- Prohibited – no resource consent will be granted.

Because the RMA allows each LTA to set its own objectives, policies and performance criteria there is significant variation in these. However, as a general rule the maximum permitted noise levels summarised in Table 1 apply within the zone types listed.

Table 1 – Typical noise performance standards

Zone	Daytime		Night-time	
	dB L_{Aeq}/L_{A10}	dB L_{AFmax}	dB L_{Aeq}/L_{A10}	dB L_{AFmax}
Living	50-55	75-85	40-45	65-75
Rural	55-60	75-85	40-45	65-75
Industrial	55-60	75-85	45-60	75-85

It should be noted that there are exceptions on both the high and low side of these numbers and that there are a multiplicity of zones have characteristics that mix aspects of these basic zone types (e.g. rural residential, mixed use and rural industrial amongst others. Each LTA defines these zones as it sees fit, including variations in the definition of what constitutes night-time from 1900-0700 hours to 2200-0700 hours. Similarly, most LTA's measure and assess noise at rural dwelling notional boundaries (a line 20 m from the façade of the dwelling), but some do this at site boundaries. To complicate matters further, LTA's rely on several different versions of relevant New Zealand Standards when defining the measurement and assessment of noise.

2.3 New Zealand Standards

The measurement of noise is described by New Zealand Standard NZS6801 in versions dated 1991, 1999 and 2008 (4, 5, 6). The assessment of noise is described by New Zealand Standard NZS6802 in versions dated 1991, 1999 and 2008 (7, 8, 9). The most commonly used versions of these Standards are the 1991 version and the 2008 version. In general, as LTA's work through the mandated 10 yearly review of their District Plans, they update to the 2008 versions of NZS6801 and 6802.

Typically, those LTA's using the 1991 versions of the Standards also utilise the L_{A10} parameter although some use L_{Aeq}. Some LTA's allow averaging of noise during the daytime, while some do not.

Some LTA's penalise for special audible characteristics (SAC) such as tonality or impulsiveness, while some specifically exclude such assessment. So far, those LTA's that have adopted the 2008 versions of the Standards have chosen to do so in their entirety. In those cases L_{Aeq} replaces L_{A10}, averaging of noise emissions by up to a maximum of 5 dB is permitted during the daytime only and SAC penalties are all included to create a noise rating level defined as XX dB $L_{Aeq\ (15\ min)}$. It is this rating level that is compared directly to the District Plan performance standard or any resource consent performance standard.

2.4 Other Guidance

The RMA, and District Plans require that where an activity is discretionary a determination is made as to the scale of adverse effect that might arise. The key trigger is whether or not the resulting effect is 'minor'. Somewhat unhelpfully, minor is not defined. This judgment is left to the acoustician, those hearing a resource consent application on behalf of an LTA and Environment Court Judges to determine.

In general terms some guidance can be taken from the objectives, policies and performance standards of District Plans and guidance notes in NZS6802. As a matter of good practice however, comparison between the existing noise environment (level and character) versus the resulting environment is an important consideration. Those arguing for or against an activity may also call upon any other form of standard such as ISO, DIN, BS, AS Standards, or World Health Organization Publications. Research or conference papers may also be called upon in some cases.

The result is often a very robust, if somewhat uncertain, examination of the specifics of a particular application. For a large company such as Fonterra, with operations spread the length of New Zealand, this makes planning and design of new factories and support facilities more difficult as the range of factors and performance standards to be considered vary significantly.

2.5 Reverse Sensitivity

While District Plans are generally geared toward protecting a noise receiver from more than minor adverse effects, it is important to also consider the situation where a lawfully established producer of noise may have new, noise sensitive, activities seek to establish nearby. This is described as reverse sensitivity. Typical noise sensitive activities include residential, educational and healthcare developments. In such cases the decision maker must consider the effects on the pre-existing factory that may arise if they are subjected to complaints or enforcement activity that would not have existed prior to the sensitive activity establishing nearby.

The difficulty is that not all District Plans have triggers in palce to initiate consideration of reverse sensitivity. This places significant onus on existing activities to remain aware of proposed developments within up to 1-2 kilometers from their own sites.

3. CASE STUDIES

When Fonterra came into being in 2001 it inherited around 30 production sites spread from one end of New Zealand to the other. Some of these were already very large factories while others were small. All of these factories pre-dated the RMA. In many cases expansion had occurred progressively over a long period of time with little or no consideration to complying with what are now considered to be appropriate noise standards. Added to this, in the context of shrinking employment opportunities during the 1970's-1990's in many rural regions there was perhaps a disincentive for communities to complain about factories establishing or expanding. The creation of Fonterra enabled the industry to take a more holistic approach to the allocation of milk between factories. As mentioned above it also created pressure to create more milk processing capacity on demand.

This paper describes the outcome of these pressures using two case studies. The first is Fonterra Darfield. This is the first green-field site developed by Fonterra since 2001 and thus uniquely did not come with any existing noise non-compliances and complaint history. The second is Fonterra Pahiatua. This was a small regional WMP processing factory that at one time was considered as likely to be surplus and to be closed.

3.1 Fonterra Darfield – A Greenfield Development

Fonterra Darfield is located in rural inland Canterbury, approximately 45 minutes drive from Christchurch and 5 minutes drive from the nearby town of Darfield (Figure 1). The chosen site consisted of a large farm with established irrigation, similarly surrounded by mostly arable farms

representing around a dozen households. Within the wider Canterbury region a large number of arable farms were undergoing conversion to dairy. This was placing significant logistical pressure on Fonterra as milk had to be transported by road tanker a significant distance to other plants for processing. These other plants were themselves approaching capacity, despite having been expanded several times in the preceding decades.

Figure 1 – Fonterra Darfield location

Because of the obvious noise compliance issues that had arisen at many of these other sites over decades of development, Fonterra was determined to design and build compliance with appropriate noise standards into the Darfield factory. As Fonterra had recently constructed a large new WMP factory and associated boiler and support facilities (including a rail spur) at Edendale in Southland, we decided to closely study Edendale in preparation for our involvement with the proposed Darfield factory.

Edendale is Fonterra's oldest and largest production site and is one of the largest food production sites in the southern hemisphere. A fleet of 65 milk tankers collects 2.4 Billion litres of milk per year producing a total of 420,000 MT of product – mostly WMP (10). The newest dryer, ED4, is the world's second largest, producing 28 tonnes per hour. In all the site employs 600 staff.

By detailed measurement and analysis of Edendale we were able to create a robust and verifiable SoundPLAN model of the Darfield site. Fonterra's modelling of milk supply in Canterbury at that time suggested that there would be pressing need for a new plant to be operative within two years of commencing design work and that a second plant would be required within five years. Our design brief was to allow for a total of 4-5 plants at the site, although not all would necessarily be WMP plants. For budgeting purposes we opted to model all future stages as WMP plants, as these have the largest noise foot print in our experience.

1. Our initial model allowed for two WMP dryers (16 and 30 tonne/hour);
2. Two boilers (30 and 45 MW);
3. A milk tanker arriving or departing every 118 seconds on average, with a 37 tanker shift change every 12 hours;
4. Rail movements at night with the commencement of Stage 2; and
5. Allowance for the plant to at least double in size again.

3.1.1 Noise sources

Analysis of the Edendale ED4 dryer project and the wider site showed that when translated to the proposed Darfield site the following noise sources were of critical importance – these are ranked with the source of greatest contribution first:

1. Milk tankers and general traffic;
2. Rail activity (engine run-up for brake test);
3. (Un)loading of rail rakes using large container stackers;
4. Rail activity – moving on siding;
5. Cooling towers;
6. DAF (dissolved air flotation) plant;
7. Boiler stack;
8. Tanker wash; and
9. Steam delivery pipes ringing.

This analysis immediately raised two red flags with us when considering traditional dairy factory designs. The first was that many of the most significant noise sources related to transportation and material handling. Traditional dairy factory noise design had focused exclusively on noise generated by mechanical plant such as fans and pumps and yet even the worst of these was well down the list of significant contributions. The second was that with the Edendale ED4 design, the main dryer stacks and HVAC air intakes did not contribute to the overall noise emissions significantly and neither did building breakout from the main dryer enclosure. These items are frequently problematic at other sites.

Further analysis revealed that somewhat fortuitously the main design and build contractor had increased the specification on the dryer attenuation, while in the case of the HVAC air inlets the high level of performance was more a matter of building design than particular treatment. This underscored to us that it was possible to design relatively quiet plants, whereas in the past it was frequently maintained that dryer buildings were inherently noisy. Another feature of Edendale ED4 was that the main dryer building was built from 150-180mm concrete tilt slab with no windows (this latter feature was to prevent light spill to the nearby state highway). In the past many dryer building had been constructed from steel skinned EPS panels. Not only are these poor providers of sound insulation, but when the radiating surface area becomes very large they are problematic as noise sources. The tilt slab construction had been selected for structural reasons in this instance, but had proved extremely valuable from a noise control perspective.

This preliminary analysis convinced us of two things. That it was possible to build and operate the proposed number of stages on the Darfield site, but not at either of the two locations initially proposed (shown as red donuts on Figure 2). Instead, following a discussion with Fonterra's environmental and capital projects teams, the decision was made to construct the site at the location shown in Figure 2. The large white roof is the dry store with the dryer to the right. Note that dwellings are situated close to both of the sites initially proposed. The relocation of the factory location on the site increased separation to the nearest dwellings by approximately 500 metres and also allowed significant separations of the road and rail on site from the nearest dwellings.

Figure 2 – Fonterra Darfield under construction with alternative locations indicated.

Fonterra Darfield dryer 1 can be seen in Figure 3. Note the absence of windows and the large attenuators on the dryer stack discharges. Dryer 2 construction has just commenced in that photograph (foreground). The Darfield 1 boiler can be seen in the background to the left.

Figure 3 – Fonterra Darfield dryer 2 under construction (dryer 1 in background) image courtesy Fonterra

3.1.2 Compliance & noise effects

Our modelling of the Darfield site stage 1 & 2 development, using an enhanced version of the Edendale ED4 project, and combining allowance for tankers and other activities not considered at Edendale, yielded the noise contours shown in Figure 4.

Figure 4 – Fonterra Darfield noise contours for stages 1 & 2 plus tanker shift change while loading rail.

The nearest dwelling (circled) receives less than 35 dB L_{Aeq} during peak tanker shift change, even with rail loading and all plant in production. This is well below the resource consent performance standard of 45 dB L_{Aeq} during the night-time and allows sufficient additional budget for future expansion at the site and also increased rail movements (contour not shown).

This has been confirmed by repeated compliance monitoring that demonstrates that under light downwind conditions the noise emissions from the site are within 1-2 dB of those predicted.

An important consideration when modelling and assessing industrial noise is that under the RMA certain activities are exempt from compliance with District Plan noise standards. These include vehicle traffic on public roads and rail traffic operating within a rail designation (essentially the publicly owned rail corridors). However, it is also a requirement that the effects (positive or negative) of any such additional road or rail traffic are considered. Thus, when modelling sites such as Darfield, we include all road and rail movements that occur within the site for assessment against the compliance standard. However, for those movements that occur on the public road and rail network, we are required to assess the resulting change in noise level, the absolute level with respect to the potential for adverse effects (such as sleep disturbance or serious annoyance) and the objectives and policies relating to the zoning of the surrounding area.

This was a significant issue that was addressed during both the stage 1 and stage 2 consent processes. In the context of the RMA we concluded that the adverse noise effects arising from the off-site transportation were less than minor because:

- The average road and rail noise was not increased by more than 2 dB, even at peak times;
- Each potentially annoying rail event was able to demonstrate that no SAC was generated and that the night-time L_{AFmax} at the nearest dwellings was unlikely to cause sleep disturbance; and
- That the character of additional vehicle movements on the state highway was substantially the same as existing vehicle movements (This particular highway carries significant heavy vehicle traffic as the main road link between the South Islands east and west coasts).

An additional, non-noise, argument was also that the purpose of roads in rural production areas is to provide transportation for materials arriving at farms and to remove goods, such as milk from farms.

3.1.3 Annoyance noises

One critical lesson learned at Edendale was that community reaction to industrial noise could be substantially mitigated by treating any distinctly noticeable noise source. Examples of this at Edendale included squeaky coal conveyors, compressed gas discharges and numerous small fans with tonal components. While the site as a whole was not able to be brought into strict compliance without replacing two old boilers completely, through elimination of all ‘noticeable’ noise emissions, leaving only broadband noise sources there was a marked drop in community noise complaints.

Together with Fonterra and the design/build contractors we diligently eliminated such noise sources from the Darfield design. The only complaints to date have arisen from the container stackers used to load rail wagons. These were fitted with both reversing alarms, which were disabled and replaced by visual warning devices (the area is also restricted access) and cab movement alarms, which were also disabled

3.2 Fonterra Pahiatua – A Site Expansion

Subsequently to the completion of the Darfield stage 2 development, Fonterra embarked on the expansion of the existing, somewhat elderly, factory near Pahiatua (Figure 5).

Figure 5 – Fonterra Pahiatua location.

At the time that design work began, Fonterra Pahiatua had two WMP dryers (3 and 5 tonne/hour) and a gas fired boiler. The expansion sought to add a third 14 tonne/hour WMP dryer, modelled on the Darfield dryers, an additional 30 MW gas boiler and a substantial reconfiguration of the existing site.

While arguably compliant with District Plan noise standards (there was some debate around application of SAC), the existing factory generated a particularly unpleasant and noticeable tone at 250Hz, which was audible over a significant distance. The community reaction to the thought of a significant expansion of the site could be described as mixed at best. Residents worst affected by noise were those of the village of Mangamutu which is directly across the road from the factory, However, residents of farm houses on the ridge above the site (roughly level with the top of the dryer building) also expressed dissatisfaction with the existing site.

3.2.1 Site investigation

Following a detailed survey of noise sources and emissions from the site we developed a detailed calibrated noise model for the existing factory. Using receiver locations at complainant dwellings, we were able to confirm that the source of the marked tonality was primarily the dryer 1 stack discharge. We were also able to demonstrate that at least a 5 dB reduction in noise could be achieved through treatment of three dominant noise sources.

1. Dryer 1 stack;
2. Dryer 2 stack; and
3. HVAC Process air inlets for both dryer 1 and dryer 2.

Dryer 1, the oldest of the two existing plants, lacked both a noise attenuator and any particulate emission control. Dryer 2 did have an attenuator, retrofitted some decades previously. While performing as designed, this attenuator provided only moderate noise reduction. The HVAC inlets at Pahiatua are unique in our experience. Air for both dryers is drawn through six large tunnels, each approximately 3x3m in area and several metres deep. Rather than large centrifugal fans as found on other sites, each tunnel contained a four bladed variable pitch constant speed propeller – essentially an aircraft propeller. Other than a simple weather louvre and air purification filters there was no noise mitigation.

As the development plan was to construct a third WMP dryer of similar scale to Darfield dryer 1, we were able to incorporate the as-built model for that dryer into the model for the existing Fonterra Pahiatua site. This demonstrated that in order to achieve compliance post expansion we would need to reduce the total existing site noise emission by at least 5 dB.

The solution chosen was to fit large rectangular attenuators to the discharge stacks of both dryers, capable of achieving an insertion loss of at least 21 dB in the 250 Hz octave band. To be effective, it was also necessary to retrofit dryer 1 with equipment to control particulate emissions. Given the age of the building the addition of a total of 6 tonnes of noise and particulate control equipment to the roof was a non-trivial exercise. After evaluating several options including the replacement of the HVAC constant speed fans with centrifugal units, the final decision reached was to custom build attenuator splitters in sections that could be carried up the exterior access stairs an installed inside the HVAC tunnels. No significant pressure drop could be tolerated and at least 11 dB insertion loss was required in the 250 Hz octave band. The contractor was able to achieve this and completed the design and installation within 6 weeks

3.2.2 Compliance & community reaction

Noise contours for the pre-existing Fonterra Pahiatua plant and tanker shift change (peak 15 minute period) are provided in Figure 6. These contours do not reflect any penalty for SAC. As a result of the strong 250 Hz tone a 5 dB penalty would be applied. Figure 7 shows the predicted post-development noise contours, including noise mitigation as described above. The as-built noise model is still under preparation, however compliance and commissioning measurements made over the first production season suggests that the outcome is a good reflection of this model with the noise level achieved being typically within 2 dB of that modelled. We note that late in the design phase of the project the decision was taken to relocate and reduce the size of the dry store, move the new dryer slightly eastward and move the new tanker access slightly northward. While this results in localized changes to the noise contour, at Managmutu to the south and east and at the farmhouses to the north of the site the contours remain an accurate reflection of the result.

The result is that the site has increased production from 8 to 22 tonnes per hour at peak capacity while achieving typical noise reductions at nearby dwellings of 1-3 dB. Most importantly, the harsh and unpleasant 250 Hz tone is now completely absent. The resulting sound scape is such that the best way to verify that the dryers are operational is to check whether the rain covers on the stack discharge

are open. Even those residents who submitted in opposition at the resource consent hearing have subsequently expressed satisfaction.

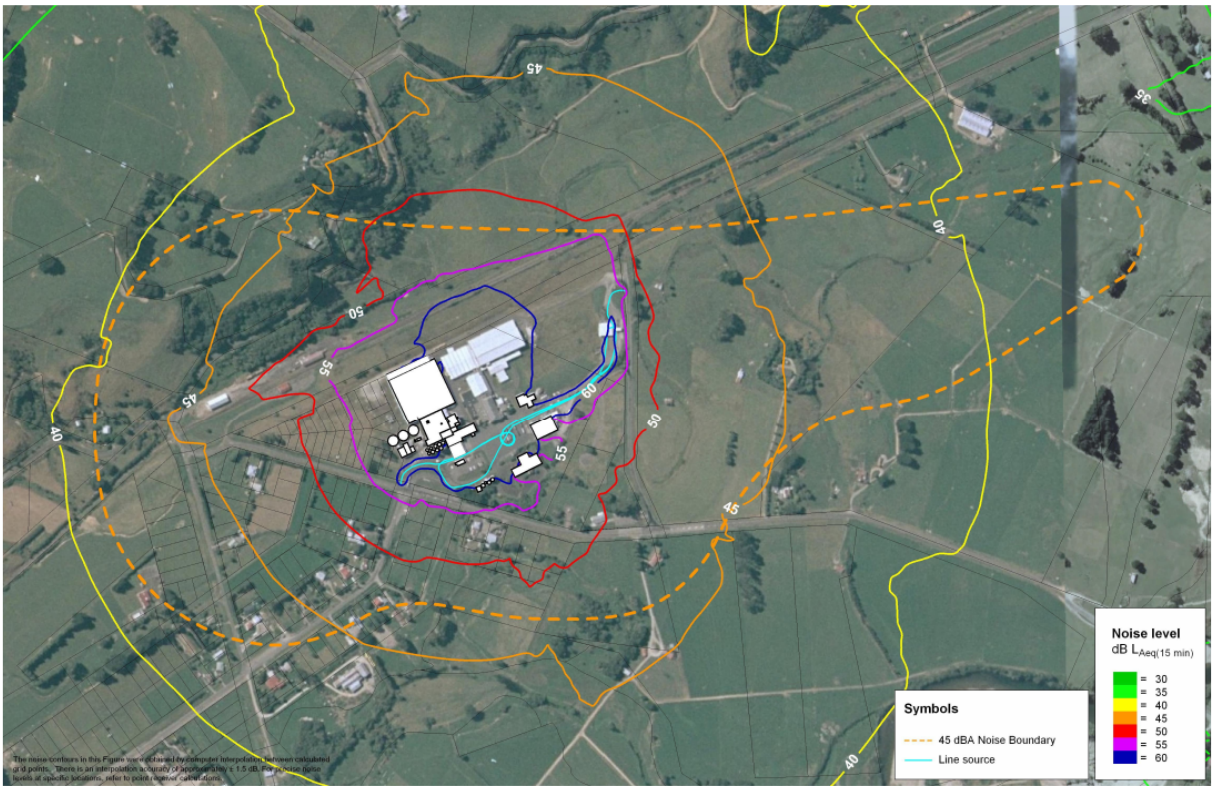

Figure 6 – Fonterra Pahiatua plant + tanker shift change noise contours prior to expansion.

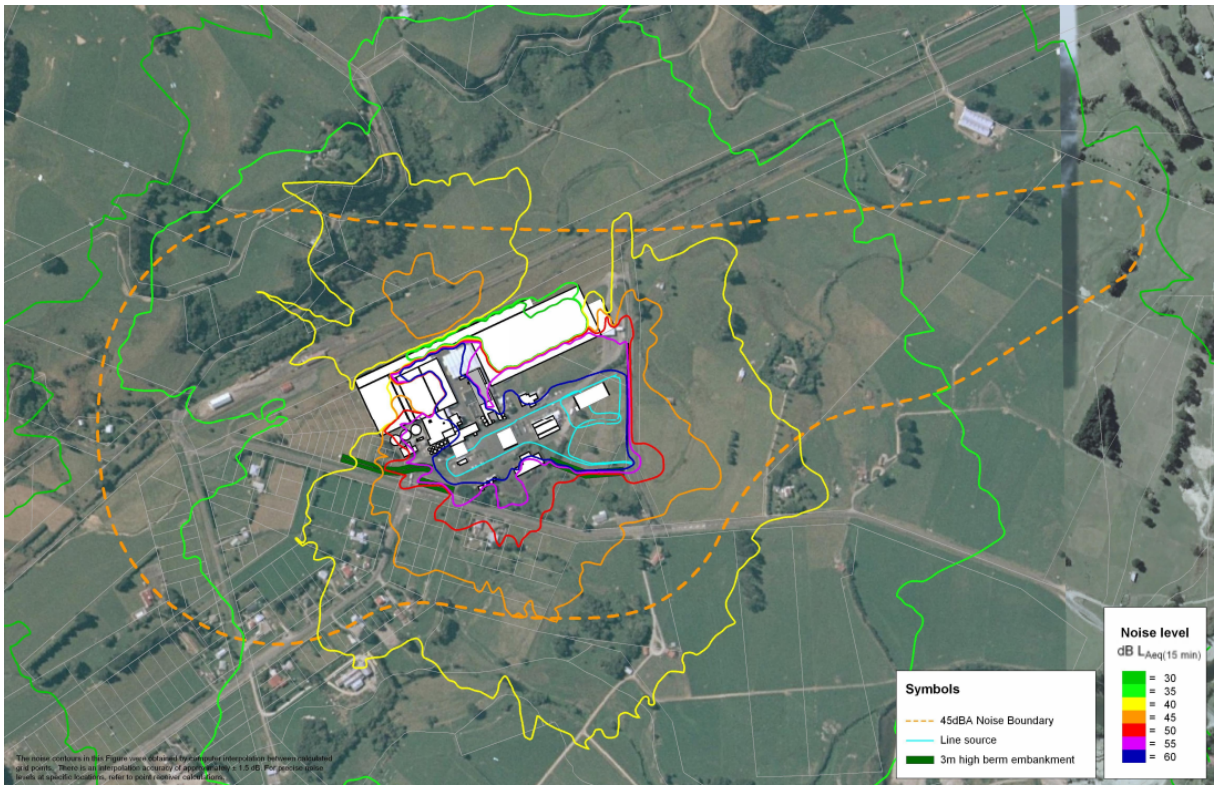

Figure 7 – Fonterra Pahiatua modeled plant + tanker shift change noise contours after to expansion.

Note: the dashed orange line in both Figures 6 and 7 represents a trigger for consideration of application of specific noise limits based on the date of dwelling construction, not the location at

which a specific noise limit is necessarily applied.

4. LOOKING TO THE FUTURE

As stated earlier, the last five years has seen the authors involved in eight large scale dairy developments for Fonterra, along with numerous smaller projects for both Fonterra and other dairy companies establishing in New Zealand. This has provided us with a significant opportunity to establish, through robust resource consent processes, what noise effect outcomes are considered acceptable by both LTA's and the local communities affected.

Under the RMA it is a requirement that LTA's undertake a review of their District Plans at least every 10 years from the date the last plan became operative. These District Plan reviews are normally comprehensive in nature and typically take between 1-4 years, depending on the review strategy chosen and whether any proposed changes are contentious. The majority of LTA's around the country are currently undertaking reviews, or are about to do so. Based on the experience gained over the last five years Fonterra is endeavouring to establish a unified framework for the assessment of effects arising from its dairy factories.

As it impossible to internalise the noise effects from such large factories, especially where the community is already in close proximity, the consideration of future land zoning and reverse sensitivity has taken centre stage in our thinking. This strategy is based on Fonterra seeking to be a good neighbour, while also ensuring that they can carry out their business in an efficient manner and protect the financial investment in the sites which can amount to many hundreds of millions of dollars. Such investments assume plant life of many decades, well in excess of the District Plan review cycle. Ensuring that very robust objectives, policies and performance standards are in implemented in the current round of District Plan reviews has thus become a high priority.

4.1 Underlying Assumptions & Principles

We have assumed that the following discussion applies to large rural industrial sites. We do not consider this necessarily a suitable proposed rule framework for either small industrial sites or for large sites within urban or peri-urban settings. Rural settings for large industries embody specific circumstances. Namely that the environment is normally already substantially modified by significant transportation networks (State Highways and Rail), the number of dwellings potentially affected is generally relatively small and separation distances are often large, but can be as little as the width of a road reserve in some cases.

We have developed the following principles to inform our approach to future development when working with large scale industries such as dairy factories:

- Rules should provide certainty to both the factory and the community.
- Wherever possible no dwelling or noise sensitive activity should be exposed to greater than 45 dB $L_{Aeq\ (15\ min)}$ during the night-time.
- Where an existing factory exceeds the noise standard at a dwelling or noise sensitive activity any future 'creep' of noise emissions should be halted.
- For factories of any significant scale, and especially those which are likely to be expanded in the future, noise contours should be used to establish a noise control boundary (NCB).
- These NCB's should be regularised in shape as much as possible to reflect the extent of the 45 dB L_{Aeq} contour, while also following easily identifiable features such as roads, railways and property boundaries. This is to aid night-time compliance work and make it easy for existing and future property owners to understand exactly where the potential for adverse noise effects may lie.
- Factory noise within bedrooms should ideally be no more than 30 dB $L_{Aeq\ (15min)}$ and must not exceed 35 dB $L_{Aeq\ (15min)}$.
- Where a dwelling already exists within the NCB, the factory will take, or appropriately assist the dwelling owner to achieve the applicable internal noise level.
- Where someone seeks to establish a new dwelling within the NCB, they will be required to undertake appropriate sound insulation work including ventilation where appropriate.
- No new dwellings to be established inside a 55 dB $L_{Aeq\ (15min)}$ contour as even satisfactory outdoor amenity can be provided.
- Provided that noise and other performance standards are met, the site is able to expand or modify as a permitted activity (i.e. no resource consent required).

4.2 Resulting District Plan Framework

In order to effectively implement these principles, LTA's should adopt objectives that establish a rural industrial zone or overlay to a rural zone and which adequately describe the activities that may be expected within the zone and the resulting amenity expectations. This also requires that surrounding land not in the rural industrial zone or overlay is described in a manner that enables say farming activity, or perhaps low density living such as lifestyle blocks, but which discourages intensive housing and creates a slightly relaxed expectation for amenity consistent with the various performance standards. Next policies must enable the creation of NCB's as a means of enforcing noise performance standards and triggering reverse sensitivity considerations such as sound insulation requirements for noise sensitive activities. Finally, a set of appropriate performance standards that are based on the principles above must be developed.

An example of the end result of this process is illustrated in Figure 8. This is an Outline Development Plan (ODP) that is in the Selwyn District Plan for the Synlait dairy factory, another client of Marshall Day Acoustics. In essence it demonstrates the containment of future noise effects (as represented by the NCB) while showing the location of key road and rail infrastructure and maximum building heights within the site (the buildings themselves are not shown).

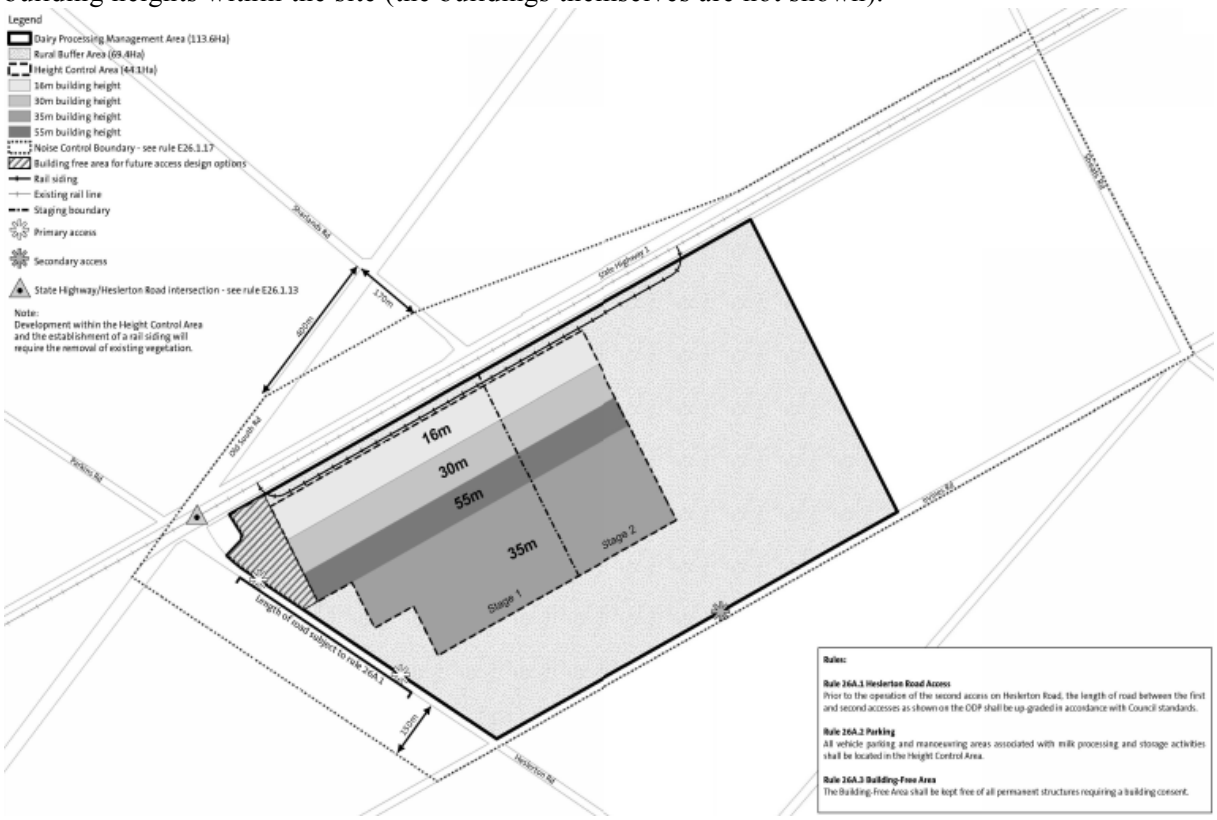

Figure 8 – ODP for the Synlait dairy factory in Selwyn (NCB shown as dotted line).

There are two noise rules that accompany the Synlait NCB. In summary these are:

1. That noise arising as a result of any activity shall not exceed 55 dB L_{Aeq} (daytime) and 45 dB L_{Aeq} (night-time) at the NCB shown on the ODP; and
2. Rail movements into, within and out of the Dairy Processing Management Area are excluded from compliance with the above rules, although this exclusion does not apply to the loading or unloading of goods.

The basis for the rail noise exemption on site is that in order to have the ODP and NCB created, a comprehensive assessment of noise effects had to be submitted to the LTA as part of the application. This involved a District Plan change hearing in the case of the Synlait site, although at other sites a resource consent hearing would possibly suffice. Having established that the adverse noise effects arising from a limited number (1-2) of rail movements at night were acceptable, the easiest control mechanism to place on a site is a restriction on the number of such movements, rather than a noise limit. Nearby residents can easily count trains to verify compliance.

For future work at other locations we are proposing a comprehensive suite of sound insulation rules to accompany the NCB and the compliance noise standards in order to achieve the outcomes described in Section 4.1 above.

5. CONCLUSIONS

Having undertaken a significant number of large scale dairy factory projects, including design, modelling, consenting and commissioning, we have demonstrated to clients the value of using detailed calibrated noise models. Key benefits include the ability to quickly identify the causes of excessive noise and tonality and quantify the level of treatment required for individual noise sources. Alternative design or mitigation options and plant layout changes can be rapidly evaluated to arrive at an optimised site design.

Final noise contours and the accompanying assessment of noise effects can be used to develop a noise control boundary that is readily understood by all stakeholders and that provides a clear trigger location for compliance, reverse sensitivity and sound insulation actions.

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