Hilltops Free Range Eggs
Rangelands Assessment

Property Address:	Reynoldsdale, 1056 Lachlan Valley Way, Boorowa NSW 2586
Local Government:	Hilltops Shire
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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
SCL190423	Draft	19/04/2023	J. Price		
SCL190432	Draft V1	26/04/23	J. Price	Dr S. Tait	J. Price
SCL190432	FINAL	8/05/2023	J. Price		J.Price

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1 Introduction

Scolexia have been engaged by Hilltops Free Range Eggs to undertake an assessment of the potential impacts of stormwater quality from the land use (Free Range Eggs) to satisfy the stormwater requirements of the Secretary's Environmental Assessment Requirements' (SEARs) (triggered by the drinking water catchment overlay) and Hilltops Council.

The SEARS requirements include:

- an assessment of potential impacts on the quality and quantity of surface and groundwater resources
- details of the proposed stormwater and wastewater management systems (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.

The council requirements include:

- Stormwater Quality –a report / letter from a qualified person to confirm that the run-off from range areas will not impact on drinking water quality.

The following report will review the current practices undertaken on the site, identify bird behaviours that influence manure and nutrient deposition, identify potential nutrient loss pathways and review the risks to surface and groundwater based on site specific characteristics (Siting, design and management). The report will then identify any mitigation strategies to assist in minimising the potential risks to surface and groundwater and identify the overall risk to the surface and groundwater and subsequent drinking water catchment.

2 Background- Production site overview

Hilltops Free Range Eggs operate a site located at 1056 Lachlan Valley Way, Boorowa NSW 2586.

The production system accommodates a maximum of 30,000 birds in a free range system. The birds are housed in groups of 900 birds in a mobile caravan system which are constructed with open based flooring. There are 2 to 3 caravans per flock with a total of 33 caravans available for use. The feed and waterers are also mobile and are located outside of the caravan. Water is supplied from rain and bore water.

The caravans and associated infrastructure (water/feed) are moved every week in summer and every 2 weeks in winter to distribute the manure and maintain groundcover.

The distance between caravans is maintained at 150m and the birds have unrestricted access to the caravans at all times. The flock return to the caravans at night time.

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Currently the poultry ranges are divided into 13 paddocks across 114ha with the total property area of 380ha. Each flock occupies sun divisions within the 13 paddocks. The birds have a low stocking rate of 45 birds/ha. The remaining non range area is utilised for grazing of sheep and feed crops such as oats, Japanese millet, and wheat. This area could be alternated with the current range area if required in the future.

Mortalities are collected on a daily basis and stored in a chiller prior to disposal at Jugiong landfill. There is no burial or composting proposed on the site.

The range areas are located on land with a slope of 2-3% with groundcover maintained above 80%.

There is one named watercourse, Geegullalong Creek to the west of the range areas, which flows intermittently. There are a number of drainage lines/ topographical depressions in the eastern half of the Site which also flow intermittently. Boorowa River flows 7km to the south.

The nearest sensitive receptors (neighbours) are located over 1km away from the ranges.

The property report generated by NSW planning portal indicates that there are no overlays identified relating to flooding/inundation, fire, or wetlands on the site. There are, however, overlays relating to drinking water catchment (which triggers designated development), groundwater vulnerability and terrestrial biodiversity.

The groundwater vulnerability mapping and terrestrial biodiversity is identified across a small section of the property and is not located in the range areas. The drinking water catchment is identified as impacting the majority of the site. Further details on the site context are provided in the scoping report.

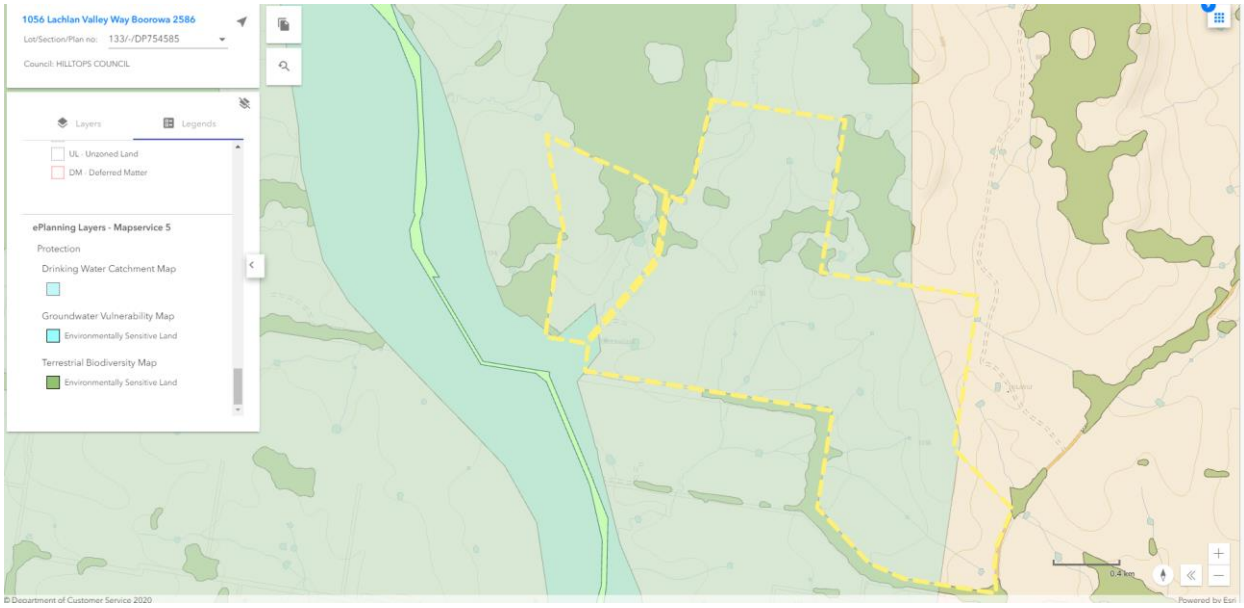

Figure 1. Overlays affecting the property (NSW, eplanning, 2023)

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Due to the drinking water catchment overlay impacting the site, the following report focuses on the land use, (siting, design and management), water quality risks and potential impact on the drinking water catchment.

3 Manure Deposition on Free Range Farms

To assess the risks, an understanding of bird behaviours and manure deposition is required.

Manure is deposited on a free-range chicken meat farm in two locations: the shelters and the range area. In regard to manure deposition, birds behaviourally produce a significant component of manure deposition when drinking and eating. This generally occurs when the birds are in the shed when feed and water are provided. Birds are normally confined to sheds for around 12 to 16hrs a day. Peak feeding time is when the majority of manure produced from the bird is deposited within the sheds.

On Hilltops farm the birds are provided with vermin proof feeders and waterers located outside of the caravans and the caravans have an open floored base. The birds also have unfettered access to the ranges which means the birds will be in the caravan during the dark hours (i.e, approx. 12 hours). As a result of the behavioural characteristics, the deposition of manure on the range is expected to be split between r the caravans (underneath), feed and water infrastructure, and the range area. Minimal deposition is expected to occur further away from the infrastructure.

Although birds have daily access to the range areas, there are many factors that influence the use of the outside areas such as flock behaviours, bird status, fear, comfort and access to vegetation, food and water. For example, during periods of high ambient temperatures, the birds will minimally access the range area as is the case under inclement weather. Similarly, birds will avoid the range area under the threat of airborne predators. These factors not only influence whether birds go outside the sheds but also the distance and areas they range in. This in turn influences the nutrient deposition rates and patterns in the range areas. Birds moving further into the range will spread nutrient deposition across the wider range area.

In commercial flocks there is a large variation in the frequency of birds present on a range at any given time with smaller flocks having a greater use of the range. The smaller flock sizes used in Hilltops Free range in each paddock should result in a majority of birds accessing the ranges. This may lead to the likely smaller proportion of the nutrients deposited on the range to be distributed further away from the infrastructure than would otherwise be the case with commercial fixed shed free range operations where the majority of nutrients are generally seen within the first few metres of the sheds. Soil monitoring will allow a more accurate depiction of nutrient deposition across the range.

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Depositing the majority of the nutrients around infrastructure has a higher risk of hotspots if not carefully managed. An advantage of this, however, is that relocation of the infrastructure regularly provides a level of control over the distribution of the nutrient more evenly across the range and rejuvenation of the groundcover (reduced erosion and nutrient loss). Monitoring will provide a more accurate indication of site-specific manure distribution across the range areas.

For Hilltops Free range site, we have determined the nutrient deposition on the range to be 100% of nutrients excreted due to manure deposited in the caravans (mesh floor), outside infrastructure and unfettered access to the range.

4 Manure Nutrient Estimation

The estimation of total solids and nutrients has been based on values averaged from digestibility and nutrient balance modelling using EggBal (not published), (MAF, 2012) and (ASABE, 2005) (LDMOPF,2020). For the purposes of the report Nitrogen (N) and Phosphorus (P) are the focus due to their potential environmental implications regarding water quality impacts.

Table 1. Estimation of total solids and nutrients as excreted per bird place (Source LDMOPF, 2020).

Species	TS kg/year	VS kg/year	N kg/year	P kg/year	K kg/year
Layer	6.87	5.00	0.584	0.175	0.212

Table 2. Estimation of total solids and nutrients for the whole site and per caravan.

	TS/kg/year	N/kg/yr	P/kg/yr
30,000 birds	206,100	8,760-14,046	5,250
900 birds	6,183	210-420	158

**For N calculations a range of 20-50% losses have been shown.*

Note: N losses are likely to be at the high end of the possible range (i.e, deposition at the low end of the range estimated in Table 2. due to atmospheric exposure and subsequent volatilisation.

Based on the estimation, the expected nutrient across the whole available range area of 114ha is approx. 76-122kg/N/ha/year or 46kg/P per ha/year. The N and P are within acceptable agronomic application rates. However, monitoring will confirm this, because a mass balance estimation approach does not take into consideration the effects of soil assimilation, microbial activity etc which may reduce nutrient availability for losses.

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It should be noted however that the manure is not evenly distributed across the 114ha and thus a better indication of nutrient deposition would be to divide the birds into their 900 bird flocks per caravan which are rotated weekly to give an indication of potential nutrient deposition.

As the exact proportion of manure deposited in the caravans is unknown, an assessment of a number of scenarios based on weekly and fortnightly movements have been reviewed. The scenarios include manure deposition of 100% under the caravan, 50:50 caravan and infrastructure and 30% infrastructure, 50% caravan and 20% in the outer ranges.

Table 3. Estimation of nutrients based on weekly and fortnightly rotations (100% under the caravan, 50:50 caravan and infrastructure and 30 infrastructures, 50 caravan and 20 outer ranges).

900 birds	kg/N/week	kg/N/2weeks	kg/P/week	kg/P/2weeks
100*%	4-8	8-16	3	6
50:50%**	2:2	4:4	1.5:1.5	3:3
30:50:20%**	1:2:0.8	2:4:1.5	0.9:1.5:0.6	1.8:3:1.2

*Used 20-50% range N losses **Used 50%N losses

From the above estimations, if all manure was deposited in the same spot for a week, the nutrient additions are very low compared to other grazing livestock such as cattle i.e., 1 cow adds 59 kg N/year or 32kg P/year (ASABE, 2005) or 1.1kgN/week or 0.6kg P/week.

5 Nutrient Loss Pathways

5.1 Surface Water Run-off

Nutrients can be exported in surface water run-off in a dissolved form or attached to soil particles (erosion) during stormwater events. When nutrient levels are in excess of soil or vegetation requirement, nutrients can travel off site to nearby waterways/waterbodies as overland flow or via drainage lines and gullies.

If nutrients are not managed, and were to enter waterways in large amounts, these may cause eutrophication in waterbodies (creeks, rivers, dams, lakes etc). This may promote the growth of algae including toxic blue green algae.

The site is located within the water supply catchment of the Boorowa River which is located 7km to the south of the property. Geegullalong creek is located to the west of the site and there are a number of drainage lines on the eastern side of the property. The site has no other riparian or wetlands identified on site and is not subject to flood prone land (no flood overlays on the site).

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The distance to waterways plays a major determining factor in the potential for nutrient and other contaminants to enter waterways. As the distance increases, adsorption of dissolved nutrients in surface runoff increases, as does the likelihood of sediment deposition and an associated reduction in particulate bound nutrients. Sediment deposition is dependent upon decreasing energy of runoff waters through runoff modifying features, groundcover, or decreasing slope. The lower energy of runoff waters is also associated with increased infiltration, and thus less nutrient laden water being available for runoff. (AEL, 2018)

No caravans or infrastructure are located within 100m of the waterways. Enacting a separation of the caravans and infrastructure to the drainage lines will further reduce the risk of nutrient movement from the site. The nearest soil mapping (RC_CT_la006_Boorowa, espade) indicates that soils appear to be moderate to well-draining yellow chromosols which will minimise the potential for overland flow.

Annual mean rainfall in Boorowa according to BOM (accessed 24/04/23) is 612mm. Lower rainfall climates are more suitable for free range systems with the Free range pig industry suggesting suitable areas being that below 760mm. Low rainfall minimises overland run-off, reduces nutrient pooling and minimises soil displacement (erosion).

Having a low slope of 3% as indicated facilitates drainage but assists in reducing the velocity of water movement across the surface allowing infiltration and reduced run-off.

Having groundcover maintained at over 80% on site as indicated will further minimise nutrient movement via both overland flow and through erosion. Grass cover is the most effective vegetation to create vegetative filter systems/strips that also trap the soil particles and reduce the velocity of flow allowing water and nutrient infiltration and uptake rather than run-off. In areas amended with poultry manure, Chaubey et al. (1995), found vegetative filters reduced TKN by 81% and TP by 91%. (AEL, 2018).

An approximation of this effect can be demonstrated by assuming that the distance between nutrient sources and waterways is roughly equivalent to a vegetative filter strip (81% reduction in TKN, 90% reduction in P for a width of 21.4m) (Chaubey et al., 1995 – see Chapter 4: References). This allows calculation of residual risk based on distance from the waterway. Using the lower reduction rate (~80% for N) and applying an efficiency factor of 50% to account for the un-managed nature of the area results in the following residual risk.

Table 4. Estimation of total solids and nutrients for the whole site and per caravan (Source AEL, 2018).

Distance to waterway (m)	Estimated residual nutrients
30	49%
100	9%
200	1%

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5.2 Groundwater leaching

The risk to groundwater is influenced by a range of features of the site such as hydro- geology, depth to groundwater, soil type and the existing quality of the ground water. Nutrients in ground water can also influence surface water where shallow aquifers are linked to the surface water system. (AEL, 2018)

There is an area on the farm mapped as groundwater vulnerable, however no range areas are located in this area. A bore on site is said to be 20m. Groundwater is mapped as low to moderate productivity (national maps, 2023). Sandy loam soils underlain with clays will reduce leaching potential into the groundwater.

Ensuring low nutrient levels (through monitoring) coupled with the indicative soil type on site, along with deposition distribution (regular rotations) and low rainfall (as indicated by BOM) will minimise manure/nutrient build up and subsequent leaching potential into groundwater.

5.3 Soil Degradation

Soil structure decline and bare ground can increase nutrient losses through increased erosion.

Maintenance of groundcover is the best strategy for minimising soil erosion. Groundcover is made up of materials that cover the immediate surface of the soil (e.g., grasses and dead plant material). This material protects the soil from wind and water erosion by reducing the erosivity potential of rainfall, slowing flow rates and improving infiltration rates.

Nutrients will be regularly monitored in the range areas, and the caravans relocated to distribute the nutrients more evenly. A number of management and mitigation options are proposed to address soil degradation and nutrient risk including regular relocation of the caravans and infrastructure, along with maintenance of groundcover.

The soil in the area is indicated to be a Sandy loam over clay. This will enhance infiltration and reduce overland flow and erosion. Erosion hazard has been identified as slight (espade, 2023).

5.4 Topography

Steep slopes of over 10% are potentially more susceptible to erosion and nutrient loss. A gently sloping site will generally have enhanced drainage and low erosion potential. Free range areas are ideally located on gently sloping land which helps in avoiding waterlogging and localised flooding. Features that facilitate run-off such as drains and gullies need to be managed or avoided in range areas. In the broader landscape, it is ideal to locate free range areas where visual barriers (hills or ridges) block the line of sight between roadways or nearby infrastructure. (AEL 2018)

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The range areas are located in an area of approximate 3% slope. The slight slope facilitates drainage but assists in reducing the velocity of water movement across the surface allowing infiltration and reduced run-off.

Drainage line buffers, nutrient management practices and vegetative filter strips will be utilised to minimise the risk of nutrients leaving the site via overland low and erosion.

5.5 Flood Risk

Flood prone areas increase the risk of potential nutrient losses to sensitive areas such as waterways via overland flows and increased erosion. Range areas should be located above the 1 in 100-year flood line, as flooding can impact on the operation of the farm and increase risk of surface water contamination.

The watercourse located on the property is 100m from the caravan and infrastructure. The site is not located on flood prone land and there are no flood overlays on the property.

6 Nutrient Risk Assessment for Range areas

Nutrients deposited with soil in free range areas are a potential environmental risk which needs to be managed through appropriate siting, design and management of the range area.

The risk of nutrient losses to surface or ground water are driven by source and transport factors (McDowell and Nash, 2012, Melland, 2003, Nash, 2002). Source factors determine how much nutrient is available to cause potential impacts. Transport factors determine how likely it is that these nutrients will reach the receiving environment.

Some typical source factors are the amount of nutrients deposited across the range, distribution of the nutrients and background levels. Some transport factors that influence risk include erodibility of the soils, erosivity of the rain, slope and shape of the land, groundcover, permeability of soil, phosphorus buffering capacity, added run-off modifiers such as levees, distance to waterways and depth to groundwater. (AEL, 2018)

Not all of the factors above are of equal importance based on their impact on risk. For this reason, Australian Eggs Ltd have developed a nutrient risk assessment based on the latest research and knowledge.

The risk assessment has been developed with reference to the basic principles influencing soil loss as outlined in the Revised Universal Soil Loss Equation (RUSLE) and the original USLE and nutrient losses, as outlined in the National Environmental guidelines for Piggeries (NEGP)-Environmental Risk Assessment (Tucker et al., 2010) tool and the Farm Nutrient Loss Index (FNLI - Melland et al., 2007). (AEL 2018)

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The FNLI has been used as a basis for the risk assessment tool. The FNLI uses a numerical weighting system that provides a risk score and overall rating. The system is influenced primarily by site attributes, providing a good basis for choosing a good site and avoiding one that will lead to higher inherent risks. The rating system in the original FLNI has been adapted in the present application using expert judgement to provide factors relevant to poultry stocking rates and farm sizes. This has been done with reference to known soil nutrient impacts caused by these differences, as documented in Wiedemann et al. (2018) and (AEL, 2018).

In determining the amount of nutrients deposited on the range, the presence of trees was noted to significantly increase the nutrient levels in soil, on the range (Wiedemann et al., 2018). As such, the score for stocking rate in the risk assessment is doubled if trees are present on the range. Note: While this tool was primarily developed for use in the assessment of range areas associated with fully enclosed sheds, it can be adapted for use with other housing systems, as follows:

- For open floored housing (such as slatted floor mobile sheds) where manure is not collected, the stocking rate score should be doubled. A large proportion of manure deposition is expected to occur within sheds and failure to collect these nutrients makes it available for loss.

- For mobile systems, the total nutrients deposited on the range is proportional to the time that the shed is in each new location and a unique range area is used. If a mobile housing system is rotated between three unique range areas (no overlapping), the risk at each range area is 1/3 of the total risk. As such the score for 'Stocking Rate' should be reduced accordingly. The number of rotations and period between them should be sufficient to allow reestablishment of groundcover. (AEL,2018)

Scolexia have reviewed the inputs provided in the scoping report and these seem to reasonably reflect the desktop revision undertaken by Scolexia. The only revision to the assessment is the doubling of the stocking rate as there are trees and infrastructure on the range. This, however, does not impact on the overall score as it stays in the same category due to the low stocking rate. Even if this moved into the next category it would still generate a low-risk outcome.

7 Pathogens

Layer manure and spent bedding contain potential pathogens, however the level of these is unlikely to pose a risk to human health (AEL,2018). The majority of pathogens in livestock and poultry are host specific meaning that they only impact that particular species and thus it is less common for livestock pathogens to infect humans.

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Pathogens are also very susceptible to environmental conditions. They are minimised through exposure to sunlight (UV penetration and temperature) and wind (desiccation/dehydration). As the manure is directly deposited on the land at Hilltops FR, the immediate exposure to the elements coupled with surface and groundwater management practices and buffers to waterways, should minimise any pathogen migration from the site and impacts on the drinking water supply catchment.

Note: as per any manure management practice a withholding period of 3 weeks should be enacted, along with removal of obvious manure deposition areas prior to grazing any ruminants on the range areas to minimise access to restricted animal materials. (AHA, 2019).

8 Recommended Management/Mitigation Practices

To ensure that the risk of nutrient and manure run-off remains low the following mitigation practices should be maintained:

- Ensure buffer distances of 100m are maintained to waterway.
- Ensure caravans and infrastructure are located approximately 25m or greater from the drainage lines. (VFS as determined by table 37 of AEL, 2018 requires a filter strip of a minimum 2m with good cover and 13m with poor cover- however a larger buffer as suggested allows for a more conservative approach).
- Maintain where possible groundcover of over 80% (especially within buffers to drainage lines)
- Regularly move caravans, waterers and feeders every week in summer and every 2 weeks in winter to encourage nutrient distribution and pasture recovery.
- Undertake regular soil testing to ensure range areas remain within agronomic recommended rates. An agronomist can assist in interpreting results, aiding agronomical assessment for maintaining pasture growth cover and making nutrient stripping recommendations if required. Adjust management if necessary to ensure nutrient levels remain low.
- If required (elevated nutrient levels) consider cropping range areas periodically to remove nutrients from the area.
- Areas around caravans and infrastructure can be spread if required to distribute nutrients more evenly across an area.
- If an area becomes denuded, consider spreading materials such as straw to minimise soil loss.
- If nutrient levels start to rise, consider using alternative range areas on other parts of the property taking into consideration the above buffers and practices and/or fit bases to the caravans and spread over wider areas.

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9 Monitoring

Regular Monitoring should occur in the range areas to gain an understanding of the actual nutrient levels in the soils taking into consideration climate, soil microbes, adsorption capacity etc. Trees and other infrastructure out in the paddocks encourage birds further into range areas. Taking into consideration these factors and the small flock sizes, representative soil testing of the wider range will allow a greater understanding of nutrient levels and allow additional mitigation strategies to be implemented if required.

Soil monitoring of the standard agronomic parameters is recommended annually to begin with and depending on the results thereafter every 2 years and then 3 years if justified. A suitable qualified consultant or agronomist can be utilised to interpret the results. An example of the typical soil parameters includes:

Table 5. Recommended soil analysis parameters (AEL, 2018).

Soil Test	Depth	Frequency
pH	0-0.1 m 0.3-0.6 m Base of root zone	Annually 3 yearly 3 yearly
Electrical Conductivity (EC) - (1:5 soil/water)	0-0.1 m 0.3-0.6 m Base of root zone	Annually 3 yearly 3 yearly
Nitrate-N	0-0.1 m 0.3-0.6 m Base of root zone	Annually Annually Annually
Avail. Phosphorus (Colwell, Olsen or Bray)	0-0.1 m 0.3-0.6 m Base of root zone	Annually 3 yearly 3 yearly
Phosphorus sorption capacity or phosphorus buffering index (PBI)	0-0.6 m Base of root zone	Annually 3 yearly
Organic Carbon	0-0.1 m	3 yearly
Potassium	0-0.1 m 0.3-0.6 m Base of root zone	Annually 3 yearly 3 yearly
Exchangeable cations & CEC (Calcium, Sodium, Potassium, Magnesium)	0-0.1 m 0.3-0.6 m Base of root zone	Annually 3 yearly 3 yearly

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10Conclusion

Based on the information provided and a desktop study, Hilltops Free Range Layer farm site appears to be located in an area suitable for free range layers. The separation to waterways, topography, soil type, available land, climate, separation to sensitive receptors and minimal environmental overlays, when coupled with good design and management is conducive to mitigating environmental impacts.

Unlike extensive grazing systems the deposition in free range mobile caravan systems can be managed through rotations to minimise manure deposition areas and encourage distribution over a wider area which subsequently reduces potential surface water run-off and groundwater leaching.

Providing buffers to waterways and drainage areas, along with the maintenance of groundcover minimises potential nutrient losses through reduced velocity, increased infiltration and uptake of nutrient by vegetation.

Monitoring of the site will allow for a greater understanding of the true nutrient levels of the farm and due to the type of system there is a myriad of mitigation option available to further reduce risks if required.

Taking into consideration the site characteristics, low stocking densities and nutrient outputs of the production system as estimated, it is my professional opinion that if the management practices and buffers (scoping document and within) are maintained, there is minimal risk of nutrients and other contaminants migrating off site to the adjacent waterways and groundwater and subsequently impacting on the drinking water supply catchment.

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12Tables List

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