SOILANDWATER

LAND CAPABILITY ASSESSMENT

41 KING STREET
TARAGO NSW 2580
LOT 3 DP 1118635

23 October 2023 (V01)

FRANKLIN CONSULTING AUSTRALIA PTY LTD

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SOILANDWATER

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Limitations

This report has relied on the information provided by the client prior to this report, and from site investigation as undertaken on a specific date. The results provided are indicative of the conditions at the time the inspection was carried out.

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PROJECT DESCRIPTION

The proposed report supports an application for re-zoning of 41 King Street, Tarago and the subsequent subdivision creating 29 lots - comprising 28 residential lots and one lot reserved for a bioretention dam (Lot 5).

Of the proposed 28 residential lots:

- 25 lots are 2,000 – 4,000 m^2
- 3 lots are >4,000 m^2

The land capability assessment is designed to determine the suitability of the residential lots based on the capacity to sustainably manage effluent on-site, as per Council requirements and Australian Standards. The suitability and constraints for dwelling construction are also considered in this assessment.

Constraints to on-site effluent management and dwelling construction have been assessed in accordance with:

- assessment of on-site effluent capability, based on Appendix C of ANZ Standard 1547:2012, *Site and Soil Evaluation for Planning, Rezoning and Subdivision of Land* and also the NSW guideline*, The Silver Book*;
- assessment of land capability for dwellings is based on excluding land which is greater than 15% slope, seasonally waterlogged, salt effected or within riparian corridor buffers.

SUMMARY FINDINGS

The proposed lot layout has been developed to demonstrate the feasibility of the re-zoning application. An assessment of the land capability of the property makes the following findings:

- There is generally ***adequate areas of unconstrained land available to support on-site effluent disposal*** on each proposed dwelling lot in the subdivision layout.

- There is generally ***adequate areas of unconstrained land available to support dwelling construction*** on each dwelling lot in the subdivision layout.

- On-site effluent treatment associated with future development should be ***restricted to Advanced Secondary Treatment Systems*** to reduce the potential cumulative impacts to groundwater and surface water systems.

- Onsite effluent disposal of treated effluent should be ***restricted to surface spray or drip, or subsurface drip irrigation*** due to limited soil depths across significant areas of the property.

- Primary treatment and subsoil effluent disposal is not suited to the site due to limited soil depth significantly constraining subsoil absorption.

- The ***dam close to the western boundary should be removed*** to reduce the need for a 40-metre buffer from onsite effluent disposal activities on lots in this vicinity.

- ***The dam close to the eastern boundary will be modified to become a bioretention basin*** to reduce the need for a 40-metre buffer from onsite effluent disposal activities on lots in this vicinity.

- ***Road drainage infrastructure parallel to the southern boundary will be designed to intercept overland flow from lots and divert this to the proposed bioretention basin*** to reduce the area impacted by the 100-metre buffer required between the watercourse and on-site effluent disposal activities.

OVERVIEW

Soil and Water was engaged by Group One to assess land at 41 King Street, Tarago, Lot 3 DP 1118635, in the Goulburn Mulwaree Local Government Area, to determine the suitability of the lots within the proposed subdivision layout to provide for domestic on-site effluent disposal, road construction, servicing infrastructure and the construction of a dwelling.

The assessment includes the identification of the following constraining attributes which may limit site suitability for development related land uses including:

- **i.** General suitability of site/soils for on-site effluent disposal (consistent with the NSW Government "Silver Book" and the Australian Standard 1547:2012).
- **ii.** Areas of outcropping rock
- **iii.** Areas of existing vegetation
- **iv.** Watercourses, water storages and riparian buffer areas
- **v.** Areas of steep or otherwise unsuitable land for construction due to erosion and other risks
- **vi.** Areas of land degradation including salinity, gully, sheet, rill or streambank erosion

The proposal includes recommendations for managing identified constraints and sensitive areas. Recommendations are general in nature and are designed to assist in determining appropriate land management practices for the development and the site.

REPORT SCOPE AND TECHNICAL REFERENCES

The report assesses the undeveloped Building Envelope on Lots 1-29 (excluding Lot 5) to identify areas which are unconstrained and therefore suitable for the onsite disposal of effluent and the construction of a dwelling.

This involves excluding land with major physical constraints such as steep slopes, rocky outcrops, poor drainage, areas within buffer distances of property boundaries watercourses, storages, flow lines and existing and proposed buildings.

All information required by the approving authority, usually regional Councils, is contained in this report, including suitable types of sewage management systems, management prescriptions, site plan and photographs, with supporting information in this report including nutrient balance and limitation tables.

The report also refers to, or relies on, standards and technical references listed below.

On-site Sewage Management for Single Households (The Silver Book) NSW Govt, 1998.

AS/ANZ Standard 1547:2012 On-site Domestic Wastewater Management.

Designing and Installing On-Site Wastewater Systems: A Sydney Catchment Authority Current Recommended Practice. Sydney Catchment Authority, 2014.

Goulburn Mulwaree Local Environmental Plan 2009 (Clause 7.3)

Goulburn Mulwaree Development Control Plan 2009 (Chapter 7)

Soil Landscapes of the Canberra 1:100,000 Sheet. Jenkins, B.R. (2000) Department of Land and Water Conservation, NSW.

METHODOLOGY

A detailed on-site assessment was undertaken on the undeveloped lot to determine areas suitable for onsite effluent disposal and dwelling construction within the proposed subdivision lot layout.

The assessment included measurements of slope, aspect, exposure, visual appraisal of landform and soil conditions. The location of constraints identified during the site inspection are included in **Figures 11 & 12** in this report.

The buffer distances required from drainage lines have been mapped and are also provided in this report.

The report includes a preliminary assessment of the suitability of soils for on-site effluent management. Soil profiles were augured in representative parts of the landscape across the proposed residential lots. The soil profiles are described in **Appendix 1.** Soil samples from each of the soil landscapes represented on-site were sent to a NATA accredited laboratory to test soil attributes related to the suitability of soils for onsite effluent disposal, ***(Laboratory soil test results will be included in Appendix 1once available)***.

It should be noted that this report does not constitute a detailed Effluent Management Design Report as required by Council to approve the installation of systems for each new dwelling. It is expected that such a report will be required for each lot prior to the construction of a dwelling.

SITE INFORMATION

Local Government Area: Goulburn Mulwaree Council

Address/locality: 41 King Street, Tarago
Lot 3 DP 882432

Owner/Developer: C/- Group One Pty Ltd

Figure 1: Lot location (https://maps.six.nsw.gov.au/)

Figure 2: Proposed subdivision (extract from client plans)

Intended water supply: Non-reticulated - roof catchment with tank storage for domestic potable water on all lots.

Recommended effluent management: Effluent for the new residential lots will be managed on-site via a combination of a secondary treatment system (including disinfection) and effluent disposal through surface spray or drip irrigation or subsurface drip irrigation.

(NB: The primary treatment of effluent with disposal through subsoil absorption is not considered suitable for the site due to limited soil depth.)

Local experience: The major constraints related to on-site effluent dispersal are the buffer distances required from watercourses, dams and drainage depressions and limited soil depth.

Many similar rural residential developments have been established in the region which share a similar range of constraints. Generally, these have not posed significant problems to the successful establishment and operation of rural residential land use and related infrastructure.

Figure 3: Looking southeast over proposed Lot 5 and dam to be redeveloped to become a bioretention basin.

Figure 4: Looking southwest over areas of unconstrained land.

Figure 5: Looking north over small areas of fill to be removed.

Figure 6: Looking across dam next to the western boundary – to be removed.

Figure 7: Looking east over unconstrained areas of the development.

Figure 8: Looking south towards watercourse adjacent to boundary.

SITE & SOIL ASSESSMENT

Climate

The climate is typically a cool and moderately dry climate. Average annual rainfall for the area is 685 mm. Warm summers with large evaporative deficit, cool winters with small evaporative deficit; average summer monthly rainfall is 63 mm; average monthly winter rainfall 50 mm; average monthly summer evaporation is 131 mm, average monthly winter evaporation is 46 mm.

Climate is suitable for the surface dispersal of secondary treated effluent via surface or sub-surface irrigation.

Exposure

The proposed development is extensively cleared with groundcover of native and semi-improved perennial pasture. Proposed dwelling lots all have adequate exposure for surface or shallow sub-surface irrigation.

Exposure is suitable for the surface and sub-surface irrigation of effluent within the proposed residential lots.

Slope

Slopes across much of the landscape range from gentle to moderate and are generally unconstrained for effluent disposal or dwelling construction. There are small areas of steep slopes >15% which are constrained for onsite effluent disposal and dwelling construction.

Slopes are generally not a constraint to the onsite effluent disposal or construction of dwellings. Small areas of steep slopes are constrained and should not be utilised for dwelling construction or effluent disposal activities.

Landscape

The local area includes three soil landscape units. The Misery Mountain Soil Landscape Unit, (Soil Landscapes of the Braidwood 1:100,000, B.R.Jenkins,1995), corresponds to northern areas of the property. This is described as steep to rolling mountains and hills on volcanics with local relief 200-45m between 680-1200m elevation and with slopes <20%.

The Morass Soil Landscape Unit corresponds to the southern areas of the property. This is described as undulating rises on Tertiary sediments with local relief 9-30m between 670-700m elevations with slopes ranging 3-10%.

The Sight Hill Soil Landscape Unit corresponds to elevated areas in the west of the property. This is described as rolling to steep hills on

volcanics with relief 40-150m between 650-820m on slopes extending above 20%.

The landscape is an elevated gentle crest feature located between watercourses to the west and north and paralleling the southern boundary.

The proposed dwelling lots mostly coincide with divergent slope form with minor areas of convergent slope constrained for effluent disposal.

Generally divergent slope form suited to the dispersal of secondary treated effluent through surface or sub-surface irrigation. Small areas of convergent slope form constrained for effluent disposal.

Surface rock and outcrop

Surface rock is common across the property however localised in extent and not a constraint to effluent disposal.

Rock is not a constraint to effluent dispersal or dwelling construction.

Hydrology

The silty loam to clay loam textured soil across the site has a moderate permeability, of 0.5 to 1.5 m/day (from table M1 of ANZ STD 1547:2012).

Approximately 5-10% of annual rainfall forms surface runoff, although in individual high intensity storm events over 50% of rainfall may form runoff. The areas of steeper slopes and shallow soils will generally convert a greater proportion of rainfall into surface runoff than flatter areas with deeper soils.

Rainfall that does not form surface runoff is either lost through evaporation and transpiration or infiltrates the soil. Rainfall which infiltrates soil generally drains vertically through the soil profile until it meets a less permeable subsoil layer (e.g. hard pan or clay layer), where a significant proportion drains laterally downslope as subsurface flows.

The upslope subsurface flows move perpendicular to the contour of the slope and concentrate in lower parts of the landscape creating areas of seasonal waterlogging. This is compounded by the naturally slower drainage associated with lower parts of the landscape.

Development within catchments can change the hydrology by increasing the amount of compacted and non-permeable hard stand areas thereby reducing infiltration and subsurface flows. This is balanced by an increase in surface water runoff.

Potential hydrological impacts associated with increasing the amount of impermeable surface are considered in a separate study.

Effluent disposal will need to be properly designed and located on suitable soil types (including depths) to minimise hydrological impacts from surface irrigation, such as effluent run-off or rapid effluent drainage through permeable soil profiles into groundwater systems. Adequate areas of suitable soils exist within each dwelling lot to limit these risks.

Soils

Representative soil profile descriptions for the development area are provided in **Appendix 1** of this report.

The soils on the property are generally of low agricultural value which is reflected by the historical grazing land use and groundcover of unimproved perennial pastures. A change of land use to large lot residential will have minimal impact of the agricultural productivity of the region.

The soils in areas considered suitable for the Building Envelopes consist of moderately to well drained Tenosols to Dermosols. These were formed in situ on parent material. Soils comprise a massive to weakly structured silty to sandy loam soil topsoil with depth ranging to 45cm. In deeper profiles a red sandy clay loam underlays topsoil to depths exceeding 100cms in places.

Extrapolating from the relevant soil data from *Soil Landscapes of the Braidwood 1:100,000 Sheet Report,* the representative analytical shows a moderate phosphorous sorption level, non-saline subsoils and low exchangeable sodium. As such the soils are free of any significant chemical limitations to effluent dispersal.

Laboratory soil test results are provided in **Appendix 1** (once available)**.**

Soils are generally unconstrained for dwelling construction. Site Classification of the Building Envelopes on each lot will be required to ensure foundations are appropriate for soil reactivity and wet bearing strength.

Limited soil depth is a major limitation to effluent disposal by absorption trench but is adequate for surface or shallow subsurface irrigation.

CONSTRAINTS ANALYSIS

Soil erosion

Soil type is susceptible to water erosion however the generally low to moderate slopes and extensive groundcover is adequate to limit the erosion risk in the proposed residential lots.

Areas of steep slopes are highly susceptible to erosion. Soils disturbance should be minimised in these areas and groundcover levels need to be maintained. As a result, effluent disposal and dwelling construction is not recommended in these areas.

Recommendations

- *Dwellings and effluent disposal activities should not be undertaken in areas of steep slopes.*
- *100% groundcover be maintained in areas designated for effluent dispersal with the Building Envelopes on Lots 1-3.*
- *Any areas of soil disturbance should be mulched and revegetated to reinstate an adequate groundcover to minimise erosion risk.*
- *Any existing areas of erosion should be remediated over time and following remediation, all areas should be monitored, and remedial measures implemented should further erosion be detected.*

Salinity

Dryland salinity is an issue across parts of the Goulburn Mulwaree Council area and is related to changed landscape hydrology, climate, geology, soils and land management.

No areas of dryland salinity were detected on the property during inspection.

Good land management practices will minimise the potential for dryland salinity to occur on the site and/or for the site to contribute to dryland salinity off-site.

Recommendations

- *The area and vigour of deep-rooted perennial pasture should be maximised as far as practical.*
- *Revegetation including deep rooted native trees and shrubs should be encouraged.*

Groundwater

Figure 9: Groundwater Bores https://realtimedata.waternsw.com.au/

There are no bores within 100 m of the proposed residential lots. Lots 1, 4 and 6 have bores between 200-300m from the lots. These bores are:

GW114458 (domestic use) Depth 18m Yield 0.750L/s WBZ 11-15m
GW048965 (general use) Depth 15.20m WBZ 9.70-15.20m
GW111294 (domestic use) Depth 24m Yield 1.0 L/sec WBZ 12-15m.

There is a low risk of contamination to the groundwater system given:

- horizontal separation of > 200m for all lots to nearest bores,
- vertical separation of > 9m to water bearing zones,
- low rate of secondary treated and disinfected effluent applied to the surface or shallow subsurface,
- low transmissivity of fractured rock groundwater aquifers as underlay the area.

Recommendations

- *Maintain a minimum 100 m buffer between any future bores and effluent dispersal areas associated with the new residential lots.*
- *Ensure that an Effluent System Design Report is produced prior to the installation and operation of on-site effluent disposal systems and that these reports include a minimum 100 m buffer from any bores.*
- *Ensure a water supply works approval is sought prior to constructing a bore (the application is available at www.water.nsw.gov.au).*

Riparian and Watercourse

The *Goulburn Mulwaree Development Control Plan 2009* (Chapter 5.2) requires that

> *on-site sewerage disposal is a minimum of 100 metres from rivers, creeks and perennial watercourses, and 100m from an intermittent watercourse…or 40 metres of a dam or drainage depression defined as low points that carry water during rainfall events but dry out quickly once rainfall has ceased.*

The watercourses to the west and south of the property are mapped in Water NSW mapping. The watercourse south of the property is not a perennial stream (refer **Figure 10a.**).

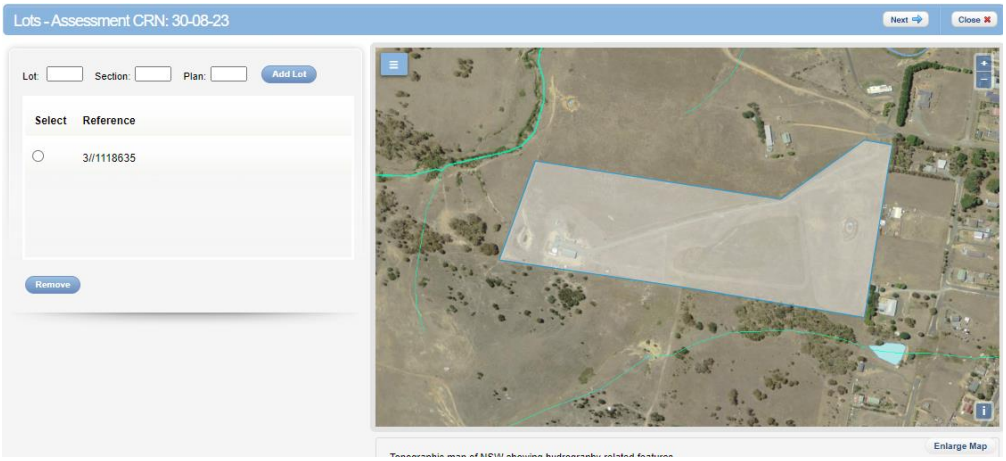

Figure 10a: Water NSW mapping (NorBE Tool)

A 100-metre watercourse buffer is required from both of the mapped drainage features and onsite effluent disposal activities.

A minor drainage depression adjacent to the western boundary of the property is not mapped as a watercourse but is a defined drainage depression which requires a 40-metre buffer from any effluent disposal activities on the property.

There are two farm dams on the property which (if retained) will require a 40-metre buffer from any effluent disposal activities on the property.

Areas within the required buffers are constrained for on-site effluent disposal.

NSW DPI Office of Water (Guidelines for riparian corridors on waterfront land) defines the riparian corridors required for different stream orders, to maintain the integrity of these sensitive riparian areas, refer **Figure 10b.**

Figure 2. The Strahler System

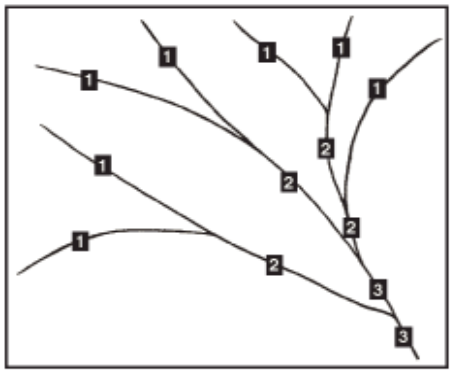

Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Figure 10b: Stream ordering and riparian corridor widths (NSW DPI Water Guidelines)

The watercourse to the north of the property is a 3rd Order Stream which requires a riparian corridor of 30 metres, refer **Figure 10b**. The watercourse to the south of the property is a 1st Order Stream which requires a riparian corridor of 10 metres, refer **Figure 10c**.

Areas within the required riparian corridor are constrained for dwelling and associated infrastructure development. These riparian buffers have been mapped in **Figure 11.**

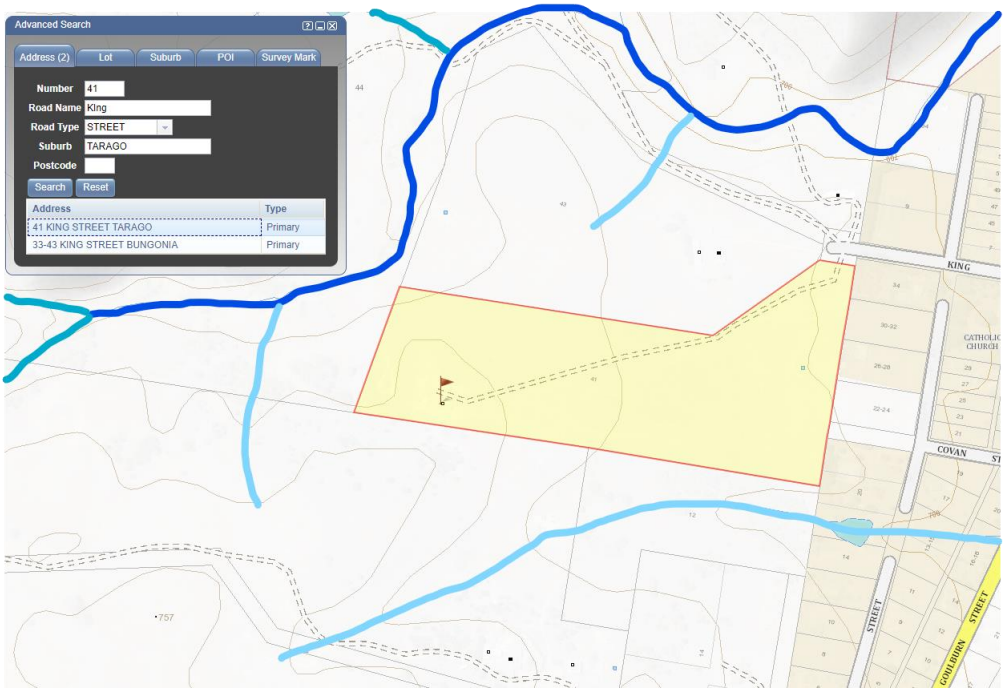

Figure 10c: Stream orders 1st / 2nd / 3rd order watercourse

Recommendations

- *No dwellings or associated infrastructure shall be constructed within 30 metres of the 3rd order watercourse to the northwest of the property.*

- *No dwellings or associated infrastructure shall be constructed within 20 metres of the 2nd order watercourse to the northwest of the property.*

- *No dwellings or associated infrastructure shall be constructed within 10 metres of the 1st order watercourse to the south of the property.*

- *The dam close to the western boundary should be removed to reduce the need for a 40-metre buffer from onsite effluent disposal activities on lots in this vicinity.*

- *The dam close to the eastern boundary will be modified to become a bioretention basin to reduce the need for a 40-metre buffer from onsite effluent disposal activities on lots in this vicinity.*

- *Road drainage infrastructure parallel to the southern boundary will be designed to intercept overland flow from lots and divert this to the proposed bioretention basin to reduce the area impacted by the 100-metre buffer required between the watercourse and on-site effluent disposal activities.*

MANAGEMENT OF EFFLUENT

Summary

This report assesses the general availability of an adequately sized area of land within the proposed residential lots which are well drained, gently sloping and with a moderate soil cover and suitable site conditions for the dispersal of effluent.

Key constraints to effluent dispersal on the property are:

- Watercourse buffer of 100m from watercourse to the northwest and south of the property
- Dam and drainage depression buffers of 40m
- Steep slopes
- Areas of fill material
- Areas of convergent slope form.

An area of 1,100 m^2 has been nominated to assess the feasibility of the proposed layout based on the capacity for onsite effluent dispersal associated with future dwellings. This is based on a four-bedroom dwelling requiring around 500 m^2 plus an allowance for a reserve area as well as buffers from buildings, boundaries and driveways.

There is generally an adequate area of land within each lot which is unconstrained for effluent disposal and therefore considered suitable for this purpose, refer **Table 1** below and **Figure 11.**

Lot/Effluent Disposal Area		Lot/Effluent Disposal Area		Lot/Effluent Disposal Area	
1	1995m^2	11	1360m^2	21	880m^2
2	1430m^2	12	1370m^2	22	1030m^2
3	1330m^2	13	1400m^2	23	1360m^2
4	2900m^2	14	1400m^2	24	1410m^2
5	-	15	1400m^2	25	1160m^2
6	3990m^2	16	1450m^2	26	1320m^2
7	1510m^2	17	1250m^2	27	1300m^2
8	1440m^2	18	2050m^2	28	2120m^2
9	1440m^2	19	1530m^2	29	2930m^2
10	1420m^2	20	960m^2		

Table 1: Area of unconstrained land suitable for effluent disposal on each lot.

NB: Areas are approximate and intended to demonstrate feasibility of onsite effluent disposal on proposed lots not to accurately identify areas suited to effluent disposal – this will be undertaken at the development application stage when lot layout is finalised.

There which may not have 1,100m^2 of unconstrained land available for onsite effluent disposal. The provision of an equal size reserve effluent irrigation area may not be possible on these lots. In these instances, a reserve area equivalent to 50% of the required effluent irrigation may be considered adequate given:

- reserve area is unlikely to be required due to sustainable irrigation practices;
- low probability that the entire primary irrigation will fail (i.e. 100% of the area) requiring and equal size reserve area to be activated.

The most widely used form of effluent treatment on relatively unconstrained rural residential developments in the region is a NSW Health accredited aerated wastewater system, with the secondary treated, disinfected effluent irrigated onto the surface. Reliability and maintenance issues with such systems are well known and the risk of failure is relatively low.

There are a number of more innovative options for effluent treatment and disposal. The most promising of these is the Wisconsin sand mound, of which there are a small number in the region. These systems have a small footprint, (less than 150m^2), have a high degree of reliability and have a low energy requirement. There is however a lack of experienced installers for such systems in the region and the climate presents some issues in terms of maintaining grass cover through hot dry summers if effluent is not being regularly loaded into the mound. This is generally only an issue if the attached dwelling is not permanently or fully occupied.

In general, the area is not suited to the subsoil absorption of primary treated effluent due to the limited soil depth across much of the property. As a result, both subsoil absorption and evapotranspiration/absorption beds for primary treated effluent would not be recommended for the site.

The use of subsoil irrigation beds for dispersal of wet composting closet treatment systems (eg worm farms) are also considered unsuited to the site due to the soil depth constraint.

The following section addresses the specific requirements for a number of suitable effluent management options in order to show that on-site effluent can be achieved sustainably on the subdivision.

This report assumes that a detailed planning for effluent management will occur at the time of submitting building plans to council. At this stage the

exact location, footprint, occupancy and usage patterns of the proposed dwelling will be known. These are all critical elements of the final design process which cannot be addressed by this report.

Secondary treatment system and surface irrigation

NSW Health accredited systems treat effluent to a minimum secondary standard, suitable for disposal by surface or subsurface irrigation (see list at http://www.health.nsw.gov.au/PublicHealth/environment/water/wastewater.asp). This includes aerated wastewater treatment systems (AWTS), sand and textile filters and biological filters.

The sizing of the effluent irrigation area is based on nutrient balance which gives a general guide to a sustainable area required for irrigation.

Council requires that effluent irrigation systems be fixed installations. Surface spray irrigation systems can be significantly improved by having at least two or three lines of sprinklers on risers attached to rigid supports, 30-50cm above ground level, with each riser tied into the delivery line. A manual valve on each line allows all or some of the lines to be used. The buried distribution lines with risers minimises the risk of damage by mowing and encourages the irrigation area to be better managed than current practice.

The size of the area required for effluent irrigation will vary according to the number of bedrooms in the dwelling, which determines the design effluent loading. Based on the hydraulic and nutrient balance shown in **Appendix 2**, the sizing of the irrigation area is shown below:

Three bedrooms	360m2
Four bedrooms	500m2
Five bedrooms	550m2
Six bedrooms	600m2

Council also requires adequate suitable land for a reserve effluent dispersal area. Additionally, buffers of 6m are required from buildings and property boundaries.

Primary treatment and subsoil absorption

Generally not suitable due to limitations of limited soil depth.

This is considered a major constraint to effluent disposal through subsoil absorption.

Innovative effluent management systems

A Wisconsin mound pump dosed from a septic tank may be suited to the site and soil conditions. Mound design would need to be developed on a site-by-site basis, including a soil profile at the mound site. Indicatively, based on the soil profiles for this assessment, the Basal Loading Rate would be 16mm/day and Linear Loading rate 47mm/day. The footprint would be slightly less than 150m2 on a flat or gently sloping site.

Effluent management

Recommendations

- The recommendations and prescriptions of this report should be used to inform conditions associated with rezoning and subsequent development of the property.
- A lot specific *site and soil assessment for on-site effluent management* will be required at the time of submitting building plans to Council for the residential lots the prescriptions of this report should be applied to the design process of each lot.
- The effluent treatment and disposal system must be located within the areas suitable for effluent disposal based on those areas which are not constrained, refer **Figure 11**.
- Buffers to be applied to effluent dispersal areas will include:
  - 100 m from the main watercourse
  - 40 m from all dams and drainage depressions
  - 100 m from any future bores
  - 6 m from property/lot boundaries
  - 6 m from buildings and driveways.
- The effluent management systems considered suitable for the residential lots include aerated wastewater treatment systems (including disinfection) with NSW Health accreditation, dispersing effluent to a designated effluent surface irrigation area. The irrigation area size should be based on potential occupancy derived from bedroom number.
- As a guide, the following areas would be appropriate for the soil and site conditions of the site:
  - Three bedrooms……...360m^2
  - Four bedrooms……500m^2
  - Five bedrooms……..550m^2
  - Six bedrooms……600m^2
- To ensure effective distribution of treated effluent, and provide protection of irrigation lines, the minimum requirement for irrigation dispersal should be buried distribution lines with decoupling sprinkler heads. There should be a minimum of two runs of distribution lines connected by a manual valve to allow for alternating dispersal areas.

- More innovative systems such as a Wisconsin sand mound treating primary effluent from a septic tank, or a recirculating sand filter with a subsurface irrigation field, are also suitable.
- A subsoil absorption bed receiving primary treated effluent is generally not considered suitable for the site.

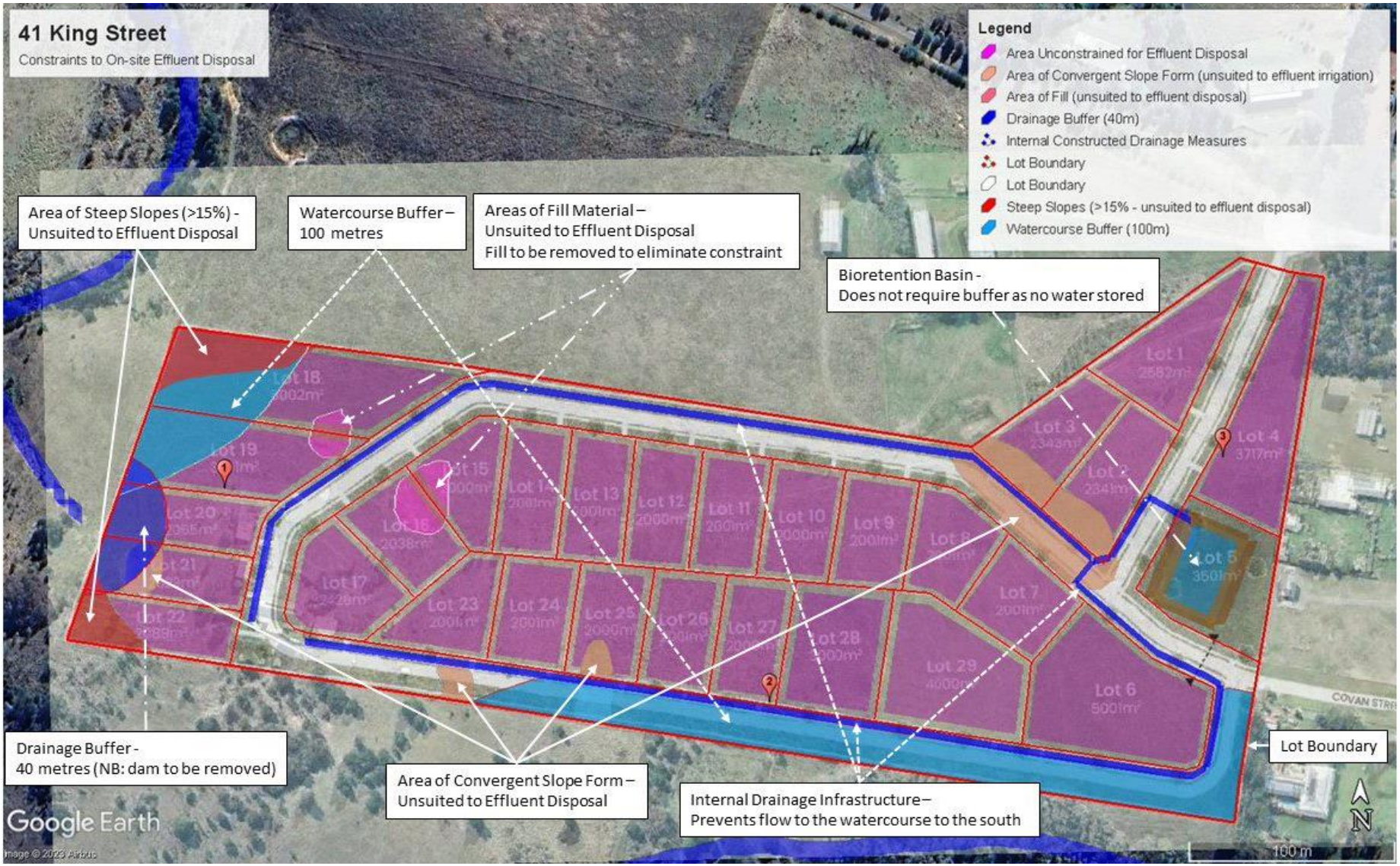

Figure 11: Property Constraints to Effluent Disposal

CAPABILITY FOR DWELLING CONSTRUCTION

Summary

Land considered unsuitable or constrained for the construction of dwellings generally consists of areas with the following attributes:

- a slope grade of greater than 15% - the threshold is consistent with many building codes and Council requirements and also corresponds to the slope above which erosion hazard significantly increases (Landcom, 2004);
- seasonally waterlogged or flood prone land - including the minor drainage depressions drain the site;
- unsuitable soils – including areas of existing erosion and/or mapped highly erodible dispersive soils, low wet bearing strength soils and unstable soils prone to movement;
- areas within the riparian corridor widths required from mapped 1st and 3rd order watercourses required by NSW DPI Water Guidelines.

The 100m buffer from watercourses and the 40m buffers from minor drainage depressions and dams required from effluent disposal areas, are not constraints to dwelling construction.

The remaining gentle to moderately sloping, free draining land can be considered as suitable for dwelling construction.

Dwelling construction

Recommendations

- *Dwellings and associated infrastructure will not be located on areas of mapped steep land, refer* ***Figure 12.***

- *Dwellings and associated infrastructure will not be located within the 10 or 30m riparian corridors required from 1st and 3rd order watercourses adjacent to the property, refer* ***Figure 12.***

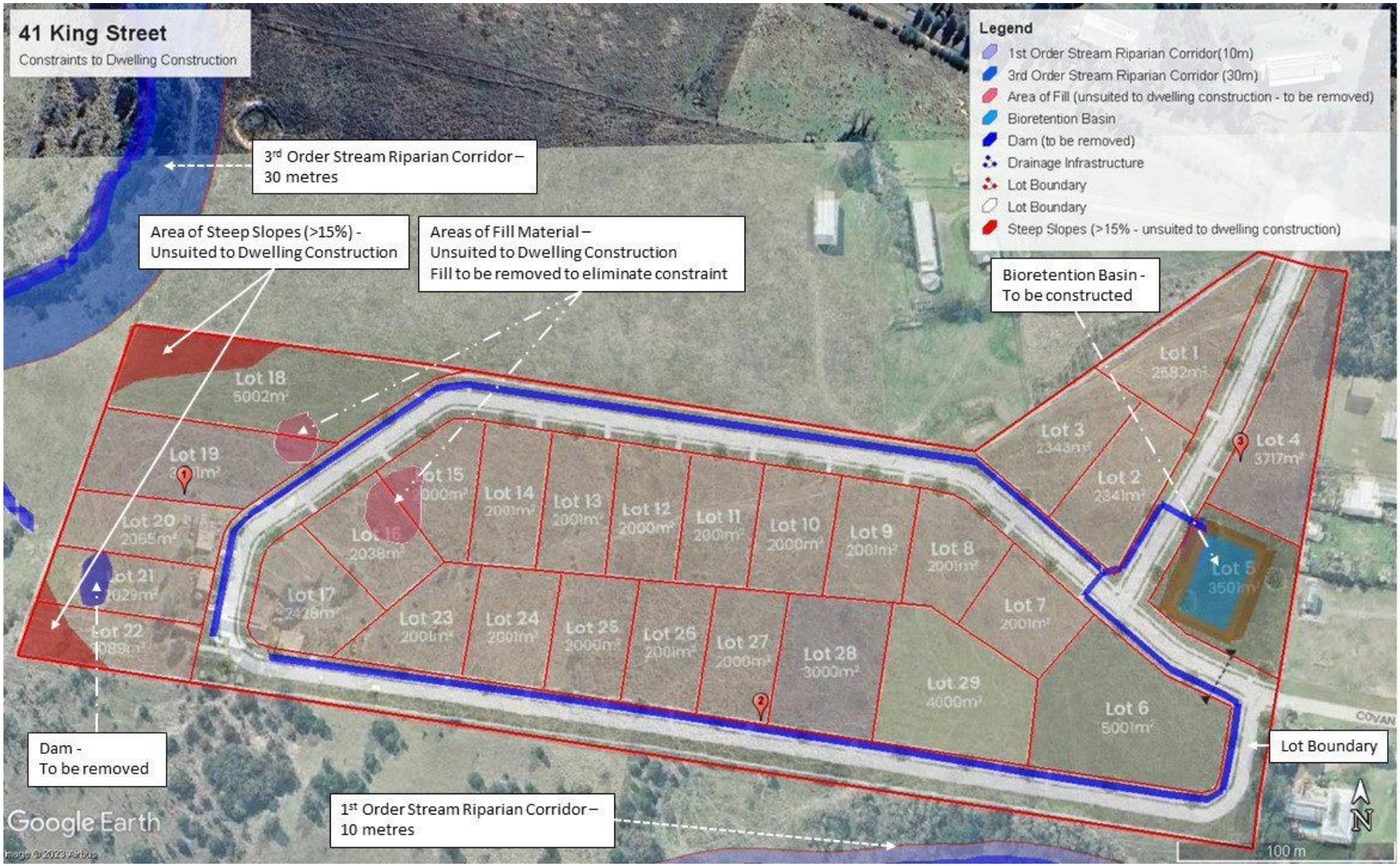

Figure 12: Constraints to Dwelling Construction

SITE AND SOIL LIMITATION ASSESSMENT

The following two limitation tables are a standardised guide to the site and soil characteristics which may limit the suitability of the site for effluent disposal and which would require attention through specific management practices. The tables have been reproduced from *On-site Sewage Management for Single Households* (tables 4 and 6, Anon, 1998). The highlighted categories represent site and soil conditions of the land covered in this report.

The tables show that the land which may be considered suitable for effluent application has only slight to moderate limitations, and no severe limitations.

Site limitation assessment – Proposed Dwelling Lots

Site feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Flood potential	All land application systems	> 1 in 20 yrs.		Frequent, below 1 in 20 yrs	Transport in wastewater off site
	All treatment systems	components above 1 in 100 yrs.		Components below 1 in 100 yrs.	Transport in wastewater off site, system failure
Exposure	All land application systems	High sun and wind exposure		Low sun and wind exposure	Poor evapo-transpiration
Slope %	Surface irrigation	0-6	6-12	>12	Runoff, erosion potential
	Sub-surface irrigation	0-10	10-20 (sub surface drip)	>20	Runoff, erosion potential
	Absorption	0-10	10-20	>20	Runoff, erosion potential
Landform	All systems	Hillcrests, convex side slopes and plains	Concave side slopes and foot slopes	Drainage plains and incised channels	Groundwater pollution hazard, resurfacing hazard
Run-on and seepage	All land application systems	None-low	Moderate	High, diversion not practical	Transport of wastewater off site
Erosion potential	All land application systems	No sign of erosion potential	Limited signs of erosion	Indications of erosion e.g. rills, mass failure	Soil degradation and off-site impact

Site feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Site drainage	All land application systems	No visible signs of surface dampness		Visible signs of surface dampness	Groundwater pollution hazard, resurfacing hazard
Fill	All systems	No fill	Fill present		Subsidence
Land area	All systems	Area available		Area not available	Health and pollution risk
Rock and rock outcrop	All land application systems	<10%	10-20%	>20%	Limits system performance
Geology	All land application systems	None		Major geological discontinuities, fractured or highly porous regolith	Groundwater pollution hazard

Soil limitation assessment

Soil feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Depth to bedrock	Surface and sub surface irrigation	> 1.0	.5-1.0	< 0.5	Restricts plant growth
or hardpan (m)	Absorption	> 1.5	1.0-1.5	< 1.0	Groundwater pollution hazard
Depth to seasonal water table (m)	Surface and sub surface irrigation	> 1.0	0.5-1.0	< 0.5	Groundwater pollution hazard
	Absorption	> 1.5	1.0-1.5	< 1.0	Groundwater pollution hazard
Permeability	Surface and sub surface irrigation	2b, 3 and 4	2a, 5	1 and 6	Excessive runoff and waterlogging
Class	Absorption	3, 4		1, 2, 5, 6	Percolation
Coarse fragments %	All systems	0-20	20-45	>40	Restricts plant growth, affects trench installation
Bulk density (g/cc) **SL** **L, CL** **C**	All land application systems	 < 1.8 < 1.6 < 1.4		 > 1.8 > 1.6 >1.4	restricts plant growth, indicator of permeability
pH	All land application systems	> 6.0	4.5-6.0	-	Reduces plant growth
Electrical conductivity (dS/m)	All land application systems	<4	4-8	>8	Restricts plant growth

Soil feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Sodicity (ESP)	Irrigation 0-40cm; absorption 0-1.2mtr	0-5	5-10	> 10	Potential for structural degradation
CEC mequiv/100g	Irrigation systems	> 15	5-15	< 5	Nutrient leaching
P sorption kg/ha	All land application systems	> 6000	2000-6000	< 2000	Capacity to immobilise P
Aggregate stability	All land application systems	Classes 3-8	class 2	class1	Erosion hazard

APPENDIX 1: SOIL PROFILE DESCRIPTIONS

Soil Profile 1: Crest behind existing dwelling/sheds.

Soil classification	Depth (cm)	Properties
RUDOSOL	0-40	A Medium brown, sandy loam, dry & friable, massive structure, coarse at 10% as large stones 30-50mm.

Figure 13: Soil Profile - Crest behind existing dwelling.

Soil Profile 2: Mid-slope location next to southern boundary

Soil classification	Depth (cm)	Properties	
DERMOSOL	0-40	A	Light brown, sandy loam, dry & friable, massive to weak structure, 5-10% coarse as stones 10-55mm, break to
	40->100	B	Red brown sandy clay, moist & firm, moderate structure, 10% coarse as river stones up to 60mm, continues

Figure 14: Midslope location next to southern boundary.

Soil Profile 3: Lower slopes, adjacent to dam & access road

Soil classification	Depth (cm)	Properties
KANDASOL	0-45	A Medium brown, fine sandy loam, moist & friable, weak structure, <5% coarse as stones, deemed auger refusal at rock layer.

Figure 15: Lower slopes, adjacent to dam & access road.

APPENDIX 2: EFFLUENT AREA SIZING

Water balance

Using the same DIR for spray irrigation on clay loam soils of 4 mm/day and adopting the most conservative (i.e. largest) estimate of additional design loading of 800 L/day, the following land application areas are required to manage additional hydraulic loading, nitrogen and phosphorous generated:

- **Sizing based on hydraulic loading:**

A = Q (l/day)/DIR (mm/day)
where A = area; Q = 800 l/day; DIR = 4 mm/day
A = 800/4 = 200 m^2
Area required = 200 m^2

Nitrogen balance

- **Sizing based on nitrogen balance:**

A = Q(l/day) X TN (mg/l)/L_n (critical loading of TN, mg/m^2/day)
where A = area; Q = 800 l/day; TN = 25mg/l (from Silver Book)
Assume 20% loss by denitrification; 25mg/l – (25 X .2) = 20mg/l
L_n = 15,000mg/m^2/yr (ie 150kg/ha/yr, for introduced species)
A = 800 X 20 X 365/15,000 = 389m^2
Area required = 400 m^2

Phosphorous balance

- **Sizing based on phosphorous balance**

A = P_{gen}/(P_{uptake} + P_{sorb}) [P sorption capacity in upper 50cm & 50 year design period]
P_{gen} = 10mg/l X 800 X 365 X 50 = 146kg
P_{uptake} = 4.4mg/m^2/day X 365 X 50 = .080kg/m^2
P_{sorb} = 2250kg/ha = .225kg/m^2
A = 146/(.08+ .225) = 478 m^2
Area required = 500 m^2

Design effluent disposal area

Therefore, a land application area of approximately **500 m^2** will account for phosphorous, nitrogen and water applied based on estimated connections and usage patterns associated with the construction of a 4-bedroom house.
An allowance of a reserve land application area will double this area to **1000m^2**.

A six-bedroom dwelling will require **600 m^2** of effluent irrigation area.

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