Chapter 28

Waste management

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Chapter 28 Waste management

The Secretary's environmental assessment requirements for the Narrabri Gas Project include a requirement to assess potential impacts associated with waste generation and management and to provide a waste management strategy. This chapter first identifies potential waste streams through a waste inventory, and then discusses the management of solid and liquid wastes, including salt and sewage.

The key findings of the impact assessment in relation to waste were:

- Construction and operation of the project would generate a range of wastes including green waste, waste construction materials, drill cuttings, drill fluids, waste maintenance materials, salt and sewage.
- Waste generated by the construction and operation of the project would be managed through the implementation of a Waste Management Plan developed in accordance with the *Waste Avoidance and Resource Recovery Act 2001*.
- Approximately half of the drill cuttings would be re-used on site whilst the remainder would be disposed of at an appropriately licensed facility.
- Drilling fluid would be recycled, reducing the volume of drilling fluid for disposal by approximately 90 per cent. The remaining 10 per cent would be disposed of to an appropriately licensed facility.
- Residual salt from the treatment of produced water would be classified as general solid waste under the NSW EPA Waste Classification Guidelines and would be disposed of at an appropriately licenced facility.
- The residual environmental risk presented by these and other waste materials generated by the project would be low to very low.

The main waste streams identified as occurring during the construction phase of the project are drill cuttings and fluids generating during drilling and completion of wells; sewage effluent from construction sites and workers' accommodation; general construction and demolition waste (such as pipe offcuts, concrete and wood); and general putrescible waste from site offices and workers' accommodation. The main waste streams identified as occurring during the operational phase of the project are salt and solids generated through the operation of the water treatment facility; sewage effluent; and general solid and putrescible wastes from site offices and well maintenance.

All waste generated by the project would be managed under a Waste Management Plan and in accordance with the requirements of waste legislation.

Drilling fluids utilised during the drilling of wells would be recycled at the approved drilling fluids recycling facility, located at the proponent's Narrabri Operations Centre on Yarrie Lake Road.

During operation, salt would be generated through the treatment of the produced water—refer to Chapter 7 for produced water management information. Salt volumes would peak at around 115 tonnes per day in years two to four of the project when the highest number of wells commence production. The long-term average over the 25-year assessment period would be around 47 tonnes per day. The salt would be managed by off-site disposal to an appropriately licensed facility.

If improperly managed, waste can impact human health and environmental values including soil, air, surface water and groundwater. Waste generated by the project would be managed in accordance with the waste and resource management hierarchy defined in the *Protection of the Environment Operations Act 1997* (PoEO Act), and the requirements of the *Waste and Resource Recovery Act 2001* and other relevant legislation.

Waste mitigation, including recycling and disposal methods is identified in this chapter. These measures are designed to address the risks associated with waste from the project. They are included in the statement of commitments and would guide the preparation of a Waste Management Plan for construction and operation. All wastes not managed on site would be reused, recycled or disposed at appropriately licensed facilities.

The implementation of the Waste Management Plan would satisfactorily manage the potential impacts of waste on human health and environmental values. As a consequence, the residual environmental risk presented by waste generated by the project would be low to very low.

28.1 Methodology

The following tasks were undertaken as part of the waste assessment:

- determination of the regulatory framework
- identification of waste-generating activities – this was undertaken with reference to the description of the project (refer to Chapter 6 – Project description)
- classification of waste in accordance with the classification schemes in the PoEO Act and *Protection of the Environment Operations (Waste) Regulation 2014* (the Waste Regulation; refer to Section 28.2.2)
- estimation of waste quantities – waste quantities were estimated with reference to the description of the project (refer to Chapter 6 and Chapter 7) and publicly available literature on waste management for similar projects. Where necessary and appropriate, nominal quantities were assessed to identify potential impacts and waste management options
- identification of waste management options – waste management options were identified with reference to the requirements of legislation and supporting guidelines, which were included in a conceptual Waste Management Plan.

Waste quantities provided in this chapter are indicative for the purpose of identifying potential waste impacts and appropriate waste management options. The proposed waste management options are scalable and would therefore accommodate actual waste quantities generated.

This chapter is to be read in conjunction with other chapters that assess waste streams including waste water (Chapter 12 and 13), soils and contaminated land (Chapter 14), particulate and gaseous wastes (Chapter 18), greenhouse gas emissions (Chapter 24), and hazardous substances (Chapter 25).

28.2 Legislative context

A general assessment of legislation and approvals relevant to the project is provided in Chapter 4. The key legislation relevant to the management of waste generated by the project is the PoEO Act, Waste Regulation and the *Waste and Resource Recovery Act 2001*.

The PoEO Act establishes the procedures for issuing environmental protection licences regarding matters such as waste, air, water and noise. A general description of the PoEO Act is provided in Chapter 4.

Under the PoEO Act, the Waste Regulation covers a range of issues including the obligations on consignors (producers and agents), transporters and receivers of waste for waste transport licensing and tracking requirements. It covers authorised agents, consignment authorisations and record keeping and returns. There are also sections on the waste and sustainability improvement scheme and recycling of consumer packaging.

28.2.1 Definition of waste

Waste is defined under the PoEO Act as:

(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment

(b) any discarded, rejected, unwanted, surplus or abandoned substance

(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance

(d) any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations

(e) any substance prescribed by the regulations to be waste.

28.2.2 Classification of waste

The PoEO Act, Waste Regulation and *Waste Classification Guidelines* (NSW EPA 2014c) provide a classification system for waste. The classifications relevant to the waste generated by the project are listed in Table 28-1.

Table 28-1 Waste classifications and associated waste types

Classification	Description of waste types
Category 1 trackable waste	Waste type described in Schedule 1, Part 1 of the Waste Regulation that exhibits any of the characteristics specified in Schedule 1, Part 3.
Category 2 trackable waste	Waste type described in Schedule 1, Part 2 of the Waste Regulation that exhibits any of the characteristics specified in Schedule 1, Part 3.
Hazardous waste	Defined under The Australian Dangerous Goods Code: • Class 1 (explosives) • Class 2 (gases) • Division 4.1 (flammable solids) • Division 4.2 (substances liable to spontaneous combustion) • Division 4.3 (substance which when in contact with water emits flammable gases) • Class 5 (oxidizing substances and organic peroxides) • Division 6.1 (toxic substances) • Class 8 (corrosive substances).
Liquid waste	Defined in the *Waste Classification Guidelines* (NSW EPA 2014) as waste that: (i) has an angle of repose of less than 5 degrees above horizontal, or (ii) becomes free-flowing at or below 60°C or when it is transported, or (iii) is generally not capable of being picked up by a spade or shovel.
Restricted solid waste	Restricted solid waste includes wastes assessed and classified as such, in accordance with the procedures outlined in the *Waste Classification Guidelines* (NSW EPA 2014c). No wastes have been pre-classified as 'restricted solid waste'.

Classification	Description of waste types
Special waste	Defined in the *Waste Classification Guidelines* (NSW EPA 2014c) as: • clinical and related waste • asbestos waste • waste tyres.
General solid waste (non-putrescible)	This includes: • glass, plastic, rubber, plasterboard, bricks, concrete or metal • paper or cardboard • household waste from municipal clean up (not containing food waste) • grit and screenings from potable water and water reticulation plants that has been dewatered so that it does not contain free liquids • drained oil filters (mechanically crushed), rags and oil absorbent materials • cured concrete waste from a batch plant as it would remain from its application on construction activities within this development application • building and demolition waste.
General solid waste (putrescible)	This includes: • household waste that contains putrescible organics • waste from litter bins collected by or on behalf of local councils • food waste • grit or screenings from sewage treatment systems that have been dewatered so that the grit or screenings do not contain free liquids.

Many waste types are pre-classified under the PoEO Act and do not require testing. However, if a waste is not pre-classified it may need to be tested to determine its classification.

28.2.3 Waste tracking and transport

Trackable wastes are listed in Schedule 1 of the Waste Regulation. The Waste Regulation prescribes responsibilities for consignors, transporters and receivers of trackable waste. For a given trackable waste, the responsibilities of the consignor are as follows:

> 43 Obligations on consignor of waste relating to transportation of waste
>
> (1) A consignor of waste must ensure that the waste is not transported from one place to another place unless the consignor:
>
> (a) holds a consignment authorisation the transportation of the waste from the place to the other place, and
>
> (b) has obtained a waste transport certificate for the waste and has certified that any part of the certificate that is required to be completed by the consignor has been completed accurately, and
>
> (c) has given the waste transport certificate to the transporter of the waste, and
>
> (d) has ensured that the transporter is licensed (if required by or under the Act) to transport the waste, and
>
> (e) has ensured that the waste facility to which the waste is to be transported is legally able to accept waste of the type concerned.

(2) A consignor of waste must comply with any condition of a consignment authorisation that is held by the consignor.

44 Copy of waste transport certificate to be given to occupier of waste facility

A consignor who is an authorised agent of the occupier of a waste facility must, within 7 days after the day on which the consignor gives to the transporter a waste transport certificate relating to the transportation of waste from the facility, give a copy of the certificate to the occupier in the same form as it was given by the consignor to the transporter.

Tracking requirements under the Waste Regulation do not apply if a generator can demonstrate that a waste does not have the characteristics of a trackable waste defined in Part 3 of Schedule 1. As such, waste-specific testing may be required to determine tracking obligations. Specific reporting requirements also apply under Part 6 and Part 7 of the Waste Regulation to consignors, transporters and recipients of waste tyres or asbestos. Furthermore, the Waste Regulation makes it an offence to transport waste by motor vehicle more than 150 kilometres from the place of generation for disposal, unless the waste is disposed at one of the nearest disposal facilities to where it was generated.

The movement of waste is also controlled by the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure*. This measure aims to ensure that controlled wastes listed in Schedule 1 of the measure are properly identified, transported and disposed or recycled. The management systems detailed in the measure include tracking systems, prior notification systems, licensing of transporters and regulation of producers and facilities. The measure is implemented by State and Territory governments through their regulatory systems.

28.2.4 Waste management hierarchy

The *Waste and Resource Recovery Act 2001* aims to ensure that waste management options are considered against the following waste management hierarchy:

(i) avoidance of unnecessary resource consumption,

(ii) resource recovery (including reuse, reprocessing, recycling and energy recovery),

(iii) disposal.

28.2.5 Sewage treatment and disposal

Applicable approval and referral authorities for sewage treatment and disposal include Narrabri Shire Council and the NSW EPA.

The proposed treatment systems through the operations phase of the project would be less than 200 equivalent persons and not discharging to a watercourse, and therefore will not require a separate Environmental Protection License from NSW EPA. Licences are typically required for systems with a capacity greater than 2,500 equivalent persons or systems that discharge treated sewage to a watercourse. Therefore, Narrabri Shire Council (local council) would be the main approval authority for on-site sewage treatment and disposal.

28.3 Existing environment

28.3.1 Waste generation

Solid wastes produced in the region of the project are mainly generated from industry and include:

- industrial waste (including exploration, appraisal and mining waste)
- agricultural waste (including pesticides and herbicides)
- commercial and special waste (including from hospitals)
- general domestic waste (including sewage).

28.3.2 Waste management facilities

In regional areas, solid waste disposal facilities are typically established and managed by local government. Forty solid waste disposal facilities were identified within the region of the project, 11 of which are within 150 kilometres of the project boundary. Most of these facilities are intended for domestic waste from nearby towns and properties, and therefore have limited capacity for additional waste.

The nearest licensed waste facility is the Narrabri Landfill, about 25 kilometres from Leewood. Two other larger landfill facilities are at Moree and Gunnedah, within 150 kilometres of Leewood. Tracking and transportation of waste is discussed in Section 28.5.6.

All waste, including salt product, that is not recycled or re-used will be disposed of at a landfill that can lawfully accept the waste.

The nearest local government-operated sewage treatment plant is in Narrabri about 25 kilometres north-east of Leewood. It is understood the plant treats approximately 2,900 equivalent tenements a year, equating to an estimated 1.5 megalitres per day.

28.4 Waste inventory

The following waste inventory identifies waste-generating activities, waste characteristics and estimated waste quantities that would be generated by the project. In line with the definition of waste under the PoEO Act, quantities reflect waste generated before management options are implemented, including avoidance. The waste inventory is not exhaustive and should be read in conjunction with other chapters that assess additional waste streams (refer to Section 28.1).

The peak waste generation would occur in the first three years of the project while the major facilities are under construction and drilling is also at its peak with up to six rigs operating.

The construction of flow lines, access track and wells would be undertaken for approximately 20 years with peak activity expected to occur in the first three years.

28.4.1 Construction

Construction of the staged gas processing and water management facilities would take approximately three years to complete, whilst the construction of gas wells and connecting infrastructure would occur progressively over approximately the first 20 years of the project. As such, waste generated by construction activities is assessed over a 20-year period. During these construction activities the following waste-generating activities and resulting wastes are likely to occur:

- clearing and grubbing – generating green waste (trees, shrubs and grasses)
- topsoil stripping and earthworks – generating spoil (topsoil and subsoil)
- upgrade of Westport workers' accommodation – generating general construction waste including timber pallets; concrete, metal straps, bands and off-cuts; cable reels; glass; paper; cardboard and plastic from packaging
- operation of portable amenities – generating wastewater, sewage and effluent sludge
- construction of gas and water gathering systems, and infrastructure at Leewood and Bibblewindi – generating general construction waste including timber pallets; concrete, metal straps, bands and off-cuts; cable reels; glass; paper; cardboard and plastic from packaging
- setup and commissioning of plant and equipment – generating waste air and oil filters, rags, containers and drums, chemicals, batteries and tyres, and liquid wastes such as waste oil, oily water, paints, solvents, sealants, fuels and lubricants
- concrete work at wells pads, Bibblewindi and Leewood – generating cement fluid and slurry
- drilling and completion of wells – generating waste casing materials, drilling fluids, drill cuttings.

Other waste that may be generated by a range of activities during construction include residual paints, sealants and solvents; insulation materials; electrical and electronic waste such as batteries; clinical waste generated by the workforce including sharps, pharmaceutical products, bandages and other first aid waste; and domestic waste generated by the workforce including food waste and recyclable material such as paper, cardboard, aluminium and other packaging.

Estimated waste quantities, before reuse and recycling, are shown in Table 28-2. Table 28-3 contains an inventory of key waste streams generated by construction, waste classifications (refer to Section 28.2.2) and estimated quantities. Further discussion regarding drill cuttings, drill fluid and salt generation is provided after Table 28-3. Hydrostatic testing water will also be generated during the commissioning of pipes. The source of this water and the volume required is currently unknown. All hydrostatic testing water will be tested and disposed of appropriately to either the Leewood water treatment facility or an off-site licenced facility.

Table 28-2 Estimated waste quantities during construction, before reuse and recycling

Material	Average per month (m^3)	Approximate total over assessment period (m^3)
Coal-based drill cuttings	3,000	720,000
Rock-based drill cuttings	1,700	400,000
Drilling fluids	740	178,000
Cement slurry	90	21,250
General solid waste (non-putrescible)	54	13,300
General solid waste (putrescible)	8	1,900
Special / hazardous / liquid waste	2	500

Table 28-3 Waste inventory – construction

Waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance and reuse	Storage and collection	Disposal
Rock-based drill cuttings	Drilling of vertical wells	General solid waste (non-putrescible)	No	1,700 m^3 – average per month 400,000 m^3 – over life of project	Reuse drill cuttings on site.	Mix, turn, and bury drill cuttings on well pads. Drill cuttings not utilised in beneficial reuse would be transported off site and disposed of at an appropriately licensed waste management facility.	No off-site disposal is expected. Drill cuttings would be mixed, turned and buried at nearby well pads.
Coal-based drill cuttings	Drilling of well lateral wells	General solid waste (non-putrescible)	No	3,000 m^3 – average per month 720,000 m^3 – over life of project	-	Temporary storage at site in appropriate containers.	Dispose of cuttings to an appropriately licensed facility.
Drilling fluid	Drilling of wells	Liquid waste (may be trackable, depending on the results of further testing)	Possibly tracked	740 m^3– average per month 178,000 m^3 – over life of project	About 90% re–used and recycled in drill rig.	Store drilling fluids on site in tanks and transfer to the treatment facility located at the Narrabri Operations Centre for reuse in subsequent drilling.	Classify remaining drilling fluid waste and dispose of residual waste at a facility that can lawfully receive it.
Cement slurry	Drilling of wells	General solid waste (non-putrescible)	No	89 m^3– average per month 21,250 m^3 – over life of project		Stored on site in bulk bins and collected by a licenced waste contractor for transport to an appropriate licenced landfill.	Dispose of at an appropriately licenced facility.
Recyclable containers, plastic, paper and cardboard including plastic drums	Construction and operation of Westport workers' accommodation Installation of gas and water gathering systems	General solid waste (non-putrescible)	No	12 m^3 – average per month 3,000 m^3 – over life of project	Order in bulk wherever possible. Avoid using composite materials and items. Use returnable containers wherever possible.	Keep recyclable plastic separate from non-recyclable. Place recyclable plastic in labelled containers and non-recyclable plastic in general waste bin.	Return recyclable materials directly to supplier where possible. Re-use and recycle paper, plastic, etc.

Waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance and reuse	Storage and collection	Disposal
	Construction of power plant (if required), well pad facilities, gathering lines, water treatment plant, nodal compression facility, central processing facility, high voltage transmission lines, pipelines					Ensure containers and drums are empty and cleaned appropriately and chemical labels are removed for reuse. Place on pallets in designated waste storage area for collection by contractor. Ensure paper is segregated and disposed in recycling bins.	
Concrete, and construction and demolition (C&D) waste	Construction of bulk earthworks, power plant, well pad facilities, gathering lines, water treatment plant, nodal compression facility, central processing facility, high voltage transmission lines and pipelines	General solid waste (non-putrescible)	No	33 m^3 – average per month 8,000 m^3 – over life of project	Where practicable, avoid over-ordering and delivery of excess materials through a procurement process. Re-use waste on site in the form of concrete blocks and/or crush on site for use as road base or drainage medium.	Separate, stockpile and/or crush waste for reuse on site. Separate those materials that require offsite disposal.	Dispose waste that cannot be reused on site at an appropriately licensed facility.
	Construction of Westport workers' accommodation						
Scrap metal, metal containers, wire and cable, electrical waste and electronic equipment, gas cylinders, white goods	Construction of power plant, well pad facilities, gathering lines, water treatment plant, nodal compression facility, central processing facility, high voltage transmission lines, pipelines	General solid waste (non-putrescible)	No	6 m^3 – average per month 1,500 m^3 – over life of project	Avoid over-ordering and delivery of excess materials through procurement process. Functional equipment considered for donation to community organisations. Recycle scrap metal and re-use white goods.	Separate waste for recycling and stockpile or store in appropriate container in a designated waste storage area. Organise collection by a licensed e-waste contractor.	Small quantities of some metals would be disposed of if mixed with or attached to other materials, such as timber or concrete, and cannot be easily separated. Dispose waste that cannot be reused on site at an appropriately licensed facility.
	Construction of Westport workers' accommodation						
	Worker accommodation						

Waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance and reuse	Storage and collection	Disposal
	Plant and equipment operation						
Oils and hydrocarbons	Plant and equipment operation	Hazardous waste	Yes	1 m^3 – average per month 250 m^3 – over life of project	Re-use in servicing of plant and vehicles off site.	Store oils and hydrocarbons in separate bulk or smaller containers as required. Store in a designated bunded area for collection by a licensed contractor.	Transport oils and hydrocarbons to recycling facility using an appropriately licensed contractor.
Engine oil filters (spent)		General solid waste (non-putrescible)	No			Drain filters of excess oil prior to disposal. Place in designated bin in waste storage area for collection by contractor.	
Putrescible and general waste	Construction of Westport workers' accommodation Worker accommodation	General solid waste (putrescible)	No	8 m^3 – average per month 1,900 m^3 – over life of project	In the canteen develop suitable low waste menus, serving methods and serving sizes.	Separate food scraps and store in appropriate bin.	Compost food on site where appropriate. Transport waste to landfill.
Timber, crates, pallets	Delivery of construction materials used in construction of power plant, well pad facilities, gathering lines, water plant, nodal compression facility, central processing facility, high voltage transmission lines, pipelines	General solid waste (non-putrescible)	No	2 m^3 – average per month 430 m^3 – over life of project	Avoid over-ordering and delivery of excess materials through a procurement process. Return pallets to supplier, where possible.	Stockpile timber, crates and pallets for reuse on site if suitable, or return to the supplier. Chip and mulch timber, crates and pallets if suitable (e.g. untreated).	Disposal to appropriately licenced facility as required.
	Delivery of construction materials used in construction of Westport workers' accommodation						

Waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance and reuse	Storage and collection	Disposal
Tyres	Plant and equipment operation	Special waste	Yes (where transported out of NSW)	1 m^3 – average per month 325 m^3 – over life of project	Change tyres at retailers in towns as much as possible	Place tyres on pallets at waste storage area for collection by a contractor for recycling	Return waste tyres directly to supplier where possible, or otherwise recycle.
Batteries, residual paints, sealants, solvents, resins	Surface earthworks Construction of water treatment facility Worker accommodation Plant and equipment operation	Hazardous waste Liquid waste	Yes	1 m^3 – average per month 250 m^3 – over life of project	Use rechargeable batteries wherever possible, recycle used batteries. Avoid over-ordering and delivery of excess materials through a procurement process.	Store wet and dry batteries separately in containers at designated waste storage area for collection by contractor for recycling. Store chemicals in bunded purpose-designed enclosure, for collection by a licensed operator.	Transport waste using an appropriately licensed contractor. Recycle batteries. Recover chemicals. Dispose of other materials appropriately.
Medical waste	Plant and equipment operation	Special waste	Yes	<0.1 m^3 – average per month <25 m^3 – over life of project	-	Place sharps in purpose-designed containers and other clinical waste in yellow clinical waste bags. Organise collection by a clinical waste contractor or delivery to local hospital.	Disposal of medical waste using a licensed contractor.

Drill cuttings

Drill cuttings are the waste rock and spoil extracted from wells during drilling. The quantity of drill cuttings produced by a given well depends on its type. The project includes several types of wells that differ in length and would therefore produce different quantities of cuttings. The types of wells (single vertical, single lateral, double lateral, triple later and quadruple lateral) and their volumes are described further in Chapter 6.

Two types of cuttings are expected to be produced: a mainly rock-based material from the vertical wells and a mainly coal-based material from the lateral wells. The vertical well material would be used via a mix, turn, bury strategy on the well pads, while coal based material from the lateral wells would be taken off site for disposal at a licensed facility.

Once extracted from a well and brought to the surface, drill cuttings increase in volume as the rock breaks into smaller particles. The estimated annual quantities of drill cuttings, taking into account the various types of wells and the expansion of drill cuttings, are presented in Figure 28-1.

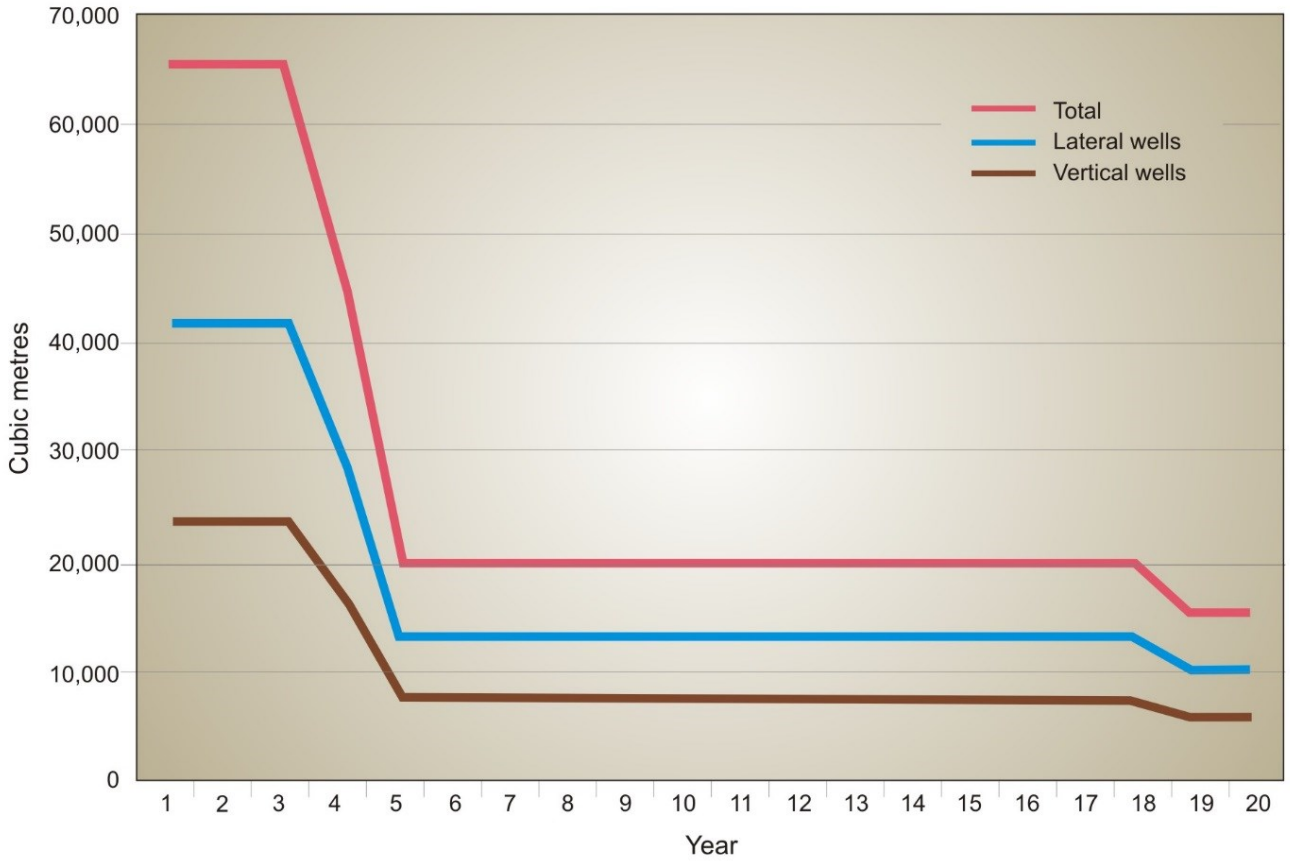

Figure 28-1 Estimated volume of drill cuttings per year

Drilling fluids

A water-based drilling fluid would be used in the drilling process to maintain well bore stability and well control. Before drilling starts, drilling mud would be prepared on site or transported to site in a tanker from the approved fluid treatment facility at the Narrabri Operations and Logistics Centre and stored in surface tanks on site.

Drilling fluid comprises either bentonite or polymer which is used to form a temporary filter cake on the sides of the drill hole, rapidly reducing the infiltration of drilling mud into the formations through which the bore extends. The drilling fluid is pumped downhole and used to cool and lubricate the drill bit, and also to carry drill cuttings to surface.

On average, approximately 740 cubic metres of drilling fluid is used per well which would result in approximately 178,000 cubic metres being used during the construction of the wells over 20 years. By re-using the drilling fluid, an average of approximately 72 cubic metres would be required to be disposed each month.

Management of drilling fluids is discussed in Section 28.5.3.

Sewage

Sewage generated by the construction workforce will be managed using packaged wastewater treatment plants at the Leewood and Bibblewindi sites and Westport worker's accommodation whilst portable ablution facilities for the storage of sewage will be used at construction sites (e.g. during drilling). Packaged wastewater treatment plants, which are extensively utilised in both municipal and project related settings, employ an aerobic process to treat sewage. The process generates effluent suitable for application to land and residual sludge that is held within storage tanks that are periodically emptied for disposal to an appropriate facility.

A 200-person capacity packaged wastewater treatment plant would be installed at Bibblewindi and a 400-person capacity packaged treatment plant would be installed at Leewood. The Westport workers' accommodation has existing approval for 64-person sewage facilities and this would be upgraded to cater for a total of 200 people. The wastewater treatment plants will be designed to Australian Standards and treated effluent would be disposed of to a dedicated on-site disposal area by subsurface infiltration or adsorption trenches, irrigation or similar, in line with all regulatory requirements.

A flow rate of 200 litres per person per day has been adopted for the workers' accommodation, in accordance with *AS/NZS 1547:2012 – On-site Domestic Wastewater Management* (a recognised standard for flow determination). Workers would have access to amenities typical of residential settings and, as such, the adopted per capita rate reflects relatively normal residential generation rates and assumes multiple showers and laundry facilities.

A flow rate of 60 litres per person per day has been adopted for all site offices (including transient facilities), which assumes toilet and hand basin waste, including kitchen and shower facilities. This is in accordance with *AS/NZS1547:2012 – On-site Domestic Wastewater Management*.

The estimated project workforce is presented in Chapter 26. Although the workforce at site offices and portable amenities would fluctuate, anticipated maximum populations have been adopted.

The estimated daily volume of sewage waste generated by the project during construction is presented in Table 28-4.

Table 28-4 Sewage generation during peak construction period

Project component	Estimated maximum persons	Volume (kL per day)
Leewood	375	23[a]
Bibblewindi	225	14[a]
Infrastructure corridors	35	2[a]
Gas field	500	30[a]
Westport workers' accommodation	200	40[b]

[a] Flow rate of 60 litres per day adopted in accordance with *AS/NZS1547:2012 – On-site Domestic Wastewater Management* for office facilities with kitchenette.

[b] *AS/NZS 1547:2012 – On-site Domestic Wastewater Management* quantifies flow rate at 200 litres per day for a residential setting. A maximum of 200 persons has been assumed to account for the total project workforce at Westport workers' accommodation, despite the existing approval for 64 persons.

28.4.2 Operation and decommissioning

The following waste-generating activities are likely to occur during operation and decommissioning:

- operation of exploration and appraisal, and production wells – generating produced water that would be treated at the Leewood water treatment facility. The produced water would be treated as per the process shown in Figure 7-4 in Chapter 7, with the treated water being beneficially reused in agricultural irrigation, dust suppression, construction, drilling and firefighting activities
- operation of water treatment facility at Leewood – treating the produced water from operation of the exploration and appraisal, and production wells which would generate:
  - solids removed during the water treatment process (refer to Stage 1 Figure 7-4 in Chapter 7)
  - brine from the reverse osmosis and brine concentrator (refer to Stages 2 and 3 on Figure 7-4 in Chapter 7 respectively)
  - salt from the salt crystalliser (refer to Stage 4 on Figure 7-4 in Chapter 7). Prior to routine load out to an off-site licenced waste management facility, the salt would be temporarily stored on site in a weather proof structure
  - used filter cartridges and reverse osmosis membranes from the water treatment facility
- operation of other infrastructure at Leewood and Bibblewindi – generating waste fuels, oils and hydrocarbons; oily water, rags and absorbent material; wastewater
- operation of plant and equipment – generating waste air and oil filters, rags, containers and drums, chemicals, batteries and tyres, and liquid wastes such as waste oil, oily water, paints, solvents, sealants, fuels and lubricants
- fencing of well sites (following partial rehabilitation)
- maintenance of wells and wellhead infrastructure – generating plastic, scrap metal, cement fluid and slurry, drilling fluids used in wells during workover activities, and some green waste in accessing areas around wells
- maintenance of gas and water gathering systems – generating pipe off-cuts and entrained water.

The estimated waste quantities before reuse and recycling are shown in Table 28-5.

Table 28-5 Estimated waste quantities during operation and decommissioning, before reuse and recycling

Material	Average per month	Approximate total over life of project
Produced water	125 megalitres	37.5 gigalitres
Brine	a subset of the produced water	a subset of the produced water
Salt (based on an average of 1.5 gigalitres of produced water per year for 25 years)	1,430 tonnes	430,500 tonnes
General solid waste (putrescible)	305 m^3	91,500 m^3
Special / hazardous / liquid waste	11 m^3	2,700 m^3
General solid waste (non-putrescible)	7 m^3	1,700 m^3

Waste that may be generated by activities during operation and decommissioning include salt generated from the water treatment process; algae and other pond solids from the water treatment facility; packaging and containers from deliveries; and domestic waste generated by the workforce including food waste and recyclable material such as paper, cardboard, aluminium and other packaging.

Table 28-6 contains an inventory of key waste streams during operation and decommissioning, waste classifications (refer to Section 28.2.2) and estimated quantities. Further detail on the generation of salt is provided in Table 28-6.

Table 28-6 Waste inventory – operation and decommissioning

Solid waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance	Storage and collection	Disposal
Produced water	Operation of exploration and appraisal, and production wells	Interim waste product – not for off-site disposal	Interim waste product – not for off-site transport	125 megalitres per month 37.5 gigalitres over life of project	Beneficial reuse of treated water in agricultural irrigation, dust suppression, construction, drilling and firefighting activities	Produced water ponds at Leewood and Bibblewindi prior to treatment	Not for disposal Managed release of treated water under licence to Bohena Creek
Brine	Produced water treatment	Interim waste product – not for off-site disposal	Interim waste product – not for off-site transport	A subset of the produced water	Not for disposal. Treated through the brine concentrator to produce distillate for beneficial reuse and salt for licenced disposal	Brine storage ponds at Leewood and Bibblewindi prior to treatment	Not for disposal
Salt	Treatment of brine Drainage and treatment of water management ponds, pipes and tanks at water treatment facility	Expected to be general solid waste (non-putrescible)	No (unless confirmed by further testing)	1,430 tonnes – average per month 430,500 tonnes – over life of project	Re-use the salt where commercially possible.	Store in bins or other contained area for transport to disposal	Disposal to a suitably licensed facility.
Algae and other pond solids	Reverse osmosis plant	General solid waste (putrescible)	No	300 m^3 – average per month 93,300 m^3 – over life of project		Stored in marked bins. Collected by a licenced contractor	Transport to a licenced landfill for disposal
Recyclable containers,	Office activities Operation and maintenance of the water facility	General solid waste (non-putrescible)	No	5 m^3 – average per month	Purchase materials in bulk. Make arrangements for suppliers to deliver	Crush and sort packaging in designated waste storage area.	Recycle waste where possible.

Solid waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance	Storage and collection	Disposal
plastic, paper and cardboard	Operation and maintenance of gas processing facility			1,200 m^3 – over life of project	in reusable or returnable containers.	Keep recyclable waste separate from non-recyclable.	Send remaining waste to landfill.
	Well plugging and decommissioning						
	Removal of well head and surface infrastructure at well sites						
	Removal of surface infrastructure associated with gathering lines, power generation facility, water treatment plant, central gas processing facility, in-field gas compression facility,						
Scrap metal, metal containers, wire and cable, electrical waste and electronic equipment, gas cylinders, white goods	Fencing of well sites	General solid waste (non-putrescible)	No	1 m^3 – average per month 170 m^3 – over life of project	Avoid over-ordering and delivery of excess materials through a procurement process. Lease equipment where possible with lessor to take back redundant / expired equipment.	Consider donating old or unused electronic equipment to community organisations. Stockpile or place in container at designated waste storage area for collection by a licensed e-waste contractor. Clean small off-cuts of oils / lubricants before placing in a bin.	Recycle scrap metal and re-use equipment.
	Office activities						
	Operation and maintenance of plant and equipment						
	Well plugging and decommissioning						
	Removal of well head and surface infrastructure at well sites during decommissioning						
	Removal of surface infrastructure associated with gathering lines, power generation facility, water treatment plant, central gas processing facility, in-field gas compression facility,						
	Decommissioning of Westport workers' accommodation						
Putrescible waste	Office activities	General solid waste (putrescible)	No	5 m^3 – average per month 1,300 m^3 – over life of project	Develop suitable low waste menus and serving methods, and serving sizes.	Separate food scraps in kitchen and eating areas and store in labelled bins. Ensure all bins on site have lids that are closed at all times.	Compost food on site, where appropriate Send unrecovered waste to landfill.
	Operation of Westport workers' accommodation						
	General surface rehabilitation including revegetation						

Solid waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance	Storage and collection	Disposal
Oils and hydrocarbons, oily rags and absorbent material	Operation and maintenance of gas and water processing and power generation facilities Operation and maintenance of gas compression facilities	Hazardous waste	Yes (where liquid)	10 m^3 – average per month 2,633 m^3 – over life of project		Store in bulk containers Store in a designated bunded and covered area for recycling by licensed contractor.	Transport waste using an appropriately licensed contractor. Collect recyclable waste for recycling using a contractor. Assess and then dispose of residual waste at a facility that can lawfully receive it. Service plant and vehicles off site at facilities with established recycling services.
Engine oil filters (spent)	Maintenance of water gathering system Operation of water treatment facility Operation of gas processing facilities and power plant. Operation of plant and equipment	General solid waste (non-putrescible)	No			Drain filters of excess oil prior to disposal. Place in correctly labelled bin at designated waste storage area for collection by contractor. Ensure oily rags are not mixed with clean rags. Place in correctly labelled bin at waste storage area.	
Concrete and construction and demolition waste	Maintenance of gas gathering system	General solid waste (non-putrescible)	No	<1 m^3 – average per month 12 m^3 – over life of project	Where practicable, avoid over-ordering and delivery of excess materials through a procurement process. Reuse waste on site for concrete blocks.	Stockpile and crush waste concrete for use on site.	Dispose waste that cannot be reused on site at an appropriately licensed facility.
Timber, crates, pallets	Delivery of materials required for operation and maintenance of facilities	General solid waste (non-putrescible)	No	1 m^3 – average per month 200 m^3 – over life of project	Avoid over-ordering and delivery of excess materials through a procurement process.	Stockpile timber, crates and pallets for reuse on site if suitable, or return to the supplier. Chip and mulch timber, crates and pallets if suitable (e.g. untreated).	Return pallets to supplier. Chip and mulch untreated timber.

Solid waste	Activity	Classification	Trackable waste	Approximate quantities	Avoidance	Storage and collection	Disposal
Medical waste	Decommissioning of facilities	Special waste	Yes	<0.1 m^3 – average per month <10 m^3 – over life of project	-	Place sharps in purpose-designed containers and other clinical waste in yellow clinical waste bags for collection by a clinical waste contractor or delivery to local hospital.	Dispose of waste using an appropriately licensed contractor.
Batteries, contaminated soil, paints, solvents, sealants, resins, fluorescent lights and tubes	Office activities	Hazardous waste	Yes	<1 m^3 – average per month 100 m^3 – over life of project	Use rechargeable batteries wherever possible, and recycle used batteries. Avoid over-ordering and delivery of excess materials through a procurement process.	Store wet and dry batteries, properly cleaned and sealed, in separate containers at waste transfer station for collection by contractor for recycling. Store chemicals in bunded purpose-designed enclosures, for collection by a licensed operator. Place intact fluorescent tubes in old tube boxes and place in container for collection by contractor.	Transport waste to disposal facility using an appropriately licensed contractor. Recycle batteries. Recover chemicals and fluorescent tubes. Dispose of other materials appropriately
	Operation and maintenance of water treatment facility						
	Operation and maintenance of gas processing facilities						
	Transfer of produced water from wells to Leewood ponds						
	Removal of well head and surface infrastructure at well sites						
	Removal of pipes and surface infrastructure at gas processing facility						
	Drainage and treatment of water management ponds, pipes and tanks at water treatment facility						
	General surface rehabilitation including revegetation						
	Decommissioning of temporary worker accommodation						
	Maintenance of water gathering system						

Salt

As detailed in Section 7.8, salt is generated through the treatment of produced water. Produced water volumes are predicted to peak between around the second to fourth year of the project, and therefore, estimated salt volumes would also peak around that time. Forecasts show that the estimated average daily solid salt volumes in the produced water would be as follows:

- for the peak period in around years two to four, around 115 tonnes of salt per day would be extracted through the treatment process, and disposed off-site to a licensed landfill as a solid salt waste product. This equates to around two and a half B-double truck loads per day
- for the remaining years through the assessment period, an average of around 47 tonnes of salt per day would be extracted through the treatment process, and disposed off site to a licensed landfill as a solid salt waste product. This equates to a little over one B-double truck load per day.

The salt would be classified as general solid waste under the *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-liquid Wastes* (NSW EPA 2014c).

The salt product would be temporarily stored on site in a weather proof structure prior to load-out. The salt product would be collected and transported to an appropriately licensed facility by truck in accordance with all legislative requirements. The vehicles used to transport the waste will be fit for purpose and waste tracking and other legislative requirements in relation to the transport of the waste will be undertaken.

There are a substantial number of waste facilities that are currently licensed to receive general solid waste, including both Government and local Municipal facilities as well as privately owned facilities.

The proponent has held discussions with a number of major waste disposal organisations and they have indicated that they have the capacity and capability to dispose of the salt waste at a number of their appropriately licensed facilities.

Sewage

During operation, the majority of sewage waste would be generated at Leewood and Bibblewindi; the latter having existing sewage treatment facilities that would be upgraded to accommodate an increased workforce.

As noted above, a flow rate of 60 litres per person per day has been adopted for all site offices, which assumes toilet and hand basin waste, including kitchen or shower facilities. This is in accordance with *AS/NZS1547:2012 – On-site Domestic Wastewater Management*.

The estimated project workforce is presented in Chapter 26. Although the workforce at site offices and portable amenities would fluctuate, anticipated maximum populations have been adopted.

The estimated daily volume of sewage waste generated by the project during operation is presented in Table 28-7.

Table 28-7 Sewage-generating activities and volumes during operation

Project component	Estimated maximum persons	Volume (kL per day)
Bibblewindi (~25 years' duration)[a]	45	3
Leewood (~25 years' duration)[b]	45	3

[a] Bibblewindi has existing sewage facilities and includes an existing nodal compression facility.

[b] Leewood includes water treatment plant, power generation facility (if required), and central gas processing facility.

28.5 Waste management

A Waste Management Plan would be prepared for the project. It would build on the existing Waste Management Plan in place for exploration activities in the project area with the findings of this assessment and would be updated as the project progresses. Additional information would also be gathered through detailed design, construction and operation and in consultation with chosen contractors and suppliers regarding product use and wastes generated. The Waste Management Plan would:

- estimate waste quantities
- record how and where different types of waste would be generated
- review potential impacts
- specify waste and recycling collection systems and infrastructure
- specify how waste would be transported and stored on site
- specify how waste would be transported off site and where it would be recycled and disposed.

The majority of waste streams from the project are not likely to require transport further than 150 kilometres (refer to Section 28.2.5), given the available facilities (refer to Section 28.3.2). Further transportation may be required for some waste streams (e.g. salt) if local facilities are unable to accept the waste. Tracking and transportation of waste is discussed in Section 28.5.6.

28.5.1 Waste hierarchy

For the purpose of managing waste generated by the project, the waste management hierarchy (refer to Section 28.2.4) has been expanded to include the following actions:

- Avoid – Choose a process so as to avoid the production of the waste.
- Reduce – Review the process and raw materials to reduce the production of the waste.
- Reuse – Re-use as much as possible in the process to minimise the waste.
- Recycle – Use the waste stream as a raw material in a different process or as an alternative source of energy / fuel.
- Treatment – Appropriately treat waste and / or neutralise residues.
- Disposal – Dispose of wastes responsibly using appropriate methods.

28.5.2 Waste prevention

Waste prevention is the first step in reducing the amount of solid waste generated. Where appropriate, the generation of waste would be prevented or reduced by choosing lower waste inputs, increasing the efficiency in the use of raw materials, energy, water and land, redesigning processes or products and improving maintenance and operation of equipment.

Careful project planning would ensure that the amount of material brought onto site for the construction and operation of the project is minimised, resulting in a cost saving and reduction in the volume of waste going to landfill. Excess materials and used chemical containers would, where practical, be returned to the supplier or other local users.

The project would consider the need to minimise packaging when purchasing resources for the project and would encourage bulk purchasing to reduce the amount of packaging waste. Most of the infrastructure at Leewood, Bibblewindi and Westport workers' accommodation would be pre-fabricated off site minimising the generation of waste on site.

28.5.3 Waste recycling and reuse

Solid waste, where practicable and taking into account health, safety and hygiene issues, would be separated and collected at the designated waste storage areas. Materials identified as construction wastes would be re-used or recycled as follows:

- where possible, vegetation wastes from site clearing would be stockpiled, mulched and re-used for site rehabilitation.
- solvents, metals or oil would be recovered and re-used for a secondary purpose.
- recyclable building wastes would be collected separately and re-used or recycled. For example:
  - wood from concrete formwork would be recovered and re-used
  - scrap steel and off-cuts would be recycled
  - pallets would be re-used or recycled
  - plastics would be recycled
  - paper and cardboard would be re-used or recycled
  - oils would be collected and sent for recycling.

Once the quantities of recyclable waste generated by the construction and operation of the project are confirmed, market demand for recyclable waste streams would be investigated. The availability and capacity of local facilities would also be a factor in maximising recycling and reuse.

Drilling Waste

Once a well has been drilled, the drilling fluid would be displaced from the well by the cementation process or by production fluids. Drilling fluids would be managed in accordance with a Fluids Management Plan. This would involve delivery and treatment of drilling fluids at the treatment facility located at the approved drilling fluids treatment facility to be located at the Narrabri Operations and Logistics Centre. The facility would, among other things, provide storage capacity for fluids, remove ultra-fine and colloidal solids, mix chemicals to the drilling fluids and return fluids to field operations.

The waste would be transported to a subsequent well for reuse or back to the fluids treatment facility for storage and treatment. Before drilling fluid is re-used at another well, the chemical and physical properties would be tested and the fluid amended, in accordance with the plan as required. Spent drilling fluid unsuitable for reuse would be transported by a licenced contractor for disposal at an appropriately licenced facility. Under the PoEO Act, this waste may be required to be tracked.

It is proposed that drill cuttings from the vertical part of the well, which is expected to be predominantly rock material, would be beneficially re-used on well pads using a mix, turn, bury strategy. The application of drill cuttings at well pads would be carried out with regard to the volume and characteristics of the drill cuttings, the characteristics of the receiving soil, and the volume and nutrient requirements of growth media. A balance of these factors would be required to ensure successful rehabilitation.

In accordance with advice from the NSW Environment Protection Authority (refer to Appendix E), the beneficial reuse of rock-based drill cuttings in this manner would not require a resource recovery exemption or trigger other waste licensing requirements.

Drill cuttings from the lateral part of the well, which is expected to be predominantly coal-based material, or other drill cuttings that are inappropriate for beneficial reuse would be transported off site and disposed at an appropriately licensed facility.

28.5.4 On-site waste management

All on-site waste management facilities would be developed in accordance with internal waste management procedures and all legislative requirements in relation to waste management and disposal.

Most general waste generated on site would be collected and consolidated at a designated waste storage area at either Leewood or Bibblewindi. The waste storage area would most likely consist of a compound for bins, containers, pallets and other waste equipment. Garbage and recyclables would be stored separately for appropriate reuse, recycling or disposal. Most waste is expected to be collected from the waste storage area by licensed contractors. Contractors may also collect directly from other sites in the operational area where this is required. Salt from the water treatment process would be stored at Leewood in a purpose built storage area prior to offsite disposal at a licenced waste management facility.

Waste requiring disposal would be sent off site to an appropriately licensed waste facility. All waste transport would be undertaken by licensed transporters and tracked in accordance with legislative requirements.

Sewage waste

A description of the sewage arrangements during construction and operation are provided in Section 28.4.

The described on-site sewage management systems would not meet the trigger levels for a licence under the PoEO Act and associated *Licensing Guidelines for Sewage Treatment Systems* (NSW EPA 2003) and would be subject to approval by the Narrabri Shire Council.

The size and siting of an irrigation area would be subject to appropriate assessment with consideration of site specific conditions and an Effluent Management Plan would be prepared and implemented. On-site sewage treatment would produce approximately one kilolitre of sludge per week in total for the three sites, which would be transported to an approved sewage treatment facility.

28.5.5 Non-routine waste

In the event of a spill, waste generated during clean-up, including spoil, absorbent materials or cleaning products, soil or other items would be classified and stored appropriately prior to disposal at a facility licensed to accept the waste.

If potential sources of existing land contamination are found (such as farm dumps, decommissioned livestock dips or chemical drum storage areas) the response procedure defined in the Waste Management Plan would be implemented including notifications required to landholders and regulatory authorities in accordance with legislative requirements.

28.5.6 Waste tracking and transport

The project would implement all necessary measures in order to adhere to the regulatory requirements for waste tracking and transport. This would include engagement of appropriately licensed consigners, transporters or receivers of waste; maintaining records of waste tracking information; and reporting non-compliance in accordance with legislative requirements to ensure corrective action. In the event that interstate transport of waste is necessary, consignment authorisations would be sought from the relevant authority. These authorisations may stipulate additional conditions for the management of the waste.

28.6 Risk assessment

A risk assessment was undertaken for the potential impacts associated with waste for the project (Table 28-8). A range of mitigation and management measures are proposed to control potential impacts of the project with regard to waste. Table 28-8 demonstrates the effectiveness of these mitigation measures in reducing impacts and, as such, the level of environmental risk posed by the project. The risk assessment process is provided in Chapter 10.

Table 28-8 Environmental risk assessment

Potential impact	Phase	Pre-mitigated risk			Mitigation and management measures	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Waste to be disposed constrains capacity at receiving landfills	Construction	Possible	Moderate	Medium	A Waste Management Plan will be implemented. Solid salt product will be disposed of at an appropriately licensed facility in accordance with regulatory requirements.	Unlikely	Minor	Low
	Operation	Possible	Moderate	Medium		Unlikely	Minor	Low
	Decommissioning	Unlikely	Moderate	Medium		Unlikely	Negligible	Very low
Uncontrolled release of waste (may cause impact to land, surface or groundwater and dependent ecosystems)	Construction	Possible	Minor	Low		Unlikely	Minor	Low
	Operation	Possible	Minor	Low		Unlikely	Minor	Low
	Decommissioning	Possible	Minor	Low		Unlikely	Negligible	Very Low
Controlled release of waste (may cause unauthorised impact to land, surface or groundwater and dependent ecosystems)	Construction	Unlikely	Moderate	Medium		Remote	Minor	Very low
	Operation	Unlikely	Moderate	Medium		Remote	Minor	Very low
	Decommissioning	Unlikely	Minor	Low		Remote	Minor	Very low
Increase in vermin and pest populations	Construction	Likely	Minor	Medium		Unlikely	Negligible	Very low
	Operation	Likely	Minor	Medium		Unlikely	Negligible	Very low
	Decommissioning	Possible	Minor	Low		Unlikely	Negligible	Very low

28.7 Conclusion

The likely waste types and volumes identified during construction, operation and decommissioning of this project can be managed resulting in minimal impacts. The waste management strategies identified in this assessment would be formalised in a Waste Management Plan for the project. The implementation of the Waste Management Plan would be satisfactory to manage potential impacts of waste on human health and environmental values. As a consequence, the residual environmental risk presented by project waste management is low to very low as shown in Table 28-9.

Table 28-9 Waste management residual risks

Potential impact	Residual risk		
	Construction	Operation	Decommissioning
Waste to be disposed constrains capacity at receiving landfills	Low	Low	Very low
Uncontrolled release of waste (may cause contamination of land, surface or groundwater and dependent ecosystems)	Low	Low	Very low
Controlled release of waste (may cause unauthorised contamination of land, surface or groundwater and dependent ecosystems)	Very low	Very low	Very low
Increase in vermin and pest populations	Very low	Very low	Very low