Waste 12

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12.1 Introduction

This section describes the wastes to be generated by the construction, operation, decommissioning and rehabilitation of the GFD Project.

In the GFD Project area and surrounding area, solid and liquid wastes are generated from domestic and commercial premises as well as agricultural, industrial and resource extraction activities. Regional councils provide waste collection, recycling and disposal facilities and services for residential and commercial properties. Commercially operated waste management facilities provide additional options for collection, treatment and disposal of solid and liquid wastes.

This section has been prepared in accordance with section 4.4 and 4.5 of the *Terms of reference for an environmental impact statement* issued March 2013. The index to locate where each ToR requirement is met within the EIS is included at Appendix B: Terms of reference cross-reference. Emissions to air are addressed in detail in Section 15: Air quality and Section 16: Greenhouse gases. Santos GLNG's approach for dealing with coal seam water and brine is set out in the Coal seam water management strategy (Appendix Z).

12.2 Regulatory context

This EIS has been prepared in accordance with the State and Commonwealth regulatory context described within Appendix C: Regulatory framework. The legislation, policies and guidelines that apply to waste management values and potential impacts of the GFD Project are outlined in Table 12-1. Post-EIS approvals are presented in Section 2: Project approvals.

Table 12-1 Regulatory context – waste

Legislation	Relevance to the GFD Project
National Environment Protection Measures (Implementation) Act 1998 (Cth) This Act provides for the implementation of national environment protection measures (NEPMs) within the Commonwealth Government's jurisdictions and activities. NEPMs are a special set of national objectives designed to assist in protecting or managing particular aspects of the environment such as air and water quality, land contamination, hazardous wastes, and the reuse and recycling of materials.	The following NEPMs are relevant to the waste aspects of the GFD Project. • National Pollutant Inventory (NPI) NEPM sets out agreed national environment protection goals. Emissions and transfers of substances on the reporting list must be recorded on a database that is accessible to the community. • Movement of Controlled Waste between States and Territories NEPM lists waste streams, constituents and hazardous characteristics to identify whether materials are hazardous and provides for tracking interstate transport of controlled wastes. • Used Packaging Materials NEPM requires businesses producing a significant amount of packaging waste to self-regulate to a specified standard to ensure their packaging materials are recycled or reused appropriately. Failure to comply will result in a fine.
Hazardous Waste (Regulation of Exports and Imports) Act 1989 (Cth) The Act regulates the export and import of hazardous waste with the intent of protecting human health and the environment.	Export and import of hazardous waste, should it be required by the GFD Project, would be conducted safely in accordance with this legislation so that humans and the environment, both within and outside Australia, are protected from the harmful effects of the waste.

Legislation	Relevance to the GFD Project
National Waste Policy: Less Waste, More Resources (EPHC, 2009).	The *National Waste Policy* supports annual reporting of waste emissions to land, air and water through the NPI. Facilities that emit or consume greater than threshold amounts of 93 nominated substances are required to report their emissions to the NPI database to provide stakeholders and government agencies with information on the type and quantity of substances emitted to land, water and air. Gas and water treatment facilities being proposed under the GFD Project may trigger reporting under the NPI scheme.
Australian code for the transport of dangerous goods by road and rail (National Transport Commission, 2011).	The code sets out the technical requirements and guidelines for transportation of dangerous goods by road and rail.
Environmental Protection Act 1994 (Qld) (EP Act) The EP Act is the principal legislation for the protection and management of environmental values within Queensland. The Act aims to protect the natural environment and associated ecological systems and processes, while allowing for sustainable development.	Section 13 of the EP Act defines waste as 'anything that is left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity; or surplus to the industrial, commercial, domestic or other activity generating wastes'. Under the EP Act, waste generated by a development must be managed in compliance with the *Waste Reduction and Recycling Act 2011*.
Environmental Protection Regulation 2008 (Qld) (EP Regulation) The EP Regulation prescribes the regulatory framework for managing the impacts of industrial, agricultural and resource development projects on the environment. This includes the definition and approvals processes for environmental impact statements and environmentally relevant activities.	The EP Regulation defines regulated waste as waste that is commercial or industrial waste, whether or not it has been immobilised or treated, and is of a type, or contains a constituent of a type, mentioned in Schedule 7 of the EP Regulation. Certain regulated wastes are considered trackable waste, and the EP Regulation provides a process to allow such wastes to be tracked from point of generation to processing, recycling or disposal facilities. The EP Regulation has been amended so that better quality coal seam water is exempt from the definition of regulated waste. This change applies where coal seam water has a pH between 6 -10.5 and an electrical conductivity less than 15,000 micro Siemens per centimetre (µS/cm). Certain waste management activities, including disposal and transport of waste, are defined as environmentally relevant activities (ERAs) and require approval under the EP Regulation.
Waste Reduction and Recycling Act 2011 (Qld) The Act aims to promote waste avoidance and reduction and to encourage resource recovery and efficiency. The Act provides a strategic framework for managing wastes by establishing a waste and resource management hierarchy.	The *Waste Reduction and Recycling Act* repealed the *Environmental Protection (Waste Management) Policy 2000* (Qld) and amended the EP Act and Regulation to modernise waste management and resource recovery practices in Queensland. It promotes waste avoidance, resource recovery and efficiency by improving ways of reducing and dealing with waste, including allowing for introduction of a price signalling approach i.e. waste levy. The Act provides a strategic framework for managing wastes through a waste and resource management hierarchy, as listed below in the preferred order to be considered: • Avoid unnecessary resource consumption • Reduce waste generation and disposal • Re-use waste resources without further manufacturing • Recycle waste resources to make the same or different products • Recover waste resources, including the recovery of energy • Treat waste before disposal, including reducing the hazardous nature of waste • Dispose of waste only if there is no viable alternative.

<table>
<tr><th>Legislation</th><th>Relevance to the GFD Project</th></tr>
<tr><td>Waste Reduction and Recycling Regulation 2011 (Qld)
The regulation prescribes fees associated with applications under the Waste Reduction and Recycling Act 2011 and further detail on managing waste, including reporting requirements.</td><td>The Waste Reduction and Recycling Regulation 2011 (Qld) sets out the mechanisms to achieve the objectives of the Waste Reduction and Recycling Act 2011 (Qld), mainly in relation to waste levies. As of June 2012, the waste levy was set to an amount of zero. However, while the State Government has removed the landfill levy, the legislation underpinning the levy, the Waste Reduction and Recycling Bill 2011, has not been repealed.</td></tr>
<tr><td>Environmental Protection (Waste Management) Regulation 2000 (Qld) (Waste Regulation)
This regulation establishes an integrated framework for minimising and managing waste to achieve the principles of ecologically sustainable development.</td><td>The Waste Regulation contains requirements for storage and handling of certain regulated wastes that are considered ‘trackable wastes’. This regulation outlines a process that allows such wastes to be tracked from the point of generation to the point of final processing, recycling or disposal. The GFD Project will generate a number of trackable wastes that will need to be managed in accordance with this regulation.</td></tr>
<tr><td>Queensland waste strategy.</td><td>The Queensland Government is developing an industry led waste strategy. The previous strategy Queensland's Waste Reduction and Recycling Strategy 2010-2020 is being reviewed as part of the development.</td></tr>
<tr><td>Coal seam gas water management policy (EHP, 2012)
This policy guides operators in managing coal seam water, including beneficial use in a way that protects the environment and maximises its productive use as a valuable resource.</td><td>The objective of the policy, to encourage the beneficial use of coal seam water, is achieved when coal seam water and saline waste is managed consistently with prioritisation hierarchies and specified management criteria. The prioritisation hierarchy for managing and using coal seam water and saline waste are described below:
<table>
<tr><th>Priority</th><th>Coal seam water</th><th>Saline waste</th></tr>
<tr><td>1</td><td>Coal seam water is used for a purpose that is beneficial to one or more of the following: the environment, existing or new water users, and existing or new water-dependent industries.</td><td>Brine or salt residues are treated to create useable products wherever feasible.</td></tr>
<tr><td>2</td><td>After feasible beneficial use options have been considered, treating and disposing coal seam water in a way that firstly avoids, and then minimises and mitigates, impacts on environmental values.</td><td>After assessing the feasibility of treating the brine or solid salt residues to create useable and saleable products, disposing of the brine and salt residues in accordance with strict standards that protect the environment.</td></tr>
</table></td></tr>
<tr><td>Approval of coal seam gas water for beneficial use (EHP, 2013a).</td><td>Coal seam water should be beneficially used where it is practical and sustainable. This guideline provides a framework for managing the various beneficial uses to be applied to coal seam water.</td></tr>
<tr><td>Approval of a resource for beneficial use (EHP, 2012).</td><td>A waste can be approved as a resource if it is considered that it has a beneficial use other than disposal. If a waste is approved as a resource, it is no longer considered a waste for the purposes of the EP Act. This guideline provides guidance for applicants seeking a new approval of a resource for beneficial use or transfer or amendment of an existing approval under Chapter 8 of the Waste Reduction and Recycling Act 2011.</td></tr>
<tr><td>Characterisation and management of drilling fluids and cuttings in the petroleum industry (EHP, 2013b).</td><td>Onshore petroleum operators are provided with this guidance to:
Assess and characterise waste drilling fluids and cuttings (such as rock materials, solids and fines)
Develop ways to manage wastes produced from drilling activities that address environmental risks and are consistent with the requirements of Queensland's environmental legislation.</td></tr>
</table>

Legislation	Relevance to the GFD Project
Petroleum activities and notifiable activities (EHP, 2013c).	Notifiable activities are activities that have the potential to cause land contamination and must be reported to the Department of Environment and Heritage Protection (EHP) to be recorded on the Environmental Management Register (EMR). Land that has been significantly contaminated (poses a risk to human health or the environment) may be listed on the Contaminated Land Register (CLR) to ensure the land is remediated and made suitable for future intended land uses. Land will be removed from the EMR/CLR if evidence is provided to satisfy EHP that no notifiable activity has occurred, or that the land has not been significantly contaminated. Land contamination is discussed in section 9.4 of Section 9: Land resources.

This EIS seeks to obtain primary approvals for the project including the Queensland Government Coordinator-Generals Report and Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Cth) approval.

Application for or amendments to existing environmental authorities will occur subsequent to this EIS process. Other subsequent approvals required after the EIS process has been completed, corresponding triggers and legislative frameworks applicable to the GFD Project are identified in Section 2: Project approvals.

Approval of this EIS will trigger a number of subsequent approvals required for the GFD Project to proceed. Approvals will be required on tenure and off-tenure. Section 2: Project approvals summarises the key approvals necessary for the planning, construction, operations and decommissioning of the GFD Project. The triggers for each approval, the relevant administering authority and application details are provided. Consultation on the subsequent approvals will be ongoing with the administering authorities.

12.3 Assessment methodology

This assessment describes the waste management values and assesses the GFD Project's potential impacts on these values. Impacts were assessed using the risk assessment methodology which considers the likelihood and consequence of a potential impact to assess its level of risk. The full description of the risk assessment methodology is provided in section 5.6.3 of Section 5: Assessment framework.

For the purposes of describing environmental values, data was sourced from a range of primary and secondary data sources, including complementary technical studies prepared for the GLNG Project and existing Santos GLNG documentation relating to waste generation and management, relevant State and local government web sites, and legislation, policies and guidelines.

12.4 Environmental values

Environmental values with the potential to be impacted by waste generated from the construction, operations and decommissioning of the GFD Project include:

- Natural environment, including land, water resources, air quality, fauna and flora
- Productive capability of land i.e. its potential for use for agricultural, forestry or other uses
- Health and safety i.e. the life, health and wellbeing of people, including the GFD Project workers
- Sustainability of natural resources (e.g. construction materials, fuel, electricity, water)
- Available landfill capacity for waste disposal
- Visual amenity.

The context and status of these environmental values is described in Sections 7 to 23 of this EIS.

Santos GLNG has developed licensed waste collection, treatment and disposal facilities (e.g. sewage treatment plants, water management facilities, fluid injection facilities) to support GLNG Project operations, and also has used existing commercially operated waste management facilities. Details of the existing waste management facilities in proximity to the GFD Project area that have potential to accept waste from commercial operations are listed in Table 12-2. Allowable annual capacity will be confirmed in consultation with the relevant operator once actual location and timing for development of GFD Project components are known.

Table 12-2 Waste management facilities located in region

Facility name	Operator	Commercial and Industrial	Construction/ Demolition	Domestic	Resource recovery
Blackwater Landfill Ardurad Road, Blackwater	Central Highlands Regional Council	✓	✓	✓	Co-mingled recyclables, concrete, bricks etc., green waste, motor oil, regulated waste (asbestos, etc.), soil, steel, timber, tyres and wet-cell batteries.
Chinchilla Waste Management Facility Clarkes Road, Chinchilla	Western Downs Regional Council	✓	✓	✓	Cardboard, co-mingled recyclables, concrete, bricks etc., cooking oil, green waste, motor oil, second hand goods, soil, steel and non-ferrous metals, timber, wet-cell batteries.
Dalby Waste Management Facility Dalby-Jandowae Road, Dalby	Western Downs Regional Council	✓	✓	✓	Cardboard, co-mingled recyclables, concrete, bricks, asphalt, etc., cooking oil, drums, green waste, mobile phones, motor oil, printer cartridges, second hand goods, soil, steel and other metals, timber, wet-cell batteries.
Gemfields Landfill Rubyvale Road, Sapphire	Central Highlands Regional Council	✓	✓	✓	Co-mingled recyclables, concrete, bricks etc., green waste, motor oil, steel, wet-cell batteries.
Lochlees Landfill Lochlees Road, Emerald	Central Highlands Regional Council	✓	✓	✓	Co-mingled recyclables, concrete, bricks etc., green waste, motor oil, steel, wet-cell batteries.
Meandarra Landfill Meacle Road, Meandarra	Western Downs Regional Council	✓	✓	✓	Steel.
Miles Landfill Leichhardt Hwy, Miles	Western Downs Regional Council	✓	✓	✓	Cardboard, co-mingled recyclables, concrete, bricks, asphalt, etc., green waste, motor oil, soil, steel and non-ferrous metals, timber, wet-cell batteries.
Rolleston Landfill Rolleston Aerodrome Road, Rolleston	Central Highlands Regional Council	✓	✓	✓	Co-mingled recyclables, concrete, bricks etc., green waste, motor oil, steel, wet-cell batteries.
Roma Town Landfill Short Street, Roma	Maranoa Regional Council	✓	✓	✓	Cardboard, glass, paper, steel and other metals, regulated waste (asbestos, grease trap, septic, etc.), soil, timber, tyres, waste oil, wet-cell batteries.
Tara Landfill Fry Street, Tara	Western Downs Regional Council	✓	✓	✓	Cardboard, co-mingled recyclables, concrete, bricks etc., drums, green waste, motor oil, steel, timber, wet-cell batteries.
Tieri Landfill Tieri Road, Capella	Central Highlands Regional Council	✓	✓	✓	Co-mingled recyclables, concrete, bricks etc., green waste, motor oil, steel, wet-cell batteries.

Facility name	Operator	Commercial and Industrial	Construction/ Demolition	Domestic	Resource recovery
Trap Gully Landfill Forestry Road, Biloela	Banana Shire Council	✓	✓	✖	Construction waste (concrete, bricks, asphalt, etc.), grease trap waste, regulated waste (asbestos), tyres.
Wandoan Landfill Tip Road, Wandoan	Western Downs Regional Council	✓	✓	✓	Minor quantities of construction and demolition, and commercial and industrial waste are accepted, subject to approval. Steel.

12.5 Potential impacts

Potential impacts to the identified environmental values and receptors may result from excessive waste generation from the inefficient use of resources or from the improper management of wastes generated during the construction, operation, decommissioning and rehabilitation of the GFD Project. The potential impacts to be assessed are outlined in Table 12-3.

Table 12-3 Waste-related potential impacts

Hazard	Potential impact
Waste generation	Excessive use of natural resources (disposed as waste)
	Waste to be disposed to landfill (additional to current levels)
Waste management	Uncontrolled release of waste (may cause contamination of land, surface or ground waters and dependent ecosystems)
	Controlled release of waste (may cause contamination of land, surface or ground waters and dependent ecosystems)
	Increase in vermin and pest populations.

12.5.1 Resource efficiency

The GLNG Project is well established in the region and Santos GLNG can draw on existing and already approved infrastructure (e.g. access roads, power lines, modular building units, unit equipment from gas compression and water management facilities) to provide shared, co-located or relocated infrastructure and facilities for the new gas field development. As the gas field development will occur progressively over the life of the GFD Project, there will be further opportunity to relocate infrastructure to new facilities in different areas of the gas field. This will minimise the draw on natural resources that would normally be required to construct new infrastructure and facilities.

Where new gas field infrastructure is developed, Santos GLNG will design and engineer infrastructure (e.g. gas compression and water management facilities) with consideration for energy efficiency and to minimise losses (e.g. gas, water, materials.). Santos GLNG prioritises reuse and recycling where practicable to divert waste from landfill and maximise resource efficiency (section 12.5.2.4). This will minimise waste generation and pressure on the capacity of licensed waste facilities in the region, especially those licensed to accept regulated wastes. Santos GLNG is continuously seeking process and design improvements, and new technologies to support resource efficiency and cleaner production.

The GFD Project will be a net generator of water and has the potential to assist in mitigating water shortages in the region such as through the provision of water to third parties. The Coal seam water management strategy (Appendix Z) aims to manage coal seam water to provide beneficial uses where practicable, while avoiding, minimising and mitigating environmental impacts in accordance with the relevant regulatory framework. Water extracted from coal seams may be used to mitigate the GFD Project's impacts to groundwater resources or reused for operational applications as a preference and then beneficially used to supply other industry, agriculture or to supplement environmental flows, where practicable.

12.5.2 Waste generation and management

Generation of waste will occur throughout the construction, operation and decommissioning of each project component described in Section 4: Project description, and is summarised in Table 12-4. GFD Project activities will generate solid, liquid and gaseous wastes, which can be broadly classified as:

- **Regulated waste:** wastes that require specific controls or actions as defined by legislation; listed, hazardous, regulated, controlled or trackable wastes typically have unique handling and disposal requirements in order to manage specific hazards associated with them.
- **General waste:** wastes not defined as regulated waste under legislation; general wastes comprise putrescible wastes (easily decomposed, recyclable by composting) and non-putrescible wastes (not easily decomposed, may be recyclable).
- **Recyclable waste:** waste types that are able to be reconditioned, reprocessed or reused.

As described in Section 4: Project description, the final number, size and location of the project components will be determined progressively over the life of the GFD Project and will be influenced by the location, size and quality of the gas resources identified through ongoing field development planning processes. The potential waste types, sources and likely quantities are identified in Table 12-4 and are representative of the waste streams that can be expected to be generated from the GFD Project (as described in Section 4: Project description).

12.5.2.1 Construction

The construction phase of GFD Project will be associated with the largest development footprint in terms of area, workforce, materials, plant and equipment (e.g. vehicles). Construction of the GFD Project infrastructure is expected to generate the largest waste volumes to be managed. The potential waste types, sources and likely quantities associated with construction are shown in Table 12-4.

12.5.2.2 Operation

Upon completion of construction, disturbed areas will be rehabilitated and the extent of disturbance reduced to the footprint of the operating facility. Furthermore, operational activities have reduced demand for workforce, material and transport, when compared with construction. Consequently, the operation phase of the GFD Project is expected to generate overall smaller volumes of waste to be managed. The potential waste types, sources and likely quantities associated with operation are shown in Table 12-4.

12.5.2.3 Decommissioning and rehabilitation

The potential waste types, characteristics, sources and likely quantities associated with the progressive decommissioning and rehabilitation of the GFD Project are shown in Table 12-4. Prior to decommissioning each facility or area, accurate quantities of waste to be generated will be established, along with details of their physical and chemical characteristics. However, it can be expected that aboveground facilities and equipment will be either dismantled and removed for reuse on other Santos GLNG assets, or be sold, recycled or disposed of, depending on condition or demand. This is discussed in further detail in Section 25: Decommissioning and rehabilitation.

12.5.2.4 Waste management strategy

Santos GLNG will use a hierarchical approach to waste management and prioritise waste management strategies from the most preferable to the least preferable. This is illustrated in Figure 12-1.

Management of each waste stream identified in Table 12-4 is described with reference to the relevant parts of the Santos GLNG management framework, which may include environmental hazard standards (EHS) and health and safety hazard standards (HSHS) from the environment, health and safety management system or management plans discussed in section 12.6.

Figure 12-1 Waste management hierarchy

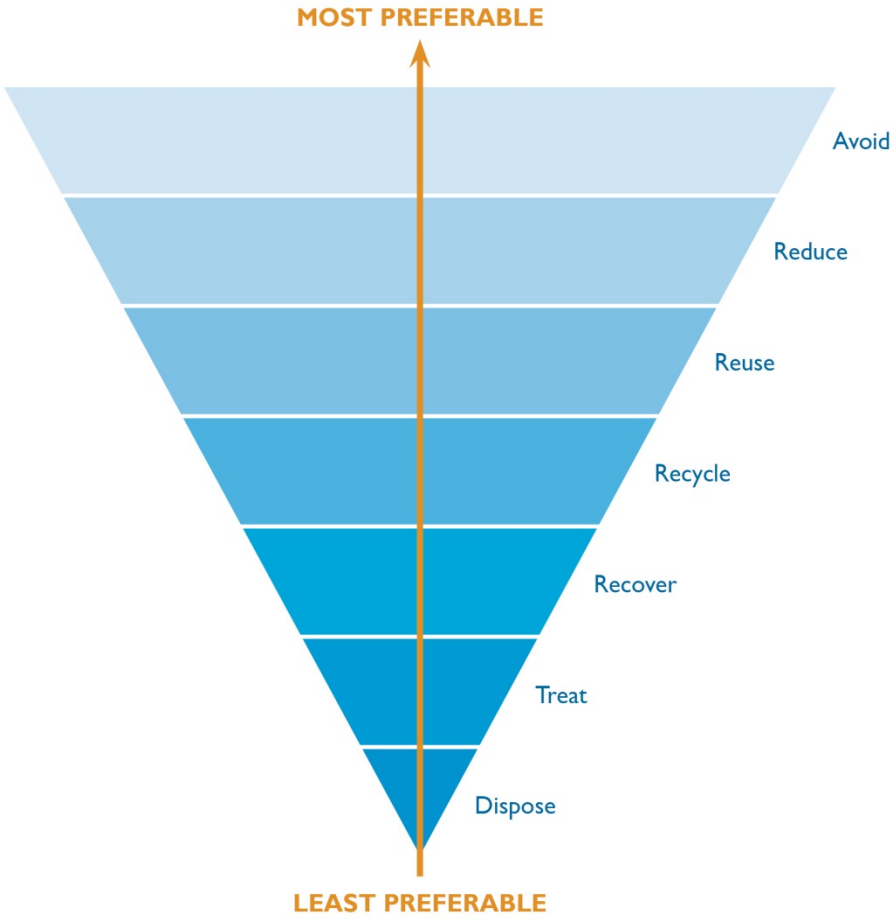

Table 12-4 Description of wastes generated from construction, operation and decommissioning

Waste	Type	Construction		Operations		Decommissioning		Management
		Source	Quantity	Source	Quantity	Source	Quantity	
Air emissions (particulate matter)	Solid (can be either solid or liquid)	Dust generation from construction activities, vehicle operation and exposed areas.	Varies by activity and weather	Dust generation from vehicle operation and exposed areas.	Varies with activity and weather	Dust generation from demolition and rehabilitation activities, and vehicle operation.	Varies by activity and weather	Avoid generating dust by minimising disturbance and rehabilitating disturbed areas, using sealed roads where practicable and implementing dust suppression techniques. Refer Section 15: Air quality.
Air emissions (from fuel combustion e.g. SO_2 and NO_x)	Gas	Vehicles.	Minor	Gas compression facility operation, burning of fuels for power generation, vehicles.	Minor	Vehicles.	Minor	Vehicles will be fitted with appropriate exhaust systems and devices maintained in good working order. Fuel burning or combustion equipment will be selected, operated and maintained in accordance with the manufacturer's specifications to comply with emission limits, and emit via appropriately designed stacks. Refer Section 15: Air quality.
Coal seam water	Liquid; may be regulated waste if it does not meet the quality criteria in the EP Regulation	N/A	N/A	Operation of production wells.	Varies by number/ timing of producing wells; up to estimated peak of 40 ML per day for a gas field.	Decommissioning of water storage.	Minor	Coal seam water will be managed in accordance with relevant regulatory requirements. As per coal seam water management strategy (EIS Appendix Z), coal seam water will be stored in regulated water storages before being *beneficially used where practicable.* EHS03 Produced water applies (refer to section 12.6.1).

Waste	Type	Construction		Operations		Decommissioning		Management
		Source	Quantity	Source	Quantity	Source	Quantity	
Concentrated waste from desalination (i.e. concentrate, with total dissolved solids between 3,000-14,000 mg/L, varies by volume, quality and treatment method) and residual brine and solid salt	Liquid; regulated waste	N/A	N/A	Water management facility.	Estimate 10% of water treated by desalination from coal seams by volume	Decommissioning of brine storage.	Minor	Brine concentrate and residual salt will be managed in accordance with relevant regulatory requirements. The options available for brine management for the GFD Project are; commercial salt recovery or brine or salt disposal. EHS03 Produced water applies (refer to section 12.6.1).
Concrete	Solid; general waste	Construction of wells (casing), surface infrastructure (footings), footpaths, etc.	Minor	N/A	N/A	Demolition of surface infrastructure (footings), footpaths, etc.	To be quantified prior to demolition.	Excess concrete will be returned to the batching plant where practicable. Demolition waste will be crushed and reused as road base for the GFD Project, or disposed to licensed landfill facility. Footings may remain below ground.
Contaminated soil	Solid; regulated waste	Construction activities.	Minor	Leaks or spills from fuel and chemical storages, sewage treatment or vehicle maintenance activities.	Minor	Storage during construction, operations and decommissioning activities.	Minor	Contaminated soil is to be suitably contained for removal and further treatment or disposal by a suitably licensed operator. Contaminated soil removed from a location on the EMR will have a disposal permit issued prior to removal. EHS08 Contaminated soils applies (refer to section 9.4 of Section 9: Land resources).

Waste	Type	Construction		Operations		Decommissioning		Management
		Source	Quantity	Source	Quantity	Source	Quantity	
Drilling fluid, cuttings and flow back (may contain chemical additives used in drilling and completions)	Liquid; regulated waste	Construction and completion of wells.	2,500 tonnes per annum (tpa)	Well workover.	1,250 tpa	N/A	N/A	Contained at the well lease prior to reusing or recycling where feasible, or disposed of at a licences waste management facility.
Electrical and batteries	Solid; may be regulated waste	Construction activities e.g. electrical parts, mobile phones, radios and batteries, and vehicle batteries.	6 tpa	Battery powered equipment (e.g. vehicle and plant, mobile phones, radios), maintenance of electrical systems, camp operations.	6 tpa	Decommissioning activities (e.g. electrical parts, batteries.)	Minor	Dry- and wet-cell batteries will be segregated and stored in appropriately labelled and bunded bins or pallets for collection by licensed waste contractor for reuse, reprocessing, recycling or disposal, as appropriate.
Excavation waste (i.e. soil and rock)	Solid; general waste	Earthworks, dam construction, pipeline trenches.	Minor	N/A	N/A	Decommissioning and rehabilitation activities e.g. land contouring.	Minor	Used for levelling, backfilling, constructing access roads or water storage, etc.
General waste (putrescible)	Solid; general waste	Construction activities and accommodation camps.	18,000 tpa	Operation of gas field facilities and accommodation camps.	4,500 tpa	Demolition activities and accommodation camps.	9,000 tpa	Non-recyclable general waste will be segregated in covered bins for collection and transport by licensed waste contractor to licensed landfill facility. HSHS10 Food safety applies (refer to section 12.6.1).
Grease trap waste, cooking oil	Liquid	Accommodation camps.	150 tpa	Accommodation camps.	100 tpa	Accommodation camps.	50 tpa	Stored in designated grease trap or cooking oil storage container for collection by licensed waste contractor for reprocessing, recycling or disposal, as appropriate.

Waste	Type	Construction		Operations		Decommissioning		Management
		Source	Quantity	Source	Quantity	Source	Quantity	
Green waste	Solid; general waste	Clearing of vegetation.	Minor	Vegetation management	Minor	N/A	N/A	Stockpiled and reused (potentially as mulch) for rehabilitation purposes. Declared weeds will be managed in accordance with the Pest and weed management plan (Appendix Y-J).
Oily waste (e.g. plastic containers, filters, absorbents)	Solid; regulated waste	Construction activities, vehicles.	10 tpa	Commissioning, operation and maintenance of gas field facilities and vehicles.	2 tpa	Decommissioning activities, vehicles.	1 tpa	Collected and stored in appropriately labelled and bunded bins for collection by licensed waste contractor for reprocessing, recycling or disposal, as appropriate.
Oily water	Liquid; may be regulated waste	Construction activities.	2,500 tpa	Commissioning and maintenance activities relating to gas production, separation and compression, and vehicle wash down.	500 tpa	Decommissioning activities.	250 tpa	Contained for treatment (e.g. via oil/water separator) or collection by licensed contractor for reprocessing, recycling or disposal, as appropriate.
Plastic (e.g. containers, pipe)	Solid; may be regulated waste	Construction activities, largely packaging.	5 tpa	Operation of gas field facilities and accommodation camps.	2 tpa	Decommissioning activities.	3 tpa	Segregated and stored in centralised waste storage area for recycling or disposal, as appropriate.
Recyclable waste (e.g. glass, paper, cardboard, timber)	Solid; general waste	Construction activities, largely packaging.	1,000 tpa	Operation of gas field facilities and accommodation camps.	1,000 tpa	Decommissioning activities.	250 tpa	Segregated and stored in appropriately labelled bins or stockpile areas in central waste storage area for collection by licensed waste contractor for recycling.
Scrap metal (e.g. pipe off-cuts, drums, aerosol and aluminium cans)	Solid; general waste	Construction activities.	100 tpa	Operation of gas field facilities and accommodation camps.	20 tpa	Decommissioning activities.	50 tpa	Segregated and stored in centralised waste storage area for reuse, or return to supplier, or collected by licensed waste contractor for recycling.

Waste	Type	Construction		Operations		Decommissioning		Management
		Source	Quantity	Source	Quantity	Source	Quantity	
Sewage/Septic (200 L/person/day approx.) and sewage biosolids	Liquid	Accommodation camps.	Approx. 4 ML/day for small drill camp, up to 80 ML/day for large temporary camp	Accommodation camps and management facilities.	Approx. 16 ML/day for permanent operations camp	Accommodation camps.	Varies by size of camp	Treatment in a package sewage treatment plant, with treated effluent disposed by irrigation and biosolids collected for disposal at licensed facility. EHS10 Water resources applies (refer to section 12.6.1).
Storm water runoff	Liquid	Construction activities.	Varies with weather	Operational areas.	Varies with weather	Decommissioning activities.	Varies with weather	Chemical storage areas will be isolated from stormwater runoff.
Topsoil	Solid; general waste	Clearing of vegetation from disturbed or pastoral land, construction activities.	Minor	N/A	N/A	N/A	N/A	Stockpile, spread across disturbed areas as part of rehabilitation.
Triethylene glycol (TEG) coolant	Liquid, regulated waste	N/A	N/A	Commissioning and maintenance of gas compression facilities.	Minor	Decommissioning of gas compression facilities.	Minor	Collected in secure bunded containers to be transported by a licensed contractor to a licensed regulated waste facility.
Tyres	Solid; regulated waste	Vehicle maintenance.	100 tpa	Vehicle maintenance.	20 tpa	Vehicle maintenance.	10 tpa	Stored in central waste storage area for collection by licensed waste contractor for treatment or disposal to regulated waste facility in accordance with product requirements.

Waste	Type	Construction		Operations		Decommissioning		Management
		Source	Quantity	Source	Quantity	Source	Quantity	
Waste chemicals (e.g. paint, solvents, cleaning fluids, coolant, herbicides)	Liquid; regulated waste	Construction of wells, pipelines, facilities or roads, vehicle operation.	50 tpa	Commissioning, operation and maintenance of gas field facilities and vehicles, operation of water management facilities, weed control, etc.	10 tpa	Decommissioning activities, vehicle operation, etc.	1 tpa	Stored in bunded containers in central waste storage area for collection by licensed waste contractor for treatment or disposal to regulated waste facility in accordance with product requirements. HSHS08 Chemical management and dangerous goods applies (refer to section 12.6.1).
Waste oil	Liquid; regulated waste	Construction activities, vehicles.	500 tpa	Commissioning and maintenance activities relating to gas production, separation and compression, and vehicles.	100 tpa	Decommissioning activities, vehicles.	50 tpa	Stored in bunded containers in central waste storage area for collection by licensed waste contractor for reprocessing, recycling or disposal to regulated waste facility.

Source: Santos GLNG, 2013; estimated waste quantities have been scaled according to proposed GFD Project phase and development schedule for wells and facilities.

12.6 Mitigation measures

12.6.1 Environment, health and safety management system

Santos GLNG's management framework (described in Section 6: Management framework) includes Environment Hazard Standard EHS04 Waste that specifies minimum acceptable performance standards for waste management processes and procedures for Santos GLNG operations and activities, including waste generation, transportation, receiving, storage, recycling, treatment and/or disposal. This standard will apply to the GFD Project.

EHS04 specifies a number of waste management control elements that must be in place for Santos GLNG operations and activities. These include:

- Setting environmental performance objectives to identify and manage areas where potential environmental impacts could be significant
- A waste hierarchy to provide a guideline to target waste production and disposal
- Defining waste types generated, including regulated wastes and general wastes
- Identifying legal and other obligations
- A waste inventory to record details of incoming and outgoing waste
- Preparation of waste management plans
- Management and requirements for waste management/receiving facilities
- Management and requirements for temporary waste management/receiving facilities
- Design and management requirements for purpose-built landfill facilities
- Waste tracking and transport requirements
- Monitoring and reporting requirements.

EHS04 requires a Santos GLNG operation or activity that generates, handles, stores, transports or disposes of waste to have a Waste Management Plan (WMP) that details how these waste management controls will be implemented. The WMP and associated mitigation measures for the GFD Project are described in section 12.6.2.

A range of other management standards listed in Section 6: Management framework apply to manage specific types of wastes. These include:

- EHS03 Produced water, for coal seam water
- EHS05 Air emissions, for emissions to air
- EHS08 Contaminated sites, for contaminated soil
- HSHS08 Chemical management and dangerous goods, for chemical waste
- HSHS10 Food safety, for putrescible waste.

12.6.2 Management plans

Santos GLNG is committed to implementing the mitigation measures in Table 12-5 to manage potential waste impacts. The measures discussed in this section will be used to manage wastes and will be considered during the planning and scheduling of GFD Project activities to minimise waste impacts at nearby receptors. These measures are incorporated into Santos GLNG's management plans provided in Appendix Y: Draft environmental management plan.

Table 12-5 Management plans relevant to waste management

Management plan	Mitigation measures
GFD Project Environmental protocol for constraints planning and field development (the Constraints protocol)	The Constraints protocol applies to all gas field related activities. The scope of the Constraints protocol is to: • Enable Santos GLNG to comply with all relevant State and Federal statutory approvals and legislation • Support Santos GLNG's environmental policies and the General Environmental Duty (GED) as outlined in the EP Act • Promote the avoidance, minimisation, mitigation and management of direct and indirect adverse environmental impacts associated with land disturbances • Minimise cumulative impacts on environmental values. The Constraints protocol provides a framework to guide placement of infrastructure and adopts the following management principles: • Avoidance — avoiding direct and indirect impacts • Minimisation — minimise potential impacts • Mitigation — implement mitigation and management measures • Remediation and rehabilitation — actively remediate and rehabilitate impacted areas • Offset — offset residual adverse impacts in accordance with regulatory requirements. The Constraints protocol enables the systematic identification and assessment of environmental values and the application of development constraints to effectively avoid and/or manage environmental impacts. For example, infrastructure will be sited in a way that minimises the need for new disturbance or clearing of vegetation, and modular buildings and unit equipment will be reused by relocating from decommissioned facilities to new facilities, where practical.
Chemical and fuel management plan (CFMP)	The CFMP details the appropriate storage and handling practices of chemicals and fuels. The objectives of the plan are to: • Facilitate compliance with relevant legislation, regulations and approvals • Provide a framework for Santos GLNG to store and handle bulk chemicals and fuels in a way that minimises risk to the environment and human health • Assess the potential risk of a chemical or fuel prior to its use • Identify and implement appropriate mitigation measures. Regulated wastes will be stored in appropriate containers / tanks that are appropriately labelled and, where applicable, in accordance with the recommendations of relevant Safety Data Sheets, AS1940:2004 The storage and handling of flammable and combustible liquids, other relevant dangerous goods standards and the CFMP. Wastes generated as a result of, or in response to, spill management activities will be managed in accordance with the CFMP, the *Environmental Protection Act 1994* (Qld) and *Environmental Protection (Waste Management) Regulation 2000* (Qld).
Coal seam water management strategy	The Coal seam water management strategy outlines the overarching approach to managing coal seam water. The strategy prioritises the beneficial use of coal seam water where practicable, while avoiding, minimising and mitigating environmental impacts, in accordance with the relevant regulatory framework.
Contingency plan for emergency environmental incidents (Contingency plan)	The Contingency plan details the management practices in place within Santos GLNG to minimise environmental harm during an emergency environmental incident. The plan identifies potential incidents, and provides response actions, including escalation, communication, reporting and monitoring.
Erosion and sediment control management plan (ESCMP)	The ESCMP identifies erosion and sedimentation risk and provides an erosion and sediment control strategy that incorporates understanding of the risk inherent to local land resource characteristics. The ESCMP is supported by the Erosion and Sediment Control Manual, which provides erosion, sediment and drainage controls in line with best practice guidelines.

Management plan	Mitigation measures
Waste management plan (WMP)	The WMP details the strategy, methods and controls for managing waste generated by Santos GLNG activities. The plan identifies the types of wastes generated by Santos GLNG activities, and describes the waste management framework and how the waste management hierarchy is applied to generated waste. Wastes generated by the GFD Project will be managed in accordance with the WMP. The WMP aims to minimise waste volumes and risk of environmental harm through improving operational efficiency and therefore environmental performance. The WMP details: • Applicable legislation, policies and regulations to waste management, transport and disposal • Classifications of generated wastes to determine applicable management measures • Management measures for storage, transport and disposal of wastes. The waste management hierarchy of waste avoidance, reduction, reuse, recycling, recovery, treatment and disposal will be adopted, in accordance with the *Waste Reduction and Recycling Act 2011* (Qld). The WMP may include mitigation measures such as: • Apply the waste management hierarchy (illustrated in Figure 12-1) to – — Minimise waste volumes and the risk of causing harm to the environment — Maximise operational efficiency and environmental performance. • During planning and design, consider alternative approaches to materials used, construction and operational techniques and maintenance of a process to achieve a less resource intensive and more efficient process. • Use contracts to encourage waste avoidance and set provisions related to waste targets. • Identify and separate waste streams that can be reused with no or minimal treatment (e.g. packaging, pallets, metal or plastic containers, intermediate bulk containers) or collection by a licensed waste transporter for recycling. • Use engineered waste facilities that are appropriately licensed to accept the waste type being disposed of and the ability to receive the required volumes of waste. • Review and audit waste management practices to investigate improvements in existing processes and materials used to achieve a more resource efficient process. Monitoring and reporting of waste generation, transport and disposal will be undertaken in accordance with the WMP.
Decommissioning And abandonment management plan (DAMP)	The DAMP describes the management framework in place for when petroleum activities cease. The objectives of the plan are to: • Undertake decommissioning assets in a manner that complies with regulatory requirements and minimises the risk of environmental harm • Undertake decommissioning activities in a manner that meets stakeholder expectations • Leave a landform that is stable and compatible with intended post-closure land use • Provide the beneficial reuse of Santos GLNG infrastructure constructed to third parties (e.g. landholders or local authorities) where an appropriate agreement has been signed by both parties and regulatory authorities are satisfied. Waste management is a key component of decommissioning activities. Prior to commencement of decommissioning activities, asset-specific decommissioning plans will be determined, including measures such as: • Conduct an inspection to identify equipment and materials to be removed for reuse (by Santos GLNG or third parties) or recycling • Prepare an inventory of chemicals, fuels and oils and their required handling, storage and transportation requirements • Segregate general waste and regulated waste to be removed and sent to a recycling or disposal facility licensed to accept the waste • Implement a no burning policy.

Management plan	Mitigation measures
Land release management plan (LRMP)	The LRMP addresses the management of releases of water to land in Santos GLNG's gas fields, including: • Coal seam water use for irrigation, construction and operations purposes • Treated sewage effluent releases to land • Use of treated sewage effluent for construction and operational purposes • Low point drain water releases to land • Hydrostatic test water releases to land. The document includes the principles, methods and controls to effectively manage and minimise the risk of environmental harm being caused by release of water to land. Implementation of the LRMP applies the general principles, methods and controls to prevent environmental harm being caused by releases of waters to land and to ensure contaminants are not directly or indirectly released to land or waters, except as permitted under the relevant environmental authorities.
Pest and weed management plan (PWMP)	The management of pest and weed species will be undertaken in accordance with the PWMP. The plan includes measures such as: • Identification of pest and weed species and areas of infestation • Avoidance of traversing and placing infrastructure in areas of known infestation • Prevention of the spread of pest and weed species by implementing appropriate work practices and promotion of risk awareness • Control of identified pest and weeds through containment, reduction or eradication as required by legislation. Implementation of the PWMP will provide for appropriate management of declared weed species in cleared vegetation (greenwaste) and appropriate containment of putrescible food waste to minimise the risk of pests and weeds becoming established in the GFD Project area. Santos GLNG will review local government's pest and weed management plans and apply measures from these to the PWMP where it is appropriate.

The potential waste impacts identified in section 12.5 will be managed through the policies, standards and mitigation measures discussed as part of the management framework above. While these measures will reduce the risk of impacts, risks will not be wholly eliminated and the risk that some waste impacts could occur will remain.

12.7 Risk assessment

As discussed in section 12.3, impacts were assessed using the risk assessment methodology. As the GFD Project area covers a large geographical area, the general nature of potential impacts to environmental values associated with GFD Project activities are identified and assessed within this section.

Table 12-6 summarises the assessment undertaken for the potential impacts of the GFD Project on values identified in section 12.4. For each identified potential impact, the assessment considered:

- The potential pre-mitigated risk, which that only the Constraints protocol has been applied and the potential impacts are at their greatest
- The mitigation measures that will be used to manage the potential impacts. These measures will reduce the likelihood and/or consequence of the potential impacts
- The residual risk of the potential impact after the implementation of mitigation measures. The residual risk takes into account the potential for impact that remains after the mitigation measures are applied.

Table 12-6 Waste impact assessment

Potential impact	Phase	Pre-mitigated risk			Mitigation and management measures	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Excessive use of natural resources (disposed as waste)	Construction	Possible	Minor	Low	Implement the WMP and associated procedures, which may include mitigation measures such as: • Apply the waste management hierarchy (illustrated in Figure 12-1) to: — Minimise waste volumes and the risk of causing harm to the environment — Maximise operational efficiency and environmental performance. • During planning and design, consider alternative approaches to materials used, construction and operational techniques and maintenance of a process to achieve a less resource intensive and more efficient process. • Use contracts to encourage waste avoidance and set provisions related to waste targets. • Identify and sort out waste streams that can be reused with no or minimal treatment (e.g. packaging, pallets, metal or plastic containers, intermediate bulk containers) or collection by a licensed waste transporter for recycling. • Review and audit waste management practices to investigate improvements in existing processes and materials used to achieve a more resource efficient process.	Possible	Minor	Low
	Operation	Possible	Minor	Low		Possible	Minor	Low
	Decommissioning	Unlikely	Minor	Low		Remote	Minor	Very Low
Waste to be disposed to landfill (additional to current levels)	Construction	Almost certain	Minor	Medium		Likely	Negligible	Low
	Operation	Unlikely	Minor	Low		Remote	Negligible	Very Low
	Decommissioning	Possible	Minor	Low		Unlikely	Negligible	Very Low

Potential impact	Phase	Pre-mitigated risk			Mitigation and management measures	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Uncontrolled release of waste (may cause contamination of land, surface or ground waters and dependent ecosystems)	Construction	Possible	Minor	Low	Implement the WMP, LRMP and associated procedures, which may include mitigation measures such as: • Store wastes (usually in labelled bins) within designated waste storage areas located at each asset/ activity location. • Store regulated waste in appropriately labelled and bunded containers and tanks in accordance with the recommendations of relevant Safety Data Sheets, AS1940:2004 *The storage and handling of flammable and combustible liquids*, other relevant dangerous goods standards and the CFMP. Implement the mitigation measures in Contingency plan and associated procedures in response to an environmental emergency incidents, with more specific response actions dependent on the type and location of the emergency environmental incident and detailed in the relevant emergency preparedness and response plan.	Unlikely	Minor	Low
	Operation	Possible	Minor	Low		Unlikely	Minor	Low
	Decommissioning	Possible	Minor	Low		Unlikely	Minor	Low
Controlled release of waste (may cause unauthorised contamination of land, surface or ground waters and dependent ecosystems)	Construction	Possible	Minor	Low		Unlikely	Minor	Low
	Operation	Possible	Minor	Low		Unlikely	Minor	Low
	Decommissioning	Possible	Minor	Low		Unlikely	Minor	Low
Increase in vermin and pest populations.	Construction	Likely	Minor	Medium	Implement the WMP and associated procedures, in order to avoid the spread of weeds and not encourage pest animals. This may include mitigation measures such as: • Store putrescible wastes in covered containers wherever practicable to minimise odours, exposure to Santos GLNG personnel and access to fauna. Implement the PWMP and associated procedures which may include mitigation measures such as: • Appropriate management of declared weed species in cleared vegetation (greenwaste).	Unlikely	Minor	Low
	Operation	Likely	Minor	Medium		Unlikely	Minor	Low
	Decommissioning	Possible	Minor	Low		Unlikely	Minor	Low

12.7.1 Monitoring and review

Monitoring and reporting of waste generation, transport and disposal will be undertaken in accordance with the WMP. The implementation and effectiveness of the WMP and its associated procedures will be assessed against baseline waste characterisation data via:

- Checklists to assess and manage compliance
- Internal and third party audits to formally assess compliance with regulatory requirements and Santos GLNG procedures
- Review of internal incidents, near misses or hazards
- Analysis of relevant data collected to assess trends in waste generation and management.

Assets and activities that generate, store or manage waste will use a waste management inventory to record details of wastes produced, including:

- Type and volume of waste
- Source of waste
- Destination/fate of waste.

Environment, health and safety performance data will be collected, analysed and reported, in accordance with EHSMS14 Monitoring, measurement and reporting, to establish whether risks associated with the wastes generated by Santos GLNG's operations are being managed, minimised and, where reasonably practicable, eliminated.

Coal seam water management will be monitored in accordance with the requirements of Appendix Y: Draft environmental management plan and Appendix AE: Water resources management plan.

12.8 Conclusions

Santos GLNG will use a sustainable approach to waste management that follows the waste management hierarchy, consistent with the *Waste Reduction and Recycling Act 2011*, to target waste production and disposal. Implementation of the management framework will ensure that residual risks will be reduced to low as shown in Table 12-7.

Table 12-7 Residual impacts – waste

Potential impact	Residual risk		
	Construction	Operations	Decommissioning
Excessive use of natural resources (disposed as waste)	Low	Low	Very low
Waste to be disposed to landfill (additional to current levels)	Low	Very low	Very low
Uncontrolled release of waste (may cause contamination of land, surface or ground waters and dependent ecosystems)	Low	Low	Low
Controlled release of waste (may cause contamination of land, surface or ground waters and dependent ecosystems)	Low	Low	Low
Increase in vermin and pest populations.	Low	Low	Low