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# Independent Market Operator of WA

## Review of Fixed Fuel Cost for Maximum Reserve Capacity Price in the Wholesale Electricity Market

### Diesel Fuel Storage and Handling Facility

October 2008

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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# Executive Summary

GHD was commissioned by Independent Market Operator (IMO) of Western Australia to report on a concept design and costing for a diesel fuel storage and handling facility which provides 24 hour operation of a 160 MW gas turbine power station. The facility and power station are theoretical and the report is intended to form part of information required by IMO for determination of fixed fuel costs for maximum reserve capacity price in the Wholesale Electricity Market.

The diesel storage and handling facility will have gross capacity of 1056 tonnes and includes a 960 tonne tank working volume plus a 96 tonne allowance for tank minimum working fuel level or dead volume.

GHD has prepared a report for IMO in November 2007 (Reference No. 21/16396/135587 and same title as this report) covering the cost for the diesel fuel storage and handling facility. This report is essentially similar to that report except that the costs have been updated for a 2008 pricing basis.

The estimated fixed capital cost for the fuel storage and handling facility as described in this report and including the value of a half-full working quantity of fuel is A$3.23M. This fixed capital cost includes:

» A$2.31M portion for the engineering, procurement and construction of the facility,

» plus A$0.92M portion for the value of a base fuel storage quantity of 576 tonne (480 tonne for a half-full working quantity plus 96 tonne minimum tank level quantity).

Costs are based on Year 2008 prices and exclude excise and GST.

The estimate is of pre-feasibility or a Type 1 quality as described in the Estimation Guidelines in Appendix B.

The price for diesel fuel is based on A$ 35.64/GJ (high heating value) and this corresponds to A$1.601/kg or A$1.347/L converted using diesel properties of 45 MJ/kg and 0.84 specific gravity. This price basis is obtained from Section 5.4 of IMO, 2008, Final Report, “Review of the Energy Price Limits for the Wholesale Electricity Market in the SWIS” dated 7 September 2008”. This price excludes excise and GST on the basis that both are rebated to the power generator.

The report describes the background, qualifications and conceptual basis for the scope, engineering and costing of the diesel storage and handling facility.

# 1. Introduction

## 1.1 Background

The Independent Market Operator of Western Australia is required to periodically review the maximum prices in the Wholesale Electricity Market.

Appendix 4 of the Wholesale Market Rules details the methodology used by the IMO to calculate the Maximum Reserve Capacity Price. The Maximum Reserve Capacity Price is used in the Reserve Capacity Mechanism to set the ceiling price or cap for the Reserve Capacity Auction if one is held and is used in the determination of an administered price for capacity in the case where a Reserve Capacity Auction is not held. Value for capacity in both cases is held in the notional construct called a Capacity Credit. Capacity Credits may be either traded bilaterally or can be bought and sold through the IMO.

The Maximum Reserve Capacity Price is based on the cost of procuring and installing an open-cycle gas turbine peaking power station within the South West Interconnect System (SWIS). The methodology uses a generic procurement scenario defined in the Market Rules. Each year the IMO reviews the appropriateness of the values used to determine the Maximum Reserve Capacity Price.

One of the components in this process is the cost associated with the development and construction of an on-site liquid storage tank with sufficient capacity for 24 hours of operation on liquid fuel, including the cost of keeping the tank half full at all times. This cost is denoted as Fixed Fuel Cost (FFC) in Appendix 4 of the Market Rules.

The cost is to be expressed in Australian dollars and should include all design development and engineering costs.

GHD has prepared a report for IMO in November 2007 (Reference No. 21/16396/135587 and same title as this report) covering the cost for the diesel fuel storage and handling facility. This report is essentially similar to that report except that the costs have been updated for a 2008 pricing basis.

## 1.2 Scope of Work as Described by IMO

The following description of the scope of work is extracted from the IMO Request for Tender Document IMO 015, Section 2.2.1 (as per original scope issued September 2007).

The Contractor is to provide an estimate of the cost of providing fuel storage and handling facilities for a Greenfield gas turbine power station including:

- A fuel tank of 1,000 t (nominal) capacity including foundations and spillage bund,
- Facilities to receive fuel from road tankers,
- All associated pipework, pumping and control equipment.

The estimate should be based on the following assumptions:

- Land is available for use and all appropriate permits and approvals for both the power station and the use of liquid fuel have been received.
- The capacity of the storage tank should be sufficient to allow for 24 hours of continuous operation for a 160 MW open cycle gas turbine power station.

- The Contractor shall provide both the outcome and the methodology to the IMO in the form of a report and model as necessary. The report will be made public as part of the consultation process required for the review being conducted under clause 4.16.3 and 4.16.4(d) of the Market Rules.
- Any costing components that may be time-varying in nature must be completely disclosed as part of the model provided to the IMO. Such examples might be the cost of the liquid fuel, which will vary over time and as a function of exchange rates etc.
- The Contractor is expected to document all assumptions used in its review and analysis and must discuss in detail any and all particular assumptions that could have a material impact on the FFC component.
- The costing should only reflect fixed costs associated with the FFC component and should include an allowance for keeping the tank half-full at all times.

## 1.3 Scope Qualification by GHD

The concept design and cost estimate for the fuel facility will be based on the following qualifications.

- The fuel facility concept design would be reasonably typical for storage and handling of diesel fuel for service to an open-cycle gas turbine power station.
- The facility battery limits start from the loading bay and manifold for receipt of fuel from road tankers through to storage tank, diesel transfer pumps, diesel filtration and ends at a tie-in point on the fuel transfer pipe to the gas turbines, not further than 100 m and upstream from the turbine fuel train limits.
- The facility design complies within AS 1940 and includes for spillage bund containment and fire fighting accordingly.
- The fixed cost will include a half-full fuel working level and the cost of fuel per litre will be provided from IMO.
- The cost estimate will not include the additional costs of a dual fuel gas turbine plant over a gas fuel only gas turbine.
- The cost estimate will not include modified burners for the gas turbine, water injection facilities and associated demineralised water production and storage facilities should such facilities be required for distillate firing.
- The concept design and cost estimate quality will be a Type 1 estimate as described in the GHD Estimation Guidelines shown in Appendix B.
- The concept design will be described in the report by schematic process block diagrams and schematic plot plan diagram of the facilities.

# 2. Engineering Basis

The scope and engineering basis for the conceptual design and indicative costing of the diesel fuel storage and handling facility are described in this section.

## 2.1 Design Standards

The facility is designed in accordance with AS 1940 “Storage and Handling of Flammable and Combustible Liquids” and also AS 4041 “Pressure Piping”.

The stored fluid is hydrocarbon automotive distillate (or diesel) and is classified as “combustible liquid Class C1”. The facility design assumes that the fuel is conditioned further by filtration and separation of any free water to a quality suitable for the gas turbine service.

The physical and thermal properties of diesel vary depending on grade or source. This report uses a high heating value of 45 MJ/kg and a specific gravity of 0.84.

The tank structural design is in accordance with API 620 “Design and construction of large, welded, low-pressure storage tanks”.

## 2.2 Facility Process Configuration

The conceptual fuel storage and handling facility schematic process block diagram and battery limits are shown in Figure 1 in Appendix A. The facility process scope includes:

- Road tankers unloading manifolds and pumps for fuel supply,
- Fuel storage tank of volume determined based on working fuel quantity and additional operational margins,
- Fuel transfer from tank to power station using pumping units, fuel conditioning (filtration and free water separation) and metering to be delivered to the fuel train inlet of the turbines at a suitable fuel quality and pressure (piping to a maximum of 100 m from facility boundary and upstream of fuel train),
- Oily water treatment for site drainage water, spillages and process drains,
- Spillage bund containment for main tank and all process areas,
- High plant availability on demand,
- Basic instrumentation for local pressure, temperature and level measurement,
- Fuel transfer control from the power station control centre,
- Electrical power provided to the facility switch box inlet terminals,
- Clear water drainage outlet provided to the facility boundary,
- Oily sludge collected by road tanker for off-site disposal.

## 2.3 Facility Layout

The conceptual fuel storage and handling facility schematic layout diagram and battery limits are shown in Figure 2 in Appendix A. The facility layout scope includes:

- Road tanker loading bay with sealed road surface,
- Fuel loading manifolds and pumps,
- Fuel storage tank of steel construction and with spillage bunds of concrete construction,
- Fuel transfer pumps including filtration and water separation,
- Oily water treatment system including sump pump and oily water separator,
- Connection to utilities such as power and drainage at the facility perimeter,
- Perimeter fence and gates.

Other infrastructure such as access roads, external site utilities, control centre, site security, and the like have been excluded on the basis that such will be provided as part of the overall power station infrastructure.

## 2.4 Fuel Storage Capacity

The stored fuel is required to operate the 160 MW gas turbine power station for an equivalent period of 24 hours at full load. The working fuel quantity of 960 tonnes is calculated using a fuel high heat value of 45 MJ/kg and a fuel to electrical energy efficiency of 32% for an open-cycle turbine.

The tank gross capacity of 1,056 tonne is calculated based on a 10% allowance for a tank minimum working fuel level (or dead volume).

## 2.5 Tank Characteristics

The tank overall volume is 1,380 $m^3$ calculated from the gross tank capacity using a fuel specific gravity of 0.84 and including a 10% allowance for an ullage space above the maximum tank working fuel level.

A height to diameter aspect ratio of 0.5 is used and the calculated tank shell dimensions are 15.2 m diameter and 7.6 m height.

The tank arrangement is a vertical above ground tank with fixed roof. The material of construction is carbon steel and is externally coated.

The tank ground geotechnical properties are assumed to provide good foundation and therefore a conventional concrete ring foundation is used.

A spillage bund is provided for containment of the full tank gross volume. The bund walls and floor are constructed from reinforced concrete. The bund internal area is 35 m x 35 m and the bund wall height is 1.4 m being the sum of 1.1 m maximum containment level and 0.3 m additional allowance.

The tank structural accessories include fixed stairways and platforms for external access and manholes in the roof and side for internal access. The tank process accessories include inlet, outlet with floating suction header, vent and drain nozzles and instrumentation for level and temperature level.

## 2.6 Road Tanker Loading Bay

The fuel supply loading bay includes for a B-double loading area and two fuel loading manifolds with pumping units.

The loading zone is a sealed road surface and the manifold area is bunded with humps all around and drained to the main tank bund. Road access to the loading bay is excluded from the scope of this report.

The loading pumps are sized to transfer the 46 tonne B-double load to the tank within about 1 hour which equals to about 7.5 L/s each of the two loading manifold.

## 2.7 Fuel Transfer to Gas Turbines

Fuel is transferred from the storage tank to the gas turbines on demand by means of the pumping facility located adjacent to the main tank bund. The pumps are arranged in a duty run and standby run with each run including valves, pump and electric motor set, filter and coalescer/separator.

Each pump is powered by a variable speed drive unit included in the scope of the facility.

The transfer pumps instrumentation includes basic pressure gauges and metering. Pump operation and control is by the power station control centre.

The estimated fuel flow rate is 13.2 L/s for the power station full load condition of 160 MW and a high pressure is required to suit the gas turbine fuel train specification.

The pumping piping also includes a bypass arrangement to allow circulation and mixing of the fuel in the storage tank if left stagnant for a lengthy period.

The pumping area is 5 m x 5 m with a concrete floor and a 0.25 m high bund wall.

## 2.8 Site Drainage

The drainage design includes oily water containment to capture any fuel leaks. All stormwater, flushing water and spillages are drained into the main tank bund sump where the collected water will be directed by manual inspection and control. Contaminated drainage will be diverted to an oily water separation unit and only clear water will be discharged to the main site drainage system.

## 2.9 Oily Water Treatment System

The oily water treatment system includes the main bund sump, an oil separator unit and a 10 $m^3$ sludge tank provided with the fuel storage facility scope.

Oily water may be collected from tank bund drainage, loading area drainage, other bunds, storage tank or vessels bottom settled water or flushing of oil or fuel spillages. All oily water is directed to the oily water separation unit. Clear water may be discharged to the site drainage system while oily sludge is directed to the sludge tank for collection by road tanker and off-site disposal.

The oily water treatment area is 5 m x 5 m with a concrete floor and a 0.25 m high bund wall.

## 2.10 Fire Protection

The fuel is a Class C1 Combustible Liquid and requires basic fire protection equipment such hydrant hose and fire extinguishers as per AS 1940.

A powder-type fire extinguisher is installed at two location along the tanker loading bay and one location near the transfer pumps.

## 2.11 Tank Location

The tank is located within the spillage bund and the bund dimensions provide sufficient separation from the fill points, equipment and security fence (>7.5 m). The design assumes that any office, building, workshop, amenity blocks will be located with at least 18 m separation from the storage tank.

# 3. Fixed Cost Basis and Estimate

The estimated fixed capital cost for the fuel storage and handling facility as described in this report and including the value of a half-full working quantity of fuel is A$3.23m. This fixed capital cost includes:

» A$2.31M portion for the engineering, procurement and construction of the facility,

» plus A$0.92M portion for the value of a base fuel storage quantity of 576 tonne (480 tonne for a half-full working quantity plus 96 tonne minimum tank level quantity).

Costs are based on Year 2008 prices and exclude excise and GST.

The estimate is of Pre-feasibility or a Type 1 quality as described in the Estimation Guidelines in Appendix B.

The price for diesel fuel is based on A$35.64/GJ (high heating value) and this corresponds to A$1.601/kg or A$1.347/L converted using the diesel properties from Section 2.1. This price basis is obtained from Section 5.4 of IMO, 2008, Final Report, “Review of the Energy Price Limits for the Wholesale Electricity Market in the SWIS” dated 7 September 2008. This price excludes excise and GST on the basis that both are rebated to the power generator.

An estimate summary is shown in Table 1.

**Table 1 – Estimate Summary**

| No. | ITEM DESCRIPTION | A$'000 |
|---|---|---|
| 1 | Fuel Storage Tank –<br>Ø fabrication and construction of roofed vertical tank, externally coated, process nozzles, access manholes and concrete ring foundation,<br>Ø Spillage bund of concrete wall and floor,<br>Ø Stairways and access platforms,<br>Ø Instrumentation for level and temperature measurement,<br>Ø Geotechnical investigation, hydrostatic testing and cathodic protection. | 1,160 |
| 2 | Fuel Supply Loading Manifolds (two sets) –<br>Ø Loading manifolds including valves and coupling,<br>Ø Loading pumps and motors,<br>Ø Piping and electrical works. | 26 |
| 3 | Road Tanker Loading Bay of sealed road surface | 25 |
| 4 | Mainline fuel piping (including valves and a floating fuel suction header inside tank) | 60 |
| 5 | Fuel Transfer Pumping (duty run & standby run) –<br>Ø Two high pressure pump runs each with motor, filters & oil separators<br>Ø Flow meters,<br>Ø Piping and basic instrumentation,<br>Ø Concrete foundation and bunded plant area. | 386 |
| 6 | Oily Water Treatment System –<br>Ø Sump pump,<br>Ø Oil separator unit,<br>Ø Piping and electrical,<br>Ø Concrete foundation and bunded plant area. | 62 |
| 7 | Site preparation and early works | 14 |
| 8 | Perimeter fencing (cyclone wire mesh) | 8 |
| 9 | Fire protection (including hose reels and fire extinguishers) | 11 |
| 10 | Lighting | 11 |
| 11 | Mobilisation and De-mobilisation | 27 |
| 12 | Engineering, procurement and construction management (12%) | 215 |
| 13 | Contractor risk, insurance and profit (15%) | 301 |
| **A** | **Sub-total for facility installation** | **2305** |
| **B** | **Base fuel storage of 686 $m^3$ (576 tonne) @ A$0.900/L** | **924** |
| | **TOTAL** | **3,229** |

Appendix A

# Facility Process Diagram and Layout (Figures 1 & 2)

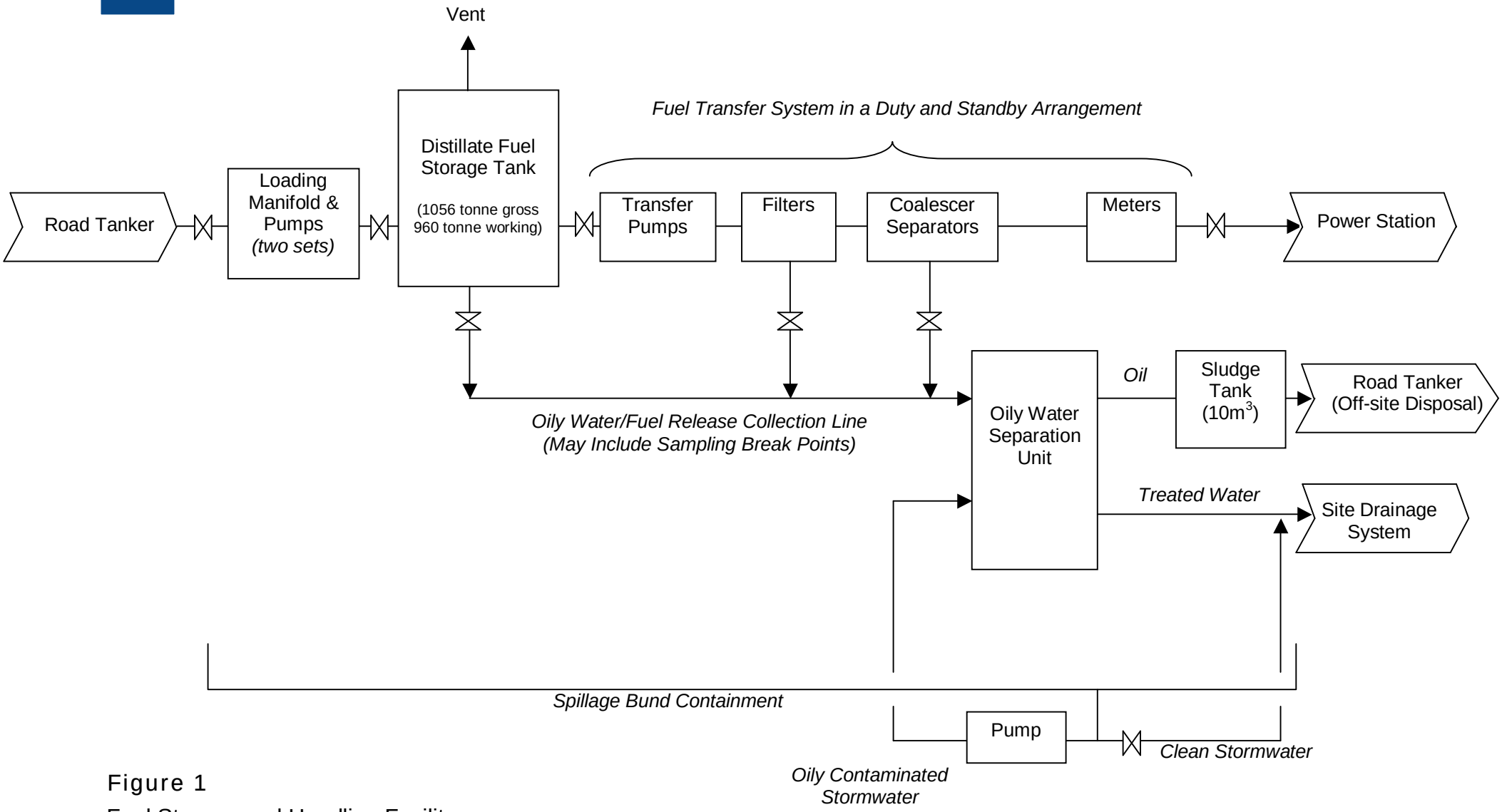



Figure 1

Fuel Storage and Handling Facility

Schematic Process Block Diagram

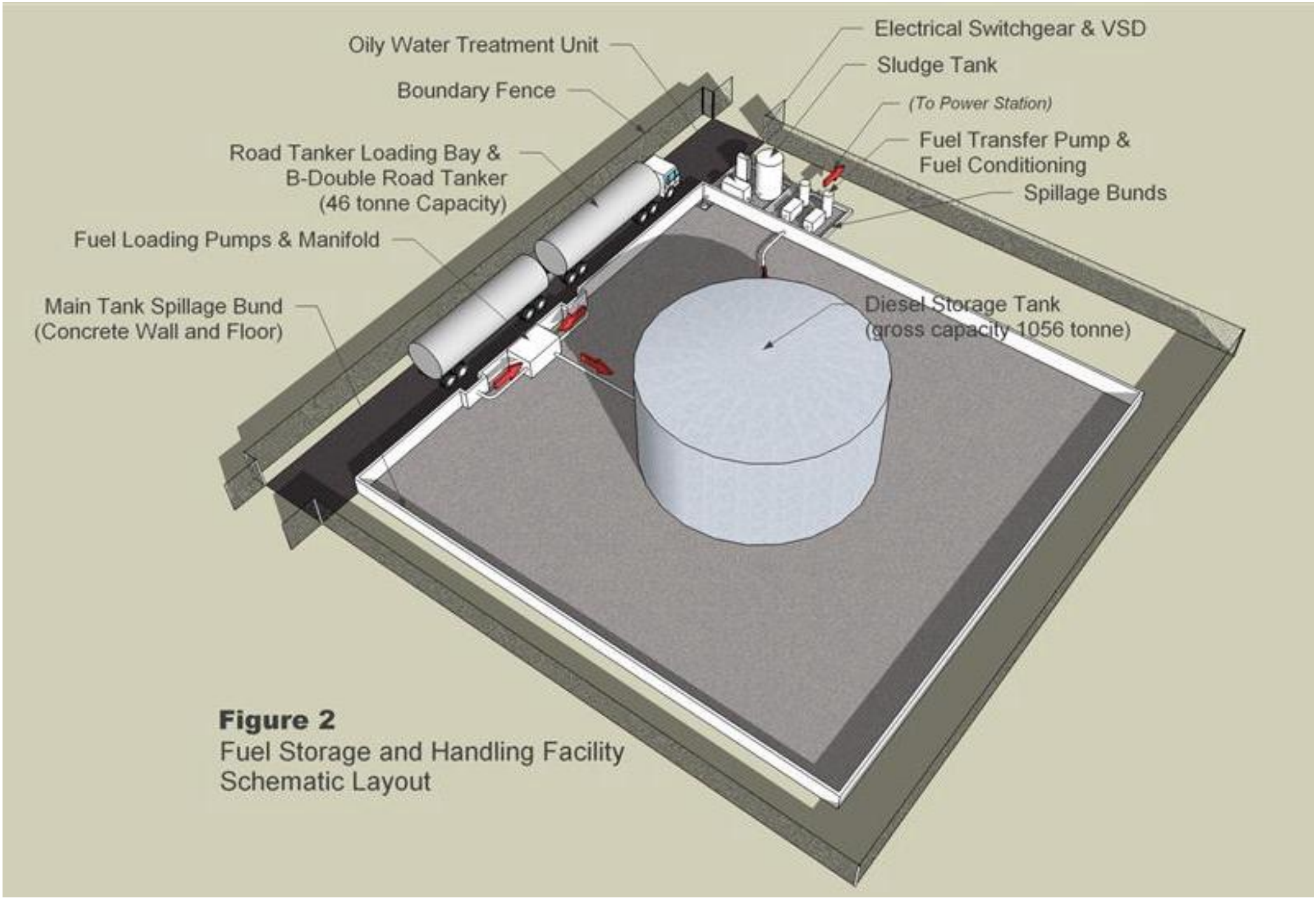


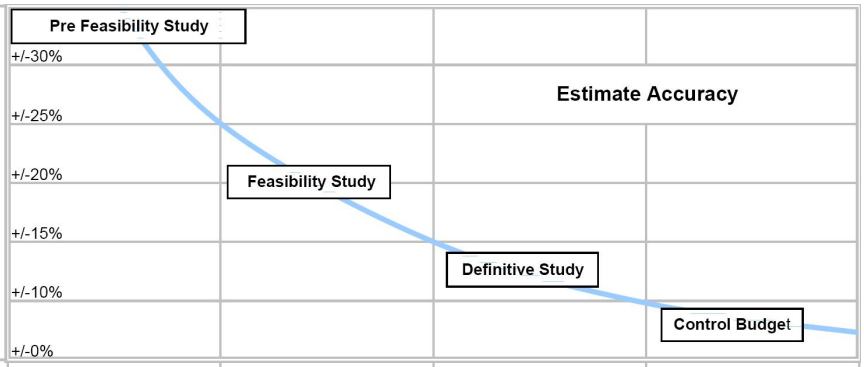

**Figure 2**
Fuel Storage and Handling Facility
Schematic Layout

Appendix B

# Estimation Guidelines

GHD MANAGEMENT ENGINEERING ENVIRONMENT

# Estimate Basis Guideline




| | | Type 1 "Order of Magnitude" | Type 2 "Feasibility" | Type 3 "Definitive" | Type 4 "Control" |
|---|---|---|---|---|---|
| **Type of Estimate** | | | | | |
| **Purpose of Estimate** | | **Options Comparison** | **Economic Feasibility Study** | **Commitment & Funding Approval** | **Project Budget Confirmation** |
| **Basis of Estimate** | | **Site** | | | |
| | Location | Assumed | Preliminary | Optimised | Confirmed |
| | Maps & Surveys | Nil | Preliminary | Detail | Final |
| | Geotech Data | Nil | Preliminary | Advanced | Confirmed |
| | Site Visits | Maybe | Desirable | Essential | Mobilised |
| | | **Process** | | | |
| | Plant Capacity | Assumed | Preliminary | Final | Optimised |
| | Energy & Material Balances | Estimated | Advanced | Optimised | Confirmed |
| | Process Flow Sheets | Assumed | Decided | Optimised | Confirmed |
| | | **Engineering** | | | |
| | Scope of Work Status | Conceptual | Probable | Confirmed | Complete & Signed Off |
| | Equipment Selection | Assumed | Preliminary | Optimised | Confirmed |
| | General Arrangements | Nil | Outline | Detail | Confirmed |
| | Piping & Electrical Drawings | Nil | Preliminary Single Line | Detail Single Line | Detailed |
| | Detailed Design Drawings | Nil | Nil | Some | 15% Complete |
| | Specifications | Nil | Preliminary | Advanced | Final |
| | Status of Engineering Completion | <1% | 1% to 5% | up to 10% | +15% |
| | | **Environmental & Safety** | | | |
| | Status of EIS | Assumed | EIS part complete | EIS approved | Consent Conditions Complied |
| | Safety Plan | Assumed | Preliminary | High Level Hazop | Detailed Hazop |
| | Constructability | Assumed | Preliminary | High Level Analysis | Detailed Analysis |
| | | **Execution Plan** | | | |
| | Schedule | Bar line | Bar line | Detailed | In Place & Operational |
| | Procedures & Controls | Assumed | Preliminary | Basis Agreed | In Place & Operational |
| | | **Capital Cost Status** | | | |
| | Cost Approach | Factoring | Factoring and Preliminary QTO | Detailed QTO & Contractor Pricing | Optimised Pricing |
| | Major Equipment | Historical Costs | Single Source | Multiple Source | Optimised Tenders or Let Contracts |
| | Mechanical, Piping & Instrumentation | Factoring | Preliminary Takeoff | Detail Takeoff or Contractor Pricing | Tenders |
| | Civil, Structural Work | Rough Quantities, $ per unit volume | Preliminary Takeoff | Detail Takeoff or Contractor Pricing | Tenders |
| | Electrical Work | $ per KW | Preliminary Takeoff | Detail Takeoff or Contractor Pricing | Tenders |
| | Indirects | Factoring | Preliminary Calculation | Detailed Analysis | Optimised |
| | | **Estimate Features** | | | |
| | Allowance for Growth | up to 30% | 15% to 25% | 10% to 15% | <10% |
| | Accuracy (90% Probability) | +/-30% | +/-25% to 15% | +/-15% to 10% | better than 10% |
| | Relative Cost of Study | X | 5X to 10X | 25X to 100X | varies |

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