Channel Infrastructure NZ

Marsden Point Refinery Recommissioning Study

Cost Estimate Report

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1. Executive Summary

The Marsden Point Oil Refinery was nominally a 135,000 barrel per day Crude Oil Refinery dependent on imported crude to produce a range of refined products including, Petrol, Diesel, Fuel Oil, Bitumen and Jet A1. The refined product was distributed throughout New Zealand via the Refinery Auckland Pipeline (RAP), coastal tankers via the refinery's jetty and by road tanker. In 2020, following historically low global refining margins coupled with the COVID-19 pandemic, the refinery was under significant financial pressure and a strategic review was initiated. Subsequently it was decided to cease refining operations and convert to a fuel terminal similar to the conversion that several Australian refineries have recently gone through. Since closure of the refinery in March 2022 the site has undergone significant modifications to enable importation, storage and export of refined product and in parallel, decommission and prepare the existing refinery plant for dismantling and removal.

Channel Infrastructure (formerly Refining NZ) engaged Worley to undertake a technical review of the facilities to determine a Capital Cost Estimate for recommissioning the existing refining facilities based on the current state of the assets as of August 2024 and in a 2020 like-for-like refining configuration prior to simplification. The study also considered that the current terminal operations would remain, and refining operations would operate in parallel.

The existing plant is in a varying condition across the process blocks and degradation can be observed; the older parts of the refinery installed in the 1960's and 80's are generally decontaminated, unpreserved and partly disassembled awaiting demolition; the newer parts of the plant such as D & E-block have seen targeted preservation of the equipment for future repurposing or sale. Preservation in these newer areas is limited to nitrogen blanketing. The older un-preserved areas of the facility make up the majority of the refining equipment and specifically include the three key processing units being the two Crude Distillers and the Hydrocracker complex. In general, the decommissioning processes have followed an approach accepted by industry for permanently decommissioning a facility of this nature guided by safety and environmental considerations. The facility has not been mothballed - a process which would require engineering assessments, additional financial investment and be underpinned by a sound business case and therefore, the observed degradation of the facility is consistent with the decommissioning approach.

A potential recommissioning would be a significant multi-year project requiring a specialist engineering and construction team to rebuild, recertify and recommission the existing facilities. This project would exceed the capacity and capability of New Zealand's workforce and international resources would be required. The rebuilding and recommissioning of the refinery would firstly need to rectify all partial dismantling as a result of decommissioning activities including replacement of removed/recycled and sold equipment. The rest of the work scope will largely be determined by inspections, repairs and refurbishments required to ensure the plant is safe to operate, meets regulatory requirements and is capable of meeting product specifications and throughputs. Given the age and condition of the majority of the equipment, significant refurbishment is required to establish a reasonable extension of operating life (15-20 years).

In addition to the scope required within the refining processing units, the tank farm will also require significant expansion if the current 20-year terminal contracts are to remain in place. To support the refining operation a new tank farm would need to be constructed on Channel Infrastructure owned land at Mair Road and would require associated piping and system integration with the existing facility. Existing unused tanks would need to be refurbished, recertified, and recommissioned.

To safely operate and maintain the existing refinery there was a significant team of specialists employed by Refining NZ across engineering, maintenance and operations teams. The knowledge and experience of these teams was gained over many years through training and management of competencies and was fundamental to ensuring the plant was operated and maintained in a safe manner. As many as 350 of these former employees (more than 80% of the original workforce) no longer work for Channel infrastructure and may not be available for re-employment, the resulting knowledge/experience gap presents a significant challenge to recommissioning the refinery. Prior to the project commencing a core owners' team would need to be re-established with the rest onboarded throughout the project, an allowance has been included for the cost of employing the owners team through the project duration.

Using both national and international resources a range of estimating methods have been used to prepare an AAECi Class 5 Capital Cost estimate based on a high-level assessment of the current condition of the plant and the agreed basis detailed in section 2.1. The study was completed utilising the existing refinery asset hierarchy at the overall block and unit level. The recommissioning project is estimated at a P50 to

P90 range of NZ$4.9 billion to NZ$7.3 billion with an order of accuracy of -20% / + 50%. To attain more cost certainty detailed onsite inspections at the equipment level would be required. In addition, this study has estimated that following a final investment decision the recommissioning project may take four years to complete. It is also noted that due to scale and complexity of the project, it may take at least two years and nominally could cost NZ$100mil to develop the business case and cost certainty required to inform a final investment decision.

To determine the most appropriate estimating methodology for each process unit, this study has reviewed the equipment make up and process description of 72 individual units. For units deemed as being a typical refining unit with a definable nameplate capacity, a new unit cost was determined from Worley US Gulf Coast data which for this study included 181 applicable reference projects. Where the unit makeup was an auxiliary or bespoke system, a new unit cost was estimated based on the equipment cost from the unit equipment list. The condition of each unit was then determined, and recommissioning factors were applied. In total it was determined that the Marsden Point facilities are comprised of approximately 2,900 individual pieces of major process equipment, of which approximately 2,320 lie within the decommissioned areas of the facility.

This study notes the following key points as having significant influence on the cost of a potential recommissioning:

- **Seadra Energy Equipment** – this study assumed that the contract for sale of equipment detailed in Table 1 to Seadra Energy would be **revoked** and the equipment would be available for recommissioning. The scope of the equipment covered under this contract is complex, high value and a significant part of the plant including the hydrocracker complex. If the sale was to proceed a significant portion of the plant would be required to be replaced.
- **Terminal Contracts –** as detailed in section 2.1 this study was completed on the basis that the tanks which are currently being utilised under a 20-year terminal contract would not be available for recommissioning. Therefore, this study has allowed to construct a new tank farm with a total working volume of 354 million litres at an estimated direct cost of 538 million. It is noted that there could be both technical and supply chain risks associated with operating the refining operation in parallel. The amount of additional product required to be exported from the facility may be constrained by the jetty and refinery Auckland pipeline. This study has not allowed to upgrade the capacity of either of these facilities.
- **Removal and Recycling of Equipment** – throughout the unpreserved areas of the plant most of the heat exchangers have been disassembled, cleaned and the heat exchanger jewellery and tube bundles have been recycled. These will all require replacement which in some units equates to over 20% of the total major equipment. This study has estimated over 300 heat exchangers will require replacement tube bundles and jewellery.
- **Permanent Isolations of the Plant** – as a key safety measure to permanently isolate the plant from the terminal operation and ensure the plant is safe for ongoing decommissioning activities and future dismantling 'air gapping' was completed. All power and instrument cables between the plant and various substations have been cut - it is estimated that up to 500,000m of cable is affected. All piping entering and exiting the off-plot areas from the plant have been cut and air gapped.
- **Degradation Since Closure** – the plant has been sitting with significant amounts of piping and equipment open to the atmosphere for approximately 2 years and given the proximity of the plant to the ocean internal corrosion is inevitable and some visual evidence can already be observed. In addition to internal corrosion the potential for external corrosion especially in insulated areas of the plant will have increased given the lack of heat input from the process. To define the full extent of repairs detailed inspections at the equipment level is required.
- **Equipment Age** – the plant varies in age significantly and it is expected that the original refining plant and the equipment installed in the 1980's expansion would require significant repairs or refurbishments to enable a serviceable design life of 15-20years.
- **Foreign Exchange Rate –** A significant portion of the cost estimate has been prepared in USD. The estimated cost is therefore inherently sensitive to Foreign Exchange movements, the exchange rates assumed for this study are as follows, NZD$1 = USD$0.60, EUR€0.55, AUD$0.90.

This study has not completed any market analysis or business case development to determine whether recommissioning the refining operation is commercially viable or beneficial to New Zealand's fuel security. Any business case that may be substantiated for the recommissioning of the refinery must consider the findings and outcomes of the 2021 strategic review which in addition to other things, highlighted the poor economics of refining in New Zealand.

2. Introduction

2.1 Study Scope and Basis

Channel Infrastructure own the Marsden Point facilities including the existing decommissioned crude oil refinery and engaged Worley to complete a study focused on preparing a Capital Cost Estimate to recommission the existing refining facilities.

Given the scale, complexity, and quantity of the decommissioned assets this assessment has been completed at the overall block and unit level - a detailed assessment at the individual equipment level has not been completed and was outside of the scope of this study.

The study has been completed on the following basis:

- The refining assets are to be recommissioned in a like-for-like configuration as of 2020 including the production of Bitumen (Unit 650). The following exceptions apply:
  - Gas Oil Hydrogen Desulphuriser I (Unit 350) and Hydrocracker Tops Treater (Unit 7700) were not operational at the time of closure and would be left as-is.
  - The Tankage currently being utilised for Terminal Operations with a 20-year customer contract will not be available for the recommissioned refining operation. This study assumed like-for-like replacement tanks would be required at Mair Road with associated piping tie-ins to the existing facility.
- Investigation or concept level engineering to reconfigure or optimise the refining operation was excluded from the scope of this study.
- The recommissioned refinery must meet the previous production capacity, reliability targets and have a safe serviceable design life of at least 15-years.
- Assets that have been disposed from site will need to be replaced. The assets which are still located on site but are included under an existing or future sales contract are considered to be available for recommissioning. Of note the units detailed in Table 1 below are included under the Seadra Energy contract, these are assumed to be available for recommissioning:

Table 1: Equipment Included Under the Seadra Energy Sale Considered Available for Recommissioning

Block	Unit	
C	7100 & 7150	Hydrogen Manufacturing and Naphtha Feed Units
	7500 & 7600	Two Stage Hydrocracker
	7800, 7830 & 7860	ADIP Units 3, 4 & 5
D	5700	Hydrogen Separation Unit 1
E	7300	Hydrogen Separation Unit 2

- The methods of decontamination and decommissioning vary across the refining units and in some cases, efforts have been made to partially preserve the equipment. These methods and processes will have significant influence on the current state of the plant. This study completed a desktop level assessment for each block to determine a basis for recommissioning. Any detailed onsite inspections at the equipment level were outside of the scope of this study.
- No consideration has been given regarding the impact that recommissioning the refinery may have on New Zealand's fuel security position as this was outside the scope of this study.
- Determination of an overall business case for recommissioning the refinery is outside of the scope of this study.
- The cost of operating the refining assets post recommissioning have not been included in this study.
- The onsite emergency services team would be re-established and therefore, the existing firefighting systems are deemed suitable.

2.2 Marsden Point History

The following history is provided courtesy of the Channel Infrastructure and existing Refining NZ websites.

Refining NZ History:
https://web.archive.org/web/20180602040235/http://www.refiningnz.com:80/about-us/history.aspx

Due to the comparatively small size of our oil market, fuels were originally imported into New Zealand by the oil companies. However, in 1956, a review of oil prices saw the Government investigate the viability of a New Zealand refinery.

Marsden Point was chosen because of its convenient deep-water harbour close to the main North Island markets, low earthquake risk and the availability of land adjacent to the site.

Building began in 1962 and the refinery was officially opened on 30 May 1964 by the Prime Minister, Keith Holyoake. The first export cargo of refined product left the refinery on 1 June, followed by the first domestic cargo on 12 June.

The refinery was substantially expanded and upgraded in the mid-1980s to accommodate increased production. Extra tanks, utility supplies and environmental treatment units were built, along with a 170-kilometre Refinery to Auckland pipeline (RAP). At the height of the expansion an estimated 5000 contractors were working on site with the final cost coming in at NZ$1.84 billion.

In 1988 the energy industry was deregulated, following the introduction of the Petroleum Sector Reform Act in December 1987. New processing agreements with the oil companies and improved operational performance have since seen the refinery maintain a strong, cost-competitive position in this deregulated market.

In 1999 we established Independent Petroleum Laboratory Ltd (IPL). New Zealand's largest fuel testing laboratory provides testing services to the refinery, local and international customers and government agencies.

Since 2005 Refining NZ has invested around $735 million on lifting the refinery's capacity and capabilities through a series of growth projects:

- *2005 Future Fuels - allowed the refinery to produce cleaner fuels - removing benzene from petroleum products and reducing the sulphur content of diesel.*
- *2009 Point Forward - increased the capacity on the refinery's principle crude distillation unit (CDU1).*
- *Te Mahi Hou - increased petrol production by around two million barrels per annum, improved energy efficiency across the refinery, reduced our CO_2 emissions by around 120,000 tonnes per annum.*

Channel Infrastructure History https://channelnz.com/who-we-are/our-history/

In response to historically low levels of gross-refining margins (GRM), exacerbated by the impacts of COVID-19, Refining NZ undertook a Strategic Review to determine the best future plans for the assets and the value they provide to shareholders. Following the strategic review, the business made the decision to simplify and then cease refinery operations as a result of structural challenges to the competitiveness of the refinery compared to newer Asian refineries, high costs of energy in New Zealand and the global movement towards reducing carbon emissions bringing new challenges and opportunities as we all transition to lower-carbon transport fuels over time.

Refining NZ was renamed Channel Infrastructure from April 2022, and now operates as an import terminal from Marsden Point under long-term contracts with its three customers, bp, Mobil and Z Energy.

Since the closure of the refining plant there has been a significant amount of work completed to convert the existing tank farm into a refined product terminal and safely decommission and decontaminate the refining units ready for dismantling or sale. Parts of equipment have since been removed and recycled and further disassembly is ongoing. In some areas efforts have been made to preserve the plant by purging with nitrogen inhibiting internal corrosion. The areas selected for preservation have been chosen based on their resale value or potential for repurposing as opposed to potential for recommissioning.

The work completed in the storage tank farm has largely been centred around converting existing refining operation tanks into finished product tanks but also included piping reconfigurations, secondary containment (bund) upgrades and firefighting upgrades.

2.3 Abbreviations and Definitions

Table 2: Abbreviations and Definitions

ADIP & ADIP-X	Proprietary Shell Amine and Acid Gas treating Solvent used throughout the refinery to treat sour gas, removing H_2S for recovery as Sulphur in the B2 Block. ADIP-X is a formula specifically designed for CO_2 recovery.
AACEi	Advancement of Cost Engineering International
Air Gapping	A method of permanently isolating equipment where either the piping or cabling is cut in two locations creating an air gap and physical isolation.
BDU	Butane Deasphalting Unit
BRU	Benzene Removal Unit
CCR	Continuous Catalytic Reforming
CDU	Crude Distillation Unit
EPCM	Engineering, Procurement, Construction Management
FEED	Front-end Engineering and Design
FID	Final Investment Decision
HCU	Hydrocracker Unit
HDS	Hydrogen Desulphuriser
HMU	Hydrogen Manufacturing Unit
HSE	Health, Safety & Environment
HSU	Hydrogen Separation Unit
HSFO	High Sulphur Fuel Oil
HVAC	Heating, Ventilation, and air-conditioning
I / O	Inputs / Outputs - the data or information that is passed into or out of a computer
MCC	Motor Control Centre
MHF	Major Hazard Facility
NDT	Non-Destructive Testing
NHT	Naphtha Hydrotreater
Off-plot	Off-plots is used to describe the area and facilities outside of the main process plant. In the case of Marsden Point the process plant is all covered within Asset North and South.
P50 & P90	As described by AACEi: *"In the context of estimate accuracy and risk analysis, the P-value of a particular estimate value indicates the expected probability that the final result (cost or duration) will be equal to or less than the specified estimate value. For example, a P50 estimate value indicates an expected 50% probability that the final result will be equal to or less than that estimated value."*
PECPR	Pressure Equipment, Cranes & Passenger Ropeways Regulations 1999
QA / QC	Quality Assurance & Quality Control
RBI	Risk Based Inspection
SCE	Safety Critical Element
SFAIRP	So far As Is Reasonably Practicable
SIF	Safety Instrumented Function
Turnaround	A plant turnaround is a scheduled stoppage of part or all of the plant's operations. The Refinery turnarounds were typically planned around catalyst cycles or Statutory Inspections.
UPS	Uninterrupted Power Supply
VDU	Vacuum Distillation Unit

VLSFO	Very Low Sulphur Fuel Oil
YP	Yard Piping – many of the interconnecting pipelines were given a YP identification number in addition to their formal line number.

3. Existing Facility Overview

The existing Marsden Point Crude Oil Refinery was designed to process middle eastern and far eastern crudes to produce; both Regular and Premium Petrol, Low Sulphur Diesel, Jet Fuel, Fuel Oil, and as by-products Bitumen, CO2 and Sulphur.

The jetty facilitated the import of Crude Oil and the export of refined product via coastal tankers to other areas of New Zealand. Refined products were also exported via road tanker and the Refinery Auckland Pipeline (RAP).

The refining plant was a highly integrated facility with operating interdependencies between each unit and block. It was possible to run some parts of the plant independently of others although this was not sustainable for extended periods of time. The complexity and interdependency of the plant is reflected by the overall plant process schematic shown in drawing T3014698, attached as Appendix A.

In general, the Marsden Point facilities were broken down into three main areas, Asset North, South and Offplots. The refining plant was located in Assets North and South each comprising of blocks and respective individual units. This study has utilized the existing asset hierarchy as the work breakdown structure and is summarised below in Figure 1. A detailed list of all process units reviewed by this study and their respective age is detailed in Appendix B.

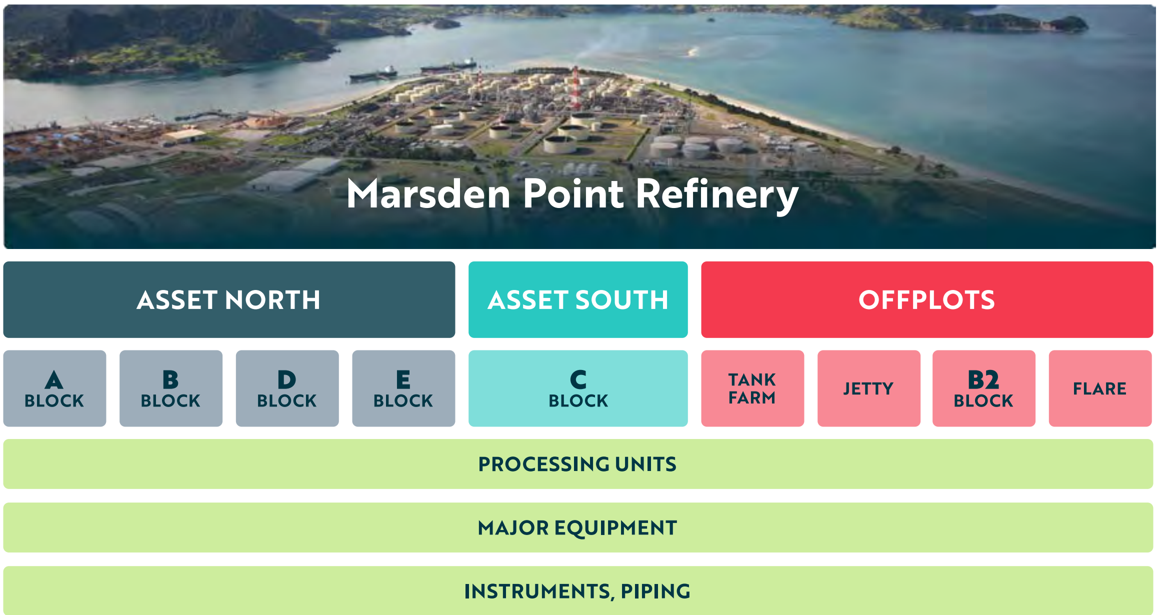

Figure 1: Overview of the Existing Asset Hierarchy.

3.1 Refining Assets

3.1.1 Asset North

Asset North was centred around the two crude distillers and associated units required to lower the sulphur content of the distilled kerosene and gas-oils. It also included a platformer unit which produced blend stock for petrol from naphtha produced in the distillation units. Asset North also included the site wide utilities.

Table 3 below provides an overview of the Asset North operations per block and a description of the age of the facilities.

Table 3: Asset North Process Blocks

Block	General Process	Equipment History
A	A-block was centered around Crude Distiller one (CDU1 - Unit 150) which was capable of processing 13,000 Tonnes per day of Crude to produce Naphtha, Kero, Light & Heavy Gas Oil and long residue. The block also included: • Unit 250 – Naptha Hydrotreater used to remove sulphur and nitrogen. • Unit 650 – a small High Vacuum distillation unit with a Bitumen Blower section. • Unit 700 – a hot oil system used throughout the block. The Gas-Oils and Kero produced by CDU1 were further processed in the Hydrogen Desulphuriser units in blocks B1 and D. The 350 Unit was an existing kerosene Hydro-Desulphuriser which was mothballed at the time of closure.	A-block's original construction was in the 1960's and had since been upgraded under two major refurbishments: • 1980's Refinery Expansion - during this project significant modifications were made to the existing facility including changes to the 250 unit. • 2009 Point Forward Project – during this project a major revamp of the key parts of A-Block was completed including de-bottlenecking of CDU1 to increase throughput. It also included the installation of a new Hot Oil Heater Unit 700. • The Original Platformer (450 Unit) was decommissioned and demolished in 2016 following the commissioning of the CCR.
B1	B1-Block included a second much smaller Crude Distiller (Unit 5100) capable of processing approximately, 5,750 Tonne/day of crude. A 1,850 Tonne/day kerosene hydro-desulphuriser (Unit 5500) which is used to reduce the sulphur content of the kerosene produced by both crude distillers and the hydrocracker. B1 block also included a small Depropaniser unit (Unit 8900)	B1 was entirely built during the 1980's Refinery Expansion and was not subject to any major refurbishments other than individual equipment upgrades.
B1 – Utilities	The Refinery Utilities were located within B-Block and generally included the following equipment: • Steam Generation including boiler feed water and condensate recovery systems. • Cooling Water Towers. • Fuel Oil and Fuel Gas systems. • Instrument Air Systems.	The current utilities systems were installed during the 1980's Refinery Expansion and were not subject to any major refurbishments. It is noted that the three steam boiler packages were intended to be installed in a boiler house however, the building was never constructed, and they were therefore suffering from corrosion.
D Block	D-Block included two main units, a Gas-Oil (Diesel) Hydro-Desulphuriser (Unit 5800) and a Benzene Removal Unit which used a BenSat process to remove Benzene from Platformate. D-Block also included a small Hydrogen Membrane unit (Unit 5700).	D-Block was entirely constructed during the Future Fuels project (2005) initiated in response to upcoming legislation. It was designed as a modular construction. Other than regular maintenance there have been no significant projects since commissioning.
E-Block	E-Block was primarily limited to one Unit 7200, which was a Continuous Catalyst Regeneration Platformer (CCR). The unit used a Honeywell UOP technology which was designed to produce high octane platformate used for gasoline blending. The heart of the platformer was five vertically stacked	E-block was newly constructed and commissioned under the Te Mahi Hou project in 2015 and increased the petrol making capacity of the refinery by 2million barrels and reduced CO_2 emissions by 120,000 Tonnes per annum. E-Block replaced the original 1960's Platformer Unit (unit 450) which was located in A-Block. Since commissioning it was subject to only one Turnaround which was completed in 2021.

Block	General Process	Equipment History
	catalyst filled reactors. The catalyst continuously cycled through the reactors and was regenerated in the regeneration section of the unit. E-Block also contained a second hydrogen membrane package (unit 7300) similar to the 5800 unit in D-Block.	

3.1.2 Asset South

Asset South was limited to C block and was the heart of the refinery centred around the Hydrocracker complex, a two-stage hydrocracker consisting of four reactors in total and achieving a 96% conversion rate.

C-block was entirely constructed during the 80's expansion and did not see any significant refurbishments other than normal maintenance turnarounds since commissioning. Table 4 below provides an overview of the key processing units in C-Block.

Table 4: Asset South C-Block key Process Units

Unit 7100 **Hydrogen Manufacturing Unit (HMU)**	The hydrogen manufacturing unit utilised a Steam Methane Reforming process to produce high purity Hydrogen required for use in the Hydrocracker. The feedstock was primarily net gas from the CCR, but various other sources could also be used including naphtha supplied via the Naphtha feed unit 7150. Through the reforming process a significant amount of CO_2 was produced which was recovered using a Shell ADIP-X process (AMINE) and subsequently vented to atmosphere. Two Third-party CO_2 recovery systems were located adjacent to the HMU which recovered a portion of the vented CO_2 which was exported to facilities on Mair Road to be processed into a food grade product.
Unit 6100 – High Vacuum Unit II (HVUII)	High vacuum unit No.2, Unit 6100 was designed to process long residue from crude distiller units 150 and 5100 to produce combined waxy distillate as feed for the Hydrocracker. The produced gas oil was then used as a blending product and the Short Residue was used in the Butane Deasphalting Unit (BDU).
Unit 6500 - Butane Deasphalting unit (BDU)	The Butane Deasphalting unit (6500) processed short residue from the 6100 to produce Deasphalted Oil (DAO) for use in the hydrocracker and Asphalt. The Asphalt could be blended into Fuel Oil or used as fuel in the various Refinery furnaces via the Asphalt Burning System Unit 9500. This unit used Butane as a solvent which was stored in the Butane Sphere's and is a similar process to what is usually referred to as a ROSE unit.
Units 7500/7600 – Hydrocracker Complex	Hydrocracker Reactor Section Unit 7500 converted a feed of Flashed Distillate, Waxy Distillate and Deasphalted Oil (DAO) in a Hydrogen rich atmosphere into mainly Naphtha, Kerosene and Gas Oil products which were sent to the Fractionation section U7600. Hydrocracker Fractionation Section Unit 7600 separated the cracked material from Unit 7500. The separated product streams were: LPG, Tops, Naphtha, Light Kero, Medium Kero, Heavy Kero, Gas Oil and Recycle Oil (MVC Bottoms). The Kero and Gas Oil products could be combined and rundown to either Jet A1 and Gas Oil or Premium Kero and Gas Oil. The gas streams from the Hydrocracker were high in Hydrogen Sulphide, these streams were processed in three ADIP Units which treated the gas removing the H_2S which was then recovered and converted into sulphur in the B2 Block. The treated sweet gas was then used in various locations across the Refinery. Hydrocracker Steam Generation Unit 7650 was designed to utilise waste heat from Units 7500 and 7600 furnace flue gases for the production of Superheated High Pressure and Medium Pressure steam.

Figure 2: Hydrocracker R-7502 being lifted into place during the 1980's Refinery Expansion. Photo courtesy of: https://channelnz.com/who-we-are/our-history/

3.2 Tankage and Off-Plots Assets

The remaining assets were categorized as Offplots and in general this asset group is made up of various systems required to support the main refining plants in Asset North and South including storage tanks, the Sulphur recovery equipment, the RAP and the flare system.

Table 5: Tankage and Off Plot Assets

Unit / Block	Description	Age
B2 Block	B2 was a small group of processing units located at the southern end of the site nearest to the ocean. The primary purpose this equipment was to recover the H_2S from the various ADIP units throughout Asset North and South and then process it into a solid Sulphur form which could be exported via truck. The following units were included within B2-Block: • 8100/8200 – Sour Water Strippers • 8300/8400 – ADIP Regeneration Units • 8500/8600/8700 – Sulphur Recovery Units • 8750 - Shell Claus Off-gas Treating (SCOT) unit. • 8800 – Sulphur handling and prilling plant.	B2 was mostly built during the Refinery Expansion in the 80's however, the SCOT unit was added in approximately '95 and enabled a higher recovery of H_2S. Until 2019 the Sulphur was exported by road tanker in liquid form by a third party. The molten sulphur was then processed at an aging facility in Whangarei. Due to the closure of this facility a new prilling plant was installed to solidify the Sulphur into small prills allowing it to be exported in a solid form. This plant was commissioned in 2019.
Flare & Relief Systems – Unit 3400	The Refinery flare arrangement was one of the major safety systems used to prevent catastrophic events in the units by providing a means of safely discharging the highly flammable gases. The Flare system consisted of: • Block battery limit collection vessels.	The flare system was installed during the 80's expansion and was only subject to routine maintenance. It is noted that the Refinery could operate with one flare train offline at any one time. Additionally, it should be noted that the upper levels of the flare tower were

Unit / Block	Description	Age
	• Large bore collection piping. • Three flare trains, two (Trains A & C) contained a 42" Hydrocarbon Flare and a 16" H_2S Flare while B train was limited to a 42" Hydrocarbon Flare. The three elevated flares are supported by a common steel structure.	inaccessible while any flare was in operation. Therefore, the only opportunity to complete maintenance on the structure was in a full plant turnaround which only occurred every 14 years.
Fire Protection Systems – Unit 2750	The refinery has an extensive firewater network which includes deluge systems, monitors and hydrants. The networks is supplied with seawater by three main delivery pumps located on the jetty.	This network varies in age but is currently still in service being utilized for the Terminal Operation.
Slops and Offgrade – Unit 3650	Slops and off grade products were collected and returned to tankage by means of the three collection headers. The various streams are then treated ready for re-processing.	This system varies in age and some parts are still being utilized for the Terminal Operation.
Bio-treater	Process water treatment comprises, De-oiling separators, off grade collection tanks and a composition buffer tank, Fluid Flocculation/Flotation Unit and a Biotreater (Activated Sludge Unit). All treated process water is gravity discharge into a network of retention basins and separation systems that eventually discharge treated water into the harbor.	Most of this system was installed in the 1980's and is currently still being utilized.
Loading and Jetty – Unit 3750	The Marsden point jetty includes three berths. • Jetty 1 was dedicated to importing Crude, Condensate and blendstock through six separate jetty hoses from a gantry. • Jetty 2 was primarily used for exporting of refined product through six jetty hoses but also included facility to import Crude through one hose as well as Blendstock. The loading facilities are all housed within a gantry. • Jetty 3 is much smaller and is dedicated to bunkering of smaller ships.	The Marsden point jetty was originally constructed during the original plant development in the 60's and originally only included the two berths, one for crude berth and one for product. The third much smaller berth was added more recently. These facilities are still fully operational however, some reconfigurations have been completed on Jetty 1.
Tankage – Unit 1150	The refinery operation required a significant tank farm which was required to store imported crudes as well as intermediate storage such as residues and finally the finished product tanks. There were approximately 106 tanks located in the off-plot areas most of which are specified under the 1150 unit. This study assumed all tanks located in the off-plot areas were a part of the 1150 unit and a list of tanks is included in Appendix C. The largest tank is T13 with a working volume of 91,000m^3 and is one of the largest storage tanks in New Zealand.	The refinery tanks are of varying ages including some from the original plant construction in the 60's and some from the 1980's expansion.

4. Refinery Decommissioning and Conversion

The last crude oil shipment was received at the refinery from Oil Tanker, Torm Ingeborg, on the 8th of March 2022 and refining operations ended on the 31st of March of the same year. Since then, until the time of writing (August 2024) there has been significant capital investment to safely decommission the refining plant and repurpose the existing assets into a Fuel Terminal.

The refining plant now sits permanently isolated from the terminal operation in various states, some areas depressurized, decontaminated, partly dismantled and open to atmosphere while other areas are 'boxed-up' and purged with Nitrogen.

The following sections provide a general record of the decommissioning processes completed as well as the current state of the various areas.

The markup provided in Appendix A provides a general overview of the site, the location of the key blocks and the general state they are currently in.

4.1 Refinery Assets Decommissioning

When any process plant is shutdown indefinitely a key decision is whether the plant is to be mothballed for potential recommissioning, or whether it is to be prepared for demolition. In the case of mothballing, the plant would be shutdown, depressurized, made safe and preserved in a manner to prevent deterioration such that future recommissioning is feasible. Preservation methods would be determined based on the anticipated mothballing period and would be specific to each equipment type. Preservation methods may include nitrogen blanketing to inhibit internal corrosion, removal of high-value equipment for storage indoors, and greasing/lubricating machinery bearings to inhibit moisture ingress and degradation. For mothballing to be pursued there would need to be financial commitment defined by a clear business case.

In the case of the refinery there was no future business case to support the additional costs required to mothball equipment therefore, the decision was made to decommission on the basis that equipment would be subsequently removed, recycled or where feasible sold or repurposed. The refinery plant could therefore be described as being permanently decommissioned.

While there have been some areas of the plant that have been under a nitrogen blanket it should **not** be assumed these areas have been mothballed as no other preservation methods have been used.

The methods used to decommission the plant is fundamental in determining the magnitude of scope required to firstly rebuild the refinery and then recommission. The following provides a general record of the decommissioning processes used throughout the main plant.

4.1.1 Blocks – A, B, C, B2 & Flare

These blocks are typically the older parts of the plant constructed in the 1960's and 1980's, they have been shut down, decontaminated, and made safe for disassembly. There have been no efforts made to preserve the equipment and as a part of the decontamination process significant components of equipment have been removed and sent for recycling.

The following provides a general record of the processes that have been completed in these areas. The items highlighted in **bold** are of particular importance to the potential recommissioning scope.

- Shutdown processes included:
  - Depressurising and draining down of liquid hydrocarbons.
  - Gas Oil flushing of systems where heavy hydrocarbons were present.
  - Steaming and chemical cleaning. Chemical cleaning such as Zyme Flow was used to neutralize areas of the plant where pyrophoric materials may be present.
  - Gas freeing by purging with nitrogen and venting to atmosphere.

- Decontamination:
  - Removal and disposal of catalysts.
  - There are some records of discrete areas of the plant being flushed with salt water.
  - **Shell and Tube exchangers & packed beds – bundles were removed, cleaned, and recycled. This was completed to ensure no residual hydrocarbons or pyrophoric materials are present at the time of dismantling. This was also completed for equipment containing a packed bed or demister pad.**
  - **Equipment Entry – once deemed safe, every vessel and column were opened and entered to verify no residual hydrocarbons remained. In some cases, additional cleaning was completed. Equipment has subsequently been partially boxed up but are still open to atmosphere.**
  - Where additional cleaning was required dismantling of equipment was completed to facilitate this, e.g. piping and equipment internals.
  - **In places where piping low points were unable to be drained holes have been drilled through the pipe to facilitate draining. Note the quantity and location of these instances is unknown and unrecorded.**
  - Hydraulic emergency shutoff (ESO) systems have been depressurised, drained down and hydraulic lines have been air gapped.
- Isolation of the plant from the terminal operations (Air Gapping).
  - **All electrical supplies from the substations to the plant were disconnected and as a means of demonstrating safe physical isolation, all cables were cut within the respective units. This was also completed for all instrumentation cables.**
  - **To safely isolate the decommissioned plant, piping at the block limits has been cut and air gapped particularly where the piping transitions between the plant and enters the off-plots areas.**
  - The firewater systems feeding the plant have been isolated.

Once the equipment no longer contained hydrocarbons it was made inaccessible, i.e vessel manways closed, and then left open to atmosphere ready for future recycling or sale.

The equipment has now been open to the atmosphere for over 2 years and given the location of the plant relative to the ocean, internal corrosion is inevitable. Some areas of the plant are made from stainless materials which may somewhat mitigate the corrosion risk although, they are still susceptible to other failure mechanisms such as Stress Chloride Cracking (SCC), which could present should the plant be restarted. Significant repairs and refurbishments are likely to be required as a result of the plant being left open to the atmosphere over this timeframe.

The items highlighted in bold above have significant impacts on a potential recommissioning and the implications are discussed below.

- **Removal of Exchanger Bundles, Packed Beds and Demisters**
  - All shell and tube bundles removed have been recycled and will require replacement. In addition, the jewellery removed including end caps, channel heads etc. have also been recycled.
  - Where the exchanger shells are in good condition it would be possible to manufacture replacement tube bundle components. However, given the age of many of these exchangers in some cases it would likely be more economical to replace the entire heat exchanger.
  - All packed beds removed have been recycled and will require replacement.
  - Vessel demisters will need to be replaced.
  - Air Cooled heat exchangers (Finfans) have had end plates and plugs removed, thereby exposing the internals of the exchanger to the atmosphere. Inspection techniques such as eddy current that are required to survey the internals of the tubes, these are expensive and typically require specialist resources.

- **Drilled Low Points**
  - While the actual corrective repairs required to fix these locations is relatively straightforward, the logistics of identifying each point will be a significant task. Additionally, there is a risk that some points are missed resulting in a loss of containment on start-up, which is not only a process safety risk but will also delay the start-up. The locations of these drilled low points have not been recorded and may not be obvious - leak detection methods would be required to identify these locations and extensive hydrotesting would be required for recertification.
- **Electrical and Instrument Cables**
  - All electrical and instrument cables between the substations and the refinery have been permanently cut and the ends have been left unsealed open to the atmosphere therefore, degradation of the cable cores is expected.
  - As these cut locations are mostly within the hazardous area methods for rejoining these cables is more complex especially given the quantity of joints required. In many cases full cable replacement cables will likely be required.
- **Air Gapping Piping**
  - All piping that has been cut and air gapped will need to be repaired.

As described above the plant is better categorized as being permanently decommissioned rather than mothballed. If the recommissioning is to proceed it is a significantly different scenario than restarting a plant that has been mothballed.

Figure 3: Typical Example of Shell & Tube Heat Exchangers Disassembled with Bundles and Jewellery such as End Caps Removed and Recycled – 20/08/24.

Figure 4: Example of Rust Scale build-up within Exchanger Shells in the 250-unit. – 20/08/24.

Figure 5: An Example of a Fanfan Cooler in A-Block showing the Tube Plugs removed and significant corrosion to the fan cowling and header box.

Figure 6: Example of Air-Gapped Piping. Left: A-Block and Off-plots, Right: D-Block and Off plots - 20/08/24

Figure 7: Typical Example of Cable 'Air-Gapping', Left: Power/Instrument Cables to Hazardous Area Junction Boxes, right: Power Supply to Electric Motor – 20/08/24.

Figure 8: Flare System showing the Elevated Flare sections removed and Disassembled at Grade - 20/08/24.

4.1.2 Blocks – D&E and Discrete Parts of C-Block

The following areas of the plant were decommissioned and partially preserved with a Nitrogen purge; this reduces the potential for internal corrosion but will **not** prevent external degradation. These areas of the plant were purged with the intent that they could be on sold or potentially re-purposed on site for new energy technology such as biofuels.

- D-Block – all units
- E-Block – all units
- C-Block – the following equipment in the Hydrogen Manufacturing unit (HMU) 7100 unit.
  - CO_2 Recovery section, ADIP-X equipment.
  - Three Reactors – (R7103,4,5)

The key difference in the decommissioning process is as follows:

- Exchanger bundles, packed beds and demisters remain installed.
- Equipment such as vessels & columns remain boxed up.
- As in the rest of the plant catalysts have been removed from all Reactors.
- While the piping has been air gapped at the battery limits, the piping is boxed up and under a Nitrogen purge.
- While the cables to the preserved equipment in C-Block have also been cut, the cables in D & E-block remain intact but the power is isolated in the substations.

Figure 9: Typical Example of the Equipment in D-Block. Left: Shell & Tube Exchangers & equipment remains Boxed up. Right: General Photo of D-Block.

Figure 10: Equipment under Preservation in C-Block. Left: HMU Reactors. Right: ADIP-X Shell & Tube Exchangers remain assembled.

Figure 11: E-Block Commissioned in 2015 remains complete and under a Nitrogen purge.

Figure 12: Example of Cables in D-Block (Left) and E-Block (Right) remaining in-situ and in tack.

4.2 Tank Farm Terminal Conversion

Since refining operations ceased in 2022 there has been a significant amount of work undertaken in the off-plot areas to convert the existing facilities into a terminal configuration. Generally, the work has been focused on tank conversions and the relevant associated scopes such as piping reconfigurations, compliance upgrades and control system improvements. In parallel to this work there has also been a significant campaign of tank decommissioning and in some cases tank demolition.

A general description of the work completed to convert the offplot facilities into a terminal conversion is as follows:

- **Tank Conversions**
  - There are currently 32 tanks in service for the terminal operation including some ancillary tanks required for the continued operation of the bio-treater and other miscellaneous systems.
  - A number of these tanks have been converted to a new service, a process which requires detailed engineering and associated modifications required to ensure the tank is suitable for storage of the new product.
  - Associated with the change to terminal service, some of the floating roof crude tanks have been converted to a fixed roof tank by the addition of a geodesic dome roof. The following provides an overview of the construction of an Aluminum Geodesic Dome installed as part of the T04 Crude Tank conversion to Jet-A1. https://channelnz.com/converting-our-crude-tanks-to-jet-fuel-storage/
  - This opportunity is also utilized to complete any inspection and maintenance work on the tank required for recertification, this would have been required otherwise.
- **Piping Reconfigurations**
  - To facilitate importation of product from the jetty to the newly converted tanks there has been many piping reconfigurations implemented to repurpose existing yard piping. In addition, there have also been piping modifications to allow export of product to the RAP and Truck Loadout Facility.
  - There has also been some partial demolition and permanent isolation of offplots piping. An example of this is shown in Figure 14 showing the piping to and from the Butane Sphere's demolished.
- **Tank Firefighting Upgrades**
  - The Marsden Point facilities were originally fully resourced by an emergency services crew who in the event of a tank or plant fire would be able to mobilise at short notice. Following refining operations closing, several automated firefighting upgrades have been completed on the in-service tanks. These upgrades have negated the requirement for a full time emergency services team which has since been disestablished.
  - The upgrades are mainly automated foam firefighting systems.
- **Secondary Containment (Bund) / Tank Compound Upgrades**
  - There are two common compliance upgrades required to bring the existing 1960/1980's standard secondary containment up to the latest NZ regulations; some bunds are insufficient in volume while others have a measured leakage rate that exceeds the allowable requirements.
  - The tanks currently in service are being managed under a compliance plan with Worksafe and a campaign of bund upgrades is underway.
  - A typical bund upgrade includes significant civil works required to either increase the bund capacity or, excavate and repair or, entirely replace the bund liner.
  - Table 6 details the tank compounds that have been upgraded or are in the process of being upgraded. Details of which tank is included under which compound is available in Appendix C.
  - Figure 13 below shows a general comparison of a tank compound / bund which has recently been upgraded relative to an existing bund.

Table 6: Tank Compounds Which have been Upgraded or are in the Process of being Upgraded.

Tank Compound	Bund/Compound Area [m2]	Indicative Stored Volume [m3]	# of tanks in Compound
P10	9000	22,700	2
C3	19500	64,150	2
C4	19000	62,370	3
P8	10500	57,370	6
P4	8000	27,860	4

- **Tank Decommissioning**
  - The tanks that have **not** been selected for conversion to terminal service have been emptied and cleaned.
  - The assumed certification expiry date for these tanks is detailed in Appendix C. Tanks that are still in certification could be bought back into service relatively easily without significant scope. However, due to the expected duration to recommission the refinery it is likely that most tanks would need to be recertified including any required refurbishments.
  - There were four bitumen tanks that were condemned and have since been demolished.
  - Most of the decommissioned tanks would require secondary containment upgrades, this is further described in section 5.8.

Figure 13: An Example of an Upgraded Bund relative to an Existing. Left: Existing Crude T04 Converted to Jet A1 located in the newly upgraded C3 Compound. Right: Crude Tank T05 currently decommissioned, piping can be seen to be removed, secondary containment is no longer compliant.

Figure 14: The piping to and from the Butane Sphere's located in the offplot areas has been demolished as part of the conversion to a terminal.

4.3 Jetty Modifications

To allow for more regular imports of refined product into the jetty there has been some modifications made to existing dedicated crude berth, Jetty 1. The following key modifications are noted:

- Crude Jetty hose number 15 has been converted to Jet Fuel.
- A piping jump over spool has been installed on the wharf head to allow for the use of existing crude pipeline YP-0 for Jet Fuel import from hose 15 through to the converted crude tanks, T-04 & T-09.

On the basis that terminal operations would continue in parallel with refining there would be significantly more product required to be exported from the site through the refinery jetty. The addition of regular Crude imports is likely to result in ships competing for berth space which has the potential to result in expensive demurrage fees. While this study has not completed any analysis to determine whether the existing two berths is sufficient for the proposed dual operation, it is something that must be investigated if recommissioning is to proceed.

This study has assumed that the existing two berths will be sufficient and has considered the following:

- The wharf line section of YP-0 would not be available for crude service. Therefore, a replacement wharf line would be required through to the existing unused sections of YP-0.
- While the two remaining 10" crude hoses on jetty 1 are currently unused and would be available for recommissioning, it is likely that offloading rates would be constrained by only two hoses and therefore, a new loading arm or gantry modifications to accommodate an additional hose would be required.
- It is also noted that the existing refining operations produced High Sulphur Fuel Oil (HSFO) which is currently being phased out across the shipping industry for a very low sulphur (VLSFO) alternative. Channel Infrastructure currently import, store and export VLSFO as fuel for ships (bunkering). Bunkering from the refinery jetty would remain as the imported VLSFO and it is assumed the HSFO would be exported to international customers. It is assumed the current fuel oil bunkering lines (YP56) should not need to be replaced and the existing fuel oil export line YP53 would be recommissioned and utilised for HSFO exports.

- The only other identified change to the jetty operation is the ability to export Bitumen. As the Marsden Point facility no longer produces, imports or stores bitumen. The existing dedicated wharf line (YP-63) is currently unused and due to its current condition, it is not feasible to be recommissioned and will require replacement.

4.4 Electrical Distribution System

The refinery equipment required a significant high-voltage power supply which was distributed throughout the site via a total of 18 substations. As the large power users all existed within the refinery units, most of the switchgear within the substations is now only partly being utilised. All the un-used circuits are permanently isolated and the cables to the various users disconnected in the cable ways, and many have been cut in the field.

During the terminal conversion minimal modifications to the electrical infrastructure has been required. However, there has been a small amount of switchgear and transformers sold.

The isolated or un-used electrical equipment is not preserved and the existing HVAC equipment in the substations are in need of replacement. Therefore, there is potential for condensation or humidity issues within the substation switchgear/MCC cells. If recommissioning is to proceed it can be expected that due to degradation some switchgear replacements may be required. In addition, the HVAC systems for each substation will require replacement.

4.5 Control System

The refinery control room is a centrally located building adjacent to C and B blocks and is currently still being utilised for the operation of the terminal. The complete site control system hardware is located within the basement of the building with an extensive HVAC system required to maintain the integrity of the equipment. As a result of the terminal conversion, the control system architecture has been significantly simplified with only a fraction of the control system capacity now being utilised.

In general, the existing control system is segregated into three discrete systems; process control system, safety instrumented system and fire and gas system. Each block had its own set of control systems which were all integrated together. In the years preceding the refinery closure there had been significant capital investment into upgrading the safety instrument system to modern Schneider Triconex equipment and a number of the process control systems had been migrated to modern equipment but not all.

Due to the reduced requirement for control system capacity some of the newer safety instrumented equipment from the refining units has been repurposed for the terminal operations. In addition, the process control system currently in use for the terminal operation has been upgraded to a modern Honeywell system. If refinery recommissioning is to proceed the existing plant safety and process control system would need to be upgraded to align with modern technology.

It is noted that all field instrument junction boxes are directly wired back to the control room & control system. This significantly increases the scope of any field cable replacements required for recommissioning. Considering a new process control system and new field cables are likely to be required, a revised control system architecture may be more economical utilising remote I/O panels located in the substations with fibre optic connections between to the main control room.

5. Recommissioning Scope

5.1 Overview

The recommissioning of the refinery would be a significant project requiring a large project, engineering, and specialist construction team. For the recommissioning project to be successful the resultant plant would need to be safe, compliant with all New Zealand regulations, and meet the required product quality and production rates. To meet the overall targets for each of these objectives an extensive scope gathering phase would be required to ensure the scope of work is correctly defined. This is not a standard greenfield or brownfield project, and a typical project lifecycle is not likely to be appropriate. The project could instead be viewed as a mega maintenance campaign or plant turnaround.

The scope of the recommissioning would be to replace all items removed during decommissioning, repair all corroded and damaged equipment, complete all required statutory inspections and then pre-commission and commission the plant. Given the age and current state of the facility, significant repairs and refurbishments would be required to give the refinery an acceptable serviceable life.

A campaign of this scale and nature would require a significant workforce of skilled labour that in some specialist areas would exceed the New Zealand market, and international labour would be required. The project execution strategy would need to consider availability of labour and on supply chain demand.

5.2 Refining Unit Repairs from Decommissioning

The following key scopes would be required throughout the refining plant to rectify the decommissioning process:

Table 7: Corrective Repairs required from Decommissioning Processes

<table>
<tr><th>Plant Area</th><th>Scope</th><th>Indicative Quantity</th></tr>
<tr><td rowspan="4">Unpreserved – Blocks A, B, C</td><td>Shell and Tube Heat Exchangers
• Survey exchanger shells and determine whether a replacement is required.
• Procure replacement tube bundles and shells as required.
• Procure replacement jewellery, end caps, channel heads etc.</td><td>~300</td></tr>
<tr><td>Finfan Heat Exchangers
Where end plates and tube plugs have been removed;
• Procure replacement parts.
• Determine whether tube internals are suitable for re-use, noting these are currently open to atmosphere.
• NDT methods such as, IRIS, Eddy Current and videoscope are likely to be required.</td><td>~200</td></tr>
<tr><td>Piping Systems
• Survey all piping to identify low points which may have been ‘drilled’, leak detection methods may be more successful. Repair all locations.
• Repair all battery limit and air gapped piping.
• In many locations piping has been disassembled to allow for draining, and components such as blinds have been removed and sent for recycling.</td><td>Un-quantifiable</td></tr>
<tr><td>Electrical Cables
• All electrical feeder cables have been cut as they transition from below ground to above ground.</td><td>Number of Cables Cut – ~2,200</td></tr>
</table>

Plant Area	**Scope**	**Indicative Quantity**
	• There are three options for rectifying this, splice in a new section of cable, terminate the feeder cable in a rated junction box and run a short new section of cable or, fully replace the cable back to the substation. • Splicing in a new section of cable is technically challenging given the following: - Age and type of cables means procuring a short piece of cable in the same specification may be challenging. - Presence of hazardous areas means the spliced joint will be required to be tagged and regularly inspected and given the quantity of cables this is not insignificant. - Location of the cut means breaking out of the concrete and minor excavation would be required. - Integrity of the existing cable and joint is critical to ensure performance. • Installation of a rated Junction Box - Like splicing this would add an additional tagged piece of hazardous area rated equipment that would require regular maintenance and inspection. - Given the proximity of the cut to grade concrete would need to be broken out to facilitate enough slack to terminate the cable in the junction box. • On the basis of the items discussed above and that the cable cuts are currently unprotected, it is assumed significant replacements will be required. If recommissioning is to proceed a detailed engineering assessment should be completed to understand what sections of cable could be reused and how the scope could be optimized.	**Total Effected Cable** ~ 227,000m
	Instrument Cables • All large multicore instrument cables between the main control room and the field Junction boxes have been cut in the field as the transition from below grade to above grade. The cables running from the main junction boxes to the various instruments are still intact. • It is not practical to splice in a new section of cable given the number and sizes of the cable cores. • New field junction boxes could be installed however, given the proximity of the cuts to grade concrete would be required to be broken out to facilitate enough slack for termination in the junction box. • Based on the items discussed above and that the cable cuts are currently unprotected, it is assumed significant replacements will be required.	**Number of Cables Cut –** ~1,070 **Total Effected Cables** ~300,000m
Partially Preserved – Blocks D & E	**Battery limit Piping** • Repair all battery limit piping.	-
	Sold Equipment • Replace any equipment which has been removed and sold such as the D-block transformer.	-

5.3 Regulatory Requirements

The Marsden Point facilities were (and still are) designated as a Major Hazard Facility (MHF) under the Health and Safety at Work act. These regulations mandate the specific process safety duties for the facility. If recommissioning were to proceed it would be critical to ensure all regulatory requirements are correctly defined to ensure the selected worklist satisfies all regulatory requirements.

The following sections describe some of the key regulatory requirements that would need to be addressed if recommissioning is to proceed.

5.3.1 Pressure Equipment

Most of the process equipment within the refining assets are required to comply with the Pressure Equipment, Cranes, and Passenger Ropeways regulations 1999 (PECPR). This includes but is not limited to; pressure vessels, reactors, process piping, heat exchangers and boilers. As described earlier, the refining assets are made up of thousands of individual pieces of pressure equipment all varying in age ranging from the 1960's through to 2020 and therefore, are designed and manufactured to a range of standards and design criteria. Under the requirements of PECPR the operator can apply a 'Grandfather Clause' where existing equipment operating within its original design conditions is only required to be maintained in accordance with its original design. If the design conditions change or modifications are made the equipment shall be reassessed and re-certified under the latest codes and standards.

As much of the equipment has now been permanently decommissioned it is unclear whether existing equipment would need to be reassessed in accordance with the current standards. If a grandfather clause could not be applied to existing decommissioned pressure equipment, significant retrospective engineering assessments would be required with resultant modifications, and potentially significant additional cost.

On the basis that the plant is to be recommissioned with like-for-like design conditions this study assumed that the Statutory Inspection body would accept existing equipment under a grandfather clause.

This assumption is a key risk to the recommissioning cost estimate. This study has made the above assumption based on the following key findings:

- D-Block (circa 2005) and E-Block (circa 2015) are likely to meet current design standards.
- Equipment installed during the 1980's expansion was designed and constructed to a high standard and upon reassessment the process equipment is likely to meet current standards with minor improvements. However, the changes in New Zealand seismic codes may result in some technical challenges.
- A-Block was subject to significant refurbishment under the Point Forward Project (2009) and therefore, equipment installed in this period is likely to meet current standards. Equipment pre-dating 2009 is likely to require significant improvements if a grandfather clause cannot be applied.

Early engagement with the statutory inspection body would be fundamental in determining the scope of reassessment.

Statutory inspections for all pressure equipment and pressure piping will be required to demonstrate the equipment is safe to operate. Any defective items will need to be repaired and, in some cases, equipment may be condemned requiring replacement. Table 8 provides an overview of the types of scope required for various types of Pressure Equipment and the potential types of repairs. This scope would be required across both partially preserved and unpreserved areas, however areas where Nitrogen blanketing has been implemented the internal inspection scope may be reduced and the potential for internal repairs is less likely.

Table 8: Statutory Inspection – high level scope

Type of Equipment	Potential Inspection Scope	Indicative Quantity
Vessels, Columns, Reactors, Heat Exchangers	• Full external inspection – Removal of Cladding and insulation. • Full internal inspection • Non Destructive Testing (NDT) such as, radiography, ultrasonic testing, magnetic particle testing, eddy current, scanning etc. • Potential repairs: - Nozzle replacements - Shell repairs – sectional replacements or weld overlay. - Repairs to non-pressure retaining components such as insulation support rings.	~1490 individual pieces of equipment.

Type of Equipment	Potential Inspection Scope	Indicative Quantity
	- Coating replacements. - Exchanger tube replacement where not already being replaced. • Hydrotesting if deemed required.	
Piping Systems	• Inspections - Removal of insulation to facilitate external visual inspection. - Inspection of all pipe supports and pipe furniture. - NDT such as, radiography, ultrasonic testing, magnetic particle testing, eddy current, scanning etc. - Internal inspection – video scope. - Operability and integrity checks on manual valves. • Potential repairs include: - Minor or major replacements of piping runs. - Replacements and repairs on pipe supports. - Replacement of manual valves. - Coating replacements - Repairs to piping as a result of decommissioning activities as mentioned in section 5.2. • Large scale hydrotesting of piping systems will be required. Note, this is a major task given the number of interconnecting piping systems and the need to find suitable locations for hydrotest boundaries.	Total piping lines installed at Marsden Point 16,640 Length varies from meters to hundreds of meters. Manual Valves likely to be in the order of multiple tens of thousands.
Minor Pressure Equipment – Ejectors, desuperheaters etc	• Inspect both visually and using NDT to determine whether safe to operate. • Repair or replace.	~500

5.3.2 Safety Critical Elements

Under the Major Hazard Facility regulations it is a requirement to establish and maintain a register of all Safety Critical Elements (SCE) including verification from an independent and competent person (ICP) that the defined SCE's are suitable and will perform their intended function. It is also a requirement that SCE's are maintained and verified to comply with their required performance standard throughout on-going operation.

For recommissioning the first step would be to identify all SCE's and their relevant performance standard, and then complete the required verification. Table 9 below provides a summary of the SCE's identified by this study and the potential scope required for recommissioning.

Table 9: Potential Safety Critical Elements

Safety Critical Element	Regulatory Requirement	Indicative Quantity
Pressure Relief Valves	Bench test – confirm correct operation, overhaul, or replace if required.	~1800
Rupture Disks	Full replacement – given the quantity likely to be best practice to replace.	~60
Control Valves (SCE)	Inspect, function test and verify seat leakage if required. Overhaul or replace as required. Note, only a portion of all control valves on the plant are defined as safety critical, these are often Tight-Shutoff valves.	~1000
Emergency Shutoff Valves	Inspect, function test, verify seat leakage if required. Overhaul or replace as required.	~90
Check valves	Where designated as safety critical, inspect and test. Overhaul or replace as required.	~250

Safety Critical Element	Regulatory Requirement	Indicative Quantity
Safety Instrument Functions (SIF)	Function test from initiator through to the final element. Instruments include, temperature, pressure, level etc. The dedicated safety control system is also a fundamental component in this.	>2500
Uninterrupted Power Supply (UPS)	Function test backup batteries and diesel generator systems. Repair and replace as required.	25
Rotating Machinery – Mechanical Seal	While not specifically designated as a SCE, the mechanical seal and seal systems for Pumps and some Compressors would need to be overhauled.	1050

5.3.3 Hazardous Area Requirements

A significant portion of the Marsden point site is designated as being some form of Hazardous Area and all electrical equipment installed within these hazardous areas must be suitably rated for the designated zone. For recommissioning of the refinery all hazardous area rated equipment will be required to be inspected to ensure it is compliant and safe for operation.

Due to the age of equipment and the state of the electrical and instrument distribution systems significant replacement should be expected following inspections. The types of equipment that fall under this category are:

- Electrical & Instrument distribution equipment including junction boxes.
- Field Instruments
- Electric Motors
- Lighting and other miscellaneous electrical items.

This study did not quantify the number of hazardous area equipment however, it is estimated to be more than 10,000.

Any non-compliant items would need to be corrected and significant replacements are likely.

5.4 Fired Equipment and Flue Gas Stacks

5.4.1 Main Refinery Furnaces

The furnaces throughout the refinery could use various fuels including, fuel oil, asphalt, refinery gas and imported natural gas. Prior to closure the more outdated furnaces were being upgraded with new modern burner management systems and this upgrade would be required for all outdated furnaces.

The burners, fuel systems and burner management systems would need to be thoroughly inspected, overhauled, and recertified. In many cases it is expected that significant replacements will be required.

Full inspection of process side tubes would be required followed by any required repairs. It is noted that most of the furnaces had been re-tubed at some point in time with improved metallurgy typically chrome molybdenum. However, the F152 furnace had not been upgraded and a re-tube would be required. This is a significant exercise requiring the roof of the furnace to be cut and removed.

Other considerations for the refinery furnaces include the integrity of the refractory which is a critical component in insulating and protecting the furnace shell from the extreme internal temperatures.

The following considerations are noted for a potential recommissioning scope:

- **All furnaces in D & E block and the Hot Oil Furnace (F701)**
  - Currently these furnaces do not have rain covers installed over the flue stack and therefore, water ingress and damage to the refractory is inevitable and there could also be potential for corrosion of the furnace shell under the refractory.

- If refractory damage is significant full removal or partial removal of the tube bank may be required to facilitate repairs.

- **The Main A-Block Furnaces**
  - The furnaces located around the A-Block stack are part of the original construction from the 60's.
  - The furnaces flue gases are directed through a series of ducting and convection banks before being expelled through the common A-Block stack, see Figure 15.
  - The hot ducts all require complete replacement due to failing refractory and significant corrosion.
  - A rain lid has recently been fitted to the top of the A-Block stack however, the stack was open to the elements for at least 12months prior. Significant water damage is expected to the refractory on the 'Dance Floor' at the base of the stack.
- **The Main B & C Block Furnaces**
  - Similar to A Block the flue gases from the furnaces in B and C block are all ducted into a common structure typically referred to as the 'Multi-flue', see Figure 16.
  - Rain lids over the four vertical stacks were installed at the same time as the A-block stack however, water damage to refractory in the duct low points is inevitable.
  - Prior to closure failing refractory within the vertical sections of the multi-flue was evident due to debris in the base of the ducts, any local failures are likely to have been impacted by water ingress and will be logistically difficult to repair.
  - The largest flue is 4.15m in internal diameter while the smallest is 1.8m.

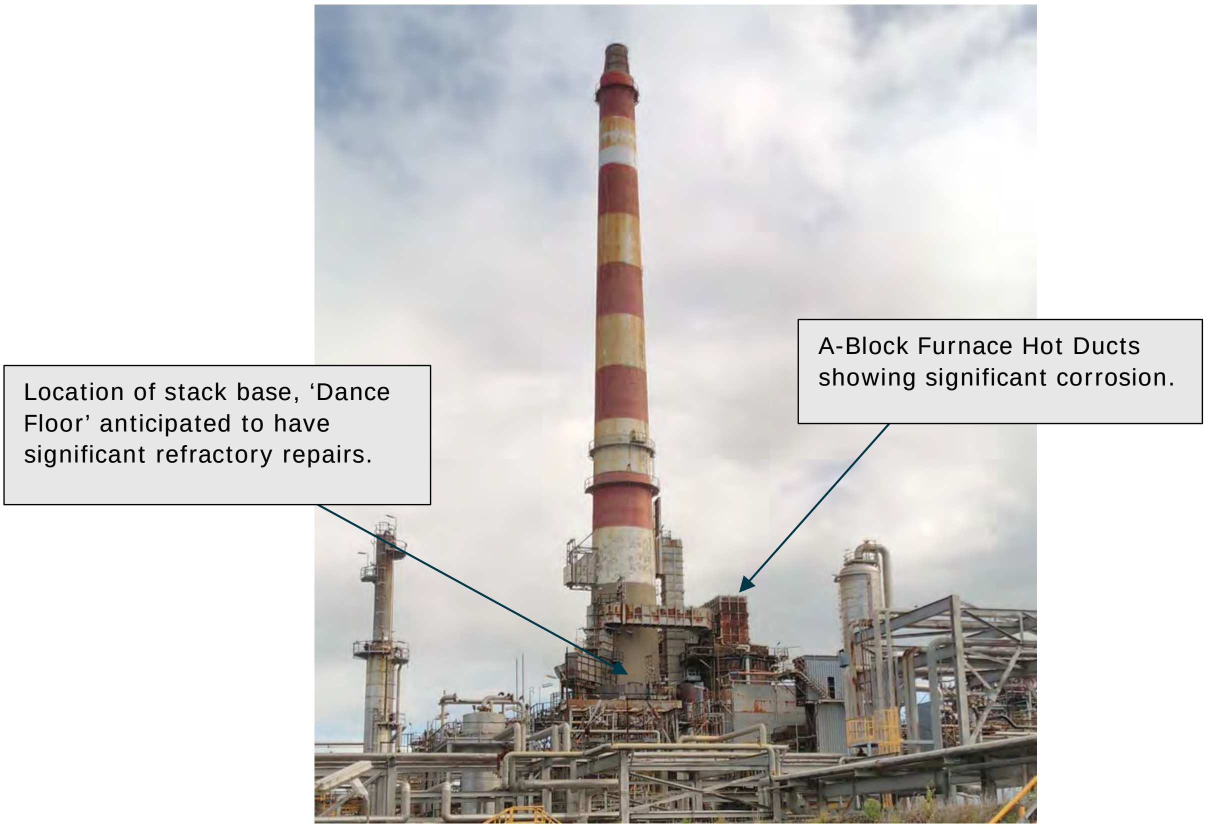

Figure 15: A-Block Stack showing location of Hot Ducts

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Figure 16: C-Block Multi-flue.

5.4.2 Utility Steam Boilers

The refinery has many steam users including turbine driven compressors and pumps, heating coils and steam tracing on piping.

The steam system was supplied by several sources including waste heat boilers in C and E-block. However, the primary source of steam was three large, fired boilers in the utilities area of B-block, each produced 1950 Tonnes of superheated steam per day. The boilers were originally installed in the 1980's expansion and were intended to be installed within a boiler house which was never installed. The boilers were suffering from significant amounts of corrosion, and it is believed that if recommissioning was to proceed new boilers would be required.

Figure 17: Two of the Three Steam Boilers in B-Block

5.5 Plant Throughput & Product Quality

In addition to the regulatory requirements associated with operation of a hazardous process facility such as the refinery, there would be a significant amount of work required to ensure that the plant would be able to achieve the target throughputs and product specifications.

The general types of scope that would be required for achieving plant throughput and product specification is detailed below in Table 10 while more specific scope associated with Rotating Machinery and Catalyst Replacements are described below in sections 5.5.1 and 5.5.2.

Table 10: Potential Scope Driven by Process Engineering

Equipment	Process Engineering Requirement	Indicative Quantity
Columns / Vessels / Reactors	• Inspect all internals and determine required repairs or replacements, such as defective column trays. • Packed beds which have been removed and recycled will require replacement.	~820
Fin fan Heat Exchangers	• Fan cowlings are important to achieve the required duty, these items are known to be suffering from significant corrosion and many will require repair/replacement. • Fan blades will need to be reviewed to determine if suitable for recommissioning. • Finned tubes are important to achieve the required duty and may be required to be replaced due to corrosion or mechanical damage.	~350
Catalysts, membranes and	New catalyst will be required for all Reactors. Process engineering to specify required type of Catalysts.	See section 5.5.2
Rotating Equipment – Pumps, Compressors	In addition to the critical safety aspects all rotating equipment will need to be inspected / overhauled to ensure they will meet the required duty.	See section 5.5.1
Process Control Instruments	All instrumentation required for process control and the control system itself will need to be verified to working correctly.	Unquantified
Piping	Verify all piping systems are clean and free of scale and blockages.	Unquantified

5.5.1 Rotating Machinery

Rotating machinery such as compressors and pumps are at the heart of the refinery and their performance and reliability is fundamental in ensuring the plant is capable of achieving the required product specifications and throughput. In addition, failures of critical items such as mechanical seals can be the cause of significant process safety incidents. Therefore, all critical pieces of rotating equipment will need to be inspected and tested with many requiring complete overhauls.

Some equipment at the refinery was driven by electric motors while others were powered by steam turbines. While some areas of the plant have been purged with nitrogen to assist with preservation there have not been additional efforts made to preserve the rotating equipment including the drivers i.e. electric motors and turbines. While nitrogen purging will have assisted to mitigate against internal corrosion on the process side of the equipment there are still significant amounts of auxiliary equipment that are not preserved.

The largest pieces of rotating equipment on site are the three hydrocracker hydrogen compressors which are four stage reciprocating compressors each powered by a 3.1MW electric motor.

The following provides an overview of the types of scope that would be required for recommissioning:

- Pumps, compressors & turbines – complete disassembly, inspection and replacement of critical components such as mechanical seals, bearings, pistons, impellers etc.

- Some items may be deemed more economical to replace.
- Complete overhaul of auxiliary systems such as secondary seal and lube oil systems.

- Fans and Blowers – inspect and replace components as required.
- Electric Motors – the larger electric drivers often include anti-condensation heaters which are used to prevent degradation & corrosion of the motor internals during unused periods. All electrical motors throughout the refinery are currently permanently isolated and no efforts have been made to preserve the motors or prevent corrosion. There will be a significant inspection scope required to determine which motors require refurbishment or replacement.

Table 11 below provides an overview of the number and types of rotating machinery required to be recommissioned.

Table 11: Indicative Quantity of Rotating Machinery

Equipment Type	Indicative Count
Compressors – Screw or Turbine	35
Compressors – Reciprocating	30
Pumps – Centrifugal	400
Pumps – Positive Displacement	200
Fans & Blowers	370
Lube Oil Skids	6
Steam Turbine	25
Electric Motors	1050

Figure 18: Four Stage Reciprocating Hydrogen Compressors

5.5.2 Catalyst Replacements

All catalysts have been removed from the various reactors and are in the process of being disposed of. If recommissioning was to proceed new catalysts would need to be procured and installed within the equipment once repairs and refurbishments were completed. The following table provides a summary of the catalysts/absorbents and membranes that have been subsequently disposed of and require replacement.

At the time of writing, it is anticipated that the lead time for catalysts would be in the order 9 months.

Table 12: Catalysts, Absorbents and Membranes requiring replacement.

Block	Unit	Type of Catalyst	Volume [m³]
A	Unit 250 – Naphtha Hydrotreater	Activated Grading and Hydrotreating Catalyst	39
B1	Unit 5500 – Hydrodesulfurization Unit 2	Activated grading and Hydrotreating Catalyst (CoMo)	16
	Utilities	Cation resin	22
		Anion resin	16
		Mixed (anion & cation)	15
		Condensate Polishing resin	6
B2	Units 85/86/87/8750 - Sulphur Recovery Units and Shell Claus Off-gas Treating Units	Claus Catalyst	40
		Incinerator Catalyst	12
		Hydrotreating Catalyst (CoMo)	13.5
C	Unit 7500 – Hydrocracker Unit	Demet Catalyst	60
		Hydrotreating Catalyst	154
		Hydrocracking Catalyst	542
		Post Treat Catalyst	6
		Activated Carbon	160
	Unit 7100 – Hydrogen Manufacturing Unit	Reforming Catalyst	25
		High temp/ low temp shift Catalyst	77
		H_2S Adsorbent	18
		Hydrotreating Catalyst (NiMo)	6
		Methanation Catalyst	12
D	Unit 5400 – Benzene Recovery Unit	BENSAT Catalyst (platinum)	10.5
		Adsorbent	10.5
	Unit 5800 – Hydrodesulfurization Unit 3	Activated grading and Hydrotreating Catalyst	168
	Unit 5700 – Hydrogen Separation Unit	9 x new membranes	
E	Unit 7200 – Continuous Catalytic Regeneration	Platforming Catalyst (Platinum)	109
		Mol Sieve Adsorbent	36
	Unit 7300 – Hydrogen Separation Unit	10 x new membranes	N/A

5.6 Off-Plot Pipe Racks

The off-plot areas contain a vast network of multi-tier pipe racks which support piping running between process units and the tank farm. This study has included these assets under Unit 9900, Interconnecting Piping.

The recommissioning scope required for these assets will mainly be driven by regulatory compliance as described in section 5.3.1. The anticipated scope for these assets is as follows:

- Piping inspections and subsequent repairs and replacements. Insulated lines will be of particular focus.
- Piperack Structural Refurbishments – most of these pipe racks were installed in the 1980's and were known to be suffering from corrosion particularly around the secondary and tertiary member connections. Repairs and refurbishments will be required including blast and paint.
- As described in 0 piping reconfigurations were implemented during the terminal conversion. These will need to be corrected while still allowing for the terminal tanks to be used for terminal operations.
- Large scale hydrotesting will be required following any repairs and for recertification.

5.7 Refining Equipment Life Extension

Although the equipment designed and installed in the 1960's and 1980's was being maintained to an acceptable standard it was past its intended design life and was therefore requiring significant investment in ongoing maintenance.

To minimize unplanned production outages due to equipment breakdown, the recommissioning scope should be selected on the basis of providing an acceptable design life and to achieve acceptable production availability targets.

Scope which may be included to satisfy this requirement includes:

- Fabric maintenance – coating replacements to inhibit ongoing corrosion.
- Replacements instead of repairs for pressure equipment and machinery.

5.8 Tankage

The tank farm is a critical component to the refining operation and is the key component allowing the refinery units to operate together as an integrated facility. If recommissioning was to proceed the existing decommissioned tanks would need to be reinspected, repaired/refurbished and recertified. As defined in section 2.1 this study has been completed on the basis that the current 20-year terminal contracts would remain in place and therefore, replacement tanks would be required to be built elsewhere.

5.8.1 Tank Recommissioning

The existing tank turnaround program was being completed on a 15-year cycle and it is assumed this turnaround period would be required for recommissioned tanks.

The following three scenarios were considered as potential recommissioning scopes:

- **Inspection, Recommission** – for tanks that currently have valid certification for at least another 8 years it was assumed recommissioning of the refinery could be achieved before the certification expired. Anticipated scope for these tanks is as follows:
  - Assumed the tanks have all been cleaned under the decommissioning process.
  - High-level internal inspection.
  - Return tank to service.
- **Inspection, Repair, Recommission**– for tanks that will have an expired operating certificate by the time potential refinery recommissioning is completed a full tank inspection and repairs will be required to attain a further 15-year operating certificate. Anticipated scope for these tanks is as follows:
  - Full internal inspection
  - Complete repairs as required including coating replacements as required.
- **Inspection, Refurbishment, Recommission –** as per category above except for factors such as insulation or product type a more significant refurbishment scope is likely to be required to attain a 15-year turnaround cycle.

- **Replacement Tanks –** The four bitumen tanks already demolished will be required to be replaced in their existing location.

In addition to the work required to recertify the tank, the tank secondary containment systems must also be compliant with current standards. Some of the decommissioned tanks are in a shared compound which has already been upgraded; for these tanks there should not be any scope associated with secondary containment. For the recommissioned tanks which are not in an upgraded bund, an upgrade in line with the latest site standard would be required.

Details of each tank and the determined recommissioning scope is detailed in Appendix C.

5.8.2 New Tank Farm

As described above there are a number of new tanks required to be constructed in a new tank farm at Mair Road. This study identified the northern plot of land on Mair Road owned by Channel infrastructure as being the most likely site to facilitate the new tanks.

The scope of work would include:

- Full green field civil development of a 128811m2 plot including:
  - Development of mounded tank compounds for seven product streams.
  - Roading development including site access from Mair Road and access ways in between tank compounds for maintenance.
  - Full storm water collection and oily water treatment systems.
  - Site perimeter security fencing and site access systems
- Construction of 32 like-for-like tanks equating to a total working volume of 354million litres.
  - 11 of the tanks are required to be floating roof, while 21 of the tanks will be fixed roof.
  - Tank gauging for overfill protection and over pressure protection devices.
- Piping tie-ins to the refining facilities:
  - It is anticipated piping manifolds and valving arrangements would be utilised to minimise the amount of long piping runs to and from the new Tank Farm.
  - Rundown lines from the refining plant to the tank farm.
  - To facilitate transfer of product back to the existing tanks and export of product to the RAP, Jetty or adjacent truck loading facility various pump sets and blending manifolds would be required at the new tank farm.
  - New piping racks and pipe bridge over Mair Road would be required.
  - A new firewater ring main would be required and any associated mobile firefighting equipment such as firefighting foam trailers. This study assumed the existing firewater pumps on the jetty would be sufficient and the existing ring main could be extended.
- Instrumentation, Controls, and Electrical tie-ins
  - A new power supply will be required for the tank farm where a new substation and equipment room would be required.
  - It is anticipated a control system would be implemented at the Mair Road facilities and a fibre optic connection to the main control room would be used.
- A key consideration if this is to proceed is consenting requirements; it is believed that this new facility would extend the limits of the existing MHF facility boundary and therefore, is likely to fall outside of the existing consent. Detailed engineering and safety studies are likely to be required to support a consent submission and revised safety case.

The marked-up plot plan in Appendix A shows the proposed location of the new tank farm.

5.9 Owners Scope

Given the complexity and scale of the refining operation there was a significant team of specialists required to keep the plant running safely and efficiently. This included Refining NZ employed operations, maintenance and engineering teams but also included a significant team of local contractors. Since closure of refining operations there has been a reduction in the owners team by approximately 350 personnel.

Some of the scope that the potential owner/operator would need to consider if the refinery recommissioning project was to proceed is described below.

- Re-establish owners' team – approximately 350 personnel.
  - Engineering Subject Matter Experts
  - Process Engineering Team
  - Inspections Team
  - Operations Management and Operations staff
  - Asset Engineering teams
  - Laboratory staff
  - Management and administration team
- Establish an owners Project Management team.
- Asset Management & IT Systems
  - The Marsden Point facility assets were previously managed using Maximo asset management software which has since been disestablished. This would need to be re-instated prior to the recommissioning project commencing as it would form a fundamental part of managing the recommissioning scope. There is a risk that the existing archived database is not complete or is inaccurate.
  - The inspections team utilised a mechanical integrity software called PCMS. At the time of writing the Channel Infrastructure inspection team is still utilising PCMS and the existing refinery assets are still available in within the software.
- Engineering and refining business procedures, policies and standards would need to be reviewed and reinstated, many of these overarching documents are safety critical.
- Procurement of Critical Spares.
- First fills – the operations and commissioning team would need define the required first fills to enable the refinery to be commissioned and production brought on specification. This study assumed that an inventory of 1,453kbbl of crude oil would be required for commissioning and the associated cost is included in the estimate.

Of particular note is the operations, engineering and maintenance teams, throughout the operation of the refinery the knowledge base of these teams was maintained through training and the experience of long serving employees. The intimate knowledge of the plant these teams held was fundamental to ensuring the plant was operated and maintained safely. This knowledge gap presents a significant challenge to the potential recommissioning project and continued safe operation.

6. Recommissioning Strategy & Schedule

6.1 Execution Strategy

As described in section 5.1 the recommissioning project would not be a typical green or brownfield project and should be viewed more as a significant maintenance campaign or a plant turnaround. A high-level approach to the identification and execution of the recommissioning scope for the main refining plant is described below. The recommissioning should be broken down into the individual blocks with dedicated project management teams assigned to each. In addition, the new tank farm could be ring fenced and managed as a typical greenfield development.

- **Define Recommissioning Premise**
  - Document and agree the overall objectives of the recommissioning including regulatory requirements, reliability, production rates and emissions targets.
  - The design life of the recommissioned plant should also be determined in addition with the project execution strategy. These decisions will be fundamental in determining the scope of the repairs and would be a key factor in determining the scale of any repairs/refurbishment.
- **Scope Gathering – Worklist Identification**
  - Develop the initial recommissioning worklist, items should be categorized against the premise, i.e. compliance, reliability, plant throughput etc.
  - The inspection worklist should be prioritised.
  - Identify significant replacements or repairs to be executed as individual projects.
  - Identify scopes requiring specific engineering and design.
  - Define and plan the individual inspection scopes.
- **Execution Phase 1 - Inspection Phase**
  - Complete inspection preparation works, scaffolding, insulation removal, surface preparations and equipment disassembly.
  - Execute inspection scopes and raise Workorders for defective items requiring repair.
- **Finalise Worklist and Complete Planning**
  - With the inclusion of the inspection findings the worklist should be challenged, and the final scope agreed and fixed.
  - Execute detailed planning for each workorder defining the required materials and budget labour hours for each scope.
  - Complete engineering & design as required.
  - Procure all required materials and effectively manage the procurement of long lead items.
  - Define the execution and contracting strategy.
  - Once the repair and refurbishment scopes are defined it is anticipated that the work scopes would be grouped together and awarded under EPCM type contracts. This could be completed by block, unit or equipment type.
- **Execution Phase 2 - Execute Worklist**
  - Execute the agreed worklist of corrective repairs, refurbishments and replacements.
  - Emergent work that may arise during execution should be appropriately managed.
- **Pre-Commissioning**
  - Following the completion of the execution works and extensive pre-commissioning phase would be required to ensure the plant is safe to introduce hydrocarbons and commence commissioning.
- **Commissioning**

6.2 Execution Schedule

A high-level timeline has been developed to estimate a potential recommissioning schedule. Following final investment decision (FID) and establishment of the owner's project team this study has estimated the recommissioning project duration would be in the order of 3.5 to 4 years.

The critical items will be long lead equipment and materials which in the case of this study has been assumed to have a lead time up to 15months. To ensure all long lead items are identified in a timely manner it would be critical to complete all priority inspection work as early as possible.

To minimise workforce demand it is assumed that the execution would be phased into two discrete campaigns of work, an inspection phase, and an execution phase where the planned repairs and refurbishments are completed.

Task / Activity	Duration (mon)	Year 1				Year 2				Year 3				Year 4			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Scope Definition - Worklist Development & Inspection Scope Planning	12																
Detailed Engineering & Design	18																
Execution Phase 1 - Inspections - Phased & Prioritised	15																
Execution Phase 2 – Execute Worklist	15																
Long Lead identified	9																
Long Lead Equipment & Materials	15																
Catalyst Procurement	9																
Pre-Commissioning	9																
Commissioning	3																

Figure 19: Indicative Recommissioning Schedule

7. Capital Cost Estimate

7.1 Cost Estimate Summary

Total estimated capital cost for recommissioning the refining units, including an allowance for Owners costs is summarized in Table 13 by major asset and estimate element. These amounts are based on third quarter 2024 New Zealand Dollars (NZD$). A further breakdown of the estimate is included in Table 14 by Asset, Block and Process Unit, including recommissioning scope basis.

The estimating methodology used is a similar approach used by Worley for estimating the life extension project for the Atlantic LNG Facility in Trinidad and Tobago. The basis of the estimate including the key assumptions and exclusions are detailed below in section 7.3.

Table 13: Estimate Summary by Asset

Asset / Element	Total NZD$M
Asset North	680
Asset South	620
Asset Offplots	1,088
Plant Wide	230
Subtotal Direct Costs	**2,618**
Common Indirects	324
EPCM Services	771
Contingency	743
Owners Costs	223
Crude Inventory	218
Subtotal Indirects	**2,278**
Total Project Costs	**4,896**

Table 14: Estimate Summary by Asset / Block / Unit

Asset	Block	Unit	Scope	Total NZD$M	Recommission Scope
			DIRECT COSTS		
Asset North	A	150	Crude Distiller Unit No. 1	140.48	Moderate Repair
Asset North	A	250 / 800	Naphtha Hydrotreater & ADIP Unit No.1	53.73	Moderate Repair
Asset North	A	350	Gas Oil Hydrodesulphuriser	-	No Scope
Asset North	A	650	High Vacuum Unit No. 1/Bitumen Blowing	50.70	Full Replacement
Asset North	A	700	Hot Oil System	13.06	Inspection, Recommission, Minor Repairs
Asset North	A	5000	A-Block Stack & Hot Ducts	12.14	Moderate Repair
			Subtotal Block A	**270.11**	
Asset North	B	5100	Crude Distiller Unit No. 2	100.26	Moderate Repair
Asset North	B	5500 / 5600	Kerosene Hydrodesulphuriser & ADIP Unit No. 2	51.72	Moderate Repair
Asset North	B	8900	Depropaniser	11.13	Moderate Repair

Asset	Block	Unit	Scope	Total NZD$M	Recommission Scope
Asset North	B	8930	ADIP Unit No. 6	1.27	Moderate Repair
Asset North	B	9100	Steam Generation/Expansion	84.73	Replacement of Boilers & Full Refurbishment
Asset North	B	9150	Condensate System	16.06	Moderate Repair
Asset North	B	9200	Boiler Feedwater	25.40	Moderate Repair
Asset North	B	9300	Fresh Water Supply/Treatment	-	No Scope
Asset North	B	9350	Industrial Water	-	No Scope
Asset North	B	9400	Fresh Cooling Water System	0.61	Inspection, Recommission
Asset North	B	9430	Gland Cooling Water System	0.24	Inspection, Recommission
Asset North	B	9500	Asphalt Burning System,	14.54	Full Refurbishment
Asset North	B	9520 / 2550	Fuel Oil System	2.29	Moderate Repair
Asset North	B	9600	Fuel Gas System	4.39	Moderate Repair
Asset North	B	9700 / 9750 / 2650	Instrument Air/Plant Air System	5.96	Moderate Repair
Asset North	B	9850	Miscellaneous chemicals	0.42	Inspection, Recommission, Minor Repairs
			Subtotal Block B	**319.03**	
Asset North	D	5400	Benzene Removal Unit	19.00	Inspection, Recommission, Minor Repairs
Asset North	D	5700	Hydrogen Separation Unit	3.92	Inspection, Recommission, Minor Repairs
Asset North	D	5800 / 5900	Gas Oil Hydrodesulphuriser 3 & ADIP Unit No. 8	31.35	Inspection, Recommission, Minor Repairs
			Subtotal Block D	**54.26**	
Asset North	E	7200 / 7300	CCR & HSU2	36.26	Inspection, Recommission
			Subtotal Block E	**36.26**	
Asset South	C	6100	HVU II (High Vacuum Unit)	50.89	Moderate Repair
Asset South	C	6500	BDU (Butane Deasphalting)	50.26	Moderate Repair
Asset South	C	7100 / 7150	HMU (Steam Reforming Hydrogen Manufacturing Unit)	97.81	Moderate Repair
Asset South	C	7100 ADIP-X	ADIP-X Unit CO_2 Recovery	19.53	Inspection, Recommission, Minor Repairs
Asset South	C	7500 / 7600 / 7650	HCU Complex & ADIP Units 3,4 &5	393.49	Moderate Repair
Asset South	C	7700	HCU tops treater	-	No Scope
Asset South	C	9901	Multiflue	7.68	Moderate Repair
			Subtotal Block C	**619.68**	

Asset	Block	Unit	Scope	Total NZD$M	Recommission Scope
Asset Offplots	OffPlots	1150	Tankage	262.52	Various – see Appendix C
Asset Offplots	OffPlots	1150-1	New Tank Farm	538.24	Greenfield Development
Asset Offplots	OffPlots	1200	Natural Gas	-	No Scope
Asset Offplots	OffPlots	1300	Truck Loading Facility	-	No Scope
Asset Offplots	OffPlots	1700	RAP	-	No Scope
Asset Offplots	OffPlots	2750	Fire Protection	-	No Scope
Asset Offplots	OffPlots	3400	Flare and relief system	123.64	Full Refurbishment
Asset Offplots	OffPlots	3650	Slops and Offgrade	-	No Scope
Asset Offplots	OffPlots	3750	Loading and Jetty	16.95	Modifications and Repairs
Asset Offplots	OffPlots	3800	Sludge handling system	-	No Scope
Asset Offplots	OffPlots	3900	EWT (effluent water treatment)	-	No Scope
Asset Offplots	OffPlots	9800	N2	-	No Scope
Asset Offplots	OffPlots	9820	Flushing and Seal oil system	3.75	Full Refurbishment
			Subtotal Block OffPlots	**945.10**	
Asset Offplots	B2	8100	SWS 1 - Sour Water Stripper	12.62	Full Refurbishment
Asset Offplots	B2	8200	SWS 2	11.76	Full Refurbishment
Asset Offplots	B2	8300	ADIP Regen 1	11.18	Full Refurbishment
Asset Offplots	B2	8400	ADIP Regen 2	16.75	Full Refurbishment
Asset Offplots	B2	8500	SRU 1 (Sulphur Recovery Unit)	26.73	Full Refurbishment
Asset Offplots	B2	8600	SRU 2	26.73	Full Refurbishment
Asset Offplots	B2	8700	SRU 3	20.34	Moderate Repair
Asset Offplots	B2	8750	SCOT (Shell Claus Off-gas Treating)	16.35	Moderate Repair
Asset Offplots	B2	8800	Sulphur handling (Sulphur Pastelle plant)	0.82	Inspection, Recommission
			Subtotal Block B2	**143.26**	
Asset Offplots	OffPlots	9900	Interconnecting Piping	99.94	Moderate Repair

Asset	Block	Unit	Scope	Total NZD$M	Recommission Scope
Plant Wide	Controls	-	Control Systems	85.57	Moderate Repair
Plant Wide	Power	-	Power Distribution	44.64	Moderate Repair
				-	
			Sub Total Direct Costs	**2,617.87**	
				-	
			INDIRECT COSTS	-	
				-	
			Common Distributables	323.53	
				-	
			EPCM Costs	771.22	
				-	
			Contingency	742.52	
				-	
			Owners Costs	222.76	
			Crude Inventory	217.95	
				-	
			Sub Total Indirect Costs	**2,277.98**	
				-	
			Total Installed Cost - Present Day	**4,895.85**	
				-	
			Escalation	Not included	
				-	
			Total Installed Costs-Including Escalation	**4,895.85**	

7.2 Estimate Classification and Accuracy

The capital cost estimate was prepared with a methodology aligned to an Association for the Advancement of Cost Engineering International (AACEI) Class 5 classification as summarized in Table 15.

Table 15: AACEi Classification Matrix Extract (Class 5)

Estimate Class	Project Definition (% of Complete Definition)	Purpose of Estimate	Methodology	Expected Accuracy Variation in low and high ranges
Class 5 Estimate	0% to 2%	Concept Screening	Capacity factored, parametric models, judgement, or analogy	Low: -20 to -50% High: + 30 to +100%

In general, Class 5 estimates are prepared for strategic business planning purposes, such as, but not limited to, market studies, assessment of initial viability, evaluation of alternative scheme, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning.

Although the project is based on varying levels of engineering definition, ranging high level unit capacity to as-built quantities, in general the estimating methodologies and basis aligns to a Class 5 approach. As discussed in other sections of this report, there is significant uncertainty in major elements of the estimate due to the brownfield and recommissioning nature of the project. This uncertainty contributes to the accuracy range for the estimate.

An estimate accuracy of -20% / +50% has been assessed for the overall estimate, based the mix of estimating methodologies applied in the estimate, as described below and the type of project.

7.3 Cost Estimate Methodology and Cost Basis

7.3.1 General

The estimate has been completed at the process unit level and the method used for each was dictated by the type of equipment and process description of each unit. On this basis the estimate work breakdown structure has followed the existing asset hierarchy.

All cost estimates have been prepared in today's dollars as of the Third Quarter 2024 and no forward escalation has been applied.

For units which are a 'typical' refining process such as a crude distillation unit or kerosene hydrodesulphuriser the input cost data has been derived from a factored nameplate capacity estimate. Where the unit is an auxiliary system or is not definable by a nameplate capacity, input cost data was typically derived from an equipment list.

For the nameplate capacity estimates the Worley Consulting Houston team were engaged to provide an estimated new build cost of each unit based on its nameplate capacity. The derived cost was based on a US Gulf Coast cost from a database of recent refinery projects, in total there were 181 project estimates used. Once factored to account for New Zealand market conditions and Foreign Exchange rates a commodity breakdown was derived to provide a new build cost per commodity in NZD.

For the smaller and more bespoke units a review of the process description and Process Flow Diagrams was completed to determine the scope and status of the equipment, where required an equipment list was developed which was used to derive a new build cost per commodity.

Tank farm and plant wide scope such as interconnect piping, ducting and site wide electrical and controls were estimated either based on preliminary quantities or allowances, as outlined below.

Based on a technical review a recommissioning category was then determined for each unit and the unit commodity costs were factored to determine a recommissioning cost.

Appendix B provides an overview of the process units, the assigned recommissioning category and the input estimating method used. More details regarding the estimating methods are provided in the following sections below.

Cost elements of engineering, project management, site indirect costs, commissioning, and contingency have been added at the Total Project Cost summary level.

7.3.2 Refining Units Nameplate Capacity Estimates

Replacement cost (excluding contingency) for the main process units have been determined based on the process unit name plate capacity. A cost curve per process unit has been developed from historical cost data by the Worley Houston team and plotted against capacity. For context, an example of a unit cost curve developed by Houston is provided below. This example demonstrates a total of 14 historical cost estimates across a range of nameplate capacities from four through to 105kBPD. The subject unit is shown as the orange data point.

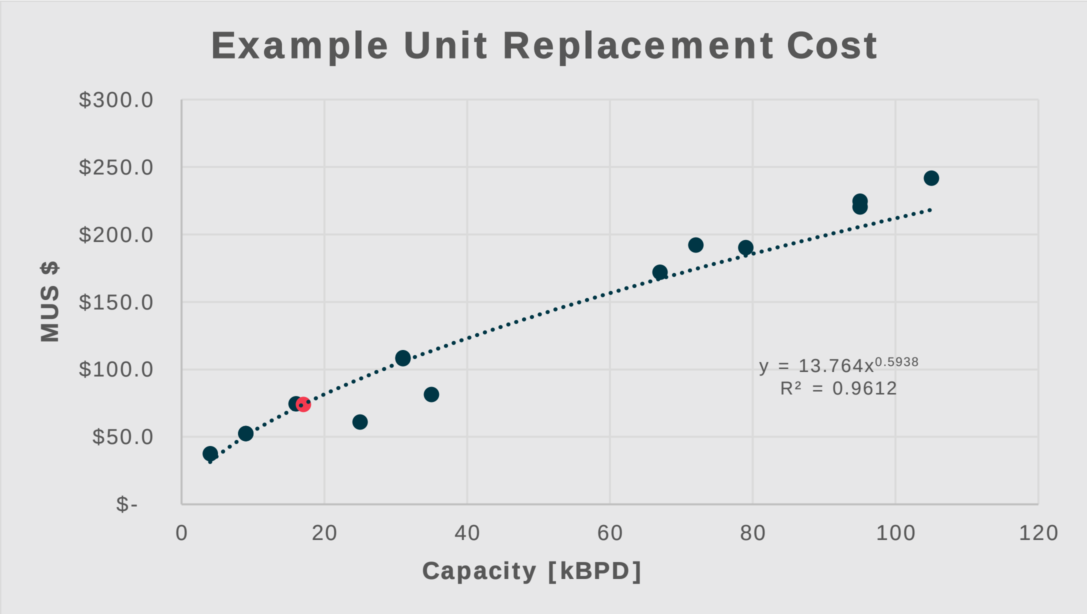


Figure 19: An example Cost Curve Developed by Worley Houston for one of the Key Refinery Process Units

Reference costs have been escalated and normalized for currency, base date, region and applicability to a United States Gulf Coast in 2024 United States dollars. Costs were scaled on process unit capacity using parametric methods.

Total costs were then broken down by material / equipment supply and installation by major commodity, based on historical ratios. Costs were then adjusted to the Marsden Point location, including identification of construction hours.

In total a new build cost by nameplate capacity was determined for 28 of the refining units utilizing a total of 181 reference projects.

7.3.3 Refining Units Equipment List Estimates

Many of the smaller auxiliary units are somewhat bespoke to Marsden Point in both equipment make-up and functionality. For these units a nameplate capacity is not representative, and an equipment list was used to determine a replacement cost of the unit.

The mechanical equipment list forms the basis for the Class 5 estimate, with the objective to achieve an estimate for new installation of the unit. Costs for other disciplines were factored off the mechanical equipment.

A detailed equipment list was developed by Engineering, identifying each piece of equipment, type of equipment, a key duty parameter, material of construction and where possible the equipment weight. The equipment weight is a key parameter to enable both equipment supply cost and installation field hours, as well as to develop bulk weights for other disciplines. Where engineering did not provide the weight, this was estimated using Worley's extensive international estimating database of weights for equipment of similar capacity.

Costing for equipment was based on Worley historical pricing, recent budget pricing, or cost curves, and based on either equipment duty (eg. USD$/kw) or weight (USD$/tonne).

Percentage bulking factors (Selexpress, Worley database) were then applied to the mechanical equipment weights to arrive at weights for structural, piping, electrical and instrument bulks. To develop cost for the disciplines unit USD$/t and shop and field manhours per tonne rates were applied to the bulk tonnages. "All in" shop and field rates per hour then applied in the estimate detailed breakdown for each item.

Site and shop productivity factors were also included in the detailed breakdown, along with a percentage allowance for freight.

Additional costs were included for insulation based on an indicative % of overall coverage provided by Engineering for each process unit and applied to estimated m2 of the various equipment items. An “all in” rate $/m2 was obtained from Worley database and applied to the estimated m2 in each case.

Concrete foundations were based on a ratio from other directs costs, based on similar units.

7.3.4 Refining Units Recommissioning Factors

From discussions with key Channel Infrastructure employees and an on-site review of the plant each unit was given a recommissioning category as defined in Table 16.

In addition, the equipment count for each unit was reviewed to determine the overall number of shell and tube heat exchangers installed within each unit which was used to determine an indicative percentage of equipment that would need to be replaced.

Each recommissioning category aligns with a standard set of recommissioning factors per commodity which were initially developed by Worley during the noted project in Trinidad and Tobago, these basecase factors are summarized in Table 17. Using engineering judgement an assessment was then completed to determine if the basecase factors were representative of the recommissioning scope for the unit. Factors were then tuned as required each unit.

Appendix D provides detail of percentage allowances applied at the unit level for each commodity based on the methodology outlined in this section.

Table 16: Recommissioning Categories

Recommissioning Category	Description
No Scope	The equipment has been reviewed and it is determined there would not be any scope required if the refining assets were to be recommissioned. In some cases, the recommissioning cost of the equipment is allowed for under other units.
Inspection, Recommission	The condition of the unit is relatively good, and no significant repairs or refurbishments are expected to meet the recommissioning premise. Inspect, recertify, and recommission the unit.
Inspection, Recommission, Minor Repairs	As above, except there is anticipated to be minor repairs required to bring the unit back to a serviceable state.
Moderate Repairs	There is expected to be significant repairs due to the age and condition of the unit.
Full Refurbishment	The age and condition of the equipment means a full refurbishment is likely to be required to meet the recommissioning premise.
Full Replacement	It is determined that it is not feasible to recommission the unit and a full replacement is required.

Table 17: Basecase Recommissioning Category Factors

Recommissioning Scope	Equipment	Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
No Scope	0%	0%	0%	0%	0%	0%	0%
Inspection, Recommission	3%	3%	3%	3%	3%	3%	3%
Inspection, Recommission, Minor Repairs	10%	5%	5%	15%	15%	20%	10%
Moderate Repair	30%	15%	20%	25%	25%	30%	15%

Recommissioning Scope	Equipment	Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
Full Refurbishment	40%	20%	40%	30%	30%	40%	20%
Full Replacement	100%	30%	100%	100%	100%	100%	100%

7.3.5 Tank Farm

A detailed list of tanks was developed by Engineering, identifying each tank by service, type (fixed dome roof/floating roof or spheres), size (diam x height), material of construction and where possible the tank weight.

Where engineering did not provide the tank weight, this was calculated by estimating using database weights for tanks of similar capacity.

Costing for tank construction was based on Worley historical pricing or recent budget pricing converted to weight (USD$/tonne).

Percentage bulking factors (Selexpress, Worley database) were then applied to the tank equipment weights to arrive at weights for structural, piping, electrical and instrument bulks.

Engineering also identified which tanks were insulated and contained heating elements.

Tanks Works have been divided into two cost centers;

- Area 1150 (Repair / Refurbishment / Recommission)
- Area 1150-1 (New Tank Installation)

In both of these cases the starting point has been using the tank equipment list information to generate a “new installation” cost for the tanks, including percentage allowance for other discipline bulks, based on the tank total weights.

For New Installation works, 100% of the cost has been included in the estimate, and for repairs, refurbishment and recommissioning of tanks the percentage of the new installation cost has been adjusted accordingly. These allowances are summarized in Table 18.

Table 18: Tank Recommissioning Category Factors

Recommissioning Scope	Tank	Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
No Scope	0%	0%	0%	0%	0%	0%	0%
Inspection, Recommission	3%	3%	3%	3%	3%	3%	3%
Repair	30%	20%	20%	30%	80%	30%	20%
Refurbish	50%	30%	30%	50%	80%	50%	30%
Replace	100%	30%	100%	100%	100%	100%	100%
Replace New Location	100%	100%	100%	100%	100%	100%	100%

A tabulation is provided in Appendix B which outlines refurbishment scope for each tank.

Insulation has been allowed based on percentage of coverage required for each given service type, applied to the tank surface area, at an average insulation rate of $2,75USD/m2.

7.3.6 New Tank Farm – Miscellaneous Items

Bunded Areas – New Tank Farm

The quantity of bunded areas (m2) for the new tank farm works was provided by Engineering.

A rate of 2.5 times the rate for bund upgrades was applied to the m2 of bunded areas to generate a cost estimate.

Miscellaneous – Pipe Sleepers

Pipe sleepers have been included for the new tank farm area, with 1400m of piperun at 4m sleeper spacing (350off), included in the estimate.

Miscellaneous – Storm Water Collection System

Storm Water piping (3000m x 600dia RCP) has been included for the new tank farm area.

Miscellaneous – Roads

New access roads have been included for the new tank farm area based on 2800m total length and average width of 6m.

Miscellaneous – Closed Drain System

A closed drain system of 1500m of 150NB CS piping has been included in the estimate, along with 2 off oily water sumps, pumps and separators.

Miscellaneous – Firewater Ring Main System

Allowance has been included for a 400NB CS fire ring main to be on concrete sleepers, aboveground, servicing the new tank farm area. Total length included 2800m including hydrants and hose reels.

7.3.7 Offplot Assets

Bund Upgrades – Existing Tank Bunded Areas

The quantity of bunded areas (m2) requiring upgrades as part of the tank return to service works, was provided by Engineering. In order to generate a cost estimate, return data from recent bund upgrades was used and converted into a rate / m2 of bunded area. This rate was applied to the m2 of bunded areas to generate a cost estimate.

As the starting point for the rates where return figures based on EPC costs, the estimates were back calculated to “direct cost” only, with the application of project indirect cost applied at a project level for this estimate.

Miscellaneous – Pipe Racks

Refurbish & Repair Racks – 2,700t of piperack is in varying states and many require structural repairs and painting. To facilitate repairs an allowance of 10% existing rate weight has been included for material supply and a repair crew of 20 trades for 6 months has been allocated for the on site works.

Repair Piping – A large number of lines have been “air gapped”, had “drain holes” drilled into the pipework at low point locations or been reconfigured for terminal operations. Provision has been made for a repair crew of 20 trades for 4 months to repair this pipework, including pressure testing of lines on completion.

New Pipe Racks / Pipebridge – Allowance for 575m of new piperack, and a 12m pipebridge has been included in the estimate, connection the new tank farm area to the plant.

Modify Pipe Racks – Add extra Tier – Allowance has been included to add an extra tier to existing 960m of piperack, with total estimated tonnage of 332t of new steelwork included in the estimate.

7.3.8 Actual Cost

For the SCOT (process unit 8750), Sulphur Handling (process unit 8800) and E-Block (process unit 7200), actual cost data was available and was used for the basis for new construction of these process units. The cost has been escalated and normalised for base date.

7.3.9 Semi Detailed

A portion of the process unit were estimated using a semi-detailed method from major quantities developed by the engineering team. In-house rates were applied to the key quantities. An example of this is the interconnecting piping and piperacks.

A similar approach was taken for the A-Block stack and Hot Gas Ducting as well as the Multiflue; with the basis being the detailed construction drawings. An assessment was made of the likely percentage of repairs required.

Flue Gas Ducting - Area 5000

The estimate for A - Block Furnaces - Flue Gas Ducting replacement and repairs, has been based on the photographs and drawings provided, with allowance for repairs or full replacement depending on the degree of deterioration identified. In each case the estimated repair allowance has been stipulated in each individual bill item.

Refractory repairs allowance has been included as a subcontract allowance and costed based on m2 of repairs applied at $4000/m3, for example 200mm thick refractory rate $4000/m3 x 0.2m thick refractory = $800/m2. Separate allowance has been included for replacement of refractory anchors.

Flare System – Area 3400

A detailed MTO for the flare system was developed Engineering from the engineering drawings and included tonnages and sizes for the flares, as well as the pipework and steelwork replacement scope. Flare interconnection piping has also been quantified separately. Costs for replacement flares has been estimated based on recent pricing, scaled to the project specific sizing. Pipework, electrical and instrumentation on the flare tower have been scaled based on percentage of the flare weight to provide tonnages for these scope items.

To develop costs for each discipline, unit USD$/t and shop and field manhours per tonne rates were applied to the bulk tonnages. “All in” shop and field rates per hour then applied in the estimate detailed breakdown for each item.

Site and shop productivity factors were also included in the detailed breakdown, along with a percentage allowance for freight. A height factor is included for work on the flare tower.

Interconnecting Unit Piping – Area 9900

A detailed piping MTO was provided by Engineering outlining the existing 211 interconnecting lines that would need to be recommissioned in the plant. These were identified by service, size, schedule, material of construction and total overall length. Lines that were traced either electrically or steam were nominated on the schedule, along with any lines requiring insulation. The MTO was converted into total pipe weight, including allowance for fittings. Pipe supports, and on / or inline instruments were allocated based on a percentage of the pipe weight.

To develop cost for each discipline, unit USD$/t and shop and field manhours per tonne rates were applied to the bulk tonnages. “All in” shop and field rates per hour then applied in the estimate detailed breakdown for each item.

Site and shop productivity factors were also included in the detailed breakdown, along with a percentage allowance for freight.

Recommissioning factors were then applied to the new build cost.

Multiflue Refractory Repairs – Area 9901

The quantities for the Multiflue were estimated based on the plot plan drawings, with an average size of 4.5m ducting considered.

The scope was estimated using the same method as that for the Fuel Gas Ducting in area 5000, however an allowance has also been made for ducting or insulation repairs or replacement as these are considered in serviceable condition. A percentage allowance has also been included for refractory repairs / replacement.

7.4 Estimating Allowances

The following estimating allowances were included as direct costs, to allow for scope not defined at this early project phase:

- Scaffolding: 10% of mechanical, piping and insulation direct construction hours (scaffolding already included for tanks and first principles estimates, such as ducting and flares).
- Site wide power distribution, upgrades, recommissioning: 12% of mechanical equipment cost (nominally NZD$2.5M per switch room).
- Site wide control system upgrades, recommissioning: 23% of mechanical equipment cost (nominally NZD$5M per equipment room assuming a revised architecture).

7.5 Installation costs

An all-in labour rate of NZD 230 per hour was used in the estimate. The all-in labour rate includes the cost of contractor blue collar labour and indirect costs (such as supervision, project management, personnel protective equipment, temporary facilities, mobile equipment, small tools, consumables, testing, home office costs, field running costs, profits and overheads).

Specific labour productivity factors have been applied for the estimate based on Greenfield or Brownfield works, factors or 1.6 and 2, respectively have been used. These factors are applied to base hourly norms where these are used in the estimate.

7.6 Common Indirect Costs

The common indirect costs are costs required to support a number of direct subcontracts and consist of temporary infrastructure and services which will be required to support the construction work. At this phase of the project, these costs are expressed as a percentage of direct costs and are based on historical data. Costs typically include:

- Development of laydown and hardstand compounds for sub contractor's, temporary parking.
- Temporary facilities for the EPCM contractor as required, common medical facilities, ablutions for sub contractor's etc., upgrades, expansion to existing as required.
- Common construction equipment, tools and supplies not included in contractor's scope (e.g. floodlights and generators, EPCM contractor's site vehicle, etc.). Heavy / high reach cranes outside of contractor's typical fleet.
- Site support services (e.g., geotechnical, topographic surveys, nurse, cleaners, etc.).
- Process plant process commissioning.
- Construction accommodation costs.
- R&R travel costs.

The following have been used in the estimate to make allowance for common indirect costs.

- Temporary construction facilities and site support and services: 3% of direct costs.
- Process plant pre-operational testing and commissioning: 2.5% of direct costs.
- Heavy / high reach cranes: 1% of direct costs

The following basis has been used for R&R travel, and accommodation costs:

- Construction duration thirty months.
- Construction of camp infrastructure at NZD$30,000 per bed
- Accommodation and meals cost assumed to be NZD$150 per person day.

7.7 Engineering, Project Services Costs

The capital cost estimate has been based on an assumed EPCM project delivery contracting strategy. As the project is still at the preliminary phase, costs for Project Management, Engineering, Procurement and Construction Management services are expressed as percentages and vary depending on the recommissioning scope. The percentages are applied to the respective recommissioning direct costs. Percentages applied are as follows:

Table 19: EPCM Services

Recommissioning Scope	Inspection	Engineering	Procurement	Construction Management	Project Management	Total Project Services
No Scope	0%	0%	0%	0%	0%	0%
Inspection, Recommission	3%	2%	0%	0%	3%	8%
Inspection, Recommission, Minor Repairs	3%	2%	0%	5%	7%	17%
Moderate Repair	3%	5%	3%	5%	7%	23%
Full Refurbishment	3%	7%	3%	5%	7%	25%
Refurbish	3%	7%	3%	5%	7%	25%
Repair	3%	5%	3%	5%	7%	23%
Replace	0%	10%	3%	7%	7%	27%
Replace New Location	0%	12%	3%	7%	7%	29%

An allowance of 5% of direct costs has also been included in the estimate to undertake a FEED for the project.

7.8 Contingency

For the total estimated value to represent the most likely outcome, an amount of contingency is indicated in the estimate to cover anticipated variances between the estimate and the final actual project cost. The contingency is added to the estimate to provide for unknown, risk-based items that cannot be estimated but are expected to occur. A contingency allowance of 20% has been applied to the total direct and indirect cost.

7.9 Owners Cost

Owners' costs has been included in the cost estimate at 5% of project cost.

This allowance is intended to cover the items listed in section 5.9 and the cost of the owner's team which would include:

- Employing an owner's team through the recommissioning project:
  - 150 - operations
  - 100 - maintenance
  - 60 - management and administration
  - 40 - laboratory
  - 24 - Owners Project Management Team

7.10 Exchange Rate Sensitivity

Estimate base currency is New Zealand Dollars with NZD$1 = USD$0.60, EUR€0.55, AUD$0.90 used for currency conversion of historical costs and benchmark information. The majority of reference plant costs are based on United States Dollars.

7.11 Key Qualifications and Assumptions

The following qualifications and assumptions were noted when preparing the estimate:

- Estimate base date is third quarter of 2024.
- Freight allowance has been included as a percentage of bulks or equipment procurement costs at 8% of estimate cost.
- Fabrication rates for offsite fabrication works have been allowed at $100NZD per hour.
- A Brownfield site productivity allowance has been included for remediation / repairs of existing facilities of 2.0. A Greenfields site productivity allowance has been included for the new tank farm area of 1.6.
- It is assumed that Weather conditions will not adversely impact productivity factor.
- It is assumed piping will be fabricated in a workshop and piping spools will be erected on site.
- A project or construction schedule has been developed to support this estimate. An overall construction period of 2 ½ years was considered at a high level, as a basis for determining camp sizing.
- Detail mobile cranage and rigging studies have not been undertaken at this early phase. Provision was included for heavy lift cranes as a percentage of direct cost. Smaller cranes up to 100t are deemed to be included in the "all in" field labour rates.
- A detailed Contract and Procurement plans have been developed as part of this estimate, the estimate is based on typical EPCM contract strategy.
- Cost estimate prepared assuming environmental, cultural heritage, statutory and regulatory approvals are in place.
- It is assumed that 30% of the construction workforce can be employed from the local area and so accommodation costs are not included for 30% of the estimated direct construction labor.
- Direct Labour rates are based on typical rates for similar project sites. The extended work week is nominally 56 hours, it is expected a typical R&R work cycle will be agreed for distant workers, considering the extended work week, however this does not impact the estimate at this early phase.
- Project delivery will not be constrained due to concurrent projects.
- Costs associated with vendor representatives on site during construction have been included at 3% of equipment cost.
- An allowance based on a percentage of equipment supply has been included for capital spares, operating spares and commissioning spares at 3% of equipment value.

- First fills included at 0.5% of equipment value except D and E Block where historical actual costs are included.
- Owner's cost includes an allowance to procure 1.450mil barrels of Crude Oil at an assumed rate of $90USD to facilitate commissioning the plant.

7.12 Exclusions

The following items were excluded from the capital cost estimate:

- No geotechnical investigations were undertaken.
- No formal logistics study has been undertaken.
- Variations to exchange rates other than those nominated in the estimate.
- No allowances for deferred capital costs.
- Finance and interest charges for project duration.
- No allowance for salvage value for any demolished equipment and materials.
- Any environmental requirement not identified in this estimate.
- Taxes other than import duties.
- No allowance for abnormal weather conditions.
- No allowance for presence of asbestos or for removal.
- Fire protection of steelwork or concrete encasement of structures.
- No provision has been included to remove lead paint, or associated encapsulation.
- No allowance has been made for soil remediation for any in situ contaminants if required.
- No allowance has been included for extended periods of industrial unrest.
- No allowance has been made for delay costs associated with obtaining statutory approvals.
- Sunk costs.
- Market forces and escalation.
- No allowance for cleaning and removing the demolished items from the site.
- Operating cost
- Carbon tax
- Cost and delay impact due to global pandemics
- Effect of concurrent projects on the availability of staffing, construction labour and materials
- The cost impact of world demand on commodities such as steel

Appendix A. Marsden Point Plot Plan & Overall Process Schematic

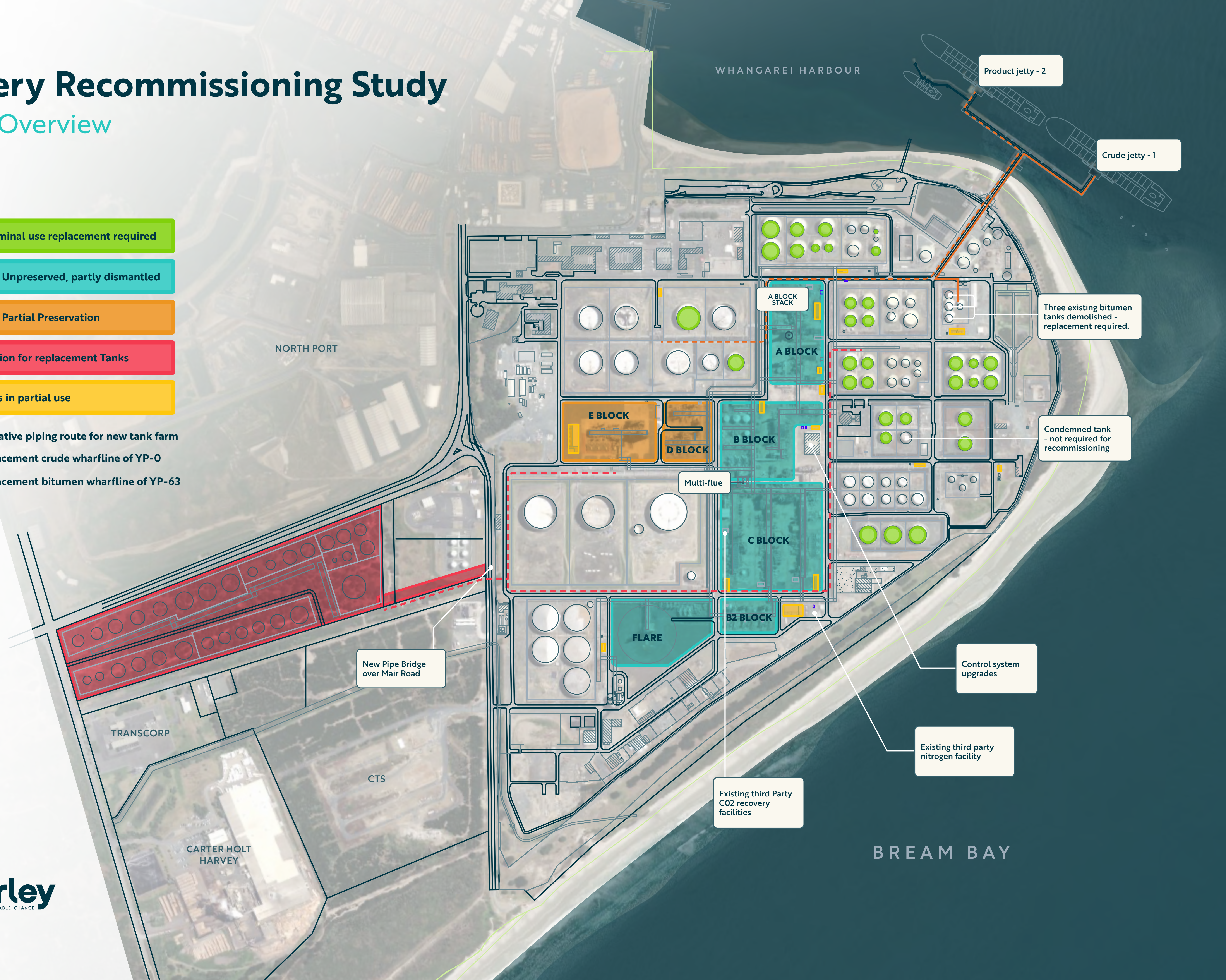
Recommissioning Study Facility Overview
T1590000

Refinery Recommissioning Study

Facility Overview

Key

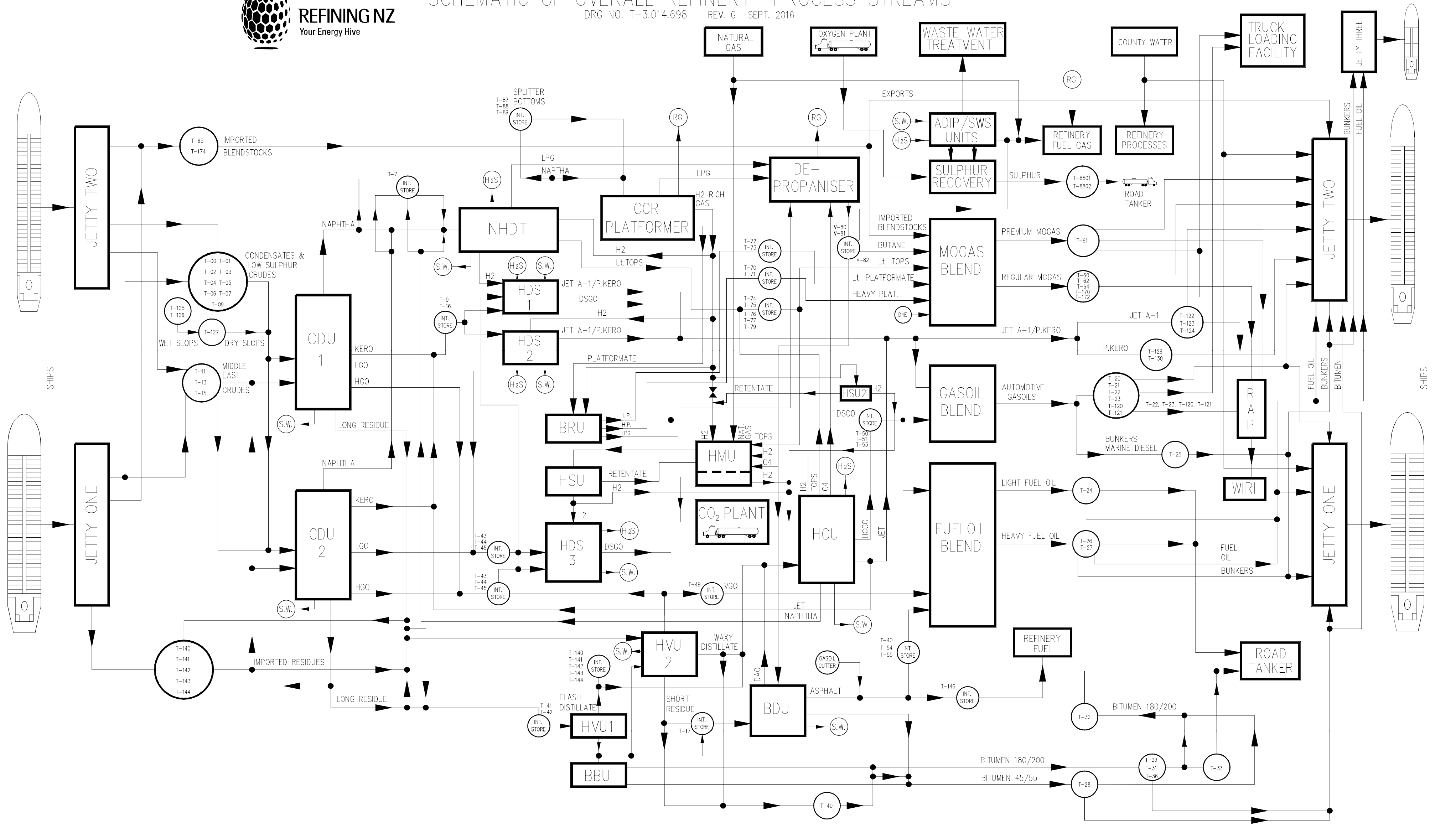
- Tank under terminal use replacement required
- Process Block - Unpreserved, partly dismantled
- Process Block - Partial Preservation
- Proposed location for replacement Tanks
- Site substations in partial use
- Indicative piping route for new tank farm
- Replacement crude wharfline of YP-0
- Replacement bitumen wharfline of YP-63



worley
DELIVERING SUSTAINABLE CHANGE

SCHEMATIC OF OVERALL REFINERY PROCESS STREAMS

DRG NO. T-3.014.698 REV. G SEPT. 2016



ADIP	–	GAS TREATING
BBU	–	BITUMEN BLOWING UNIT
BDU	–	BUTANE DEASPHALTING UNIT
BRU	–	BENZENE REMOVAL UNIT
CCR	–	CONTINUOUS CATALYST REGENERATION
CDU	–	CRUDE DISTILLER UNIT
DAO	–	DEASPHALTED OIL
DPK	–	DUAL PURPOSE KEROSENE
HCU	–	HYDROCRACKER UNIT
HCGO	–	HYDROCRACKED GAS-OIL
HDS	–	HYDRO-DESULPHURISER
HDT	–	HYDRO-TREATING
HGO	–	HEAVY GAS-OIL
HMU	–	HYDROGEN MANUFACTURING UNIT
HSU	–	HYDROGEN SEPARATION UNIT
HVU	–	HIGH VACUUM UNIT
INT. STORE	–	INTERMEDIATE STORAGE
LGO	–	LIGHT GAS-OIL
RAP	–	REFINERY AUCKLAND PIPELINE
VGO	–	VACUUM GAS-OIL

Ref Drawings

Rev	Drawn	Chkd	Eng	Description	Appr	Date
G	JPR	MEG		UPDATED AS-BUILT	J.G	09.16
F	MEG	DM		UPDATED FOR INFORMATION	AC	10.05

REFINING NZ
Your Energy Hive

Title
SCHEMATIC OF OVERALL REFINERY PROCESS STREAMS

Contrs No			Refining NZ Drg No T3014698	
Req No			Key Area	
Scale				
Project No N/A	Unit 1150	Lead No 106	Sht 1	Rev G

Appendix B. Total List of Refining Units

Study Work Breakdown Structure and Categorised Recommissioning Scope

Table 20: Unit Scope, Estimating Method

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
Asset North							
A	150	Crude Distiller Unit No. 1	1960/ 2009	*Crude - 13,000 T/d*	Significant upgrades completed under the point forward project in 2009 however, there is still significant amount of 1960's equipment that would require repairs and refurbishments required to recertify and provide an acceptable operable life. Approximately, 20% of unit equipment count is Shell & tube heat exchangers. All Instrument and Electrical Cables have been cut and most shell and tube heat exchangers have been disassembled and components sent for recycling. CUI Issues likely in hot sections of unit.	**Moderate Repairs**	**Nameplate Capacity**
A	250 & 800	Naphtha Hydrotreater & ADIP Unit No. 1	1960/ 2009	*Naphtha - 2000 T/d*	Unit is a mix of original 1960's, 1980's and 2009 (Point Forward) equipment. All Instrument and Electrical Cables have been cut and most shell and tube heat exchangers have been disassembled and components sent for recycling. Approximately, 25% of unit equipment count is Shell & tube heat exchangers. Replacement catalyst for R251 required.	**Moderate Repairs**	**Nameplate Capacity**
A	350	Gas Oil Hydrodesulphuriser	1960		Unit was mothballed at time of closure. Study assumed this would remain mothballed.	**No Scope**	**N/A**
A	650	High Vacuum Unit No. 1/Bitumen Blowing	1960	*Long residue - 1100 t/d*	Only unit remaining entirely from the 1960's. It is deemed unfeasible to recommission and a full replacement is required to maintain bitumen production. Assumed minor civil/foundations modifications only.	**Full Replacement**	**Nameplate Capacity**
A	700	Hot Oil System	2009	-	Most of the equipment was installed during Point Forward circa 2009. All Instrument and Electrical Cables have been cut and most shell and tube heat exchangers have been disassembled and components sent for recycling. The stand-alone furnace currently does not have a rain lid over the stack. Refractory issues likely and there is potential for corrosion between the refractory and furnace shell. All Instrument and Electrical Cables have been cut and most shell and tube heat exchangers have been disassembled and components sent for recycling.	**Inspection, Recommission, Minor Repairs**	**Equipment List**
A	5000	A-Block Stack & Hot Ducts	1960	-	The A-block stack is a 100m tall flue gas chimney for the A-Block furnaces, the stack was originally built with the original plant in 1960's.	**Moderate Repairs**	**Semi Detailed**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
					The concrete stack was suffering from external concrete spalling but was recently wrapped with carbon fibre. The refinery was decommissioned for some time before a rain lid was installed and therefore refractory repairs are inevitable. The hot gas flue ducts were suffering from severe corrosion and failure of the internal refractory, they will require replacement.		
B	5100	Crude Distiller Unit No. 2	1986	*Crude - 5750 T/day*	The main distillation column had the top section replaced in 2018. Production from this unit was ceased more than a year prior to the other units. All Instrument and Electrical Cables have been cut and most shell and tube heat exchangers have been disassembled and components sent for recycling. Approximately, 25% of unit equipment count is Shell & tube heat exchangers.	**Moderate Repair**	**Nameplate Capacity**
B	5500 & 5600	Kerosene Hydrodesulphuriser & ADIP Unit No. 2	1986	*Kero - 1850T/day*	Reactors will require replacement catalyst. All Instrument and Electrical Cables have been cut and most shell and tube heat exchangers have been disassembled and components sent for recycling. Approximately, 25% of unit equipment count is Shell & tube heat exchangers. ADIP Unit No2 used to treated sour gas from 5500 unit.	**Moderate Repair**	**Nameplate Capacity**
B	8900	Depropaniser	1986	*Sour LPG - 534.7T/day*	Equipment is in a condition similar to the rest of B Block. Electrical and Instrument cables have all been cut. Very limited number of shell & tube heat exchangers.	**Moderate Repair**	**Nameplate Capacity**
B	8930	ADIP Unit No. 6	1986	-	Small ADIP unit used to treat sour gas from the Depropaniser. Equipment is in a condition similar to the rest of B Block. Electrical and Instrument cables have all been cut. Very limited number of shell & tube heat exchangers	**Moderate Repair**	**Equipment List**
B	9100	Steam Generation/Expansion	1986	*Steam production – 1950T/day per Boiler plus Waste*	The three main utility boilers were installed in the 80's and were designed to be housed within a boiler house although the building was never built. Boiler replacements are required. All instrument and electrical cables have been cut. Significant CUI issues should be expected.	**Replacement of Boilers & Full Refurbishment**	**Equipment List**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
				Heat boilers			
B	9150	Condensate System	1986	-	Significant CUI issues should be expected. Shell and tube heat exchangers are mainly still installed. All instrument and electrical cables have been cut.	**Moderate Repair**	**Equipment List**
B	9200	Boiler Feedwater	1986	*BFW – 9510 T/d*	Significant CUI issues should be expected. Shell and tube heat exchangers are mainly still installed. All instrument and electrical cables have been cut.	**Moderate Repair**	**Equipment List**
B	9300	Fresh Water Supply/Treatment	Various	-	In service for terminal operations, no scope required if recommissioning is to proceed.	**No Scope**	**N/A**
B	9350	Industrial Water	Various	-	In service for terminal operations, no scope required if recommissioning is to proceed.	**No Scope**	**N/A**
B	9400	Fresh Cooling Water System	1986	*Water circulation – 43 kT/d*	This system was operational past decommissioning of plant. Cables are still in installed. Underground sections of lines require inspection.	**Inspect, Recommission**	**Nameplate Capacity**
B	9430	Gland Cooling Water System	1986	-	As per 9400 unit.	**Inspect, Recommission**	**Equipment List**
B	9500	Asphalt Burning System,	1986	-	Small furnace observed to be completely open to elements, water damage to refractory likely and degradation of tubes. Open piping observed to have contain moderate amounts of solidified asphalt. CUI issues likely.	**Full Refurbishment**	**Equipment List**
B	9520 / 2550	Fuel Oil System	1986	-	Unit predominately consist of a piping distribution network with a few pumps and a couple of exchangers.	**Moderate Repair**	**Equipment List**
B	9600	Fuel Gas System	1986	-	Unit predominately consist of a piping distribution network with a few pumps and a couple of exchangers.	**Moderate Repair**	**Equipment List**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
B	9700 / 9750 / 2650	Instrument Air / Plant Air System	1986	*K9701A/B /C - 321 t/d*	Existing larger air compressors have been decommissioned and the system has been reconfigured for smaller air compressors to support terminal operations.	**Moderate Repair**	**Equipment List**
B	9850	Miscellaneous chemicals	1986		Partly still in service with A-Block Equipment servicing requirements for the terminal operation.	**Inspect, Recommission, Minor Repairs**	**Equipment List**
D	5400	Benzene Removal Unit	2005	*Platformate – 2900 mt/day2*	Unit purged with nitrogen. Power and Instrument Cables in tack. Exchangers are still assembled and complete. Equipment factor to be increased to cover cost of replacement Catalyst.	**Inspect, Recommission, Minor Repairs**	**Nameplate Capacity**
D	5700	Hydrogen Separation Unit	2005	*Hydrogen Production 28.37 mmscf/day*	Unit purged with nitrogen. Power and Instrument Cables in tack. Exchangers are still assembled and complete. Equipment factor to be increased to cover cost of replacement membranes.	**Inspect, Recommission, Minor Repairs**	**Nameplate Capacity**
D	5800 / 5900	Gas Oil Hydrodesulphuriser 3 / ADIP Unit No. 8	2005	*Gas Oil - 3600 T/day*	Unit purged with nitrogen. Power and Instrument Cables in tack. Exchangers are still assembled and complete. Equipment factor to be increased to cover cost of replacement Catalyst.	**Inspect, Recommission, Minor Repairs**	**Nameplate Capacity**
E	7200 / 7300	CCR / HSU2	2016	*Heavy Naphtha feed – 3500 T/day*	Units were commissioned in 2015. Units are under nitrogen purge. Power and Instrument Cables in tack. Exchangers are still assembled and complete. Equipment factor to be increased to cover cost of replacement Catalyst (significant volume required).	**Inspect, Recommission**	**Actual Cost**
Asset South							

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
C	6100	HVU II (High Vacuum Unit)	1986	*Heavy Condensates - 5600 t/d*	Main vacuum column C6101 underwent significant refurb in 2018. Unit includes significant amount of insulated equipment CUI likely to be an issue. Cables have all been cut and approximately 25% of the equipment was shell & tube heat exchangers.	**Moderate Repair**	**Nameplate Capacity**
C	6500	BDU (Butane Deasphalting)	1986	*Short residue - 2600t/day*	Unit includes significant amount of insulated equipment CUI likely to be an issue. Significant amount of heat exchangers (25%). Cables have all been cut.	**Moderate Repair**	**Nameplate Capacity**
C	7100 / 7150	HMU (Steam Reforming Hydrogen Manufacturing Unit)	1986	*Hydrogen Production - 59.03mmsf/d*	One reactor replacement is required while the other reactors are currently under a nitrogen purge. The main reformer is not preserved and would likely require refurbishment. Approximately 25% of equipment is Shell and Tube Heat exchangers which partly disassembled with components sent for recycling.	**Moderate Repair**	**Nameplate Capacity**
		ADIP-X Unit CO_2 Recovery	1986	*Lean AMINE to C7106: 11800 t/d*	This section of the 7100 unit is currently under preservation. Utilised cost data for an AMINE Recovery unit, the cables in this portion of the unit have been cut.	**Inspect, Recommission, Minor Repairs**	**Nameplate Capacity**
C	7500 / 7600 / 7650 / 7800 / 7830 / 7860	HCU and Fractionation Section / HCU steam generation / / ADIP unit No3, 4 & 5	1986	*7500 Liquid feed – 4700 T/d*	Hydrocracker complex, significant amount of equipment, currently no preservation. Large quantity of Stainless-Steel materials, large high integrity rotating equipment. Approximately 20% of the equipment is shell and tube heat exchangers. Significant amount of high integrity safety systems given the high-pressure nature. All cables have been cut.	**Moderate Repair**	**Nameplate Capacity**
C	7700	HCU tops treater	1986	-	Unit was mothballed at the time closure, no scope required.	**No Scope**	**N/A**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
C	HC-9901	C-Block Multiflue	1986		The multiflued is a 120m tall flue gas stack which contains four individual flues with the following diameters, two times 4.1m, one times 4.15 and one times 1.8m. The stack openings have recently had a rain shield installed, however, water ingress in the period prior is likely to have caused damage to the internal refractory likely in low points on the ducts.	**Moderate Repair**	**Semi Detailed**
Asset Offplots							
OP	1150	Tankage	Various	-	See Appendix C	See Appendix C	**Semi Detailed**
OP	1200	Natural Gas	-	-	Unit covers single pipeline from FirstGas supply to the 9600 Unit. Recommissioning scope inside Marsden point battery limits is insignificant.	**No Scope**	**N/A**
OP	1300	Truck Loading Facility	Various	-	Unit is currently in use and is assumed not to require any modifications if the refinery was to be recommissioned.	**No Scope**	**N/A**
OP	1700	RAP	1980's	-	The RAP is currently a fundamental part of the Terminal operations. No scope assumed for refinery recommissioning.	**No Scope**	**N/A**
OP	2750	Fire Protection	Various	-	On the basis the Refinery Emergency Services teams will be reinstated the scope for the Fire Protection system is limited to minor piping modifications to reinstate any disconnected or permanently isolated sections. Cost of repairs is negligible.	**No Scope**	**N/A**
OP	3400	Flare and relief system	Various	-	Significant repairs required on two of the three elevated flare sections. All collection piping will need to be inspected and the opportunity should be taken to complete fabricate maintenance on the flare structure. Flare train vessels had the potential for Hydrogen Induced Cracking and are of a significant size.	**Full Refurbishment**	**Equipment List**
OP	3650	Slops and Offgrade	Various	-	Unit is currently operational no scope for Recommissioning. New slops tanks are required in the new tank farm these, and the associated piping tie-ins included under the Unit 1150 scope.	**No Scope**	**N/A**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
OP	3750	Loading and Jetty	Various	*N/A*	Scope assumed to be on jetty only, scope for connecting yard piping is covered under unit 9900. New 24" YP-0 crude import wharfline required, new 6" Bitumen wharfline required. New 10" Crude loading hose required, assumed jetty one gantry could be modified to accommodate additional hose. Replace two existing crude loading hoses and recommission existing decommissioned piping. Marine environment will reduce productivity as well as simultaneous operations with terminal product ships.	**Modifications and Repairs**	**Semi Detailed**
OP	3800	Sludge handling system	Various	*wet sludge feed – 120 T/d*	Unit is currently operational no scope for Recommissioning.	**No Scope**	**N/A**
OP	3900	EWT (effluent water treatment)	Various	*water to treatment unit – 3300 T/d*	Unit is currently operational no scope for Recommissioning however, the Bio treater is planned to be decommissioned, if this is to be differed Tanks T3901/2 and T90 will require recertification, this is estimated under unit 1150.	**No Scope**	**N/A**
OP	9800	N2	Various	*N/A*	The Nitrogen unit consists of a network of supply piping, all of which was operational mid-August 2024. Contracts for Nitrogen supply would need to be renegotiated.	**No Scope**	**N/A**
OP	9820	Flushing and Seal oil system	Various	*N/A*	Tankage covered under unit 1150. Supply piping and pumps will require refurbishment.	**Full Refurbishment**	**Equipment List**
OP	9900	Interconnecting Piping	Various	*N/A*	Piping between bocks and units, this cross-plot piping runs on a number of pipe racks which were assumed to be included within this unit. Piperacks were suffering from corrosion particularly around the secondary and tertiary member connections. Recertification and repair of piping and piperacks required. CUI Issues likely.	**Moderate Repair**	**Semi Detailed**
B2	8100	SWS 1 - Sour Water Stripper	1986		Given the high concentrations H2S and proximity to the ocean B2 block was suffering from increased corrosion compared to the rest of the plant. All Cables have been cut and heat exchangers disassembled with components recycled.	**Full Refurbishment**	**Equipment List**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
					CUI Issues likely.		
B2	8200	SWS 2	1986		Given the high concentrations H2S and proximity to the ocean B2 Block was suffering from increased corrosion compared to the rest of the plant. All Cables have been cut and heat exchangers disassembled with components recycled. CUI Issues likely.	**Full Refurbishment**	**Equipment List**
B2	8300	ADIP Regen 1	1986	*Rich ADIP solution – 1243 T/d*	Given the high concentrations H2S and proximity to the ocean B2 Block was suffering from increased corrosion compared to the rest of the plant. All Cables have been cut and heat exchangers disassembled with components recycled. CUI Issues likely.	**Full Refurbishment**	**Nameplate Capacity**
B2	8400	ADIP Regen 2	1986	*Rich ADIP solution - 2582 T/d*	Given the high concentrations H2S and proximity to the ocean B2 Block was suffering from increased corrosion compared to the rest of the plant. All Cables have been cut and heat exchangers disassembled with components recycled. CUI Issues likely.	**Full Refurbishment**	**Nameplate Capacity**
B2	8500	SRU 1 (Sulphur Recovery Unit)	1986	*Sulphur Production - 53.4 T/d*	Given the high concentrations H2S and proximity to the ocean B2 Block was suffering from increased corrosion compared to the rest of the plant. All Cables have been cut and heat exchangers disassembled with components recycled. CUI Issues likely.	**Full Refurbishment**	**Nameplate Capacity**
B2	8600	SRU 2	1986	*Sulphur Production - 53.4 T/d*	Given the high concentrations H2S and proximity to the ocean B2 Block was suffering from increased corrosion compared to the rest of the plant. All Cables have been cut and heat exchangers disassembled with components recycled. CUI Issues likely.	**Full Refurbishment**	**Nameplate Capacity**
B2	8700	SRU 3	1986	*Sulphur Production - 53.4 T/d*	Main furnace / exchanger vessel was replaced in 2017. Unit category downgraded to Moderate Repair from rest of B2.	**Moderate Repair**	**Nameplate Capacity**
B2	8750	SCOT (Shell Claus Off-gas Treating)	1994		This unit is approximately 10 years newer than the rest of B2 block.	**Moderate Repair**	**Actual Cost**

Block & Unit		Title and Indicative Age		Nameplate Capacity	Study Comments	Determined Recommissioning Category	Estimating Method
B2	8800	Sulphur handling (Sulphur Pastelle plant)	2019		This unit was newly installed in 2019 and solidifies molten sulphur into small prills. Recommissioning scope is limited to operational checks and start-up processes.	**Inspection, Recommission**	**Actual Cost**

Appendix C. Total List of Marsden Point Tanks

Unit 1150

Table 21: Primary Tanks included under Unit 1150

Tank	Tank Size			Tank Type	Tank Compound	Bund Upgrade Status	Insulated & Heated (Y/N)	Current Status	Certification Expiry Date (2022 Data)	Current Remaining Certification (Yrs)	Refinery Recommissioning Scope
	Volume (m3)	Height (m)	Diameter (m)								
BITUMEN											
T33	253	5	10	Fixed Roof	N/A	No bund required	Y	Decommissioned	4/10/2028	4	**Refurbish**
T32	253	5	10	Fixed Roof	N/A	No bund required	Y	Decommissioned	6/11/2034	10	**Inspection, Recommission**
T28	3303	12	20	Fixed Roof	N/A	No bund required	Y	Demolished	-	-	**Replace Same Location**
T36	3291	12	20	Fixed Roof	N/A	No bund required	Y	Demolished	-	-	**Replace Same Location**
T29	3288	12	20	Fixed Roof	N/A	No bund required	Y	Demolished	-	-	**Replace Same Location**
T31	1388	9	15	Fixed Roof	N/A	No bund required	Y	Demolished	-	-	**Replace Same Location**
CRUDE											
T04	32094	18	50	External Floating Roof	C3	New Compound		Terminal Service - Jet A1	-		**Replace New Location**
T15	74652	23	67	External Floating Roof	C7	Required		Decommissioned	5/12/2021	-2	**Refurbish**
T02	32038	18	50	External Floating Roof	C1	Required		Decommissioned	12/12/2021	-2	**Refurbish**
T05	32131	18	50	External Floating Roof	C4	In Progress		Decommissioned	31/12/2021	-2	**Refurbish**
T00	32075	18	50	External Floating Roof	C1	Required	Y	Decommissioned	28/02/2023	-1	**Refurbish**
T01	32131	18	50	External Floating Roof	C2	Required	Y	Decommissioned	-	0	**Refurbish**
T06	32056	18	50	External Floating Roof	C3	Complete		Decommissioned	1/09/2025	1	**Refurbish**
T11	74617	23	67	External Floating Roof	C8	Required		Decommissioned	25/05/2026	2	**Refurbish**
T03	32075	18	50	External Floating Roof	C2	Required		Decommissioned	3/04/2028	4	**Refurbish**
T13	91040	22	75	External Floating Roof	C9	Required		Decommissioned	13/05/2034	10	**Inspection, Recommission**
DEBALLAST											
T92	5746	13	25	Fixed Roof	N/A	N/A		Decommissioned	8/03/2022	-2	**Refurbish**
T90	5641	13	25	Fixed Roof	N/A	N/A		Decommissioned	19/12/2023	0	**Refurbish**
FINISHED & MOGAS BLEND											
T64	11616	18	30	External Floating Roof	P10	New Compound		Terminal Service	-		**Replace New Location**
T170	17798	20	35	External Floating Roof	P13	New Compound		Terminal Service	-		**Replace New Location**
T62	7654	17	25	External Floating Roof	P9	New Compound		Terminal Service	-		**Replace New Location**
T61	8070	18	25	External Floating Roof	P9	New Compound		Terminal Service	-		**Replace New Location**
T174	17798	20	35	External Floating Roof	P13	New Compound		Terminal Service	-		**Replace New Location**
T172	17798	20	35	External Floating Roof	P13	New Compound		Terminal Service	-		**Replace New Location**
T65	11149	17	30	External Floating Roof	P10	New Compound		Terminal Service	-		**Replace New Location**
T60	11724	18	30	External Floating Roof	P9	New Compound		Terminal Service	-		**Replace New Location**
FINISHED AGO											
T23	6524	15	25	Fixed Roof	P4	New Compound		Terminal Service	-		**Replace New Location**
T22	8191	18	25	Fixed Roof	P4	New Compound		Terminal Service	-		**Replace New Location**

Tank	Tank Size			Tank Type	Tank Compound	Bund Upgrade Status	Insulated & Heated (Y/N)	Current Status	Certification Expiry Date (2022 Data)	Current Remaining Certification (Yrs)	Refinery Recommissioning Scope
	Volume (m3)	Height (m)	Diameter (m)								
T20	6557	15	25	Fixed Roof	P4	New Compound		Terminal Service	-		**Replace New Location**
T21	6547	15	25	Fixed Roof	P4	New Compound		Terminal Service	-		**Replace New Location**
T120	18352	21	35	Fixed Roof	P1	New Compound		Terminal Service	-		**Replace New Location**
T55	11858	18	30	Fixed Roof	P8	New Compound		Terminal Service	-		**Replace New Location**
Flushing Oil											
T49	2683	17	15	Fixed Roof	P7	Required		Decommissioned	1/11/2025	1	**Refurbish**
T48	1729	24	10	Fixed Roof	P7	Required		Decommissioned	18/09/2034	10	**Inspection, Recommission**
FUEL OIL & CUT BACK ASPHALT											
T24	8051	18	25	Fixed Roof	P5	Required		Decommissioned	30/10/2032	8	**Inspection, Recommission**
T26	4968	17	20	Fixed Roof	P5	Required		Decommissioned	6/12/2033	10	**Inspection, Recommission**
T42	7570	17	25	Fixed Roof	P6	New Compound	Y	Terminal Service - VLSFO	-		**Replace New Location**
T41	12114	19	30	Fixed Roof	P6	New Compound	Y	Terminal Service - VLSFO	-		**Replace New Location**
T54	11851	18	30	Fixed Roof	P8	New Compound		Terminal Service - Diesel	-		**Replace New Location**
T40	11623	18	30	Fixed Roof	P6	New Compound	Y	Terminal Service - VLSFO	-		**Replace New Location**
T27	11754	18	30	Fixed Roof	P5	Required		Decommissioned	27/08/2022	-2	**Repair**
T25	3714	23	15	Fixed Roof	P5	Required		Decommissioned	23/07/2025	1	**Repair**
HIGH SULPHUR GASOIL COMPONANT											
T43	7564	17	25	Fixed Roof	P6	Required		Decommissioned	10/12/2024	1	**Repair**
T44	4796	17	20	Fixed Roof	P7	Required		Decommissioned	12/12/2022	-1	**Repair**
T46	3673	22	15	Fixed Roof	P7	Required		Decommissioned	17/08/2026	2	**Repair**
T47	3659	22	15	Fixed Roof	P7	Required		Decommissioned	16/12/2026	3	**Repair**
T45	4793	17	20	Fixed Roof	P7	Required		Decommissioned	5/06/2034	10	**Inspection, Recommission**
JET & PREMIUM KERO											
T129	3999	14	20	Fixed Roof	P2	New Compound		Terminal Service	-		**Replace New Location**
T122	12257	19	30	Fixed Roof	P2	New Compound		Terminal Service	-		**Replace New Location**
T123	12239	19	30	Fixed Roof	P2	New Compound		Terminal Service	-		**Replace New Location**
T130	3999	14	20	Fixed Roof	P2	New Compound		Terminal Service	-		**Replace New Location**
T124	12235	19	30	Fixed Roof	P2	New Compound		Terminal Service	-		**Replace New Location**
T121	18363	21	35	Fixed Roof	P1	New Compound		Terminal Service	-		**Replace New Location**
LONG RESIDUE											
T141	41421	19	55	Fixed Roof	T140s	Required	Y	Decommissioned	1/11/2021	-3	**Refurbish**
T144	41411	19	55	Fixed Roof	T140s	Required	Y	Decommissioned	-	0	**Refurbish**
T142	41345	19	55	Fixed Roof	T140s	Required	Y	Decommissioned	-	0	**Refurbish**
T140	41495	19	55	Fixed Roof	T140s	Required	Y	Decommissioned	1/11/2027	3	**Refurbish**
T143	41489	19	55	Fixed Roof	T140s	Required	Y	Decommissioned	24/04/2033	9	**Inspection, Recommission**
LOW SULPHUR GASOIL COMPONENT											
T50	11837	18	30	Fixed Roof	P8	New Compound		Terminal Service	-		**Replace New Location**
T51	11847	18	30	Fixed Roof	P8	New Compound		Terminal Service	-		**Replace New Location**
T52	4986	17	20	Fixed Roof	P8	New Compound		Terminal Service	-		**Replace New Location**

Tank	Tank Size			Tank Type	Tank Compound	Bund Upgrade Status	Insulated & Heated (Y/N)	Current Status	Certification Expiry Date (2022 Data)	Current Remaining Certification (Yrs)	Refinery Recommissioning Scope
	Volume (m3)	Height (m)	Diameter (m)								
T53	4986	17	20	Fixed Roof	P8	New Compound		Terminal Service	-		**Replace New Location**
MOGAS COMPONENT											
T71	8149	18	25	External Floating Roof	P11	Required		Decommissioned	12/02/2023	-1	**Repair**
T73	6473	15	25	External Floating Roof	P11	Required		Decommissioned	20/11/2023	-1	**Repair**
T74	4165	15	20	External Floating Roof	P12	Required		Decommissioned	OOS	0	**Repair**
T70	8149	18	25	External Floating Roof	P11	Required		Decommissioned	27/10/2024	0	**Repair**
T72	6557	15	25	External Floating Roof	P11	Required		Decommissioned	1/03/2025	1	**Repair**
T77	4691	16	20	External Floating Roof	P12	Required		Decommissioned	15/04/2026	2	**Repair**
T76	4713	17	20	External Floating Roof	P12	Required		Decommissioned	14/10/2026	2	**Repair**
T79	8116	18	25	External Floating Roof	P12	Required		Decommissioned	9/08/2028	4	**Repair**
T75	4165	15	20	External Floating Roof	P12	Required		Decommissioned	19/09/2034	10	**Inspection, Recommission**
NAPTHA / KERO											
T07	15114	17	35	External Floating Roof	C4	In Progress		Decommissioned	20/08/2027	3	**Repair**
T16	4697	16	20	External Floating Roof	C9	Required		Decommissioned	7/04/2035	11	**Inspection, Recommission**
T09	15125	17	35	External Floating Roof	C4	New Compound		Terminal Service	-	-	**Replace New Location**
PLATFORMER FEED											
T88	3652	13	20	Fixed Roof	P3	Required		Decommissioned	13/04/2022	-2	**Refurbish**
T89	7380	17	25	Fixed Roof	P3	Required		Decommissioned	29/03/2033	9	**Inspection, Recommission**
T87	3653	13	20	Fixed Roof	P3	Required		Decommissioned	12/2024	0	**Refurbish**
SHORT RESIDUE											
T17	4056	19	17	Fixed Roof	T17	Required	Y	Decommissioned	29/10/2024	0	**Refurbish**
SLOPS											
T125	620	9	10	Fixed Roof	P3	New Tank		Terminal Service	N/A		**N/A**
T127	4875	17	20	External Floating Roof	P3	New Tank		Terminal Service	N/A		**N/A**
T126	620	9	10	Fixed Roof	P3	Required		Decommissioned	17/12/2024	1	**Refurbish**

Table 22: Miscellaneous Tanks included under Unit 1150

Tank	Tank Size			Additional Info	Certification Expiry Date (2022 Data)	Current Remaining Certification (Yrs)	Refinery Recommissioning Scope
	Volume (m3)	Height (m)	Diameter (m)				
T1712A	-	-	-	RAP CORROSION INHIBITOR	15/08/2026	2	**No Scope**
T1712B	-	-	-	RAP CORROSION INHIBITOR	7/08/2026	2	**No Scope**
T3802	600			SLUDGE BUFFER TANK - Plan to Decom 2025	30/10/2034	10	**No Scope**
T3803	TBC			CENTRIFUGE EFFLUENT BASIN TANK	30/10/2030	6	**No Scope**
T3902	4920	17	20	HOMOGENISATION TANK - Plan to Decom 2025	19/02/2024	0	**Refurbish**
T3901	2740	17	15	OFFGRADE WATER TANK - Plan to Decom 2025	5/12/2024	1	**Refurbish**
T8802	600			SULPHUR DISPATCH TANK	8/10/2022	-2	**Refurbish**

Tank	Volume (m3)	Tank Size Height (m)	Diameter (m)	Additional Info	Certification Expiry Date (2022 Data)	Current Remaining Certification (Yrs)	Refinery **Recommissioning Scope**
T8401	7.1	1	3.6	ADIP MAKE-UP TANK - Located within 8400 unit. Recommissioning scope allowed under unit 8400 cost	N/A	N/A	**UNIT 8400**
T3651	11			HYDROCARBON RECOVERY HOT BOX	10/10/2026	2	**Refurbish**
T8301	5			ADIP MAKE-UP TANK - Located within 8300 unit. Recommissioning scope allowed elsewhere	N/A	N/A	**UNIT 8300**
T8302	100			ADIP STORAGE TANK	2/12/2029	6	**Repair**
V80	8		15	Butane Spheres	-	-	**Repair**
V81	8		15	Butane Spheres	-	-	**Repair**
V82	8		15	Butane Spheres	-	-	**Repair**
T106	45	4	5	Stadis (Anti Static Additive Kerosene Diluted)	12/12/2027	4	**Refurbish**
T1771	-			IPS2 OIL SUMP - below ground fibreglass tanks	8/06/2025	1	**No Scope**
T1761	56			IPS1 OIL SUMP - below ground fibreglass tanks	11/06/2025	1	**No Scope**
T154	113			Lubricity Improver (diluted in kerosene)	1/11/2026	2	**Repair**
T151	61			CFPP Improver (diluted in kerosene)	4/12/2029	6	**Repair**
T1616	2			MOGAS YELLOW DYE INJECT.TANK	25/11/2030	6	**No Scope**
T1615	2			MOGAS RED DYE INJECTION TANK	25/01/2031	7	**No Scope**
T8801	600			SULPHUR DISPATCH TANK	-	-	**Refurbish**
T9301	1280			FRESH WATER STORAGE TANK (Investigate Tank Lining)	1/10/2021	-3	**Refurbish**
T9201A	2500			BFW Tank			**Refurbish**
T9853	TBC			Fresh Caustic Tank - Plan to Decom 2025	28/06/2022	-2	**Refurbish**
T9201B	2500			BFW Tank	8/07/2025	1	**Refurbish**
T9852	700			CAUSTIC MIXING TANK	6/11/2022	-2	**Refurbish**
T9151	1090			CONDENSATE TANK	16/11/2022	-2	**Refurbish**
T9203	38			SULPHURIC ACID HOLD UP TANK	25/07/2024	0	**Refurbish**
T9152	3			CONDENSATE OBSERVATION TANK	2/09/2025	1	**Refurbish**
T9202	TBC			Brine Squeeze tank	24/01/2027	3	**Refurbish**
T9431	75			GLAND COOLING WATER SURGE TANK	-	-	**Refurbish**
T9851	22			SPENT CAUSTIC TANK.	8/09/2025	1	**Refurbish**
T7507	0			(SOUR SEAL OIL TANK)Pre Shut Complete - Credited 20Y by S. Knox	23/07/2028	4	**UNIT 7500**
T7103	33			ADIP-X Make-up Tank	20/12/2028	4	**UNIT 7100**
T7530	3			RBI - 10years but re-evaluate (SOUR SEAL OIL TANK)	19/02/2029	5	**UNIT 7500**
T7531	33			RBI - 10years but re-evaluate(SEAL OIL PROCESSING TANK)	26/02/2029	5	**UNIT 7500**
T7102	345			ADIP-X Storage Tank	13/04/2033	9	**UNIT 7100**
Diesel Fuel Tanks							
TDG5	1	-	-	Diesel for A-block	22/03/2027	3	**Repair**
TDG3	1	-	-	Diesel for offplots	22/03/2027	3	**Repair**
TDG2	3	-	-	Diesel for B-block	24/07/2023	-1	**Repair**
TDG1	0	-	-	Diesel for B-block	24/07/2023	-1	**Repair**
TDG4	1	-	-	Diesel for C-block and B2	18/07/2023	-1	**Repair**
T2704A	7	-	-	Diesel for Firewater Pumps	11/07/2027	3	**No Scope**
T2704B	7	-	-	Diesel for Firewater Pumps	11/07/2027	3	**No Scope**

Appendix D. Recommissioning Factors

Refining Units – Recommissioning Commodity Factors

Table 23: Recommissioning Factors applied per process unit per Commodity

Asset	Block	Unit	Units	Recommission Scope	% of Equip Replaced	Equipment	Civil, Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
Asset North	A	150	Crude Distiller Unit No. 1	Moderate Repair	15%	30%	5%	20%	25%	50%	50%	50%
Asset North	A	250 / 800	Naphtha Hydrotreater & ADIP Unit No.1	Moderate Repair	25%	30%	5%	20%	25%	50%	50%	50%
Asset North	A	350	Gas Oil Hydrodesulphuriser	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset North	A	650	High Vacuum Unit No. 1/Bitumen Blowing	Full Replacement	100%	100%	30%	100%	100%	100%	100%	100%
Asset North	A	700	Hot Oil System	Inspection, Recommission, Minor Repairs	0%	10%	2%	2%	15%	50%	50%	50%
Asset North	A	5000	A-Block Stack & Hot Ducts	Moderate Repair	-	-	-	-	-	-	-	-
Asset North	B	5100	Crude Distiller Unit No. 2	Moderate Repair	25%	30%	5%	20%	25%	25%	50%	50%
Asset North	B	5500 / 5600	Kerosene Hydrodesulphuriser & ADIP Unit No. 2	Moderate Repair	25%	30%	5%	20%	25%	25%	50%	50%
Asset North	B	8900	Depropaniser	Moderate Repair	0%	30%	5%	20%	25%	25%	50%	50%
Asset North	B	8930	ADIP Unit No. 6	Moderate Repair	0%	30%	5%	20%	25%	25%	50%	50%
Asset North	B	9100	Steam Generation/Expansion	Replacement of Boilers & Full Refurbishment	75%	40%	20%	40%	30%	50%	50%	50%
Asset North	B	9150	Condensate System	Moderate Repair	15%	30%	5%	20%	25%	50%	50%	50%

Asset	Block	Unit	Units	Recommission Scope	% of Equip Replaced	Equipment	Civil, Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
Asset North	B	9200	Boiler Feedwater	Moderate Repair	15%	30%	5%	20%	25%	50%	50%	50%
Asset North	B	9300	Fresh Water Supply/Treatment	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset North	B	9350	Industrial Water	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset North	B	9400	Fresh Cooling Water System	Inspection, Recommission	0%	3%	1%	3%	3%	3%	3%	3%
Asset North	B	9430	Gland Cooling Water System	Inspection, Recommission	0%	3%	3%	3%	3%	3%	3%	3%
Asset North	B	9500	Asphalt Burning System,	Full Refurbishment	5%	40%	5%	40%	30%	50%	50%	50%
Asset North	B	9520 / 2550	Fuel Oil System	Moderate Repair	10%	30%	5%	20%	25%	25%	50%	50%
Asset North	B	9600	Fuel Gas System	Moderate Repair	10%	30%	5%	20%	25%	25%	50%	50%
Asset North	B	9700 / 9750 / 2650	Instrument Air / Plant Air System	Moderate Repair	50%	30%	5%	20%	25%	25%	30%	15%
Asset North	B	9850	Miscellaneous chemicals	Inspection, Recommission, Minor Repairs	10%	10%	5%	5%	15%	50%	20%	10%
Asset North	D	5400	Benzene Removal Unit	Inspection, Recommission, Minor Repairs	0%	10%	5%	5%	15%	50%	20%	10%
Asset North	D	5700	Hydrogen Separation Unit	Inspection, Recommission, Minor Repairs	0%	10%	5%	5%	15%	50%	20%	10%

Asset	Block	Unit	Units	Recommission Scope	% of Equip Replaced	Equipment	Civil, Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
Asset North	D	5800 / 5900	Gas Oil Hydrodesulphuriser 3 & ADIP Unit No. 8	Inspection, Recommission, Minor Repairs	0%	10%	5%	5%	15%	50%	20%	10%
Asset North	E	7200 / 7300	CCR & HSU2	Inspection, Recommission	0%	3%	3%	3%	3%	3%	3%	3%
Asset South	C	6100	HVU II (High Vacuum Unit)	Moderate Repair	25%	30%	5%	20%	25%	75%	50%	50%
Asset South	C	6500	BDU (Butane Deasphalting)	Moderate Repair	25%	30%	5%	20%	25%	75%	50%	50%
Asset South	C	7100 / 7150	HMU (Steam Reforming Hydrogen Manufacturing Unit) & Naphtha Feed Unit	Moderate Repair	25%	30%	5%	20%	25%	75%	40%	40%
Asset South	C	7100 ADIP-X	ADIP-X Unit CO_2 Recovery	Inspection, Recommission, Minor Repairs	0%	10%	5%	5%	15%	75%	50%	50%
Asset South	C	7500 7600 7650 7800 7830 7860	HCU & ADIP Units 3,4 &5	Moderate Repair	20%	30%	5%	20%	25%	75%	40%	40%
Asset South	C	7700	HCU tops treater	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset South	C	9901	Multiflue	Moderate Repair	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	1150	Tankage	Various	100%	100%	30%	100%	100%	100%	100%	100%

Asset	Block	Unit	Units	Recommission Scope	% of Equip Replaced	Equipment	Civil, Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
Asset Offplots	OffPlots	1200	Natural Gas	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	1300	Truck Loading Facility	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	1700	RAP	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	2750	Fire Protection	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	3400	Flare and relief system	Full Refurbishment	20%	40%	5%	40%	30%	75%	50%	50%
Asset Offplots	OffPlots	3650	Slops and Offgrade	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	3750	Loading and Jetty	Modifications and Repairs	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	3800	Sludge handling system	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	3900	EWT (effluent water treatment)	No Scope	0%	0%	0%	0%	0%	0%	0%	0%
Asset Offplots	OffPlots	9800	N2	No Scope	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	9820	Flushing and Seal oil system	Full Refurbishment	15%	40%	5%	40%	30%	30%	40%	20%
Asset Offplots	B2	8100	SWS 1 - Sour Water Stripper	Full Refurbishment	15%	40%	5%	40%	30%	30%	50%	50%
Asset Offplots	B2	8200	SWS 2	Full Refurbishment	20%	40%	5%	40%	30%	30%	50%	50%

Asset	Block	Unit	Units	Recommission Scope	% of Equip Replaced	Equipment	Civil, Concrete	Structural Steel	Piping	Insulation	Instrumentation	Electrical
Asset Offplots	B2	8300	ADIP Regen 1	Full Refurbishment	20%	40%	5%	40%	30%	30%	50%	50%
Asset Offplots	B2	8400	ADIP Regen 2	Full Refurbishment	10%	40%	5%	40%	30%	30%	50%	50%
Asset Offplots	B2	8500	SRU 1 (Sulphur Recovery Unit)	Full Refurbishment	20%	40%	5%	40%	30%	50%	50%	50%
Asset Offplots	B2	8600	SRU 2	Full Refurbishment	20%	40%	5%	40%	30%	50%	50%	50%
Asset Offplots	B2	8700	SRU 3	Moderate Repair	10%	30%	5%	20%	25%	50%	50%	50%
Asset Offplots	B2	8750	SCOT (Shell Claus Off-gas Treating)	Moderate Repair	10%	30%	5%	20%	25%	50%	50%	50%
Asset Offplots	B2	8800	Sulphur handling (Sulphur Pastelle plant)	Inspection, Recommission	0%	3%	3%	3%	3%	3%	3%	3%
Asset Offplots	OffPlots	9900	Interconnecting Piping	Moderate Repair	0%	30%	5%	10%	10%	50%	30%	15%
Plant Wide	Controls	0	Control Systems	Full Refurbishment	-	-	-	-	-	-	-	-
Plant Wide	Power	0	Power Distribution	Moderate Repair	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	1150-1	New Tank Farm	Greenfield Development	100%	100%	30%	100%	100%	100%	100%	100%

Appendix E. Estimate Summary

Refining Units – Estimate Summary by Major Element

Table 24: Unit Estimate Summary

SCOPE				COSTS NZD$M								
Asset	Block	Unit	Description	Direct Hours	Equipment	Vendor Reps	Bulk Material	Freight	Labour	Contractor Indirect	Const. Equipment	Total Cost
			DIRECT COSTS									
Asset North	A	150	Crude Distiller Unit No. 1	309,300	30.71	0.92	34.16	5.14	37.17	18.74	13.64	140.48
Asset North	A	250 / 800	Naphtha Hydrotreater & ADIP Unit No.1	115,449	13.33	0.40	12.03	2.00	13.89	6.95	5.14	53.73
Asset North	A	350	Gas Oil Hydrodesulphuriser	-	-	-	-	-	-	-	-	-
Asset North	A	650	High Vacuum Unit No. 1/Bitumen Blowing	116,325	9.80	0.29	12.70	1.75	13.97	6.84	5.33	50.70
Asset North	A	700	Hot Oil System	25,621	2.50	0.08	4.26	0.54	3.01	1.69	0.98	13.06
Asset North	A	5000	A-Block Stack & Hot Ducts	27,522	-	-	4.46	0.36	3.42	1.57	2.34	12.14
Asset North	B	2550	Fuel System	-	-	-	-	-	-	-	-	-
Asset North	B	2650	Plant Air system	-	-	-	-	-	-	-	-	-
Asset North	B	5100	Crude Distiller Unit No. 2	214,443	24.78	0.74	22.75	3.76	25.78	12.99	9.46	100.26
Asset North	B	5500 / 5600	Kerosene Hydrodesulphuriser & ADIP Unit No. 2	108,789	14.19	0.43	10.67	1.96	13.07	6.55	4.84	51.72

SCOPE				COSTS NZD$M								
Asset	**Block**	**Unit**	**Description**	**Direct Hours**	**Equipment**	**Vendor Reps**	**Bulk Material**	**Freight**	**Labour**	**Contractor Indirect**	**Const. Equipment**	**Total Cost**
Asset North	B	8900	Depropaniser	24,391	2.84	0.09	2.30	0.40	2.94	1.43	1.13	11.13
Asset North	B	8930	ADIP Unit No. 6	2,850	0.13	0.00	0.46	0.05	0.34	0.18	0.12	1.27
Asset North	B	9100	Steam Generation/Expansion	125,769	37.03	1.11	14.29	4.08	15.06	7.61	5.55	84.73
Asset North	B	9150	Condensate System	34,431	2.57	0.08	5.13	0.61	4.07	2.21	1.38	16.06
Asset North	B	9200	Boiler Feedwater	48,509	5.32	0.16	8.00	1.06	5.78	3.04	2.02	25.40
Asset North	B	9300	Fresh Water Supply/Treatment	-	-	-	-	-	-	-	-	-
Asset North	B	9350	Industrial Water	-	-	-	-	-	-	-	-	-
Asset North	B	9400	Fresh Cooling Water System	1,333	0.09	0.00	0.19	0.02	0.16	0.08	0.06	0.61
Asset North	B	9430	Gland Cooling Water System	318	0.11	0.00	0.04	0.01	0.04	0.02	0.01	0.24
Asset North	B	9500	Asphalt Burning System,	27,743	3.86	0.12	3.73	0.61	3.33	1.70	1.20	14.54
Asset North	B	9520	Fuel Oil System	4,699	0.39	0.01	0.75	0.09	0.56	0.29	0.20	2.29
Asset North	B	9600	Fuel Gas System	9,745	0.50	0.02	1.53	0.16	1.16	0.61	0.41	4.39
Asset North	B	9700 / 9750	Instrument Air/Plant Air System	9,279	2.29	0.07	1.22	0.28	1.12	0.55	0.42	5.96
Asset North	B	9850	Miscellaneous chemicals	842	-	-	0.21	0.02	0.10	0.05	0.04	0.42

SCOPE				COSTS NZD$M								
Asset	**Block**	**Unit**	**Description**	**Direct Hours**	**Equipment**	**Vendor Reps**	**Bulk Material**	**Freight**	**Labour**	**Contractor Indirect**	**Const. Equipment**	**Total Cost**
Asset North	D	5400	Benzene Removal Unit	37,077	2.07	0.06	7.76	0.77	4.44	2.19	1.69	19.00
Asset North	D	5700	Hydrogen Separation Unit	6,678	0.37	0.01	1.86	0.18	0.80	0.39	0.30	3.92
Asset North	D	5800 / 5900	Gas Oil Hydrodesulphuriser 3 & ADIP Unit No. 8	61,132	3.60	0.11	12.65	1.27	7.33	3.60	2.80	31.35
Asset North	E	7200 / 7300	CCR & HSU2	40,075	2.97	0.09	22.34	1.97	4.70	2.32	1.86	36.26
Asset South	C	6100	HVU II (High Vacuum Unit)	110,643	12.24	0.37	11.50	1.88	13.32	6.64	4.95	50.89
Asset South	C	6500	BDU (Butane Deasphalting)	109,274	12.09	0.36	11.36	1.85	13.16	6.56	4.89	50.26
Asset South	C	7100 / 7150	HMU (Steam Reforming Hydrogen Manufacturing Unit)	212,694	24.54	0.74	20.98	3.60	25.68	12.64	9.65	97.81
Asset South	C	7100 ADIP-X	ADIP-X Unit CO2 Recovery	47,395	1.64	0.05	6.67	0.64	5.59	2.97	1.98	19.53
Asset South	C	7500 / 7600 / 7650	HCU & ADIP Units 3,4 &5	863,350	94.62	2.84	87.08	14.35	104.17	51.36	39.08	393.49
Asset South	C	7700	HCU tops treater	-	-	-	-	-	-	-	-	-
Asset South	C	9901	Multiflue	16,130	-	-	3.26	0.26	2.00	0.92	1.24	7.68
Asset Offplots	OffPlots	1150	Tankage	634,643	-	-	108.60	7.29	71.82	38.33	36.48	262.52
Asset Offplots	OffPlots	1150-1	New Tank Farm	1,288,639	4.12	0.12	224.02	15.93	148.13	77.16	68.75	538.24

SCOPE				COSTS NZD$M								
Asset	Block	Unit	Description	Direct Hours	Equipment	Vendor Reps	Bulk Material	Freight	Labour	Contractor Indirect	Const. Equipment	Total Cost
Asset Offplots	OffPlots	1200	Natural Gas	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	1300	Truck Loading Facility	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	1700	RAP	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	2750	Fire Protection	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	3400	Flare and relief system	296,807	14.53	0.44	36.92	4.11	36.44	17.07	14.12	123.64
Asset Offplots	OffPlots	3650	Slops and Offgrade	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	3750	Loading and Jetty	49,132	-	-	5.40	0.43	5.98	2.91	2.24	16.95
Asset Offplots	OffPlots	3800	Sludge handling system	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	3900	EWT (effluent water treatment)	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	9800	N2	-	-	-	-	-	-	-	-	-
Asset Offplots	OffPlots	9820	Flushing and Seal oil system	7,887	0.64	0.02	1.17	0.14	0.95	0.47	0.35	3.75
Asset Offplots	B2	8100	SWS 1 - Sour Water Stripper	25,398	2.30	0.07	4.05	0.51	3.04	1.58	1.08	12.62
Asset Offplots	B2	8200	SWS 2	23,673	2.16	0.06	3.75	0.47	2.83	1.47	1.01	11.76
Asset Offplots	B2	8300	ADIP Regen 1	24,101	2.37	0.07	2.91	0.42	2.90	1.44	1.08	11.18

SCOPE				COSTS NZD$M								
Asset	Block	Unit	Description	Direct Hours	Equipment	Vendor Reps	Bulk Material	Freight	Labour	Contractor Indirect	Const. Equipment	Total Cost
Asset Offplots	B2	8400	ADIP Regen 2	36,540	3.29	0.10	4.54	0.62	4.39	2.19	1.63	16.75
Asset Offplots	B2	8500	SRU 1 (Sulphur Recovery Unit)	56,790	6.34	0.19	6.39	1.01	6.85	3.37	2.58	26.73
Asset Offplots	B2	8600	SRU 2	56,790	6.34	0.19	6.39	1.01	6.85	3.37	2.58	26.73
Asset Offplots	B2	8700	SRU 3	44,200	4.51	0.14	5.01	0.75	5.30	2.66	1.97	20.34
Asset Offplots	B2	8750	SCOT (Shell Claus Off-gas Treating)	35,524	3.63	0.11	4.03	0.60	4.26	2.13	1.58	16.35
Asset Offplots	B2	8800	Sulphur handling (Sulphur Pastelle plant)	1,950	0.14	0.00	0.21	0.03	0.23	0.11	0.09	0.82
Asset Offplots	OffPlots	9900	Interconnecting Piping	276,202	-	-	34.63	2.76	33.59	16.20	12.77	99.94
Plant Wide	Controls	0	Control Systems	150,708	-	-	48.99	3.92	17.02	11.17	4.47	85.57
Plant Wide	Power	0	Power Distribution	78,630	-	-	25.56	2.04	8.88	5.83	2.33	44.64
					-	-	-	-	-	-	-	-
			SUB TOTAL DIRECT COSTS	5,799,421	354.98	10.65	846.91	91.71	685.62	350.15	277.84	2,617.87
					-	-	-	-	-	-	-	-
			INDIRECT COSTS		-	-	-	-	-	-	-	-
					-	-	-	-	-	-	-	-
					-	-	-	-	-	-	-	-
6000			COMMON DISTRIBUTABLES	-	-	-	-	-	-	297.35	26.18	323.53
					-	-	-	-	-	-	-	-

SCOPE				COSTS NZD$M								
Asset	**Block**	**Unit**	**Description**	**Direct Hours**	**Equipment**	**Vendor Reps**	**Bulk Material**	**Freight**	**Labour**	**Contractor Indirect**	**Const. Equipment**	**Total Cost**
7000			EPCM Costs	-	-	-	-	-	-	771.22	-	771.22
					-	-	-	-	-	-	-	-
8000			CONTINGENCY	-	-	-	-	-	-	742.52	-	742.52
					-	-	-	-	-	-	-	-
9000			OWNERS COST	-	-	-	-	-	-	222.76	-	222.76
9100			CRUDE INVENTORY	-	-	-	217.95	-	-	-	-	217.95
					-	-	-	-	-	-	-	-
			SUBTOTAL INDIRECT COSTS	-	-	-	217.95	-	-	2,033.85	26.18	2,277.98
					-	-	-	-	-	-	-	-
			TOTAL INSTALLED COSTS - PRESENT DAY	5,799,421	354.98	10.65	1,064.86	91.71	685.62	2,384.00	304.02	4,895.85