CHAPTER 5

PROJECT DESCRIPTION

5.1 Project Setting

The objective of this project is to recover valuable metals from an industrial waste, i.e., spent catalyst from petrochemical and other industrial processes, as given under Project Justification in Chapter 4. The proposed project employs a commercially proven plant, the same as has been successfully operating in Ako City, Japan (Ako plant) as shown in Figure 5.3(3)**.**

5.2 Project Location and Landuse

The proposed project (The Construction and Completion of a Metals from Spent Catalyst Recovery Facility (SCaRF) in Gebeng Industrial Area, Kuantan, Pahang) is to cater for used catalysts from Petrochemical plants in Pengerang, Johor, as well as (in future) other petrochemical plants to recover valuable metals. The plant is to be located on a lot belonging to the project proponent, at Lot 29132, in the Gebeng Industrial Estate (GIE), Kuantan, as shown in **Figure 5.2(1)**. The general land use for the Gebeng Industrial Area is covered under the Rancangan Tempatan Daerah Kuantan 2035 (Penggantian). Gebeng Industrial Estate (GIE) is one of the five main industrial areas gazetted in the Kuantan district. Other areas that have been gazetted as industrial areas are Tanjung Gelang Industrial area and Kuantan Port, Semambu Industrial area, Indera Mahkota Industrial area and Prima Kota Industrial area in Kuantan City. The trend of industrial development for heavy industries is more concentrated in the GIE where the proposed project will be built.

The proposed SCaRF site is located across the road from the LYNAS Advanced Material plant (hereafter referred to as LYNAS) to its south and across the road from the RE Gebeng solar energy plant to its west, as shown in **Figure 5.2(2).** It is a flat land prepared for industrial building, with the site now overgrown by secondary vegetation of low acacia trees, as shown in **Figure 5.2(3).** The existing plants next to SCaRF are LYNAS and RE Gebeng as shown in **Figure 5.2(3).**

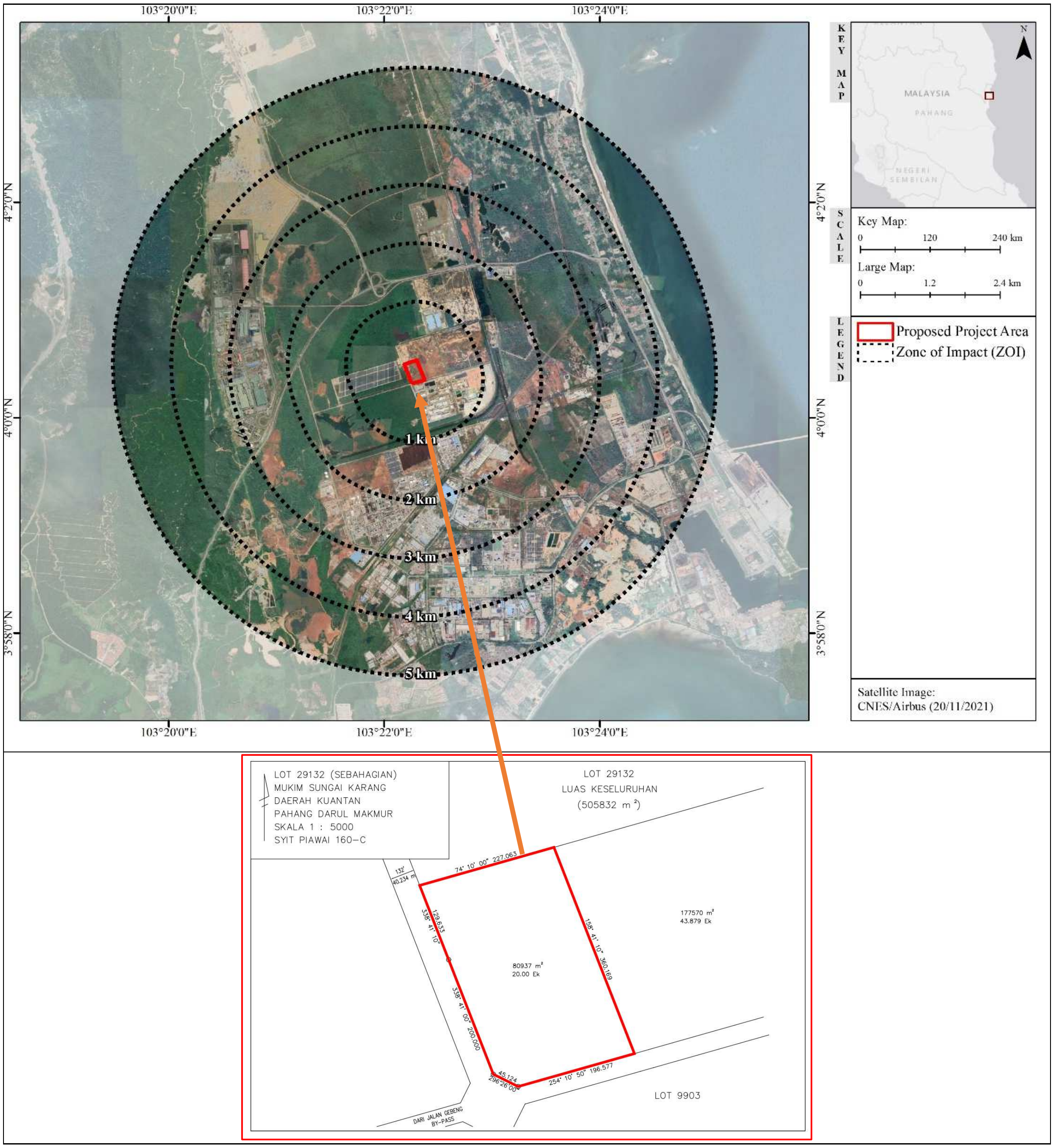


Figure 5.2(1) Location of proposed SCaRF plant in Lot 29132, Gebeng Industrial Estate, Kuantan

Figure 5.2(2) Location of proposed SCaRF across from LYNAS and RE Gebeng

Prepared SCaRF industrial site overgrown by secondary vegetation of low acacia trees

Lynas site across the road from SCaRF

RE Gebeng solar farm next door to SCaRF

Figure 5.2(3) The SCaRF site and immediate neighbours

5.3 Project Features

5.3.1 Feedstock

Spent catalyst will be processed to recover valuable metals, thus saving resources, before the residuals are appropriately disposed. The Waste Acceptance Criteria under the Environmental Quality (Scheduled Wastes) Regulation 2005, or the EQ(SW)R 2005, shall be:

SW 202: Waste Catalyst

Spent catalysts from the Petronas Pengerang RAPID plant with quantities as shown in **Table 5.3(1)** below will be processed at the proposed SCaRF. When waste transportation is being carried out, that is once waste catalyst is generated, there is about 6 to 8 trucks per day on average. This means about one truck per hour, thus it would not have significant effect on the existing road traffic (see **Section 6.11**). The trucks will as far as possible travel through highways, where there is:

- less contact with populated areas
- highway management team is always available and contactable

The loads are solids and not reactive, and will be securely covered in jumbo bags or similar at all times. The waste catalysts are as listed in **Table 5.3(1)** below.

Table 5.3(1) Used catalysts are from the Petronas Pengerang RAPID plant

Type of spent catalyst	**Tonnage (wet MT)**	**Discharge frequency**	**Packing**	**Transportation**	**Frequency**
ARDS	6,644 MT/yr	Every 3 months 1,661 MT/3 months	1,000kg sling bags	Trucking 10 MT/truck	4 weeks in 3 months ~166 trucks/ 4wks ~8 trucks/day
HDT	1,164 MT/4 yrs	Every 4 yrs	1,000kg sling bags	″	4 weeks in 4 yrs: 120 trucks/4wks = 6 trucks/day

5.3.2 Process description of Catalyst Recovery

The valuable metals to be recovered are Vanadium (V) and Molybdenum (Mo) via a typical process of slow roasting the used catalyst in a rotary kiln to oxidise the Mo and V into soluble oxides, before leaching out the soluble oxides, followed by separating out the V rich stream and Mo rich stream, then precipitating out the solids. The whole process is shown in simplified process flow diagram (PFD) in **Figure 5.3(1)** and described below. The same plant that has been successfully operating in Japan (Ako plant) is shown in **Figure 5.3(3)**.

1) Spent catalysts (SW202) from petrochemical plant(s) is sent to a vibrating sieve to remove the ceramic balls, which are carriers for the catalysts. The ceramic balls will be sent to a cement producer, which will use the ceramic component as part of the cement mix.
2) The spent catalyst particles are mixed with sodium carbonate (Na_2CO_3) as conditioning for roasting, called Soda Roasting. This prevents generation of dioxin even if chlorine is contained in spent catalyst (The Japan Ako plant, the same type of plant as for this project, has been monitoring dioxin in effluent and exhaust gas, and dioxin has never been found (Source: Taiyo Koko)). The mixed catalyst is slow roasted in a kiln under controlled temperatures to remove S and Oil.
3) During slow soda roasting Mo and V are oxidised to Na_2MoO_4 and $NaVO_3$ which are soluble salts which can be leached out later.
4) Exhaust gases from the Roaster is scrubbed in a Desulphurisation scrubber (DS) to remove gaseous pollutants, followed by an Electrostatic Precipitator (EP) to remove particulates, before release to atmosphere via a chimney equipped with continuous emission monitoring system (CEMS), with the exit gas complying to the Clean Air Regulation 2014.
5) Roasted ore is leached warm water (50ºC) to obtain the soluble Na_2MoO_4 and $NaVO_3$ in leachate and an alumina residue.
6) The alumina residue will be managed as scheduled waste (SW) and disposed to a licenced SW facility.
7) Leachate will be reacted with ammonium chloride (NH_4Cl) to precipitate out ammonium metavanadate (NH_4VO_3). NH_4Cl is recovered for reuse (process details and mass balance will be given in EIA report).
8) The NH_4VO_3 is heated in a calcination chamber to be oxidised to vanadium pentoxide (V_2O_5), which is then flaked for easy handling.
9) The residual leachate or molybdenum rich solution is precipitated using HCl to recover molybdic acid (H_2MoO_4) precipitate.
10) The residual acidic leachate is sent to the effluent treatment plant (IETS) where it is treated to meet the Standard B of the Environmental Quality (Industrial Effluent) Regulation 2009.

Process flow of the roasting and extraction processes and exhaust gas treatments involved are shown in **Figure 5.3(1) to 5.3(2)** below and can be seen in actual pictures the same process at the Ako plant in Japan (**Figure 5.3(3)** and **5.3(4)**). Bordering the front boundary of the site, as shown in the site plan in **Figure 5.7(4)** (pink line) is the Petronas Gas Berhad (PGB) gas pipeline which greatly facilitates the plant operation as the fuel gas would be available online and no storage would be required, eliminating the danger of fuel storage.

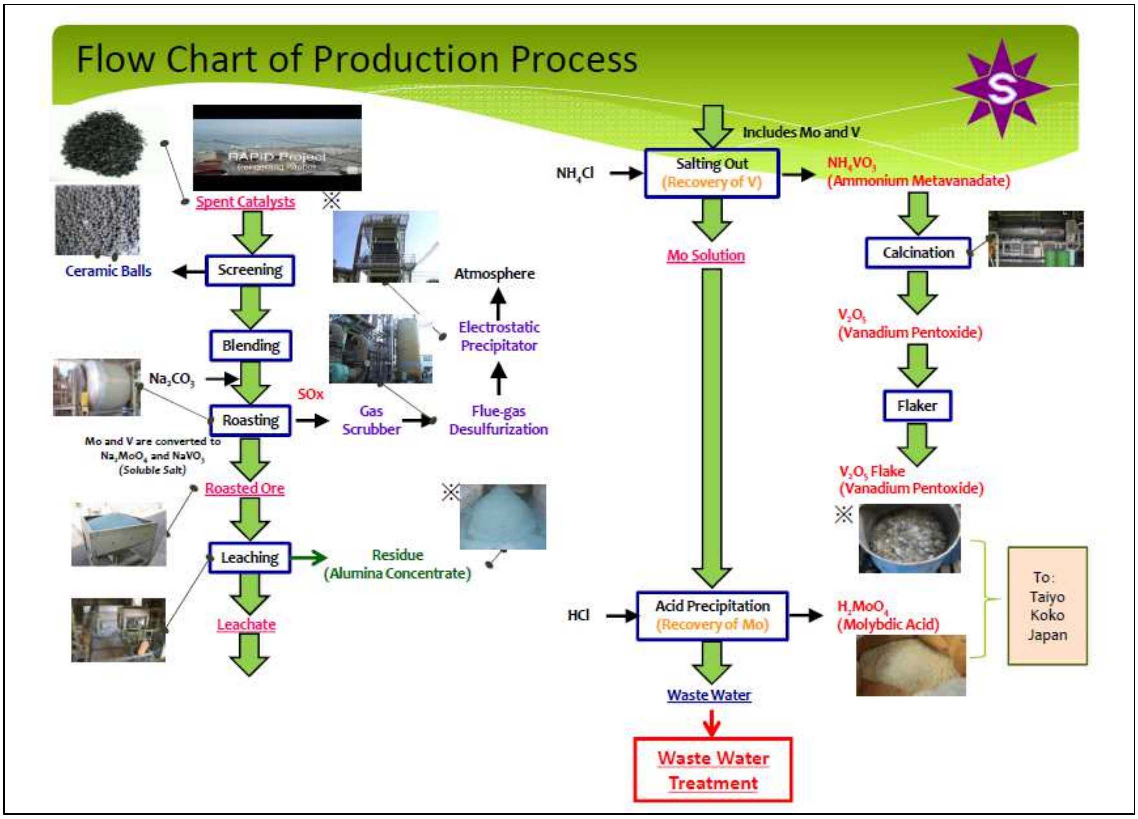


Figure 5.3(1) Simplified Process Flow Diagram (PFD) with pictures

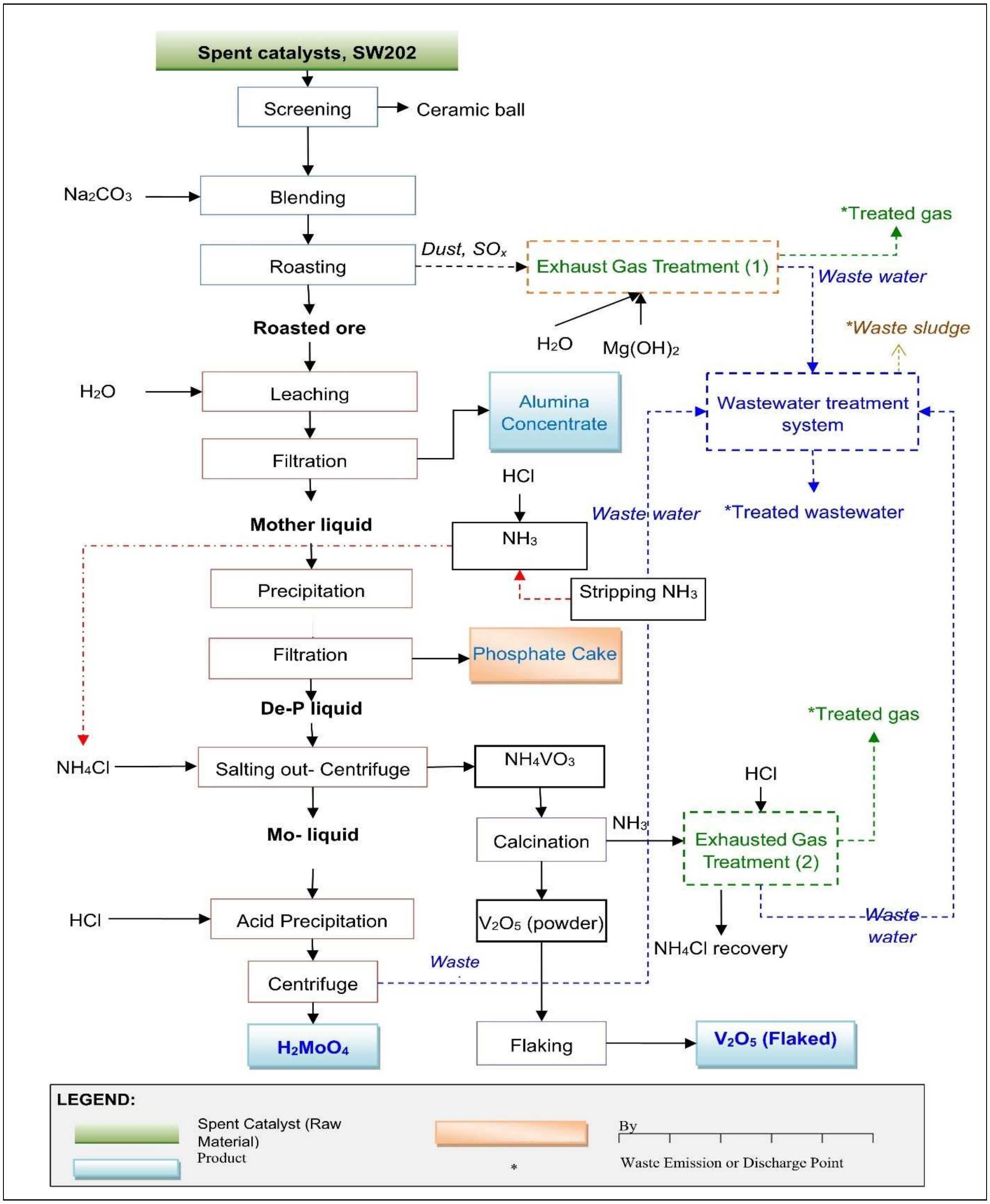


Figure 5.3(2) SCaRF Process Flow Diagram (PFD)

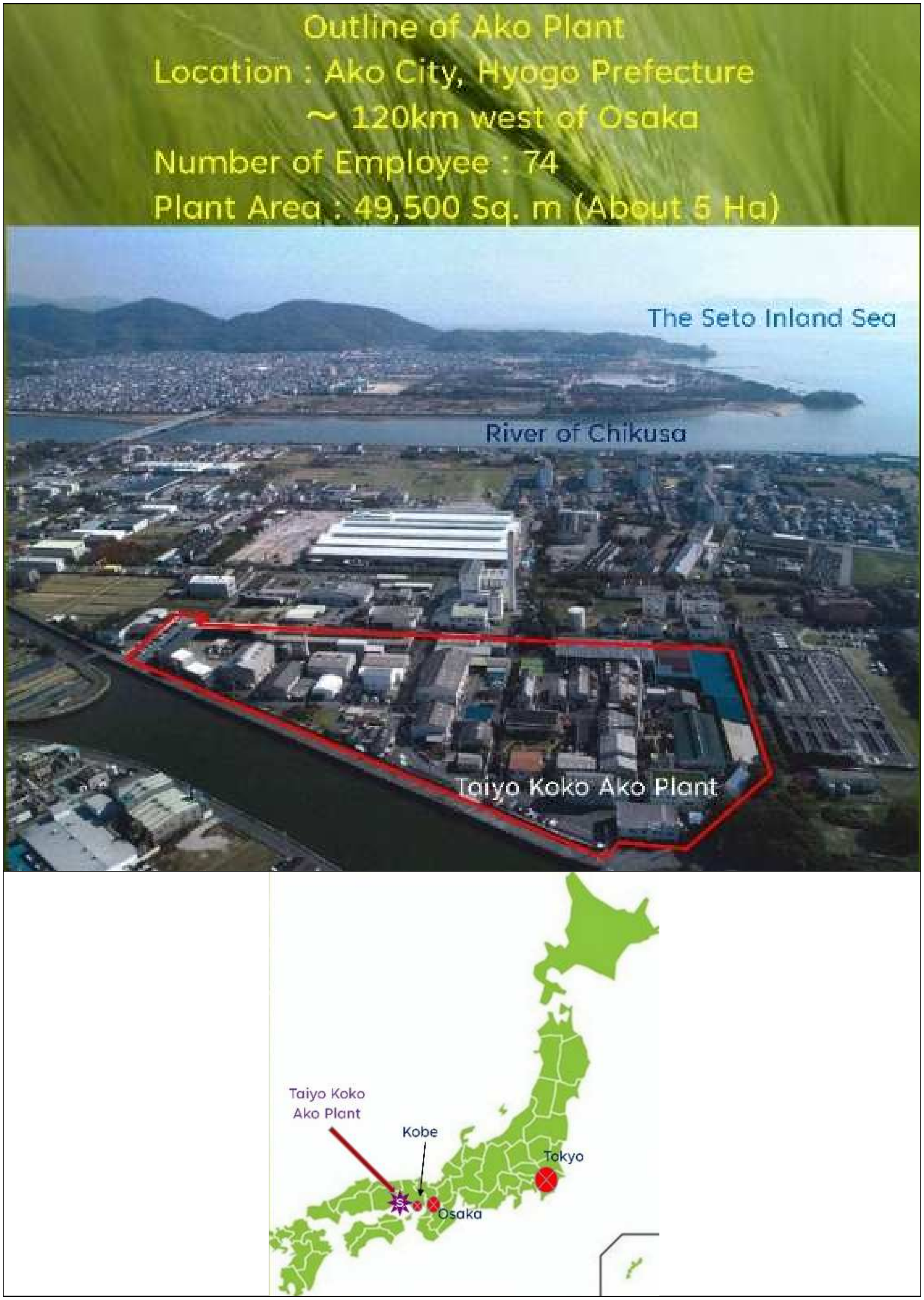


Figure 5.3(3) Location of Taiyo Koko's SCaRF plant in Ako City, Japan

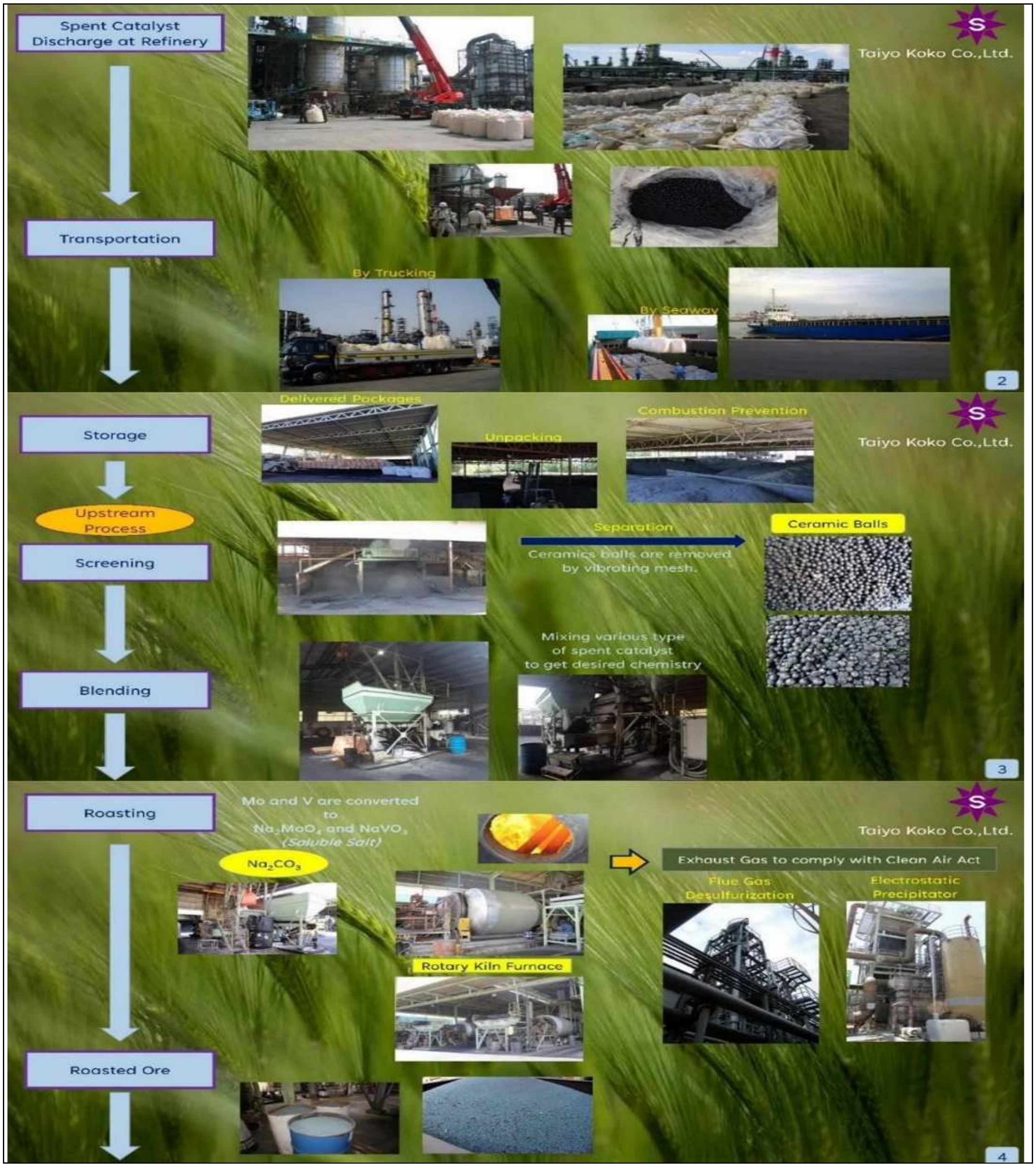

Spent Catalyst Discharge at Refinery
Taiyo Koko Co.,Ltd.
Transportation
By Trucking
By Seaway
2
Delivered Packages
Storage
Unpacking
Combustion Prevention
Taiyo Koko Co.,Ltd.
Upstream Process
Screening
Separation
Ceramics balls are removed by vibrating mesh.
Ceramic Balls
Mixing various type of spent catalyst to get desired chemistry
Blending
3
Roasting
Mo and V are converted to Na_2MoO_4 and $NaVO_3$ (Soluble Salt)
Taiyo Koko Co.,Ltd.
Na_2CO_3
Exhaust Gas to comply with Clean Air Act
Flue Gas Desulfurization
Electrostatic Precipitator
Rotary Kiln Furnace
Roasted Ore
4

Figure 5.3(4) Taiyo Koko's SCaRF processes in Ako Plant in Japan

5.3.3 Process Overall Mass Balance

The overall Mass Balance for the plant is given in **Figure 5.3(5) to 5.3(6).**

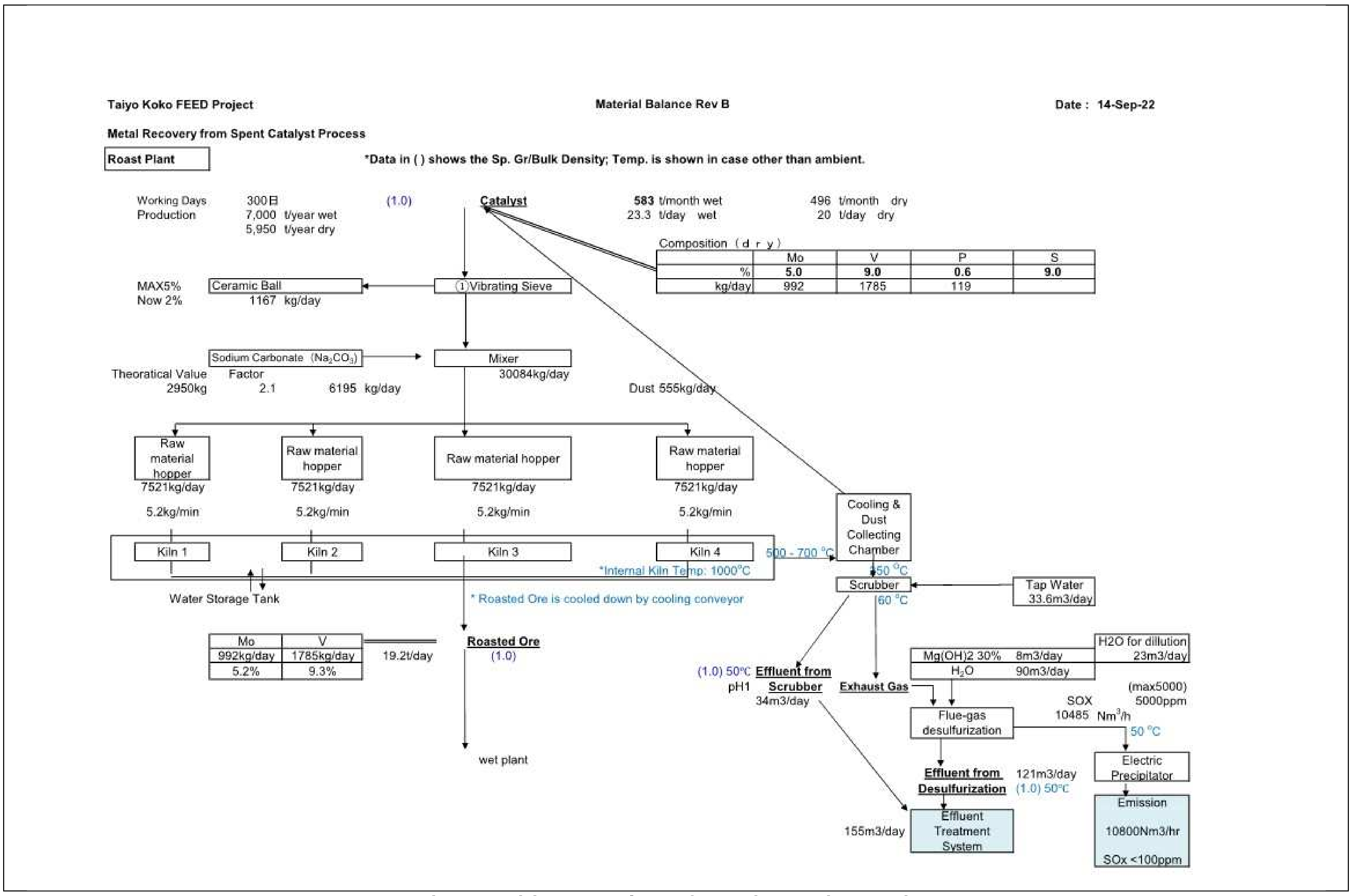
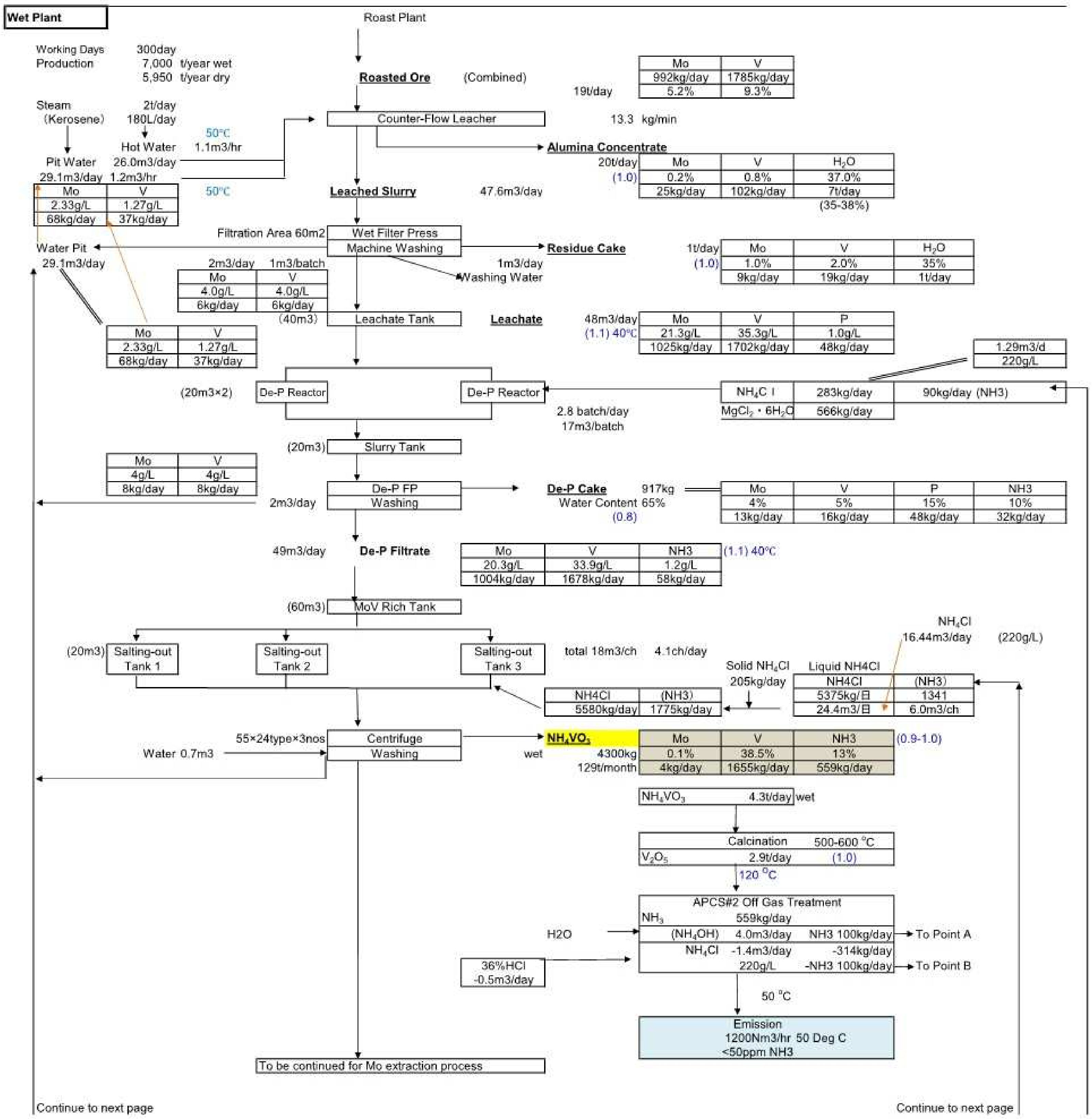


Figure 5.3(5) Mass Balance for Soda roasting section


Wet Plant
Roast Plant
Working Days 300day
Production 7,000 t/year wet
5,950 t/year dry
Roasted Ore
(Combined)
19t/day
Counter-Flow Leacher
13.3 kg/min
Alumina Concentrate
Leached Slurry
47.6m3/day
Wet Filter Press
Machine Washing
Residue Cake
Leachate Tank
Leachate
De-P Reactor
Slurry Tank
De-P FP
Washing
De-P Cake
De-P Filtrate
MoV Rich Tank
Salting-out Tank 1
Salting-out Tank 2
Salting-out Tank 3
Centrifuge
Washing
Calcination
APCS#2 Off Gas Treatment
To Point A
To Point B
Emission
1200Nm3/hr 50 Deg C
<50ppm NH3
To be continued for Mo extraction process
Continue to next page
Continue to next page

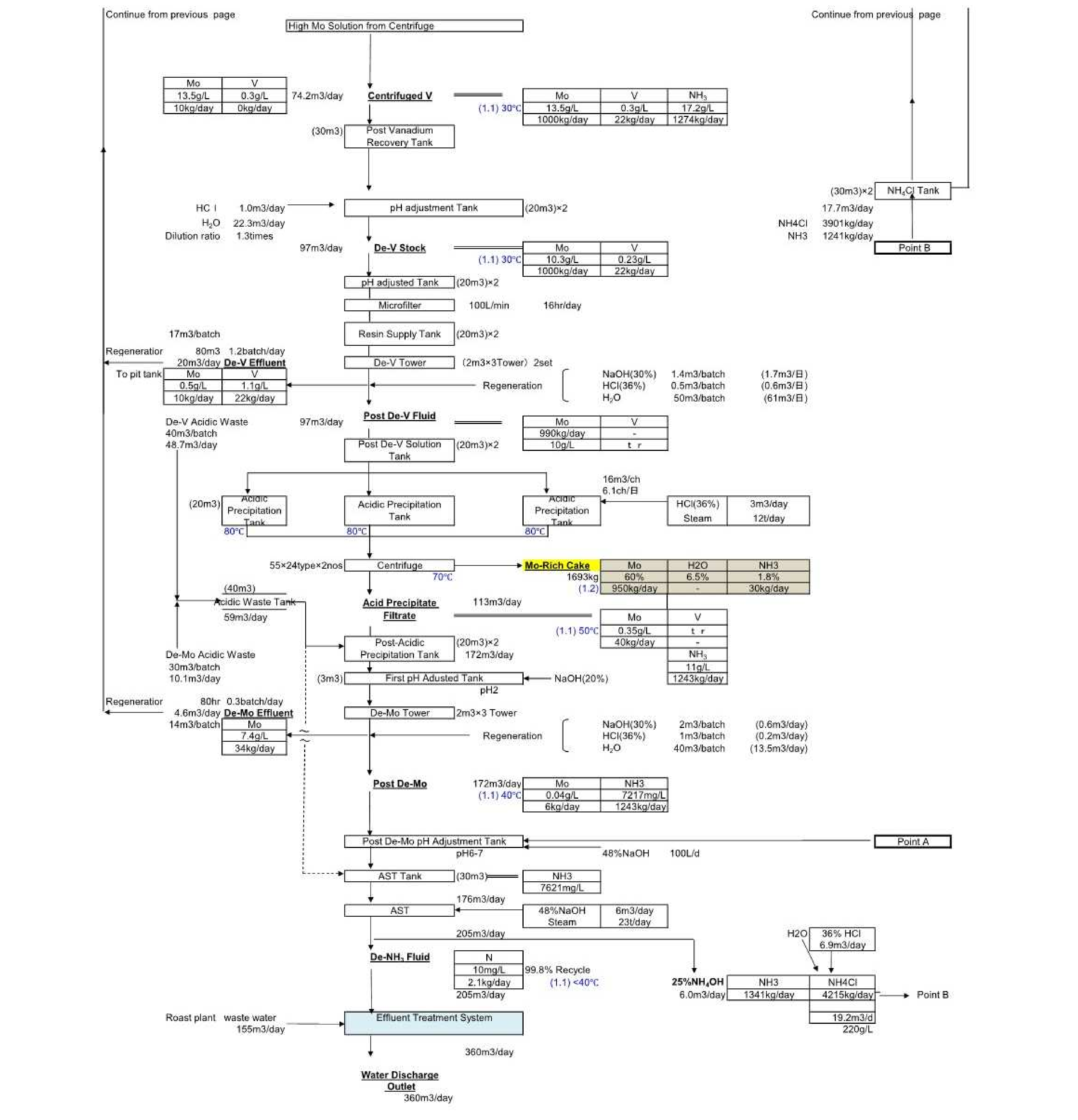


Figure 5.3(6) Mass Balance for Extraction sections

5.4 Exhaust Gas Treatment System

5.4.1 Air Pollution Control System (APCS)

Waste gases will be treated to meet the emission limits in Clean Air Regulation (CAR) 2014 in APCS with process flow as shown in **Figure 5.4.1(1) to (5)** above and described below. There are two (2) stacks: emission from roasting kiln goes to Flue Gas Desulfurization Unit and emission from calcination plant goes to Off gas Treatment unit.

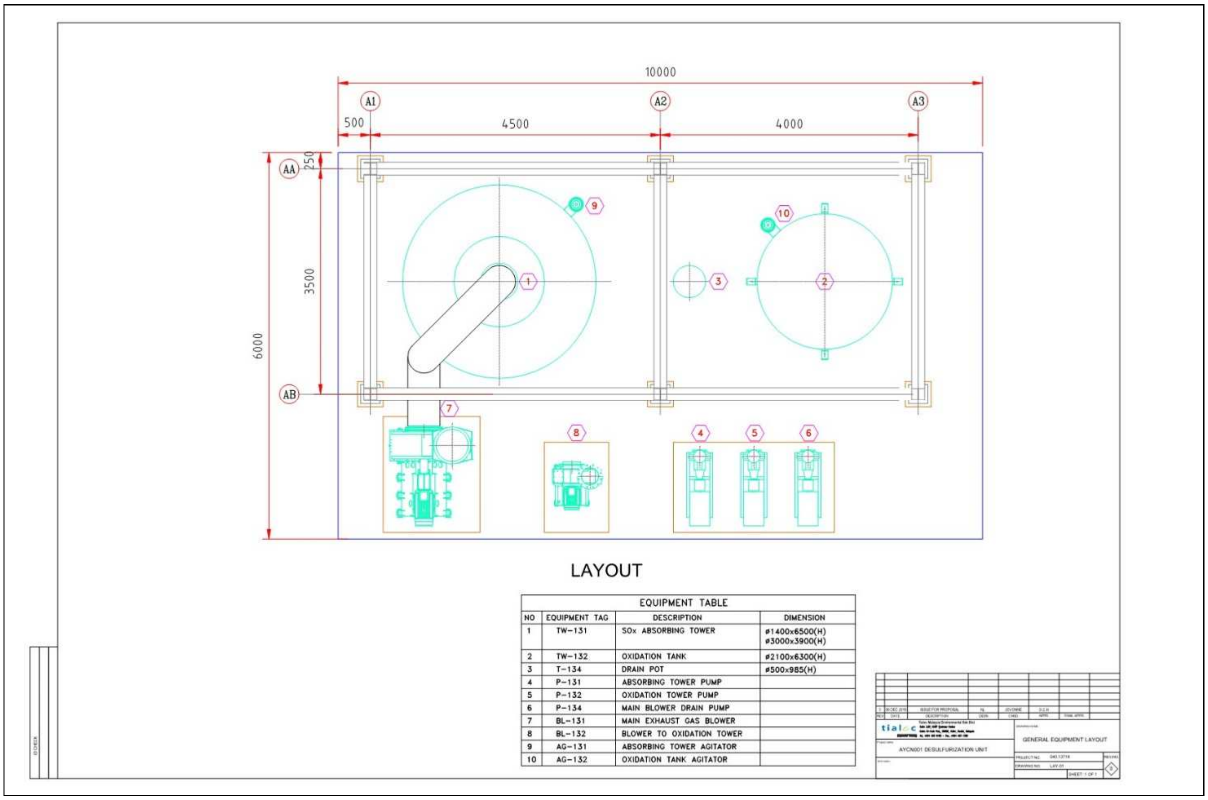


Figure 5.4(1) General Layout of the Desulphurisation system

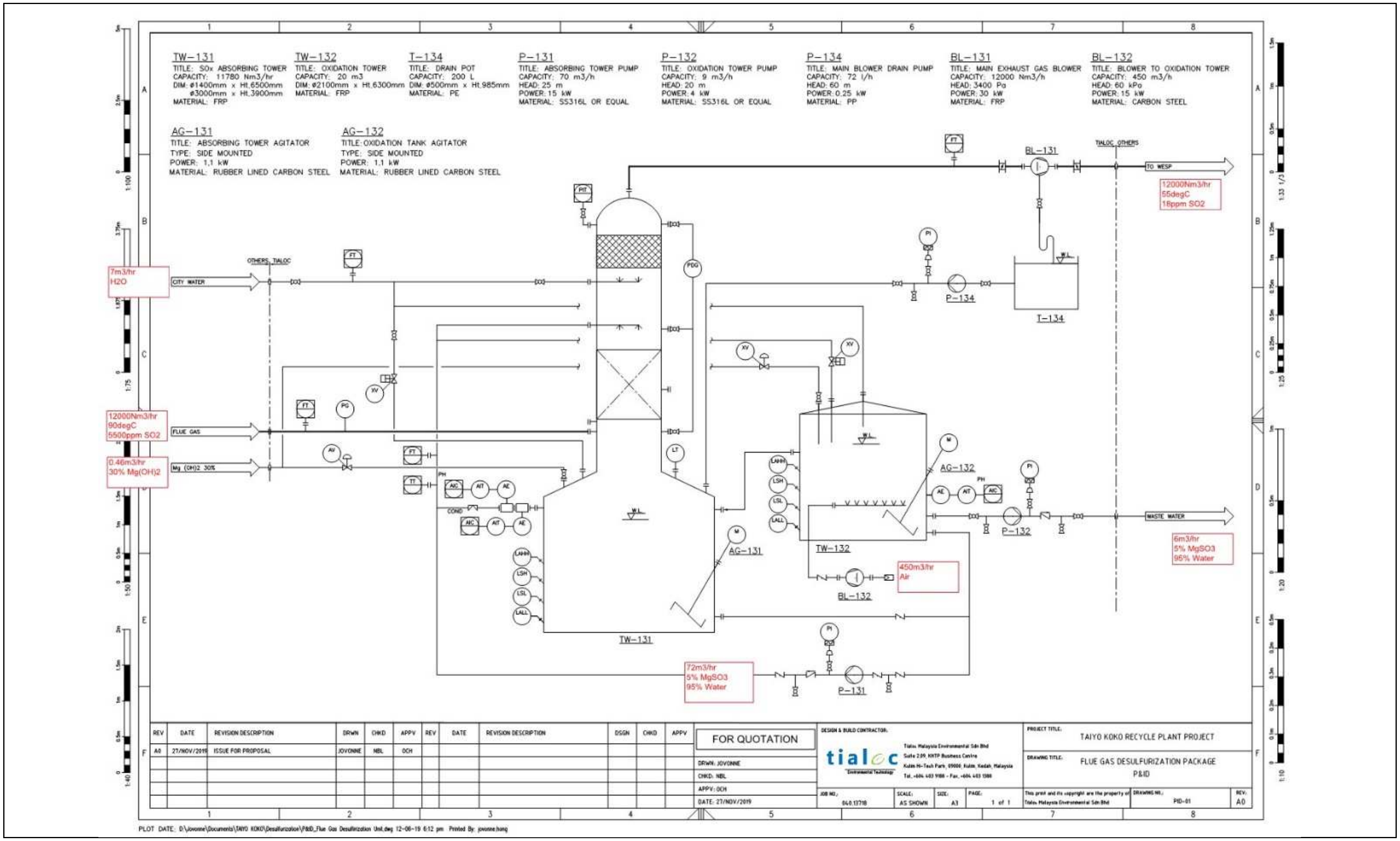
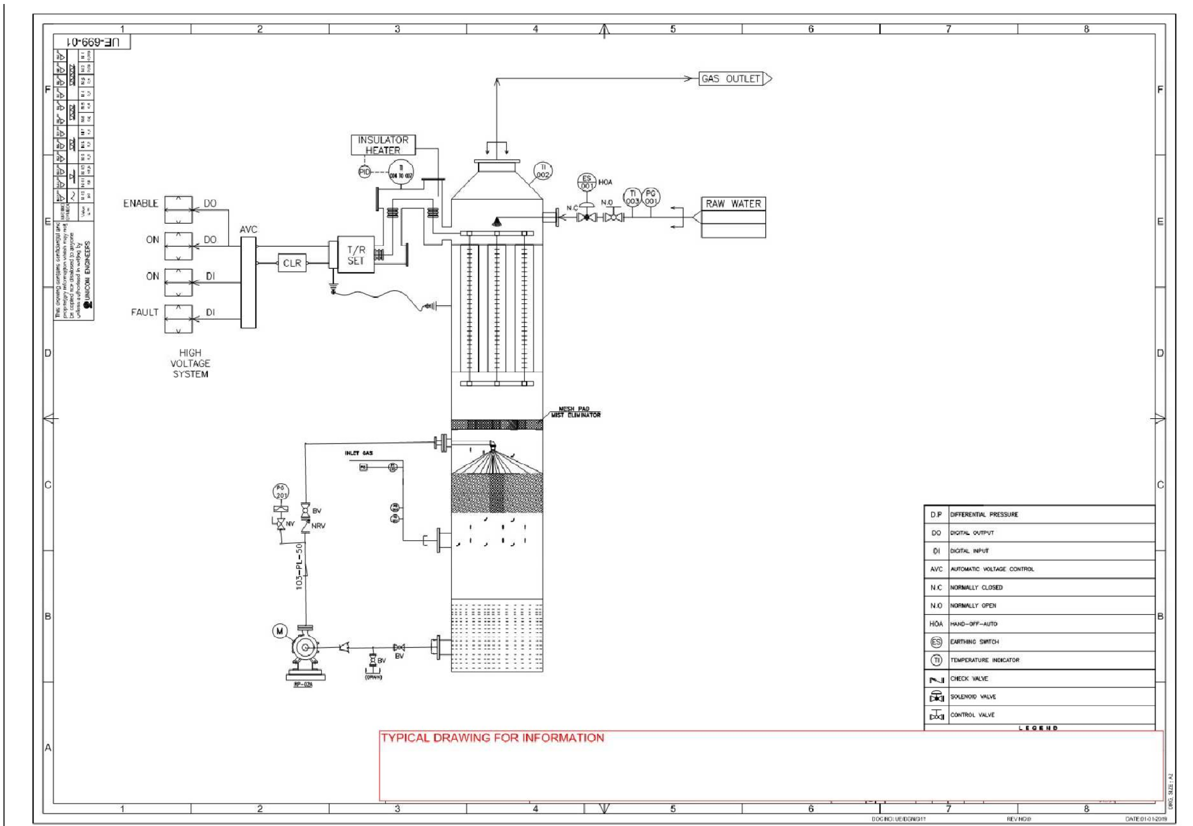
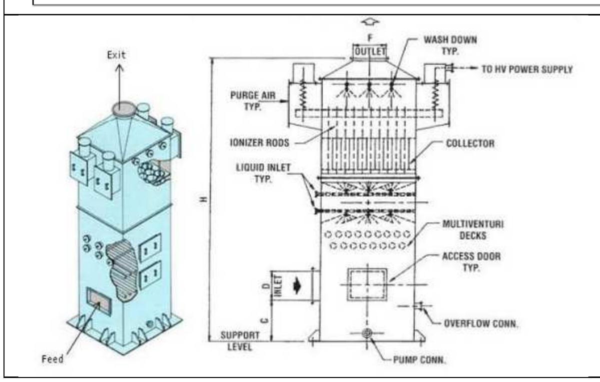


Figure 5.4(2) Process Flow Diagram of the Desulphurisation system





WET PRECIPITATOR (EP-131)

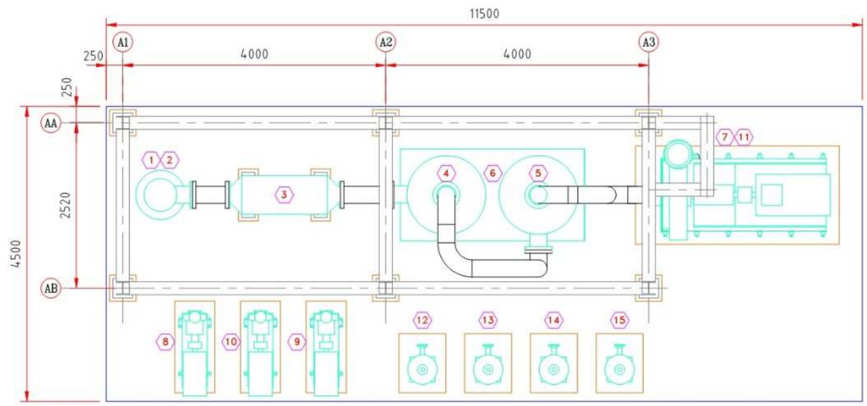
1.0 DESIGN SPECIFICATION

1.1	Gas Flow rate (Wet Base)	12000 Nm³/hr
1.2	Gas Floc rate (Wet Base)	11000 Nm³/hr
1.3	Gas inlet Temperature	55°C
1.4	Inlet Duct Load	300 mg/Nm3
1.5	Outlet Dust Load	<50 mg/Nm3
1.3	Design Pressure	1.5 kg/Cm2

2.0 ESP SPECIFICATION

2.1	Scrubbing Liquid	Water
2.2	Scrubbing Liquid Flow rate	20 m3/hr
2.3	Scrubbing Liquid Pressure	1.5 kgf/cm2
2.4	Pressure Drop	30±10 WC
2.5	Size	1500 mm Dia x 8000 mm Height

Figure 5.4(3) Wet Electrostatic Precipitator for Desulphurisation Plant



LAYOUT

EQUIPMENT TABLE			
NO	EQUIPMENT TAG	DESCRIPTION	DIMENSION
1	TW-521	Gas Cooling Tower	ø500x4600(H)
2	T-521	Gas Cooler Tank	ø750x1100(H)
3	V-521	Mist Eliminator	1700(L)x750(W)x750(H)
4	TW-522	Scrubber 1	ø1200x3600(H)
5	TW-523	Scrubber 2	ø1200x4200(H)
6	T-522	SCRUBBER TANK	1400(L)x2800(W)x1200(H)
7	ST-521	STACK	ø450x15000(H)
8	P-521	GAS COOLER CIRCULATION PUMP	
9	P-522	SCRUBBER CIRCULATION PUMP	
10	P-523	SCRUBBER TANK PUMP	
11	BL-521	ID FAN	
12	EX-521A	CIRCULATING LIQUID COOLER	
13	EX-521B	CIRCULATING LIQUID COOLER	
14	EX-521C	CIRCULATING LIQUID COOLER	
15	EX-521D	CIRCULATING LIQUID COOLER	

Figure 5.4(4) General Layout for the Off-gas Treatment Unit

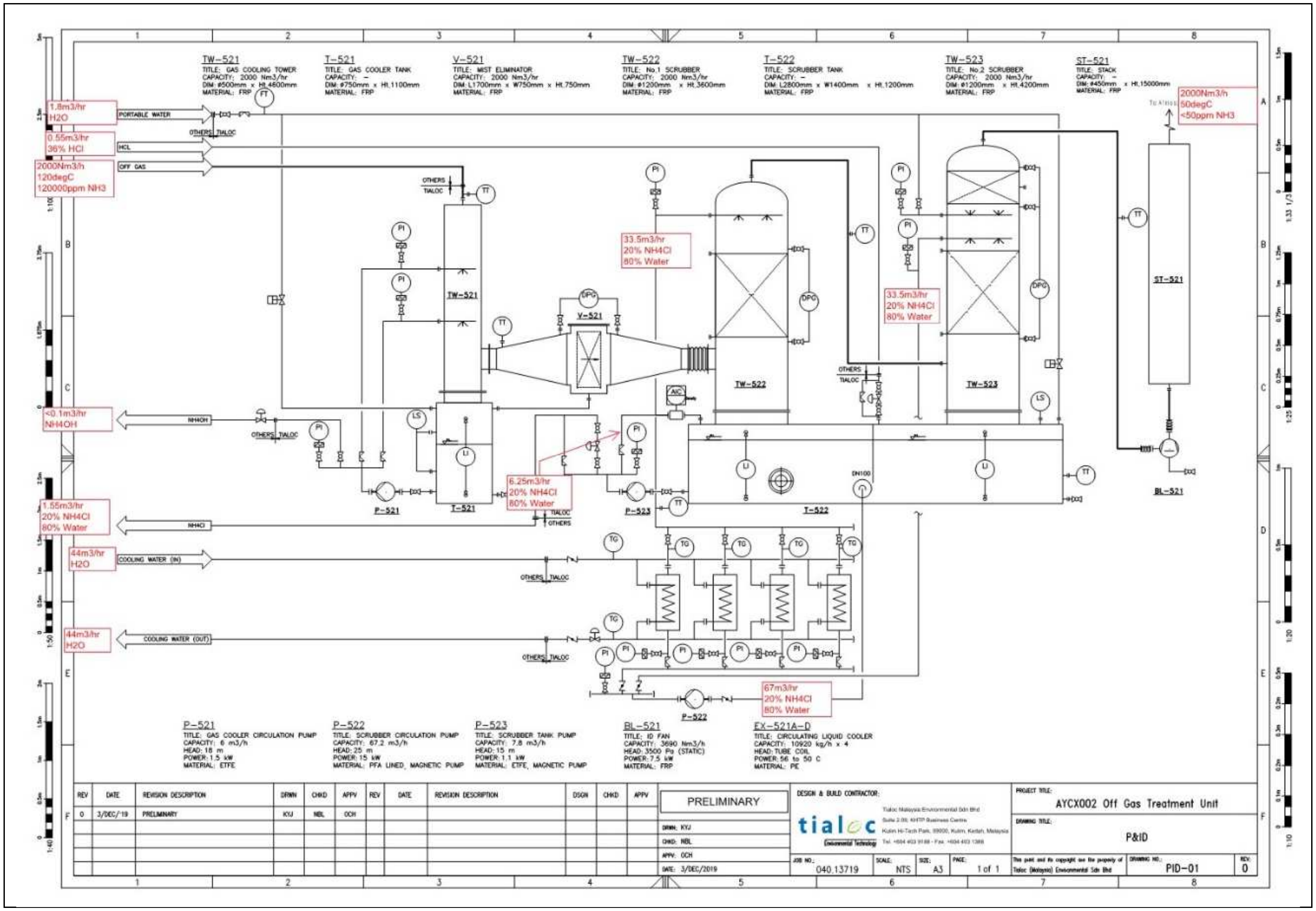


Figure 5.4 (5) Process Flow Diagram for the Off-gas Treatment Unit

5.4.2 Flue Gas Desulfurization System for Gases from Roasting Kiln

Roasting kiln exhaust gas

Slow roasting of waste catalyst is designed to oxidise the molybdenum (Mo) and vanadium (V) into soluble oxides which would be later dissolved for separation from the solids. The slow roasting also oxidises any organics present in the waste catalyst, such that the main pollutants in the exhaust gas from the roasting kiln are particulates and sulphur oxides, SO_x. The exhaust gas is first cooled in a cooling chamber, which also settles the coarser particulates. Thereafter, it is scrubbed using potable water, which converts the SO_x to sulphuric acid, which is recovered for reuse within the plant. The scrubbing also removes particulates. Thereafter, the gas is further scrubbed in a SO_x absorbing tower with vertical and horizontal sprays of alkaline magnesium hydroxide solution, with recirculation to complete oxidation of the scrubber solution to ensure complete capture of SO_x. Scrubber used water is sent to the IETS. The triple scrubbed exhaust gas then passes through a wet electrostatic precipitator (EP) that ensures complete removal of acidic gases and fine particulates before it is passed out via stack 1. Further details and mass balance are given in **Figure 5.3(3)** and below.

Desulfurization Scrubber

The flue gas passes through the SO2 scrubber and is treated before discharge. The wet scrubber applies the absorption principle. In the scrubber, the contaminated exhaust comes into contact with washing liquid and is “scrubbed” clean. The scrubber body, which is in contact with both the corrosive air and scrubber liquid, is made of FRP, a corrosion resistance material.

The scrubbing liquid contains Mg(OH)2, is re-circulated to minimize water consumption thus minimizing the operating cost. Absorbing tower pump, made from corrosive free material, draws the liquid from collection tank to main discharge headers. At the main discharge header which is consists of 3 layers of spray piping manifold, a network of discharge nozzles ensures that the liquid is sprayed equally over the scrubber.

Before discharging out of the scrubber unit, the treated exhaust passed through two layers of lamella type droplet separator. Water droplet in the treated exhaust is captured by the demister and collected back to the collection tank. The demister is cleaned regulary via automatic jet to eliminate clogging of demister. To ensure maximum efficiency, the pH of the scrubbing liquid is measured and controlled continuously via a pH measuring and Mg(OH)2 slurry dosing system.

Oxidation Tank

The waste liquid from the scrubber will be transferred to the oxidation tank. In oxidation tank, excess of O2 will complete the oxidation process of Magnesium Sulphite to Magnesium Sulphate. The roots blower will deliver the air to the aeration tank for source of O2. One agitator is installed in each tank to improve the oxidation process and avoid the settling down of the liquid. The oxidized Magnesium Sulphate will be transferred by a transfer pump to downstream for further treatment. A main exhaust gas blower will be installed after the desulfurization scrubber to provide the driving force to go through the scrubber treatment system for the flue gas.

The cleaned gas from desulfurization package will be ducted to downstream Wet Electrostatic precipitator (WESP) Unit.

Inlet Parameters

Inlet Gas	Value
Gas flow rate (wet base)	11780 Nm3/h
Gas flow rate (dry base)	10800 Nm3/h
SOx	64.45 Nm3/h
Temperature	90^{o}C

Outlet Parameters

The design is based on emission limit based on data below:

Outlet Gas at outlet of EP	Environmental Quality (Clean Air) Regulation 2014
SO2	19.08ppm (Based on half hourly averaged value)
Temperature	55^{o}C

5.4.3 Off Gas Treatment System for Gases from Calcination Plant

Off gas from calcination stage is treated via a treatment train described below. Mass balance is given in **Figure 5.3(3).**

Gas Cooling Tower

The hot waste gas will pass the gas cooling tower, mist eliminator and to the ammonia gas scrubber down stream. The gas cooling tower will be installed in vertical arrangement before the scrubber inlet. In the gas cooling tower, the hot waste gas comes into contact with the washing liquid concurrently to cool down the exhaust stream to a harmless temperature for downstream ammonia scrubber before entering the scrubber inlet. The primary nozzle spraying system of the gas cooling tower will be fed by the pumps. The main body if the gas cooling tower will be made of high temperature resin FRP. The waste gas from the quench will be cooled down from 120^oC to approximate 50^oC.

<u>Ammonia Scrubber</u>

The waste gas passes through the scrubber and is treated before discharge. The wet scrubber applies the absorption principle. In the scrubber, the contaminated exhaust comes into contact with washing liquid and is then "scrubbed" clean. The scrubber body, which is in contact with both the corrosive air and scrubbed liquid is made out of FRP, a corrosion resistant material. The scrubbing liquid is recirculated to minimize water consumption, thus minimizing operating cost. Scrubber circulation pumps, made from corrosive free material, draws the liquid from collection tank to main discharge headers. At the main discharge header a network of discharge nozzles ensures that the liquid is sprayed over the spray tower.

Before discharging out of the scrubber unit, the treated exhaust passes through a droplet separator. Water droplet in the treated exhaust is captured by the demister and collected back to the collection tank. To ensure maximum efficiency, the pH of the scrubbing liquid is measured and controlled continuously via a pH controller. Dosing of hydrochloric acid is controlled proportionally by a control valve and pH measurement.

The NH4CL concentration is maintained at >20 wt% by controlling the blow down flow rate and conductivity. The filling (adding) of the makeup water is controlled automatically via a solenoid valve and level controller.

Inlet Parameters

Inlet gas	Value
Flow	500 (min), 2000 (max), Nm3/h
Waste gas	NH3 Gas
NH3 Concentration	15000 (min), 65000 (max),ppm
Temperature	120 oC max

Outlet Parameter

Flue gas emission as per below:

- NH3<50ppm (based on ½ hourly averaged value)
- Temperature < 50^oC

Blow down water recovered:

- NH4CL 20-25 wt%

5.5 Industrial Effluent Treatment System (IETS)

5.5.1 IETS in Brief

Effluents will be treated to meet the Standard B emission limits in Environmental Quality (Industrial Effluent) Regulation or EQ(IE)R 2009, in an IETS with process flow as shown in **Figure 5.5(1)** and described below. At the IETS, a conventional treatment process is employed, where wastewaters at 385 m3/d will be equalized in an EQ tank, before physicochemical treatment comprising pH adjustment, coagulation and flocculation. Dissolved air floatation (DAF) then floats and separates the flocs, with the sludge stream going to a sludge holding tank, which feeds a screw press. The dewatered sludge is sent to a scheduled waste (SW) disposal centre (at present, the KA or Cenviro). The effluent from the DAF is pH corrected and held in a buffer tank that feeds a multimedia filter (MMF). After multimedia filtration, the effluent passes through an activated carbon filter (ACF) that removes residual organics. Final treated effluent is retained in a tank that functions as backwash water tank. Backwash water is pumped back to the EQ tank.

5.5.2 Equalisation

Wastewater from 4 streams of process namely Oily Separated Water, Kiln Gas Wastewater, Desulfurization wastewater and Extraction Plant Wastewater (after Ammonia stripping) (**Table 5.5(1))** shall be collected at an Equalization Tank (100m3) for homogenous of wastewater. The Equalization tank shall be equipped with air diffuser to aid the mixing of wastewater. An air blower is used provided sufficient air for mixing at the Equalization tank. The Equalization shall have approximately 6 hours retention time. One set of EQ pump is installed to transfer the wastewater from the EQ tank to the Chemical Treatment package. A flowmeter is installed at the EQ Pump outlet to monitor the flowrate of the treatment.

5.5.3 Chemical Treatments

The Chemical Treatment package shall consists of :

1. pH adjustment tank (3m3)
2. Reaction tank (3m3)
3. Flocculation tank (3m3)
4. Dissolved Air Flotation (DAF)

At the pH adjustment tank, caustic is dosed to increase the pH 9-10. The dosing of caustic is control by a pH sensor with controllers. At the same time, Calcium Chloride ($CaCl_2$) is dosed. The pH adjusted wastewater shall then overflow to the next Reaction Tank, where coagulant such as PAC is dosed. Heavy metal and Boron contaminants which precipitated as micro flocs shall form macro flocs with aid of coagulant. Then it is overflow into the Flocculation Tank, where Polymer is dosed. The dosing of polymer will agglomerate the macro floc to form large floc/sludge which shall be remove next process tank namely Dissolved Air Flotation (DAF).

Table 5.5(1) a) Summary of IECS - Analysis Results for detectable parameters

Operating hour:		24 hrs/d						
Test Parameter	Unit	(1) Oily Separated Water	(2) Kiln Gas Wastewater	(3) Desulfurization Wastewater	(4) Extraction Plant Waste water	Std. B	Total Flow	Design Flow
Flowrate (m^3/hr)		1.25	1.42	5.04	8.33	-	16.0	17.0
Flowrate (m^3/d)		30	34	121	200	-	385.0	408.0
Temperature	oC	40.000	40.000	60.000	40.000			
pH		6-9	1-2	7-9	11-13	5.5-9.0		
COD	mg/L	1000.000	1500.000	30.000	10.000	200.00		
BOD	mg/L	500.000	750.000	15.000	5.000	50.00		
SS	mg/L	100.000	10.000	10.000	10.000	100.00		
O&G	mg/L	50.000	5.000	5.000	5.000	10.00		
Al	mg/L	0.000	150.000	0.500	0.300	15.00		
As	mg/L	0.000	5.000	0.200	0.002	0.10		
Ba	mg/L	0.000	0.100	0.100	0.100	2.00		
B	mg/L	0.000	10.000	10.000	10.000	4.00		
Cd	mg/L	0.000	0.100	0.010	0.010	0.02		
Cu	mg/L	0.000	1.000	0.050	0.100	1.00		
Fe	mg/L	0.000	20.000	5.000	0.100	5.00		
Pb	mg/L	0.000	5.000	0.010	0.010	0.50		
Mn	mg/L	0.000	0.100	5.000	0.010	1.00		
Ni	mg/L	0.000	10.000	0.500	0.010	1.00		
Ag	mg/L	0.000	0.100	0.100	0.100	1.00		
Sn	mg/L	0.000	0.050	0.050	0.010	1.00		
Zn	mg/L	0.000	10.000	0.100	0.100	2.00		
Se	mg/L	0.000	3.000	1.000	0.010	0.50		
F	mg/L	0.000	50.000	15.000	1.000	5.00		
Cr(6+)	mg/L	0.000	0.050	0.050	0.050	0.10		
Cr(3+)	mg/L	0.000	0.050	0.050	0.050	1.00		
Cl2	mg/L	0.000	0.000	0.000	0.000	2.00		
Colour	ADMI	0.000	0.000	0.000	0.000	200.00		
CN	mg/L	0.000	0.100	0.100	0.100	0.10		

Table 5.5(1) a) Summary of IECS - Analysis Results for detectable parameters

Operating hour:		24 hrs/d						
Test Parameter	Unit	(1) Oily Separated Water	(2) Kiln Gas Wastewater	(3) Desulfurization Wastewater	(4) Extraction Plant Waste water	Std. B	Total Flow	Design Flow
Formaldehyde	mg/L	0.000	0.000	0.000	0.000	2.00		
Hg	mg/L	0.000	0.005	0.005	0.005	0.10		
NH3-N	mg/L	0.000	5.000	5.000	20.000	20.00		
Phenols	mg/L	0.000	0.000	0.000	0.000	1.00		
S	mg/L	1.000	0.000	0.000	0.000	0.50		

b) Total Loading per day into Equalization Tank

Loading	Unit	(1) Oily Separated Water	(2) Kiln Gas Wastewater	(3) Desulfurization Wastewater	(4) Extraction Plant Waste water	Total Load (kg/day)
COD	kg/day	30.00	51.00	3.63	2.00	**86.63**
BOD	kg/day	15.00	25.50	1.82	1.00	**43.32**
SS	kg/day	3.00	0.34	1.21	2.00	**6.55**
O&G	kg/day	1.50	0.17	0.61	1.00	**3.28**
Al	kg/day	0.00	5.10	0.06	0.06	**5.22**
As	kg/day	0.00	0.17	0.02	0.00	**0.19**
Ba	kg/day	0.00	0.00	0.01	0.02	**0.04**
B	kg/day	0.00	0.34	1.21	2.00	**3.55**
Cd	kg/day	0.00	0.00	0.00	0.00	**0.01**
Cu	kg/day	0.00	0.03	0.01	0.02	**0.06**
Fe	kg/day	0.00	0.68	0.61	0.02	**1.31**
Pb	kg/day	0.00	0.17	0.00	0.00	**0.17**
Mn	kg/day	0.00	0.00	0.61	0.00	**0.61**
Ni	kg/day	0.00	0.34	0.06	0.00	**0.40**
Ag	kg/day	0.00	0.00	0.01	0.02	**0.04**
Sn	kg/day	0.00	0.00	0.01	0.00	**0.01**
Zn	kg/day	0.00	0.34	0.01	0.02	**0.37**
Se	kg/day	0.00	0.10	0.12	0.00	**0.23**
F	kg/day	0.00	1.70	1.82	0.20	**3.72**
Cr(6+)	kg/day	0.00	0.00	0.01	0.01	**0.02**

b) Total Loading per day into Equalization Tank

Loading	Unit	(1) Oily Separated Water	(2) Kiln Gas Wastewater	(3) Desulfurization Wastewater	(4) Extraction Plant Waste water	Total Load (kg/day)
Cr(3+)	kg/day	0.00	0.00	0.01	0.01	**0.02**
Cl2	kg/day	0.00	0.00	0.00	0.00	**0.00**
Colour	kg/day	0.00	0.00	0.00	0.00	**0.00**
CN	kg/day	0.00	0.00	0.01	0.02	**0.04**
Formaldehyde	kg/day	0.00	0.00	0.00	0.00	**0.00**
Hg	kg/day	0.00	0.00	0.00	0.00	**0.00**
NH3-N	kg/day	0.00	0.17	0.61	4.00	**4.78**
Phenols	kg/day	0.00	0.00	0.00	0.00	**0.00**
S	kg/day	0.03	0.00	0.00	0.00	**0.03**

c) Composite waste Homogenization in Equalization Tank

Design Flow rate: 16.04 m^3/hr Operating hr 24 hr/day

385.000 m^3/day

Test Parameter	Unit	EQ Tank	Std. B
COD	mg/L	225.01	200.0
BOD	mg/L	112.51	50.0
SS	mg/L	17.01	100.0
O&G	mg/L	8.51	10.0
Al	mg/L	13.56	15.0
As	mg/L	0.51	0.1
Ba	mg/L	0.09	2.0
B	mg/L	9.22	4.0
Cd	mg/L	0.02	0.0
Cu	mg/L	0.16	1.0
Fe	mg/L	3.39	5.0
Pb	mg/L	0.45	0.5
Mn	mg/L	1.59	1.0
Ni	mg/L	1.05	1.0
Ag	mg/L	0.09	1.0
Sn	mg/L	0.03	1.0
Zn	mg/L	0.97	2.0

c) Composite waste Homogenization in Equalization Tank

Design Flow rate: 16.04 m^3/hr Operating hr 24 hr/day

385.000 m^3/day

Test Parameter	Unit	EQ Tank	Std. B
Se	mg/L	0.58	0.5
F	mg/L	9.65	5.0
Cr(6+)	mg/L	0.05	0.1
Cr(3+)	mg/L	0.05	1.0
Cl2	mg/L	0.00	2.0
Colour	ADMI	0.00	200.0
CN	mg/L	0.09	0.1
Formaldehyde	mg/L	0.00	2.0
Hg	mg/L	0.00	0.1
NH3-N	mg/L	12.40	20.0
Phenols	mg/L	0.00	1.0
S	mg/L	0.08	0.5

d) Design Wastewater Characteristics

Client : Toyo Engineering & Construction Sdn. Bhd.
Title : 385m3/day WWTP, Gebeng
Flowrate : 385 m3/day
16.04 m3/hr
Operation Hr 24 hrs

Parameter	Unit	Concentration
COD	mg/L	225
BOD	mg/L	115
TSS	mg/L	20
As	mg/L	0.51
B	mg/L	9.22
Mn	mg/L	1.59
Ni	mg/L	1.05
Se	mg/L	0.58
F	mg/L	9.65
pH		1-13

Ratio	
BOD	COD
1	1.96

Each chemical treatment tank shall be equipped with a mechanical mixer to provide good mixing during chemical addition.

The wastewater after flocculation consists of large floc/sludge then overflow into a DAF. A DAF function to remove the sludge formed by floating the sludge to the surface. One set of high-pressure pump is used to create micro bubbles with the injection of compressed air at 5-6bar. These micro bubbles attached to the sludge will then float the sludge which can be removed via a sludge scrapper in the DAF flotation compartment. Clean supernatant water shall overflow into the next buffer tank.

5.5.4 Sludge Treatment

Sludge collected at the DAF shall be transferred via a DAF desludge pump to a Sludge Holding Tank (15m3). Slurry sludge from the sludge holding shall be dewatered using a screw press. The sludge cake from the screw press with moisture content around 85% shall be disposed as schedule waste to a designated disposal site. The filtrate from the screw press shall be return to EQ tank for further treatment.

5.5.5 Effluent Fitration

At the Buffer tank, pH is adjusted using acid with a pH sensor controller to reduce the pH from 9-10 to 7-8. It is then pump using one set of Filter Feed pump thru a series of Multimedia filter (MMF) and Activated Carbon Filter (ACF). The MMF act to remove any fine suspended solids that escape the DAF system. While the ACF act as removal of COD/BOD. Clean water from the ACF shall be transfer into a Backwash Water holding tank (15m3). The Backwash Water tank acts as holding clean water which are required for backwash of MMF & ACF. Excess treated clean water shall overflow from the Backwash Water tank into the final discharge drain complying DOE Std B. One unit of flowmeter is installed at the outlet pipe to monitor the treated water flowrate. MMF and ACF shall be periodically backwash once it is exhausted/choked. The dirty backwash water from MMF/ACF shall be directed back into EQ tank for treatment again.

5.5.6 IETS Site Plan

The site plan accommodating the above unit operations is shown in **Figure 5.5(2)**.

5.5.7 IETS Mass Balance

The Mass Balance for the above treatment process is shown in **Figure 5.5(3).**

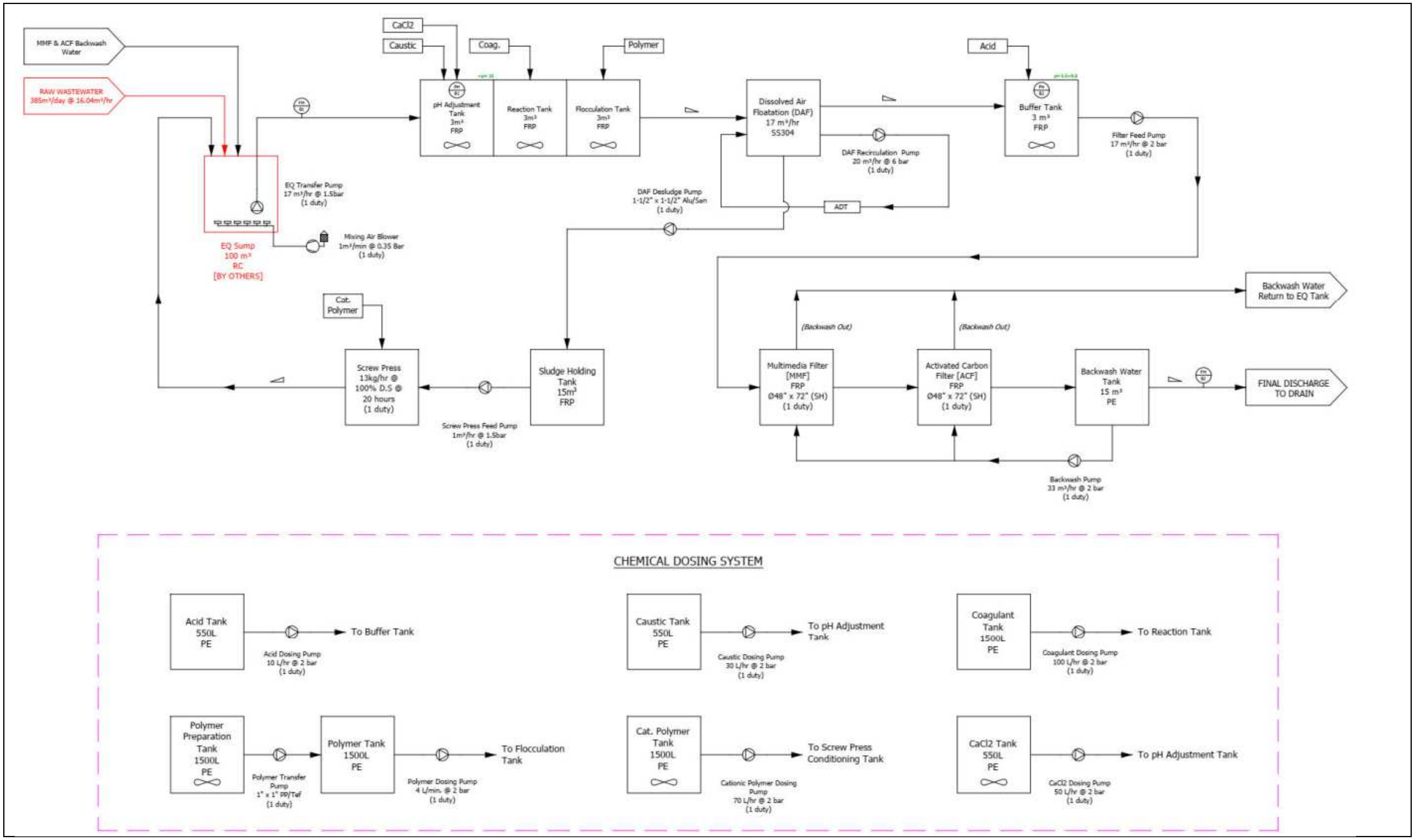
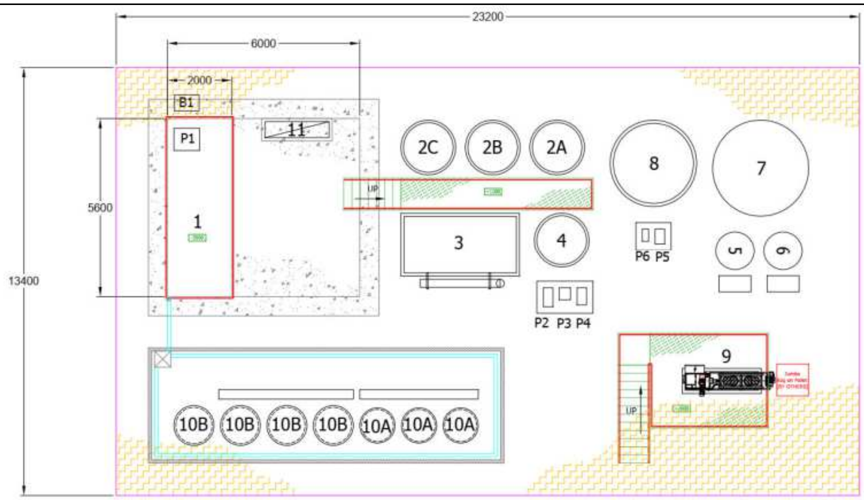


Figure 5.5(1) IETS Process Flow Diagram



BLOWER / PUMP SPECIFICATIONS:		
ITEM	BLOWER / PUMP NAME	CAPACITY
B1	Mixing Air Blower	1 m^3/min. @ 0.35bar
P1	EQ Transfer Pump	17 m^3/hr @ 1.5bar
P2	DAF Recirculation Pump	20 m^3/hr @ 6bar
P3	DAF Desludge Pump	1.5" x 1.5" Alu/San
P4	Filter Feed Pump	17 m^3/hr @ 2bar
P5	Backwash Pump	33 m^3/hr @ 2bar
P6	Screw Press Feed Pump	1 m^3/hr @ 1.5bar

TANK / EQUIPMENT SPECIFICATIONS:				
ITEM	TANK / EQUIPMENT	CAPACITY	DIMENSION	OPERATING LOAD (* *Exclude concrete and steel structures load*)
1	EQ Sump	100 m^3	6m(L) x 5.6m(W) x [3+0.5FB]m(D)	~ 120 tonne
2A	pH Adjustment Tank	3 m^3	Ø1.55m x [1.6+0.2FB]m(H)	~ 3.5 tonne
2B	Reaction Tank	3 m^3	Ø1.55m x [1.6+0.2FB]m(H)	~ 3.5 tonne
2C	Flocculation Tank	3 m^3	Ø1.55m x [1.6+0.2FB]m(H)	~ 3.5 tonne
3	Dissolved Air Flotation (DAF)	17 m^3/hr	3.5m(L) x 1.8m(W) x 1.5m(H)	~ 13 tonne
4	Buffer Tank	3 m^3	Ø1.55m x [1.6+0.2FB]m(H)	~ 3.5 tonne
5	Multimedia Filter (MMF)	17 m^3/hr	Ø48" x 72"(SH)	~ 1.5 tonne
6	Activated Carbon Filter (ACF)	17 m^3/hr	Ø48" x 72"(SH)	~ 1.5 tonne
7	Backwash Water Tank	15 m^3	Ø3m x 2.25m(H)	~ 16 tonne
8	Sludge Holding Tank	15 m^3	Ø2.5m x [3.1m(SH) + 1.5m(CH)]	~ 18 tonne
9	Screw Press	13 kg/hr @ 100% D.S.	2.9m(L) x 0.9m(W) x 1.3m(H)	~ 1 tonne
10A	Chemical Storage Tank (550L)	550 L	Ø1m x 0.8m(H)	~ 0.6 tonne x 3 nos.
10B	Chemical Storage Tank (1500L)	1500 L	Ø1.13m x 1.62m(H)	~ 1.8 tonne x 4 nos.
11	Control Panel	-	~2m(L) x 0.5m(W) x 2m(H)	~ 2 tonne

Figure 5.5(2) IETS site plan

Incoming Wastewater		
Flowrate	385	m3/day
Parameter	Conc. mg/l	Loading kg/d
COD	225	86.6
BOD	115	44.3
TSS	20	7.7
As	0.51	0.2
B	9.22	3.5
Mn	1.59	0.6
Ni	1.05	0.4
Se	0.58	0.2
F	9.65	3.7

EQ			
Flowrate	Rem.Eff	385	m3/day
Parameter		Conc. mg/l	Loading kg/d
COD	0%	225.00	86.6
BOD	0%	115.00	44.3
TSS	0%	20.00	7.7
As	0%	0.51	0.2
B	0%	9.22	3.5
Mn	0%	1.59	0.6
Ni	0%	1.05	0.4
Se	0%	0.58	0.2

Chemical Reaction Tank + DAF			
Flowrate	Rem.Eff	385	m3/day
Parameter		Conc. mg/l	Loading kg/d
COD	30%	157.50	60.6
BOD	30%	80.50	31.0
TSS	0%	20.00	7.7
As	80%	0.10	0.0
B	60%	3.69	1.4
Mn	80%	0.32	0.1
Ni	60%	0.42	0.2
Se	80%	0.12	0.0
F	80%	1.93	0.7

MMF + ACF			
Flowrate	Rem.Eff	385	m3/day
Parameter		Conc. mg/l	Loading kg/d
COD	50%	78.75	30.3
BOD	50%	40.25	15.5
TSS	50%	10.00	3.9
As	0%	0.10	0.0
B	0%	3.69	1.4
Mn	0%	0.32	0.1
Ni	0%	0.42	0.2
Se	0%	0.12	0.0
F	0%	1.93	0.7

Final Discharge				DOE DISCHARGE LIMIT
Flowrate	Rem.Eff	385	m3/day	**Std. B, mg/l**
Parameter		Conc. mg/l	Loading kg/d	
COD	0%	78.75	30.3	200
BOD	0%	40.25	15.5	50
TSS	0%	10.00	3.9	100
As	0%	0.10	0.0	0.1
B	0%	3.69	1.4	4
Mn	0%	0.32	0.1	1
Ni	0%	0.42	0.2	1
Se	0%	0.12	0.0	0.5
F	0%	1.93	0.7	5

Chemical Sludge Generation		
Total D.S.	15.63 m3/d	1.5% D.S.
Component	Conc. mg/l	Loading kg/d
Total Solid	16,500.00	257.95
SS	*20*	*7.70*
PAC	*300*	*115.50*
A.Polymer	*5*	*1.93*
Others	*245*	*94.33*
CaCl2	*100*	*38.50*

Sludge Holding Tank		
Flowrate	15.63 m3/day	
TSS	15,000 mg/l	258.0 kg/day

Screw Press		
Flowrate	15.63	m3/day

Sludge Cake				
Sludge	1289.75	kg/d	80%	% M.C.

Figure 5.5(3): Effluent treatment mass balance

5.6 Scheduled Wastes Management System

From the processes shown above there will be several residues/wastes to be disposed to licenced SW facilities; these wastes are listed in **Table 5.6(1)** below and will be shown in the Mass Balance in the EIA Report.

Table 5.6(1) Scheduled wastes to be disposed to licenced SW facilities or reused

#	Waste	Tons/year	Disposal
1)	Ceramic balls	350	Sent to cement company for reuse
2)	Alumina concentrate	5,519	Sent to SW disposal facility
3)	Alumina concentrate press cake	303	
4)	De-phosphorus cake	361	
5)	IETS sludge	471	

5.7 Plant Layout

The tentative plant layout is as shown in **Figure 5.7(1).** Main features of the layout plan are:

1) Bordering the front boundary of the site, as shown in the site plan in **Figure 5.7(2)** (pink line) is the Petronas Gas Berhad (PGB) gas pipeline which greatly facilitates the plant operation as the fuel gas would be available online and no storage would be required, eliminating the danger of fuel storage.
2) There is an existing concrete drain, joined by a reinforced concrete (RC) culvert which drains the site. There is an existing earth drain that drains the site, with water flowing towards the culvert.
3) There are three (3) entrances: for trucks, main entrance and TNB entrance.
4) Trucks carrying used catalyst goes around to the back to the unloading bays and may park at the parking bays, while awaiting next trip.
5) Large storage areas are provided for the used catalysts awaiting processing.

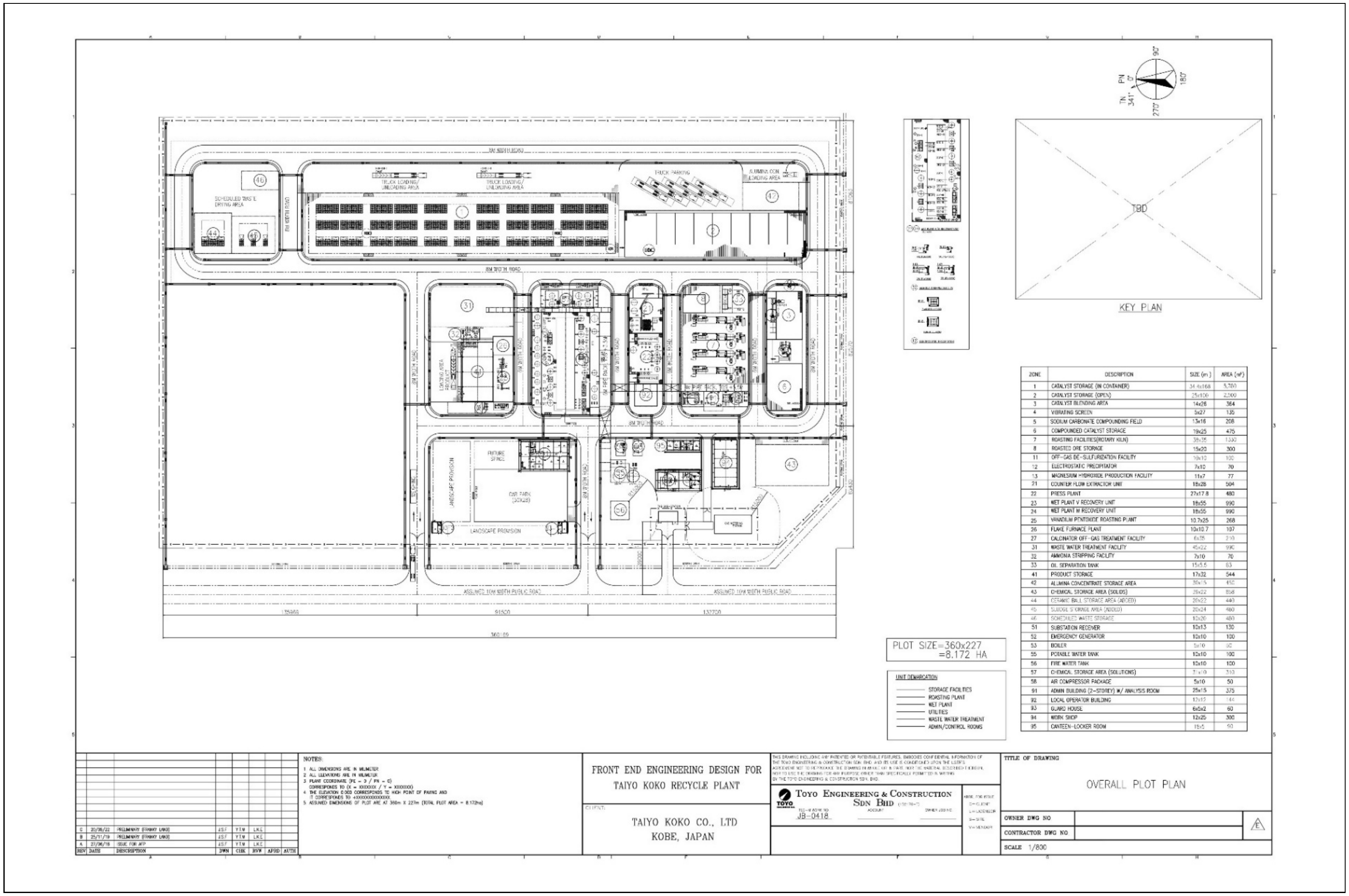


Figure 5.7(1) SCaRF overall plant layout

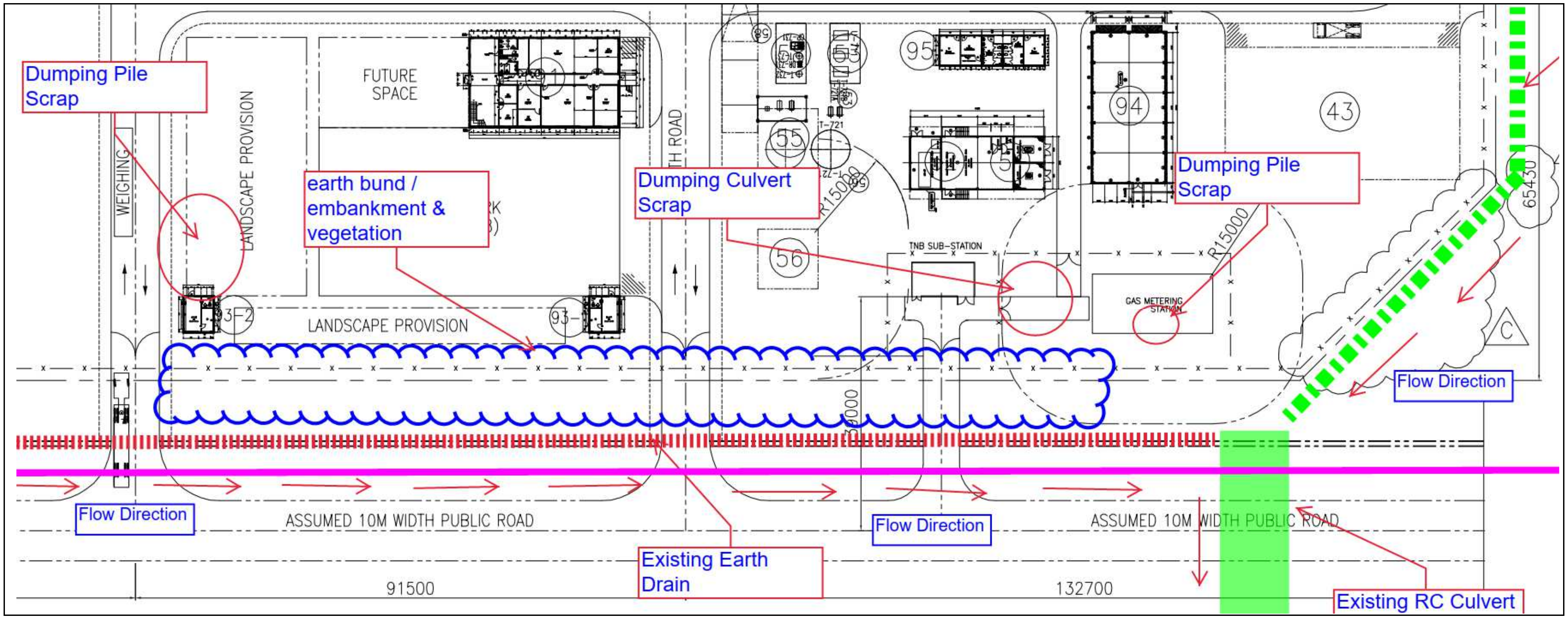


Figure 5.7(2) SCaRF plant entrances and drainage flow and gas pipeline (pink) (figure showing construction measures)

5.8 Project Activities and Implementation Schedule

In order to assess the potential impacts of each activity on the environment, the activities that will be carried out have to be understood. The list of project activities for proposed project is as **Table 5.8(1)** below.

Table 5.8(1) SCaRF Project Activities

Main activities	Sub-project activities
Project phase: Pre-Construction and Preliminaries	
Preliminaries Surveys and Investigations	Project Planning
	Preparation and submission of EIA S1 for approval by DOE
	Application for Written Permission for Setting-up of Scheduled Waste Off-Site Recovery Facility (Section 19 of EQA1974)
	Application for Licence for Setting-up of Scheduled Waste Off-Site Recovery Facility (Section 18 of EQA1974)
	Preparation and submission of EMP for approval by DOE
	Preparation and submission of Notifications for APCS and IETS for approval by DOE
	Access to Project Site
	Surveys/ Site Investigations
	Technical and Engineering Feasibility Investigations
Project phase: Construction	
Stage 1: Site clearing and erosion control measures	Marking of areas to be cleared
	Digging up and completion of runoff retention pond (RP) and earth drains feeding to the RP, as per ESCP designs, with silt trap(s) and silt fence(s) to avoid surface run-off flow directly to water body.
	Stockpiling of excavated earth at an area near within site, with runoff captured by earth drains for future backfilling.
	Clearing of vegetation and manual chopping of branches for easier handling.
	Loading of green wastes into roro bins and transporting the wastes to nearest landfill (Jabor landfill)
	Clearing off wastes dumped onto site and hauling to nearest landfill
	Mobilization of Land Surveyor for setting out of proposed site and the existing platform level.
	Covering of slopes of earth stockpile with plastic sheets to prevent soil erosion.
Stage 2: Foundation Works	Mobilization of Land Surveyor for setting out of foundation points and layouts at site
	Construction of onsite roads and drains
	Construction of foundations for various equipment as per structural design
Stage 3: Construction of Structures	On site steel bars cutting and bending works at required schedules; commenced at fabrication yard and completed concurrently upon completion of lean concreting.
	Formwork placed layer by layer, maintained by 1.2m (plywood) or 0.6m (metal formwork) each to prevent occurrence of any cold joint.
	Water stop will be placed along the horizontal and vertical construction joints.
	Concreting works using approved concrete from permitted sources upon further

Table 5.8(1) SCaRF Project Activities

Main activities	Sub-project activities
	inspection by COW. High Alumina cement applied at all internal surfaces of structures.
Stage 4: Equipment Installations and commissioning	Installations of plant equipment
	Installation of electricity supply system
	Testing of each equipment
	Commissioning of plant
	Monitoring to ensure designed performance and emission compliance.
Project phase: Operation	
SCaRF Operation	Operation of SCaRF and IETS and APCS
	Online monitoring of APCS emissions
	Online monitoring of IETS parameters of pH, temperature, turbidity and conductivity; regular monitoring of other parameters as per EQ(IE)R 2009.
	Traffic movement
	Maintenance work
	Amenities

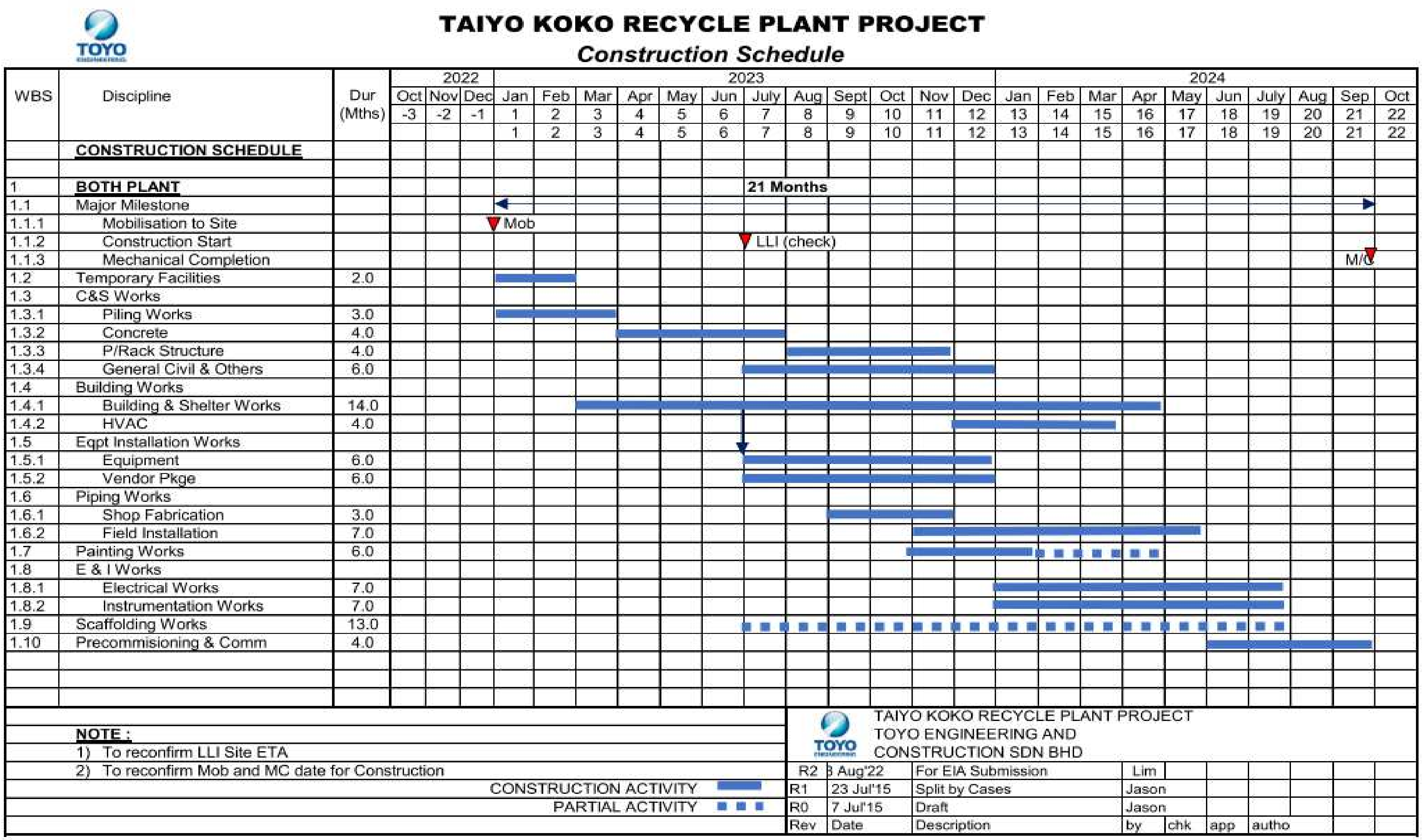


Figure 5.8(1) Project implementation schedule